The Dynamics of Firm and Industry Growth

The Swedish Computing and Communications Industry

Dan Johansson

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A dissertation submitted to the Royal Institute of Technology
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To my teachers: past, present and future

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Abstract

The growth of the Swedish Computing and Communications industry is studied in this thesis. Growth is seen as a dynamic process moved by the entry, expansion, contraction and exit of firms.

The analysis is founded on the theory of the Experimentally Organised Economy, which views the economy as an experimental process. The entire thesis is organised around the problem of resource allocation and the issue of growth through the introduction of new combinations into the economic system, using the terminology of Schumpeter (1911). Competence blocs determine the efficiency of the economic process, i.e., the extent to which it leads to sustained economic growth rather than stagnation. Change is a fundamental feature of the economic process, firms have to be flexible to survive and the economic system must promote flexibility to grow. Many trials, or experiments, are required to discover and select “winning” firms and technologies. Hence, the turnover (i.e., entry and exit) of firms is supposed to have positive effects on growth. Theory, furthermore, predicts that new and small firms are more entrepreneurial and innovative and that they, therefore, will grow faster than old and large firms.

The empirical results show that firm growth decreases with firm age, decreases with firm size, increases with firm independence, decreases with government ownership and that industry growth increases with firm turnover. Moreover, the smallest firms have been the major job contributors during the 1993-1998 period investigated empirically. It is also shown that employment growth is facilitated by a sustained high entry of firms.

Lastly, many policies, several of which were introduced in the late 1960s and early 1970s, have selectively supported large firms in mature industries. Hence, they have exercised a relatively negative influence on exactly the types of firms that have been shown to contribute to growth. These policies have also made the Swedish economy less flexible. It is argued that this partly explains the slow economic growth in Sweden compared to other OECD countries since the 1970s. An interesting question is where Sweden would have been today with a different policy orientation.

Keywords: The Experimentally Organised Economy; Competence Blocs; Industrial dynamics; Industrial transformation; Firm age, Small-firm growth; Turnover of firms; Computing and Communications industry; IT industry; Institutions.

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CHAPTER 1 INTRODUCTION

1.1 THE PROBLEM

In this study, economic growth is seen as a dynamic process moved by the entry, expansion, contraction and exit of firms. So defined, the relationship between firm dynamics and growth seems at first straightforward and easy to understand. The entry and expansion of firms lead to positive growth while the exit and contraction of firms imply negative growth, together constituting a Schumpeterian (1942) process of creative destruction.

However, this may be too simple a model of economic growth. The dynamic process that generates growth may have more complex dimensions that are difficult to observe and to understand. *First*, the contraction and exit of firms may have a positive effect on economic growth in the long run if the resources that are set free are put to effective use by new and expanding firms. In fact, contraction and exit of firms are necessary for fast and sustainable long-run economic growth, since such growth requires that the factors of production are reallocated from less efficient firms to more efficient ones. In this context, the balance between entry and expansion, on the one side, and between contraction and exit, on the other, is of importance.

Second, the degree of ignorance on the part of actors is important for the dynamics. For instance, if one accepts that economic actors are grossly ignorant, then all investments can be regarded as more or less well-prepared business experiments (see *Chapter 2*). In this context, a higher rate of entry and exit of firms (i.e. a higher turnover rate of firms), taken together, might have a positive effect on growth. The reason for this would be that more business experiments are carried out, and that the number of conducted experiments partly explains the number of successes.

Third, what factors, e.g., firm characteristics such as age and size, and in what way these factors affect the growth process is still largely wrapped in mystery.

I approach the dynamics of growth by way of two broadly defined research questions: i) Do some firm specific characteristics (such as firm age and firm size) systematically affect firm growth? and ii) Does the turnover rate of firms affect growth?

Although interesting in themselves, the answers to these two research questions also have a direct bearing on economic policy. For instance, if answered affirmatively, the answers can partly explain differences in growth rates between countries (and regions) in terms of differences in economic policy. Countries have developed economic systems that promote dynamics and flexibility to a larger or lesser extent. The USA, for example, is generally thought to have more growth-promoting institutions than European countries.

The above questions are of general interest and could be applied to any industry. This thesis approaches the dynamics and growth of the Computing and Communications (C&C) industry in terms of the theory of the *Experimentally Organised Economy* (EOE) and *Competence Blocs* (see Eliasson 1987, 1996 and Eliasson & Eliasson 1996b). This theory, in fact, identifies the C&C industry as probably the most important one (see *Chapter 3*).

1.2 PURPOSE

The purpose of this thesis is to investigate and understand the dynamic micro processes underlying aggregate economic growth. With dynamics is meant: i) entry, ii) expansion, iii) contraction and iv) exit of firms.

Specifically, the purpose of the thesis is to:

- i) *present* the theory of the EOE and Competence Blocs, which forms the theoretical basis of the thesis;
- ii) *define* the C&C industry statistically, and measure its growth and size;
- iii) *analyse* the effects of firm age and firm size on firm growth (i.e., on the expansion or contraction of firms) in the C&C industry;
- iv) *investigate* the effects of ownership (private or government) and independence (the firm does not belong to an enterprise group) on firm growth;

- v) *study* the importance of firm turnover (i.e., firm entry and firm exit) on the growth of C&C industry;
- vi) *simulate* the macroeconomic effects of the total entry and exit process on the whole economy;
- vii) *discuss* briefly the theoretical and empirical results against the background of Swedish economic policy.

1.3 METHOD

The thesis integrates theoretical and empirical analyses. The theoretical part introduces the theory of the EOE and Competence Blocs and discusses how this theory identifies the C&C industry as probably the most fundamental industry of all.

The empirical analysis is based on i) descriptive statistics; ii) econometric analysis; iii) simulations and iv) a survey directed to C&C firms (used in the simulations).

The econometric analysis uses cross-sectional time-series data. A panel-data method (see, e.g., Baltagi 1999; Hsiao 1999) is applied to test the affects of firm age, size, ownership, independence and turnover on C&C firm and industry growth.

The theory of the EOE and Competence Blocs predicts that firm growth decreases with firm age and firm size, that government ownership effects firm growth negatively, that firms in enterprise groups will grow more slowly than independent firms and that industry growth increases with firm turnover (see *Chapter 2*).

The dynamic effects of the total turnover of firms on aggregate economic growth is simulated with a micro-to-macro model of the Swedish economy (MOSES); see Eliasson (1977, 1985, 1987, 1991), Albrecht *et al.* (1989), Bergholm (1989), Taymaz (1991) and Albrecht *et al.* (1992).

The model has been developed and upgraded constantly since the beginning of the 1970s and is based on real-firm data that are collected in a planning survey, carried out jointly since 1975 by the Confederation of Swedish Industries (*Industrieförbundet*; Confederation of Swedish Enterprise, *Svenskt näringsliv*, from 2001) and The Research Institute of Industrial

Economics (*Industriens Utredningsinstitut*, IUI). Until now the model has included four industries populated with firms: raw materials, intermediary goods, investment goods and consumer goods.¹ This part of the statistical analysis began with a project for The Swedish Agency for Civil Emergency Planning (*Överstyrelsen för civil beredskap*, ÖCB) on the dynamics and flexibility of the Swedish C&C industry (Eliasson & Johansson 1999).² Among other things, a survey similar to the planning survey was carried out on the C&C industry. This study has made it possible to incorporate a separate firm-based C&C industry in the Swedish micro-to-macro model. The version of the model used here, hence, is an extension of the previous model version.

1.4 DATA

My thesis is based on internationally unique data. There are four sources:

- i) The analysis of the growth and size of the C&C industry uses aggregate data published by Statistics Sweden.
- ii) The aggregate data published by Statistics Sweden are supplemented with similar unpublished material from Statistics Sweden for the period 1973 to 1987.
- iii) The analysis of the effects of age, size, ownership, independence and of turnover is based on an extensive data set that comprises individual data on Swedish C&C firms. The data have been collected by Statistics Sweden and covers the period 1993 to 1998. This data set includes financial balance-sheet and income-statement data, as well as non-financial data, e.g., firm age. The data set includes *all* C&C firms, i.e., all firms of all sizes (from firms with no employees to firms with tens of thousands of employees), firms in all industries (manufacturing as well as service), and all types of firms (like sole proprietorships and stock companies).
- iv) The simulations of the effects of the total turnover of firms on macroeconomic performance are, among other things, based on the survey to C&C firms.³

The aggregate industry data (from 1993 and on) and the data on individual firms also cover the Swedish information technology (IT) industry, defined as the C&C industry *and*

¹ In addition, there are seven macro-defined sectors in the model economy, including the public sector, together taking the model economy up to the Swedish GNP level.

² Some of the results in *Chapters 4, 5 and 6* are published in Swedish in this book.

³ The data used in the MOSES model is described in Albrecht *et al.* (1992), *Chapter VII*.

the industry that sells C&C equipment.⁴ Whenever data are available I extend the analysis to the entire IT industry. Often, the data for the C&C industry will be reported on separately. In these cases, the reader will be told explicitly.

The growth and size of the C&C industry can be measured in several ways. I use employment (which is also used in the econometric analysis). Other measurements, such as value added, are sometimes to be preferred. There are, however, several reasons for using employment in this analysis:

- i) Employment data are more easily available than e.g., value added data, notably for a longer time, and are of better quality than other data. This is particularly so for small firms.
- ii) Other studies similar to mine usually use employment data. The use of employment data in my thesis, therefore, increases comparability to other studies.
- iii) Employment is interesting from the point of view of resource allocation, since labour, as a carrier of competence, is the most important factor of production in the theory of the EOE and Competence Blocs.
- iv) Employment, or unemployment, also has direct and large effects on economic growth and the well-being of individuals. Unemployment brings about production losses and social distress.

The simulations of the macroeconomic effects of the rate of firm turnover are, among other things, based on surveys on individual firms specifically asked about value added, which is used in this analysis.

1.5 LIMITATIONS

The theory of the EOE and Competence Blocs will be used as the analytical tool in, and the intellectual foundation of, this study. The purpose of my thesis is not, however, to compare or evaluate the theory of the EOE and Competence Blocs with other economic

⁴ See *Chapter 4* for the exact statistical definition of the C&C and IT industries.

theories, but to present it and to use it to organise my thoughts and facts about the problem of the dynamics of growth and to guide my empirical analysis.⁵

A number of reasons makes me prefer the theory of the EOE and Competence Blocs to other theoretical frameworks. The main reason for choosing the theory of the EOE and Competence Blocs is that it is based on assumptions (see *Chapter 2*) that are realistic and reasonable for my analysis. I do not want to base my theoretical and empirical analysis of the dynamics and growth of the C&C industry on assumptions that I think are misleading or even wrong, for instance, the assumption of perfect information (which obviously gives no room for C&C technology and the C&C industry) or the assumption that firms are operating on their production possibility frontiers. I, therefore, find the characterisation of the economy as *experimental* analytically appealing, viewing business mistakes (and learning from those mistakes) as a natural and an inevitable part of economic life. Moreover, I consider the definition of the functional competencies in the competence bloc to create, select and exploit innovations highly useful.

The analysis of the (employment) growth and the size of the C&C industry conducted in *Chapter 4* is based on aggregate industry data and starts in 1973, which is the first year aggregate industry data are available and the first year it is possible to define the C&C industry in the data of Statistics Sweden. It ends in 1999, the last year aggregate data were available.

The data set used for the analysis of the effects of age, size, ownership, independence and turnover (see *Chapters 5* and *6*) starts in 1993 and ends in 1998. In 1993, Sweden changed its statistical classification system of industrial activities due to its entry into the European Union. It is possible to match individual firm data from the new and the previous classification systems. This is, however, not easy and requires heavy computational and manual work. This matching has been beyond the budget and time constraints of this thesis. 1998 is the last year micro data were available.⁶

⁵ Hence, Endogenous Growth Theory (see, e.g., Romer 1986; Lucas 1988; Aghion & Hewitt 1998), Neoclassical General Equilibrium Theory (see, e.g., Walras 1874/1954; Solow 1957), National Systems of Innovation (see, e.g., Lundvall 1992; Edquist & McKelvey 2000), Technological Systems (see, e.g., Carlsson & Stankiewicz 1991; Carlsson 1995; Carlsson 1997) or other theoretical traditions are not discussed.

⁶ The IT industry expanded rapidly during the studied period. Recently, growth seems to have decreased. There is no particular reason to expect that this would affect the test results.

1.6 RESULTS

There are empirical, statistical and theoretical results to report.

Empirical

- C&C industry growth is documented by employment from the beginning of the 1970s. Growth rates are found to diverge significantly between different sub-industries. For instance, the data consulting and data services industry has grown exceptionally fast, while the telecommunications industry shows a negative growth rate in employment.⁷ In total, the C&C industry has grown by about 50 per cent since the beginning of the 1970s (see *Chapter 4*).
- New and small firms are shown to be important for employment growth. The econometric analysis demonstrates that the age and the size of firms have a negative effect on firm growth. In other words, young and small firms have grown faster than old and large firms (see *Chapter 5*).
- Sustained high rates of new firm entry promote employment growth. New firms contribute significantly to total employment the year they are established. They grow extraordinarily fast a few years after establishment, contributing significantly to new employment. Thereafter, their growth rates fall to become “normal” (see *Chapter 5*).
- Looking at the job contribution of different size classes, it is observed that the smallest size class (firms with no employees in the beginning of the period) creates the bulk of new jobs. If excluded, total employment would have fallen strongly. It is to be noted that the largest firms were major job losers during the same time period (see *Chapter 5*). The results about age and size are in line with other results from international and Swedish empirical research.
- Independent and private firms have grown faster than firms in enterprise groups and publicly owned firms (see *Chapter 5*).
- The turnover of C&C firms is shown to be important for industry employment growth (see *Chapter 6*).

⁷ Productivity has, however, increased, since output has been expanding at a rapid rate.

- The simulations identify a non-linear relationship between firm turnover and economic growth (see *Chapter 7*). The simulations indicate that this non-linear effect is partly due to an unbalanced turnover of firms.
- Bringing the theoretical and empirical results together, it can be concluded that Swedish economic policy and institutions have disfavoured the kind of firms that have been demonstrated (in this thesis) to be particularly important growth contributors (see *Chapter 8*). Economic policy and institutions have also reduced the turnover of firms by preventing or slowing down entry as well as exit and, hence, growth. A number of empirical studies observe this absence of dynamics and this lack of fast-growing firms in Sweden compared to other countries. Thus, the dominance of institutions that impede industrial dynamics and provide a bad competence-bloc environment for new and expanding firms are compatible with the lower growth of the Swedish economy compared to that of other OECD economies since the 1970s. I, in fact, argue that it is a significant part of the explanation.

Statistical

- I use an internationally unique data set on individual C&C firms. The opportunity to study annual observations on all firms in all size classes and industries gives new possibilities to understand industrial dynamics and economic growth. Therefore, I think it is of great value to use this data for scientific research, something that, to my knowledge, only Davidsson *et al.* (1994a,b, 1996) have done.⁸
- I have carried out (together with Statistics Sweden) a survey of C&C firms. *First*, the survey gives new information on C&C firms. *Second*, the survey has been structured exactly on the format of the planning survey of the Federation of Swedish Industries and IUI to make it possible to compare C&C firms with firms in other industries (not done in this thesis).
- Furthermore, this survey to C&C firms has made it possible to include the C&C industry in the micro-to-macro model of the Swedish economy (MOSES).
- I also construct Salter curves (see *Chapter 2*), which makes it possible to compare firm productivity within the C&C industry and between the C&C industry and other industries.

Theoretical

Even though the thesis is mainly empirical the theoretical contribution is the most important.

- Originally, the theory of the EOE and Competence Blocs was formulated to study industrial development as a process of competitive selection of innovations and firms (Eliasson 1987, 1991b). I explicitly relate the theory to the problem of resource allocation and point out that the theory can be generalised into a theory of dynamic resource allocation. In this context I discuss resource allocation as the creation of new knowledge.
- I relate the theory to Schumpeter's concept of new combinations and innovations, and extend the definition of the competence bloc to include the function of the inventor. Here, I focus on the role of the competence bloc in generating new ideas (previously, selection was emphasised).
- I also formulate the links between firm activities (entry, rationalisation, reorganisation, exit) and industrial dynamics (entry, expansion, contraction and exit of firms) to industrial transformation (a change in the structure of Salter curves) and macroeconomic performance.
- Previously the theory of the EOE and Competence Blocs has mainly been presented as two separate, but related, theories that explain the selection of innovations and firms etc. (the competence bloc) in an economy with incomplete information (the experimentally organised economy). I consider and present them as one coherent theory and bring the two parts together in such a way that the empirical hypotheses tested in this study can be derived.
- Eliasson (see, e.g., Eliasson 1996) presents the theory of the EOE and Competence Blocs as a theory of growth through competitive selection and argues that it is the selection of innovations and firms that distinguishes the theory of the EOE and Competence Blocs from e.g., the general equilibrium theory. To a larger extent, I emphasise the experimental character of economic decisions, generated by human creativity, and view this as one distinguishing feature of the theory of the EOE and Competence Blocs.
- I systematically summarise and present the theory of the EOE and Competence Blocs.

⁸ Note that Davidsson *et al.* come from the tradition of business administration, while I come from the

- I suggest that the C&C industry is probably the most interesting industry according to the theory of the EOE and Competence Blocs, because it serves as a device for the exploration and expansion of the state space (all combinatorial possibilities; see *Chapter 2*).
- Finally, I relate my analysis to a Swedish tradition (influenced by Schumpeterian and Austrian theories) in the study of industrial dynamics and economic development that has not had many followers in recent years.

1.7 OUTLINE OF THESIS

My thesis is written as a monograph. It includes nine chapters, one (*Chapter 7*) co-authored with Professor Gunnar Eliasson, The Royal Institute of Technology (KTH), and Professor Erol Taymaz, Middle East Technical University (METU), Ankara Turkey. The thesis is organised as follows:

Chapter 2 “The Experimentally Organised Economy, Competence Blocs and Economic Growth” introduces the theoretical framework of the thesis. The hypotheses to be tested econometrically are derived from this theory.

Chapter 3 “The Experimentally Organised Economy and the Computing and Communications Technology” presents a number of reasons to study the C&C industry, i.e., the producer of C&C equipment and services and one of the major creators and carriers of C&C technology.

Chapter 4 “The Definition and Size of the Swedish Computing and Communications Industry” defines the C&C industry and measures its size and historical growth.

Chapter 5 “Firm Size, Firm, Age and Firm Growth” analyses the effects of firm age and firm size on firm growth.

Chapter 6 “The Turnover of Firms and Industry Growth” analyses the effect of the turnover of firms on industrial growth.

Chapter 7 “Firm Turnover, New Technology Introduction and the Rate of Macroeconomic Growth” (co-authored with Gunnar Eliasson and Erol Taymaz) simulates the macroeconomic effects of the turnover of firms.

Chapter 8 “Industrial Dynamics, Economic Growth and Institutions” discusses the theoretical and empirical results against the background of Swedish economic policy and institutions.

Chapter 9 “Conclusions” sums up the thesis.

CHAPTER 2 THE EXPERIMENTALLY ORGANISED ECONOMY, COMPETENCE BLOCS AND ECONOMIC GROWTH

2.1 INTRODUCTION

This chapter introduces and summarises the theory of the EOE (see Eliasson 1987, 1991b, 1996) and Competence Blocs (see Eliasson 1995, Eliasson & Eliasson 1996b). I make a few modifications of the theory. Moreover, I derive the hypotheses that are econometrically tested in later chapters.

The theory of Competence Blocs was developed after that of the Experimentally Organised Economy to explain the organisation of competitive selection in the EOE – i.e., in an economy with incomplete information and largely ignorant actors. In what follows I will regard the EOE and Competence Bloc theory as integrated parts of one single theory.

In its original form the theory was formulated to study the competitive selection of innovations and firms as a factor behind firm dynamics and industrial development. This chapter generalises the theory further and applies it to the fundamental problem of dynamic resource allocation in a non-Walrasian setting. The chapter also relates the theory to the Schumpeterian concept of new combinations.⁹ In particular, the chapter establishes a relationship between individual firm activities, industrial dynamics, industrial transformation and macroeconomic performance. It pinpoints, but does not elaborate on, the importance of private property rights for industrial dynamics and economic performance.¹⁰ The theory has mainly been formulated during the last decade and is not yet fully developed. The chapter identifies and suggests areas where the theory should benefit from further elaboration.

⁹ The theory of the EOE and Competence Blocs does not include the Schumpeterian concept of new combinations, except in the sense that the endogenous expansion of state space (the so-called Särimer effect; see Eliasson 1987, p. 29) from which selections are made occurs through innovative recombinations of technologies and learning.

The theory of the EOE and Competence Blocs is the latest development in a long Swedish tradition in the study of industrial dynamics and economic growth, in particular Wicksell (1898), Åkerman (1939, 1944, 1950) and Dahmén (1950). This tradition is evolutionary in its character and rooted in the Schumpeterian (1911/1934) and early Austrian tradition.

The micro-based EOE and Competence Bloc theory emphasises the importance of competence for efficient resource allocation and firm competitiveness. A dominant theme is the experimental nature of all economic decisions. Tacit knowledge, incomplete information and bounded rationality introduce a realistic state of deep ignorance on the part of all economic actors, including government. This makes practically all-economic activities to some extent uncertain (as distinct from risky in Knight's 1921 sense) and unpredictable. It also introduces industrial dynamics and transformation as a process of experimental exploration and expansion of business opportunities. Economic performance, then, is conditioned on an efficient process of creating, identifying, selecting, expanding and exploiting business opportunities. This in turn depends on the competence of the economic actors.

Section 2.2 presents the theory of the Experimentally Organised Economy. The analysis starts by relating the chapter to the traditional economic problem of resource allocation, i.e., the economising on scarce resources. The theory of the EOE defines the problem of resource allocation as a problem of information, knowledge, competence and incentives. That is, efficient dynamic resource allocation requires that economic actors have the incentives to acquire and use information (knowledge) and competence about consumers' preferences and how to satisfy them. This section relates to the concept of new combinations and defines the state space (all combinatorial possibilities) and its subset, the business opportunity set (all profitable combinatorial possibilities). Profits are made from the exploration and exploitation of state space and the business opportunity set. Due to tacit knowledge, bounded rationality and the extremely large state space no actor (or group of actors) has perfect knowledge, but rather is grossly ignorant of even

¹⁰ Eliasson (1998a) studies the relationship between institutions, property rights, incentives and industrial development, but that analysis has not yet been explicitly integrated with the theory of the EOE and Competence Blocs.

for them relevant circumstances. Hence, business decisions can be seen as experiments guided by the competencies of the actors and set up and tested in the market.

Section 2.3 introduces Competence Bloc theory which explains how a decentralised market economy efficiently co-ordinates the plans and activities of the economic actors when the actors only have a fragmented knowledge of the whole. Competence Bloc theory states that the efficiency of the economic process is conditioned on the competence of the economic actors and their incentives. A competence bloc defines the minimum set of economic actors with different but supplementary competencies required for the process of creation and exploitation of innovations to become efficient. The actors in the competence bloc interact in their pursuit of profits. They organise their economic activities in firms.

In *Section 2.4* the role of the firm in the theory of the EOE and Competence Blocs is discussed. The firm plays a critical role as a dynamic and experimentally organised actor (see Eliasson 1996, p. 110 ff.). It appears as a competent team pursuing profits through the exploration and exploitation of state space featuring a dominant competence input in production (see Eliasson 1990a) rather than a production function – the prevailing view in traditional economic theory.

Section 2.5 explains how the firm's pursuit of profits through internal reorganisation creates industrial dynamics, industrial transformation and economic growth. Moreover, it discusses how the creation, identification, expansion and exploitation of business opportunities, emanating from improvements in the allocation of resources, generate macroeconomic growth and employment. The section also gives an example of the effects of institutions on the industrial process.

Section 2.6 states the hypotheses that are tested in later chapters. Particularly, the effects of: i) firm age and firm size on firm growth (*Chapter 5*); ii) the turnover of C&C firms on C&C industry growth (*Chapter 6*) and iii) the effects of total firm turnover on macroeconomic growth (*Chapter 7*) are studied.

Section 2.7 summarises the chapter and suggests problems for further research.

2.2 RESOURCE ALLOCATION IN THE EXPERIMENTALLY ORGANISED ECONOMY

The best way to understand the theory of the EOE and Competence Blocs is to begin with the fundamental economic problem of resource allocation.

This problem is concerned with how to use the factors of production, such as labour, capital and land, to efficiently produce preferred goods and services. The EOE and Competence Bloc theory defines the problem as one of co-ordination, information processing, knowledge use, competence accumulation and incentives. We have a problem of co-ordination since the economic actors have to co-ordinate their plans and activities. We have a problem of information and knowledge since information and knowledge about consumers' preferences and about how to satisfy them are required. Information is a subset of knowledge, namely the codable and communicable part of knowledge, while tacit knowledge is defined as non-codable knowledge. We now have a problem of competence since the carrying out of plans and co-ordination depends on the competence to create, interpret and use knowledge.¹¹ The competence of the actors determines firm and macroeconomic performance. The more competent the actors, the more efficiently they carry out their plans and activities. Creativity, the ability to come up with new ideas and solutions, is an important dimension of the competence capital. Finally, the incentive structure determines the remuneration of productive activities and, in turn, what activities are undertaken. Moreover, the production has to be carried out without anyone being completely knowledgeable (see below) about all available combinatorial possibilities, the actors involved and their plans and activities etc. Thus, the actors have to co-ordinate something they have only partially understood.

Schumpeter (1934, pp. 14-15) regards all ways the factors of production are integrated in production processes, in products, in the distribution of products etc. as different *combinations*. I follow Schumpeter and define the introduction of the new combinations into the economy as *innovations*. As Schumpeter I distinguish between (a) coming up with a novel idea (an *invention*) and (b) introducing the idea into the economy (an innovation).

¹¹ The theory of the EOE and Competence Blocs defines competence as the ability to use knowledge and information for a particular purpose (see Eliasson 1999c, p. 4).

Schumpeter (1934, p. 66) defines five major types of innovations (my italics):

- (1) The *introduction* of a *new good* - that is one with which consumers are not yet familiar - or of a new quality of a good.
- (2) The *introduction* of a *new method of production*, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially.
- (3) The *opening of a new market*, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before.
- (4) The *conquest of a new source of supply* of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created.
- (5) The *carrying out* of the *new organisation* of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position.

From this I define:

Definition I: The *state space* of the EOE and Competence Blocs theory as all combinatorial possibilities.

Definition II: The *business opportunity set* as all profitable combinatorial possibilities.

The business opportunity set, hence, is a subset of the state space and it requires critical *entrepreneurial competence* to identify and select combinations that lie within the more narrow business opportunity set, i.e., combinations that satisfy economic profitability criteria (see Eliasson 1996). One basic task of the competence bloc is to make this selection dynamically efficient (see below).

The EOE builds on three critical assumptions related to information and knowledge about the state space and the business opportunity set (see Eliasson 1996):

A.1. The state space as well as the business opportunity set is for all practical purposes open-ended in the long run and extremely large, beyond the comprehension of any individual or group of individuals. The openness rests on the property of state space to expand through exploration and learning, i.e., the discovery of new combinations. Eliasson (1987, 1996, p. 27) calls this the Särinner effect.¹² The Särinner effect together with bounded rationality and tacit knowledge (see assumption 2 below) give rise to the knowledge paradox establishing that even though the knowledge base of society expands, individual actors nevertheless may become increasingly ignorant about all there is to learn, since new knowledge is created faster than one can learn (see Eliasson 1990b p. 46,

1999b). The many possible combinations and the Särимner effect, in turn make the state space and the business opportunity set extremely large. Both the state space and the business opportunity set are, however, at each point in time bounded (but expanding through exploration).

A.2. Knowledge is to a large and probably to an increasing extent tacit in the sense of Polanyi (1967), i.e., it is impossible to codify and impossible to communicate.

A.3. The economic actors are rationally bounded, i.e., the economic actors have limited cognitive capacity to understand and analyse information (see Simon 1955, 1990).

The three assumptions mean that there is no way of objectively assessing the profitability of an innovation until it has been tried in the market. Hence, the only way to value new knowledge is through market experiments and *every business activity accordingly can be seen as an experiment controlled by a business hypothesis (the business idea) that is tested in the market*; thereof the name the experimentally organised economy.¹³

The assumptions of the experimentally organised economy place focus on transactions costs (Coase 1937), or the costs for information (see below). Following North & Wallis (1994), we distinguish between transformation and transactions costs. Transformation costs are the costs incurred when physically transforming inputs (land, capital, labour etc.) into outputs, while transactions costs define the costs incurred when transferring property rights from one actor to another. Dahlman (1979) divides transactions costs into costs for searching opportunities and partners, bargaining and decisions costs, and policing and enforcement costs. He then concludes that transactions costs are actually information costs since “they all have in common that they represent resource losses due to lack of information.” (Dahlman 1979, p. 148). In the theoretical framework of the EOE and Competence Blocs, transactions costs, then, are information costs for exploring and expanding the state space (or the business opportunity set), i.e., costs for discovering (or creating) new combinations (inventions), introducing them into the economic system (innovations) and disseminating them in the market (diffusion). Information costs dominate transformation costs in the sense that the organisation of the transformation process, and hence the costs for the transformation process, depend on

¹² According to the Viking mythology Särимner was a pig in Valhalla, the dwelling of Gods and dead warriors. The warriors slaughtered and ate Särимner. The next day he returned, once again to be slaughtered and eaten.

the information that is discovered, gathered and used to organise production. Information costs have also been found to be large. Wallis & North (1986) estimate them to be at least 45 per cent of the U.S. GDP, and Eliasson (1985, p. 86, 1990a) estimates them to be at least 50 per cent of total costs in large Swedish manufacturing firms and much higher at the GDP level.

Note that the three assumptions of the EOE and their implications are in sharp contrast to the assumptions made in, for instance, traditional general equilibrium (GE) theory that does not recognise contradictory information, never requires creative new innovations, never leads to mistakes and never allows tacit knowledge (see Pelikan 1986). Traditional theory builds on the assumption that the business opportunity set it is closed and limited, that it is possible to explore and that infinitely small actors choose the best solution in an absolute sense at no (or almost so) costs of information. It is assumed that consumers maximise utility by consuming well-defined goods that consumers are informed about, given the budget constraint. Consumers' income and the exogenous prices of goods determine the budget constraint. Similarly, firms maximise profits by producing the well-defined goods minimising costs using perfect knowledge about technologies etc. The problem of resource allocation is traditionally formulated as a mathematical optimisation problem with well-known and well-defined data (within a narrowly defined state space), that is solved through maximisation of profits and utility. This definition of the problem gives no room for entrepreneurship, and profits are not explained by the entrepreneurial exploration of state space.¹⁴

As Hayek (1937, 1945) pointed out, goods are not well defined and consumers and producers never have complete information about preferences, technology and so forth. Moreover, as discussed at length in Hayek (1978), the co-ordination of plans and activities is made more difficult due to the fact that information is fragmented and often contradictory. The actors have to *discover* which goods are goods, the ways to efficiently produce and distribute them etc.

¹³ Similarly, the firm may be described as an experimental machine conducting and adjusting to business experiments (see Eliasson 1990a).

¹⁴ The textbooks used in the Ph.D. programs in economics in Sweden illustrate the neglect of the entrepreneurial function in mainstream economic theory. Looking into the indexes of these books, one can almost *never* find any references to the entrepreneur. If one does, it is not in the Schumpeterian sense, i.e., an actor that introduces new combination into economy. For instance, Mas-Colell *et al.* (1995) makes one reference to the entrepreneur (in a question in the exercises on p. 475) referring to him as a borrower.

The more realistic assumptions underlying the definition of the problem of resource allocation made in the EOE changes the concept of a firm and of resource allocation. By developing and producing preferable goods and services a firm becomes more competitive than other firms. That is equivalent to saying that firms' competitiveness and long run survival is a matter of creating and allocating knowledge.

In the EOE the core business idea for the firm is to explore and expand state space, i.e., to identify and introduce new combinations in the pursuit of profits (at a significant cost). Since no one has perfect information, successful exploitation of the open-ended business opportunity set and expansion of state space therefore require many experiments, successful as well as unsuccessful. Business mistakes, hence, become a significant part of total costs for exploring business opportunities. This calls for an efficient *process* for the creation, identification, selection, expansion and exploitation of business ideas (i.e., of innovations), and for efficient ways for losers to exit. Competence Bloc theory explains how.

2.3 THE COMPETENCE BLOC

It follows from the three assumptions of the extremely large state space (business opportunity set), tacit knowledge and bounded rationality that it is impossible for any person, firm or other organisation to get a complete overview or complete understanding of the economy. Central overview and central planning of the economy, thus, is a naive and costly illusion. Competence Bloc theory shows how a decentralised economic system – the market economy – generates, identifies, selects and enlarges projects and efficiently co-ordinates plans and activities, i.e., how resources are efficiently allocated without anyone being more than fragmentarily informed of the whole and many being misinformed.

The idea behind Competence Bloc theory is that the successful creation and exploitation of new combinations (i.e., new knowledge/innovations/business opportunities) is the task of “optimising” the creation and allocation of technological as well as economic competencies without knowing the exact “content” of the competencies.

Eliasson (1995) introduced Competence Bloc theory in an industrial study of the Swedish aircraft industry. It was further developed and used in Eliasson & Eliasson (1996b) in a study of the biotechnology industry, in Eliasson & Eliasson (1997) in an analysis of the art market in 15th Florence, in Eliasson's (1998b) inquiry into the Swedish computer industry, in an industrial investigation of the industrial effects of the submarine project "Viking" (Eliasson 1999e), and in an analysis of the flexibility in the Swedish IT industry (Eliasson & Johansson 1999). A competence bloc is defined as (see Eliasson & Eliasson 1996b, p. 14):

It is the total infrastructure needed to *create (innovation)*, *select (entrepreneurship)*, *recognise (venture capital provision)*, *diffuse (spillovers)* and commercially *exploit (receiver competence)* new ideas in clusters of firms. The *competence bloc* is dominated by *human-embodied competence capital* that determines the efficiency characteristics of all other factors of production, including the organisation of all economic activities that constitute the competence bloc. This means that the choice of market and hierarchical organisation is part of the competence bloc. Above all, the definition includes the institutions of the market that are needed to activate innovations, entrepreneurship and venture capitalism...Competence bloc formation concerns the dominant intangible human-embodied competence associated with a particular industrial success, and only secondarily the physical dimension of production.

The competence bloc defines the minimum set of competencies necessary to successfully *generate, identify, select, expand* and *exploit* business ideas, i.e., profitable new combinations, in the state space. It is not possible to exactly specify the content of the competencies in the competence bloc. It is, however, possible to categorise the competencies according to their function. Since the competence is human-embodied, it is feasible to specify the actors in the competence bloc according to their function. It should be underlined that competence is defined by its function, i.e, from the result of the use of the competence. Competence Blocs theory lists eight functional competencies embodied in economic actors required as a minimum for creating industrial dynamics.^{15, 16}

- Active, competent and resourceful *customers*. The competent customer is not an ordinary customer who solely buys the product. It is more like a strategic partner who takes an active part in the development and the commercialisation of products. The active customer also serves as a channel of information and gives the firm information about the market and specific customer demands and acts as a catalyst for innovation. The active and competent customer has a decisive influence on the development and final design of new products. Sometimes the competent

¹⁵ Note the similarities with the actors inventors, entrepreneurs and creditors in Schumpeterian theory.

¹⁶ Note that I have extended the original definition of the competence bloc to include inventors.

customer also finances part of the development of the product and shares in the risks.

- *Inventors* solve specific economic and technical problems. The inventor comes up with a novel idea, the new combination that defines an invention. This by no means needs to be a technical problem, but can just as well be related to, for example, organisational and market problems (see Schumpeter 1934, p. 66).
- *Innovators* integrate technical specialities. The innovator integrates different technologies for what is needed for particular product functions. The innovator in the competence bloc fulfils a more advanced function than the Schumpeterian inventor does. He or she solves advanced technological problems and puts large-scale technologies together into technically advanced products (or systems of products) like aeroplanes and cars. His or her function in the firm, thus, advances from a person who solves “small-scale” technical problems to an organiser of large-scale product development. The innovator function is more like that of an administrator of large-scale innovative activities, than of an inventor of incremental technical changes. The function of an innovator (like that of the other actors) can be carried out by one person or a group of persons.
- *Entrepreneurs* select innovations that satisfy economic criteria and introduce them into the economy. The entrepreneur, thus, discovers inventions in the state space that he or she believes belong to the business opportunity set according to the above definition. The entrepreneur has the most critical economic function since he or she understands, selects and organises the commercialisation of the innovations.
- *Industrialists* carry the innovations to large-scale production. The industrialist integrates a number of competencies, including management, finance as well as marketing. Compared to traditional Schumpeterian theory the industrialist in the competence bloc fulfils some of the functions of the entrepreneur, notably the later stages of commercialisation. The entrepreneur still introduces new combinations, but the industrialist scales them up. The industrialist, thus, organises the growth of firms. Observe that competence bloc theory moves focus from the entrepreneur to the industrialist. The most important competence in the theory of the EOE and Competence Blocs is to organise competencies into profitable businesses. Traditionally this has been seen as the entrepreneurial competence, but now the industrialist also fulfils this additional function.

- Competent *venture capitalists* recognise and finance viable business opportunities, identified, organised and presented to him/her by the entrepreneur. This task includes an assessment of the competence of the entrepreneur as well as that of other managers of the venture. The venture capitalist provides “*competent money*”. That is, he or she provides financial resources bundled with, e.g., his or her management competence, personal network and experience. The main task of the venture capitalist, however, sharply emphasised by Eliasson & Eliasson (1996b) and Eliasson (1997), is to recognise and correctly price innovations. According to the theory of the EOE and Competence Blocs venture capitalists play a key role for industrial development. Note that “*incompetent money*”, i.e., capital not bundled with market knowledge, *probably has a negative effect on firms, since the financial capital then confers power and authority to actors who do not understand the business* (or the competence of the entrepreneur). Incompetent venture capitalists will not be able to identify, select and price projects efficiently. Accordingly, they will tend to require too large a risk premium that will kill many projects in their infancy and give poor incentives for entrepreneurs, or support projects with a low expected return. In a well-functioning market economy incompetent venture capitalists will soon be outcompeted, and the misallocation of resources will be relatively small (conditioned on a critical mass in the venture capital market). The only time large-scale misallocation of financial or other resources can go on for a long time is when government intervenes in economic life and puts the market-exit mechanisms out of order. No surprise then, that government itself has acted as the largest provider of incompetent money, e.g., to the Swedish shipyard industry (see Carlsson *et al.* 1981) and in the form of support to regions (see Bergström 1998).
- *Actors in the secondary (exit) market* provide a secondary market and thus accommodate exit availabilities for venture capitalists as well as entrepreneurs and other investors. They also constantly evaluate the management team. There are potential profits in replacing the top management of a firm in case of sustained bad performance and actors in the secondary market will enforce such change. The capital market is the ultimate controller of projects since the interest rate connects the future with the present. Note that there is a symmetric evaluation in all relations in the competence bloc. The venture capitalists, for example, certainly selects entrepreneurs and projects, but the entrepreneurs also choose to co-operate with different venture capitalists.

- *Skilled labour* carries out production.

The competence bloc is large enough, or complete, when it has had the critical mass to attract competent actors in large numbers such that its experimental selection task functions well. In such a situation the competence bloc successfully terminates losers (type 1 error) and does not miss radically new and profitable innovations (type 2 error). This, of course, presumes that the economic system creates incentives to actors to produce potential candidates for the selection of winners and losers. That is to say, before one can start talking about type 1 and type 2 errors, there must be firms (and projects) to choose among. This has a direct bearing on the discussion of the importance of a high turnover of firms. New entry of firms generates potential winners and losers that are selected in the competence bloc. A high turnover generates more “candidates” and increases the possibility of discovering a winner. Of course, a high turnover also generates losers, but an efficient competence bloc will identify and force them to exit at a relatively low cost. However, according to the theory of the EOE and Competence Blocs the largest cost is to miss winners. The economic system might also fail in generating a sufficient number of “candidates”, e.g., because of poor institutions.

The emphasis on a dominant human capital and not on physical production and physically defined techniques makes the theory of the EOE and Competence Blocs differ principally from the related development block concept of Dahmén (1950) and the technological system of Carlsson & Stankiewicz (1991). A development block is a cluster or a network of integrated physical production and distribution activities that creates strong economic synergies at some higher level of aggregation and particularly over time. The technological system refers to the productivity effects generated from the general application of a particular generic technology (Eliasson 1996). The technological system is input-defined, while the competence bloc is defined by its general ability to generate and exploit new knowledge, irrespective of where in the economic system the knowledge is created and exploited. This creation and exploitation in the competence bloc is, however, guided by the preferences of customers. One could say that one critical task of the competence bloc is to make sure that customer preferences and competencies filter down to the actors that create and select innovations. In this sense the competence bloc is market or end-user defined.

One could also say that a technological system is one of several technological inputs under the innovation item in the competence bloc. For instance, the technological system of advanced robotics interacts with the technological system of advanced sensor technology to create an innovative input in the development of a particular engineering product. This means that the competence bloc and the technological system only overlap partially, or rather interact dynamically when innovators in the competence bloc select and combine technologies from many technological systems in the innovative end of the competence bloc, to carry the new combinations onto the entrepreneurial and industrial stages of the competence bloc.

A few implications about the industrial and economic process follow from the theory of the EOE and Competence Blocs:

- i) All actors in the competence bloc have to be present to create the industrial dynamics and industrial transformation that ultimately explain (and move) economic growth endogenously. Economic development can be seen as a chain of activities starting with an *invention* (a new combination) that is introduced into the economy (*innovation*) and *diffused* in the market. The result of each activity (success or failure) depends on the competence of the actors involved at each stage, e.g., entrepreneurial and venture-capitalist competence. If one competence input is missing the chain is broken and this particular economic development might fail.
- ii) Business mistakes are a natural cost for selecting winners, not a net waste of resources.
- iii) The competence bloc serves as an attractor. Firms will locate close to a competence bloc or co-operate closely with the actors of the competence bloc to be part of the dynamic network and knowledge creation that can make them competitive.
- iv) A critical element of the industrial innovation process is to allocate and combine competencies that no one knows the full content of. Eliasson (1994) writes that this requires an organisational solution in firms and a well-functioning labour market, or a market for competence, as he prefers to call it. However, the theory recognises the capital market as the most important market for competence, since management-team competence is priced and “traded” there. According to the theory of the EOE and Competence Blocs, management-team competence is the most critical competence because it organises and allocates the most valuable

asset of the firm, i.e., the human-embodied competence of the employees (see *Section 2.4*).

- v) Truly successful competence blocs cannot be planned. They form spontaneously in markets.¹⁷
- vi) Institutions that create the right business conditions and incentives for the creation of competence blocs can, however, be supported by deliberate economic policy.
- vii) Industrial dynamics is the result of creative experimentation and selection. Research and search for knowledge are uncertain and in many cases it is impossible to estimate the costs needed to achieve desired results. Decisions about initiating or terminating projects are about critical choices based on incomplete information and not on calculations under perfect information. The organisation of research and other creative activities has a decisive influence on the generation and the results of new ideas.
- viii) Redistribution may have a negative effect on economic efficiency since it deprives successful entrepreneurs of their wealth by high taxes. In a market economy, wealth is created through competent and productive entrepreneurship. The only way to accumulate wealth is to produce better products more efficiently than competitors. Wealth accumulation is a proof of such competence. Hence, redistribution implies transferring resources from individuals who have proven to be competent managers of economic resources to individuals who have not proven to be competent managers of economic resources (Eliasson 1997).¹⁸ The competence previously associated with the money has been removed (washed out).¹⁹
- ix) One of Smith's (1776) fundamental insights was that specialisation and diversification give rise to enormous gains in the use of resources. Specialisation and diversification are limited by the size of the market, which implies that output is limited by the size of the market. This conclusion has been part of

¹⁷ Cf. for example, Lazerson & Lorenzoni (1999) who conclude that no industrial district in Italy has been promoted by active industrial policy. The industrial revolution in England involved no public activities (see Mathias 1969), except institutional changes protecting private property rights and promoting private entrepreneurship (see North & Thomas 1973).

¹⁸ This implies that the total tax level itself influences economic growth.

¹⁹ Observe that another competence is added to the money, namely the competence to use the political system to redistribute private wealth. Hence, redistribution implies that unproductive competence controls a larger share of total resources (cf. Bhagwati 1982; Baumol 1990; Tollison 1997). This effect is not explicit in the current version of the theory of the EOE and Competence Blocs.

economic analysis ever since. However, the EOE and Competence Bloc theory revises this conclusion. Allowing for quality and that new products and new markets are created through the creativity of actors in the pursuit of profits, the limiting factor no longer is the size of the market but the competence to produce new products, new qualities and to find (or create) new markets (see Eliasson 1996, p. 29).

2.4 THE FIRM AS A COMPETENT TEAM

The actors in the competence bloc establish firms to exploit business ideas. A business idea is not physical. It is a thought emanating from the mind of an individual who wants to improve his situation, in this case after having perceived an opportunity to do something in a better way than it is currently done and/or to do something completely different. In our theoretical framework, this is accomplished through the creation of competence about how to exploit information about consumers' demands and how to satisfy them in an efficient way. As has already been pointed out, this competence is human-embodied. From that it follows that the main task of the firm, and its most important competence, is to organise competent people into teams with the purpose of exploring the state space, making the organisation capable of identifying successes and mistakes (see Eliasson 1996, p. 52).²⁰ This is the task of the top-management team, and the theory of the EOE and Competence Blocs therefore emphasises the competence of the top management team, or the top competent team, in the firm (see Eliasson 1990a). They have the ultimate responsibility for organising the firm for the pursuit of profits:

The dominant, top-level organizational competence is defined by the ability to manage team competence accumulation and earn a long-run return on such human competence investments (Eliasson 1996, p. 66).

The top management converts uncertainty about the business idea and the business environment into subjectively computable risks and orients its business in the state space, i.e., the management chooses a business strategy, co-ordinates competent people, recruits new talent and defines the internal allocation of competence. It creates the incentive structure for talented people within the firm and decides on the competence specification

²⁰ Hence, the firm is described as a "competent team".

of the firm. The top-management team has the ultimate responsibility for the organisation of the firm, that in turn determines the total allocation and adjustment of the competence base, which is the foundation for creating profits. Hence, it has the ultimate responsibility for the establishment and survival of the firm and the creation of profit through the expansion of the business opportunity set. In a sense, hence, economic competence is primarily an organisational competence – the competence to organise the creation, selection, expansion and exploitation of business ideas. It includes the selection between organising economic activities in the market or in the hierarchy (i.e., firm) and to choose the organisation of market or hierarchy (firm). The theory of the EOE and Competence Blocs points out and underlines that competence is a scarce human-embodied resource and that the creation and allocation of competence, particularly organisational competence, therefore is important for economic development. It is embodied in individuals and groups of individuals (firms) and extremely redundant. Consequently competence is normally underused (in the form of underemployment) and misallocated. One reason might be badly functioning markets (read labour and financial markets) for competence.

Competence can be seen as a factor of production like, for instance, real capital. It differs, however, from all other factors in a number of respects. Most important is that competence, often tacit, is the dominant factor of production. Organisational competence operates as a leverage (or scale) factor on total productivity. It determines the efficiency in the use of other factors of production, as illustrated by for instance Westerman (1768; in Eliasson 1992, p. 251):

Likewise we found a remarkable difference in the organization of work at our shipyards compared to those in other countries. Here, almost two days of work were needed to accomplish what took only one day in England or Holland...On this and other things I want to say that...Swedish hands, when appropriately directed and put to use, lack neither skill nor force.

Competence also allocates itself, which gives it very special characteristics (see Eliasson 1996 and Pelikan 1993 for a discussion).

The theory of the EOE and Competence Blocs specifies what general competence is required of the firm for it to become financially successful in the exploration and exploitation of the business opportunity set (see *Table 2.1*). The management team needs to *orient* the firm in the state space and in the business opportunity set, i.e., they have to decide on the general activity of the firm, what business activities to engage in, what

technological and economic trajectories to follow etc. This includes risk willingness in the competence endowment (the courage to act on incomplete information). Each act is affiliated with risk because of the extremely large state space (A.1), tacit knowledge (A.2) and bounded rationality (A.3). Financial success requires efficient *selection* (i.e., identification and correction) of business mistakes, since the actors *always* will make mistakes because of A.1, A.2 and A.3. Success is also dependent on the *operational* competence to manage successful “experiments” and feedback information to adjust the orientation of the firm, if necessary.

Table 2.1 The competence specification of the experimentally organised firm

Orientation (1) Sense of direction. (2) Daring (risk-willingness).
Selection (3) Efficiency in identifying mistakes (analysis). (4) Effectiveness in correcting mistakes.
Operation (5) Effectiveness in managing (“co-ordinating”) successful experiments. (6) Effectiveness in feeding acquired experience back onto (1).

Source: Eliasson (1996, p. 56, Table III.1).²¹

The general competence specification of the firm carries over to the four main operational tasks of the firm (see *Table 2.2*). In its daily operations the firm has to:

- i) *Identify business opportunities.* This is the first step in the process of creation and exploitation of new knowledge, where novel ideas and innovations are suggested.
- ii) *Choose and select among potential business ideas.* Next, firms have to choose among business ideas and select the ones to introduce on the market. They also have to choose what ideas not to introduce or which introduced products to withdraw from the market. This is a filtering process, which includes the important choices of staff, their careers and mobility in firms.
- iii) *Co-ordinate firm activities.* The daily operations and strategic discussion are co-ordinated by the management within the firm and by markets between firms. Competition disciplines the organisation – management, employees and owners - to economise on scarce resources.
- iv) *Learn.* Finally, the firms have to create efficient systems for knowledge transfer through education, imitation and diffusion. It is of course difficult to distinguish

²¹ See also Eliasson (1990a, p. 283).

between the different knowledge activities since they are closely related. For example, the choice and selection of recruiting and training of employees and opportunities within the firm are integrated with the learning activity. The emphasis on knowledge creation and learning that takes place *within* the firm makes Eliasson & Vikersjö (1999) describe the firm as a technical and managerial university.

Table 2.2 Main operational tasks of a firm

1. Identification of business opportunities (exploring state space/business opportunity set)	The creation of new knowledge - innovation - entrepreneurship - technical development
2. Choice and selection	Filtering (knowledge) - entry - exit - mobility - careers
3. Coordination	Disciplining - competition (in markets) - management (in hierarchies)
4. Learning	Knowledge transfer - education - imitation - diffusion

Note: Coordination under item 3 is an unfortunate choice of word, because the whole economic process can be defined as a process of co-ordination. Hence, activities like the identification of business activities and choice and selection should be included in the concept co-ordination.

Source: Eliasson (1996, p. 13, *Table I.1*).

Eliasson (1990b, 1996) identifies these four operational tasks as the information activities of both the firm and the entire economy and calls them the statistical accounts of the knowledge-based information economy. He estimates them to cover more than 50 per cent of the resource input into the average Swedish manufacturing firm in the late 1980s (Eliasson 1990a).

The search for profit constantly expands the business opportunity set and the state space (the Särimer effect) and the more firms are searching, the more the business opportunity set expands, most likely faster than actors are capable of learning (the knowledge paradox). A few implications about the firm follow from this conclusion (Eliasson 1998, p. 87) – implications that further underline the experimental character of business activities:

1. It is impossible to have a total overview of every business situation. Business mistakes will, therefore, always occur and should be regarded as a natural cost for business development.
2. It is pure luck if one person will find the *best* solution (combination) of all solutions to a problem. And if he or she happens to find it, neither that person, nor anyone else, will know about it.
3. However, in spite of uncertainty, you have to believe in your solution, otherwise you will not dare to act (item 2 in *Table 2.1*).
4. Whatever you do, you will know one thing with certainty; there are better solutions. It is, however, possible that no one else has found them or introduced them into the economy.
5. You cannot, however, count on being alone if you have found a profitable market solution. You, therefore, have to act prematurely on your competence and on your intuition, since you have to reckon with the possibility that with a good solution you cannot be alone.

The theory of the EOE and Competence Blocs concludes that the mutual goal, the common denominator of the actors is the pursuit of profits. Thus, the purpose, the final goal of enterprising is to make profits, and the firm is therefore also described as a knowledge-based, profit-oriented organisation (see Eliasson 1996, p. 57). As such it can be seen as a team of competent people, a financial decision unit, co-ordinated by the top-management team in the production of profitable services and goods. The firm can also be seen as an experimental machine with financial objectives using uniquely specified competence capital (see Eliasson 1996, p. 100).

2.5 FROM MICRO TO MACRO

Each firm faces a number of investment opportunities. Some of them the firm has created itself. Some of them have been generated by factors outside its control. The firm always has to *select* between a large number of investment opportunities.

Even though not explicitly stated in the theory, the selection criterion is expected Net Present Value (NPV). According to the theory of the EOE and Competence Blocs

selection at the firm level is carried out through: the entry of firm projects, the exit of firm projects, the re-organisation of firms and the rationalisation of firms; see *Table 2.3*.²²

Table 2.3 The four selection activities

(1) Entry of firm projects
(2) Exit of firm projects
(3) Re-organisation of firms
(4) Rationalisation of firms

Rationalisation is a special case of re-organisation, the main purpose of which is to exploit economies of scale etc. by expanding inputs over a given organisational structure. The activity increases profitability e.g., from downsizing, upgrading the machine park, cutting down production plants with low productivity rather than through the introduction of new products, new processes, entry into new markets or the use of new raw materials. New firm entry and exit of existing firms are special cases of (1) and (2) in *Table 2.3*.

The basic investment rule in firms is to invest in projects as long as the expected NPV is positive and terminate projects when the expected NPV is negative. Similarly, firms re-organise and rationalise if the expected NPV increases as a consequence. Each individual firm carries out these activities to stay competitive and these activities generate the entry, expansion, contraction and exit of firms in *Table 2.4*, or what is sometimes referred to as industrial dynamics.

The critical question is how *Table 2.3* is transformed into *Table 2.4*, i.e. what makes individual firms enter and expand rather than contract and exit, generating macroeconomic growth instead of macroeconomic stagnation or decline. As discussed, this balancing of the generation and identification of winners for promotion, the missing of winners and the withdrawing of resources from losers is determined by the competence of the actors in the competence bloc. The actors in the competence bloc use different criteria to select and allocate resources to winners and withdraw resources from

²² Eliasson (1994) calls these four activities the four growth mechanisms. In Eliasson (2001b), he changed the title to the four mechanisms of Schumpeterian creative destruction and growth. I prefer to call them the four selection activities. Later, Eliasson has also called *Table 2.3* and *2.4* (together) the Schumpeterian creative destruction process.

losers. An immense number of more or less competent views are involved and it is beyond our empirical knowledge to formulate the general principles that underlie those criteria sufficiently precise to allow meaningful general conclusions. We can investigate empirically, in the form of cases, how this has been done in practice. The environmental characteristics of the EOE, however, demand that firms have a good sense of direction, that they are efficient in identifying and correcting their mistakes and that they effectively manage successful experiments (see *Table 2.1*). From the arguments based on the theory of the EOE and Competence Blocs, it is concluded that the winners satisfying these specifications will be characterised by on average being: (1) small, (2) young, (3) independent and (4) not government owned, rather than the opposite, which will be more typical of the losers from which resources will be withdrawn (see further *Section 2.6* below for a discussion).

By relating the creation and selection process of the competence bloc to the direction of resources to expected winners and the withdrawal of resources from expected losers the competence bloc is made the resource allocator in the theory of the EOE and Competence Blocs.

Table 2.4 The entry, expansion, contraction and exit of firms

(1) Firm entry
(2) Firm expansion
(3) Firm contraction
(4) Firm exit

The link between individual firm behaviour, industrial dynamics, industrial transformation and macroeconomic growth can be illustrated by Salter curve analysis.²³ Before proceeding, let us recall that the value added of all producers in a country in a particular year defines GDP, and that changes in the sum of value added define changes in GDP, i.e., economic growth.

²³ In two ways the Swedish micro-to-macro model, MOSES (Eliasson 1977, 1991b) captures the theme of this chapter. It (1) is a model approximation of the theory of the EOE and (2) it is a dynamic econometric Salter curve analysis of the above kind using real data on Swedish firms (see, e.g., Albrecht *et al.* 1992). The transformation of *Table 2.3* into *Table 2.4* occurs within the model. The verbal analysis in the following pages is mathematically specified in the MOSES model.

Salter (1960) developed and introduced Salter diagrams in his study of productivity and technological change. A Salter diagram shows the ranking of a performance variable (profitability, value added/employee etc.) over firms in an industry. Each firm can be represented by a column where the width of the column corresponds to the size of the firm in per cent. Firms are ranked according to their economic performance. Firms with good economic performance are found to the left and firms with poor performance are found to the right. *Figure 2.1* shows firms' value added/employee in the Swedish IT industry in 1996.

Figure 2.1 Salter diagram of the Swedish IT industry in 1996

Source: Statistics Sweden (CFAR) and own calculations.

Challengers – incumbent firms to the right as well as new entrants - always threaten the profitable firms in the upper left corner with competitive actions. The challengers know that it is possible to move up and to the left since other firms already have. They can (try to) imitate those firms' organisations and technical solutions or construct a better product. The firms in the upper left corner are, however, aware of this and are forced to continuously innovate to keep ahead of their competitors. If not, competition will decrease their profits and they will move down to the right-hand corner, and eventually exit from the economy. Similarly, the leaders and new entrants threaten firms to the right. They have to improve production, profitability etc., otherwise they will not be able to

attract capital or competent employees. They will move further to the right and eventually exit. Due to the extremely large state space, tacit knowledge and bounded rationality, it is never possible for any firm to the left or right to feel safe. Firms never have full information about competitors or technological development, i.e., they do not fully know the strength of competitors or if the technological development will make their products less valuable. Every firm is thus forced by real or imagined circumstances to constantly improve efficiency and to move up to the left, even if the firm already exhibits the highest profitability (value added/employee). The only thing that can protect a firm is a monopoly that reduces competition, guaranteed and enforced by government. Superior products, organisation, technology etc. creating a private monopoly are not a problem in the same way since monopoly profits sooner or later will be eroded by new entry (if allowed).

The theory of the EOE and Competence Blocs defines industrial transformation as the (outward) shifting of Salter curves as a consequence of the process of competition described above.²⁴ It takes two forms, one being interindustry related, and the other being intraindustry related. *First*, firms in a deregulated industry constantly have to try to introduce new combinations with a higher value added to stay competitive. Successful firms produce a higher value added per employee and increase their share of the industry through entry and growth over time, while unsuccessful firms decrease their share of production through contraction or eventually exit. Hence, in the case of positive economic development the Salter curve moves up to the left over time. This is illustrated in *Figure 2.2*; the Salter curve for the IT industry moved up to the left between 1993 and 1996.

²⁴ Obviously, with each individual firm being exposed and having to take competitive action economic growth is internalised even without entry. With endogenous entry the competitive growth process through selection over the Salter curves is further internalised (see Eliasson 1996).

Figure 2.2 Salter diagram of the Swedish IT industry in 1993 and in 1996

Note: 1996 year's prices.

Source: Statistics Sweden (CFAR) and own calculations.

Second, labour, capital and other factors of production organised within hierarchies called firms and dynamically co-ordinated in markets are also generally reallocated to markets with a higher value added from markets with a lower value added in a well-functioning economy. This makes the whole economy shift resources to firms and industries with better economic performance. *Figure 2.3* shows Salter curves for the IT industry and the manufacturing of basic metals and motor vehicles industry. The IT Salter curve is further out and to the left, i.e., value added is generally higher in the IT industry. Thus the IT industry will attract firms, labour, capital etc. from the manufacturing industry, and industrial transformation takes place.

Figure 2.3 Salter diagram of the Swedish IT industry and of the manufacturing of basic metals and motor vehicles industry in 1996

Source: Statistics Sweden (CFAR) and own calculations.

The aggregate change of value added defines GDP growth. In other words, the change of the Salter curves – the industrial transformation – moves GDP growth in this example (but in another case contraction might have occurred at the macro level). I have thus illustrated the links between individual firm activities and macroeconomic performance. The micro-to-macro relation can be described as a four-step process. *First*, the individual firm takes productive action in its attempt to maintain or increase profits. *Second*, the individual firm activities (entry, exit, re-organisation and rationalisation) generate industrial dynamics (entry, exit, expansion and contraction of firms) that, *third*, shifts the Salter curves and industrial transformation takes place. *Fourth*, the sum of the shifting Salter curves is converted to macroeconomic aggregates. If the incentive structure in the economy is right (an institutional issue) the shifts of the Salter curves will be predominantly outward. Hence, industrial transformation will generate economic growth.

The theory of the EOE and Competence Blocs emphasises competition as the key to industrial dynamics and transformation and, therefore, to economic growth. *First*, the

threat from both incumbent firms and new competitors constantly keeps each actor on the alert. *Second*, free entry and exit guarantees the right to explore the state space, something already Smith (1776) made a point of. Restrictions on competition imply restrictions on the possibility to explore the state space (cf. Hayek 1978).

This theory also recognises that institutions, in particular private property rights (the right to manage, access the rent from and trade assets), are the foundations of competition and the incentives for economic actors. Accordingly, they are the underlying determinants of industrial dynamics, industrial transformation and economic growth. Eliasson (1998a) links the four selection activities of the firm to property rights. He discusses the formal institutions required to guarantee and promote the entry, re-organisation, rationalisation and exit of firms. For example, the very existence of firms and the renewal of an industry require company law and establishment law that allows entry. In particular, Eliasson (1999d) emphasises that institutions reduce uncertainty, which enhance economic growth through a reduced risk premium on investments.²⁵ This is obvious from a Net Present Value calculation. The interest rate includes a risk premium, which among other things, depends on the institutional set-up. If institutional uncertainty is introduced into the economy, for example, through the frequent and unexpected change of formal rules, the risk premium and the interest rate will increase, which will have a negative effect on NPV. Fewer projects will be started and more projects ended. The entry and growth of firms will be reduced, as well as economic growth.

2.6 HYPOTHESES: AGE, SIZE, TURNOVER AND GROWTH

The previous section explained how the activities of individual firms in the pursuit of profits generate macroeconomic growth through the dynamics of firms and transformation of industries. One critical factor for growth to occur is that the selection activities of *Table 2.3* are converted into entry and expansion rather than contraction and exit of the firm in *Table 2.4*. This is partly determined by the ability of the firm to generate and exploit profitable innovations.

²⁵ Institutions, of course, can also increase uncertainty.

In general, the theory of the EOE and Competence Blocs expects firm age and firm size and other firm characteristics, such as ownership and independence, to affect this ability and, hence, to affect firm growth.

First, the theory predicts that radically new innovations with a great economic potential are generally introduced through the entry of new and young firms. Old firms may have difficulties in catching up with the latest knowledge and therefore apply old knowledge paradigms. They may easily become conservative and rely on established in-house technology instead of innovative new solutions. New and young firms, on the other hand, may be more open-minded, more flexible, more innovative and less risk-averse. To a larger extent, new and young firms will, therefore, eventually explore new knowledge with a large economic potential.

Second, Eliasson & Eliasson (2001) argue that large firms tend to internalise large parts of the competence bloc. This leads to a more narrow evaluation of projects than when the same evaluation process is distributed over the market. Hence, the large firms on average have a reduced capability to generate winners per unit of resource input compared to the small firms. While losers are rejected fast in the open (over the market) competence bloc, the larger firms have much larger resources to finance a bad project for a longer time. Hence, selection will be more efficient in smaller firms. This is particularly so in imperfect and/or regulated capital markets. The same argument is further strengthened for firms that are members of an enterprise group or government-owned.

Third, the theory of the EOE and Competence Blocs also predicts that large firms are more hierarchically organised because of their size compared to small firms. This probably makes small firms provide a better organisational milieu for entrepreneurs, a circumstance that also enhances growth.

Hence, the theory allows us to derive the hypotheses to be tested in *Chapter 5*:

1. H_0 : Firm age has no, or a positive effect on firm growth.
2. H_0 : Firm size has no, or a positive effect on firm growth.

The theory of the EOE and Competence Blocs suggests that the hypotheses will be rejected and that there is a negative relationship between firm age, firm size and firm growth.

It can be mentioned that the size distribution of firms (i.e., the relation between the number of small-sized and the number of large-sized firms), as well as the density of firms (i.e., the number of firms in different size classes per inhabitant) have consequences for economic efficiency and growth according to the theory of the EOE and Competence Blocs:²⁶

- i) The possibility to reach critical mass in the competence bloc increases with the number of actors. Competence is human-embodied and the more firms the more individuals with the competence to organise productive activities and to run firms. Many firms imply more entrepreneurs and industrialists, which in turn implies a broader and more varied competence-base when generating and exploiting business ideas. This is important for the efficient matching of new technologies with competent people, i.e., people that can recognise and exploit the potential profits of new ideas. The total mass of entrepreneurial and industrial presence in a competence bloc can also be called the pool of competence “available” to new and expanding firms. The density of firms (“the pool of competence”) in different size classes is probably important because firms of different sizes might require different managerial competence. For instance, managers from large traditional manufacturing firms may have difficulties managing new, small C&C firms due to differences in corporate culture.²⁷
- ii) The information costs associated with becoming informed through personal interaction between potential and existing entrepreneurs decrease with the number of entrepreneurs because of their larger presence and broader competence base.
- iii) There is a positive relationship between the number of entrepreneurs and the number of experiments carried out, which has been shown to have a positive effect on economic growth.

²⁶ A common explanation of the positive effects on firm growth of many firms and entrepreneurs, suggested by e.g., Davidsson *et al.* (1994a, 1996), is that existing entrepreneurs are positive role models for “to-be” entrepreneurs. The EOE and Competence Blocs theory does not dispute this particular effect but advance a few additional explanations related to competence and information.

²⁷ There is some evidence of this in the biomedical industry (see, e.g., NUTEK 1993, p. 177).

- iv) Entrepreneurial and industrial competence is largely acquired through individual learning by doing in firms. Hence, firms can be seen as universities for educating talented people in managerial skills (cf. Eliasson & Vikersjö 1999) and many (small) firms suggest a well-developed management education system.²⁸

Ownership matters critically for firm growth in the theory of the EOE and Competence Blocs. Publicly owned firms are expected to influence firm growth negatively for several reasons: i) in the free market, there will be a selection according to the owners' ability to manage the firms. In a centrally planned economy, on the other hand, owners (politicians) are appointed because of their competence to win elections (manage voters), which is a negative selection mechanism when it comes to economic performance (cf., e.g., Pelikan 1993). ii) Decision-making is bureaucratic in organisations run by politicians, and these organisations lack flexibility (cf., e.g., Moe 1997; Wintrobe 1997). iii) Politically run organisations are governed by other criteria than economic efficiency and value increase, e.g., vote maximisation, which gives (long-run) negative effects on economic performance (cf., e.g., Paldam 1997; Berggren 2000). For instance, even if a publicly run firm has efficient and creative managers, it will be more difficult to correct mistakes, e.g., to close down operations and exit, because of politics (see Eliasson 1990a, p. 285). The political aversion towards correcting mistakes depends on a number of reasons, e.g., the difficulties increase if the firm is a large employer in a sparsely populated area. iv) Political control and the power of the political system to define property rights and redistribute private property give rise to a negative incentive structure impinging on productive entrepreneurship and promoting the wrong rent-seeking behaviour (cf., e.g., Bhagwati 1982; Baumol 1990).

The theory of the EOE and Competence Blocs suggests that independent firms will grow faster than firms in enterprise groups. They will be less bureaucratic and more flexible than firms in enterprise groups, among other things because they probably have fewer levels of decision making than firms in enterprise groups. Independent firms and firms in enterprise groups, respectively, might also have different ownership structures, in which entrepreneurs dominate independent firms to a larger extent, while bureaucrats (managers and salaried employees) have a larger influence on enterprise groups.

²⁸ Small firms might also function as a cost-efficient mechanism to identify, select and develop entrepreneurial and managerial talents. Mistakes can be less and learning costs lower in small firms because

In addition to testing the hypotheses of age and size, two more hypotheses are also tested in *Chapter 5*:

3. H_0 : Government ownership has no, or a positive effect on firm growth.
4. H_0 : Being a member firm of an enterprise group has no, or a positive effect on firm growth.

Our theory suggests that government ownership and being a member of an enterprise group affect firm growth negatively. I, thus, expect to reject these hypotheses.

Furthermore, the theory also states that many entries and exits (a high turnover rate) increase growth, because it increases the probability of discovering and selecting winners. Thus, the hypothesis:

5. H_0 : The turnover rate of firms has no or negative effect on industry growth

is tested in *Chapter 6*. The hypothesis is expected to be rejected, since the theory predicts that the turnover rate of firms has a positive effect on industry growth

The macroeconomic effects of the turnover of firms in the whole economy are simulated in *Chapter 7*. There may be a non-linear relation between firm turnover and long run economic growth. A too fast turnover of firms may destabilise the price mechanism and, eventually, cause a negative effect on GNP growth, particularly if the turnover of firms is unbalanced (there are large differences in the entry and exit rates). If exit is too slow compared to entry, factor prices may increase causing inflation and low economic growth. Hence, I “test” the hypothesis:

6. H_0 : Long term growth of firms is proportional to the rate of growth in turnover.

Theory suggests that long-term growth will eventually decrease when the rate of the turnover of firms increases. I, thus, expect to reject the hypothesis in favour of a non-linear relation between the rate of firm turnover and growth. This test is not done

small values are at stake (see Lucas 1978; Davis & Henrekson 1997).

econometrically, but through simulations on the Swedish micro-to-macro model (see further *Chapter 7*).

2.7 SUMMARY

I have introduced the theory of the EOE and Competence Blocs and related it to the fundamental problem of dynamic resource allocation and economic growth.

The theory defines the state space as all combinatorial possibilities and the business opportunity set as all profitable combinatorial possibilities. In a market economy, firms make profits through producing preferred goods more efficiently than their competitors, i.e., through exploring and exploiting the state space and the business opportunity set. The theory states that it is impossible for any person or group of persons to be perfectly informed about the business opportunity set because of the extremely large state space, tacit knowledge and bounded rationality. Efficient allocation of resources thus requires co-ordination of plans and activities without anyone having an overview over the whole economy. All investments are therefore seen as business experiments controlled by the economic actors in the competence bloc - the economy is experimentally organised. The economic problem becomes a problem of co-ordination, knowledge accumulation, information processing, competence and incentives, i.e., to give the economic actors incentives to efficiently co-ordinate their plans and activities in a situation when knowledge and information is grossly insufficient, and where economic performance is conditioned on the competence of the actors. The competence bloc defines the minimum set of different but supplementary competencies required to efficiently generate, identify, select, expand and exploit new combinations.

The economic actors establish firms to commercialise business ideas (innovations). The EOE and Competence Blocs theory conceptualises the firm as a competent team co-ordinated by top management, an experimental machine and an organisational decision unit with financial objectives. Firms continuously make internal reorganisations to introduce and adjust to new combinations. Depending on the circumstances and the skills of management; firms will enter, expand, contract or exit from the market. Resources will be allocated to expanding industries from declining industries. This industrial transformation generates macroeconomic performance (e.g., economic growth

and employment). Thus, the theory establishes a link between microeconomic activities and macroeconomic performance.

The theory motivates the study of the dynamic processes that generate economic growth. Particular emphasis is put on:

- i) *The importance of young and small firms for expansion and contraction.* The theory states that small and young firms enhance dynamics since they are more flexible and innovative than old and large firms. Young and small firms are therefore the major sources of firm and industrial growth.
- ii) *The role of C&C firm turnover (entry and exit) for C&C industry growth.* According to the theory, many entrants and exits increase the possibility to discover and select the winners, i.e., firms showing the fastest growth. A high turnover (many exits and entries) will have a positive effect on industrial growth.
- iii) *The effects of total firm turnover on aggregate economic growth.* Is it possible that (unbalanced) fast turnover of firms destabilises the economy causing low, or even, negative growth?

The theory used in this thesis is a recent contribution in the Swedish tradition of analysing industrial dynamics. A next step could be to make institutions explicit in the theory of the EOE and Competence Blocs. It would also be interesting to relate the theory of the EOE and Competence Blocs to Dahmén's concept of development blocks and the natural rate of interest of Wicksell.

CHAPTER 3 THE EXPERIMENTALLY ORGANISED ECONOMY AND THE COMPUTING AND COMMUNICATIONS TECHNOLOGY

3.1 THE COMPUTING AND COMMUNICATIONS TECHNOLOGY

Computing and communications technology includes two “families” of technologies that quite unexpectedly have been merging rapidly and dramatically during the last decade.

Computing technology encompasses a number of technologies that entered a new rapid development with the innovation of semiconductor technology. Some people date modern computing technology to the 1940s when the first general electronic vacuum-tube based computer, ENIAC (Electronic Numerical Integrator and Calculator), was introduced.²⁹ Others prefer to link the modern computer to the invention of the transistor, the advent of a semiconductor industry and the miniaturisation of computers (“microelectronics”). Hence, modern computing technology is only about half a century old. Originally, the computer was designed to perform automatic calculations. It was invented to compute - to help solve complex mathematical problems: “The ‘computer’ originally meant a *person* who solved equations; it was only around 1945 that the name was carried over to machinery.” (see Ceruzzi 1998, p. 1). Today, computing technology covers a more general area and also includes the automatic manipulation of symbols and representation of pictures. There are different types of computers, but in practice we mean a digital electronic computer. The semiconductors (“chips”) of the computer determine its capacity.

Communications technology comprises a number of technologies that make it possible to transmit information by, for instance, electromagnetic or optical methods (cf. Olsson 1996, p. 21). It has a somewhat longer history than modern computing technology. Tele means distance and telecommunications, hence, means communicating over distances. Historically, mankind has developed many different methods for communication over

²⁹ ENIAC was built for military purposes. Remington Rand built the first commercial computer, UNIVAC, in 1951.

long distances, such as smoke signals or flashing lights. Modern telecommunications technology, however, dates back to the second half of the 1900th century and the invention of the telegraph and the telephone.

The invention of the vacuum tube in 1922 made the electronic computer possible. This technology, however, gave the computer very limited capacity. The invention of the transistor in 1947 by John Bardeen, Walther Brattain and William Shockley at Bell Labs dramatically changed the situation and meant a revolution for computing technology and the computing industry. (The inventors were awarded the Nobel Prize in physics in 1956.) To begin with, the transistor and other devices, such as resistors were assembled on a printed-board assembly. Jack Kilby at Texas Instrument (awarded the Nobel Prize in physics in 2000) invented the integrated circuit – the chip – that integrates several transistors and other devices (e.g., resistors) and their functions on a chip (usually of silicon) in 1958. Just one year later, Robert Noyce invented the “planar process” – a method of producing flat transistors. The planar process was important for mass production and for applying the C&C technology on an industrial scale, since it made it possible to make the electrical connections in the same process as the making of the devices. The further development of the integrated circuit has proceeded rapidly, and today a chip consists of millions of transistors.

In 1955, Shockley moved from the East Coast to California and founded Shockley Semiconductor Laboratory. He was a talented person, but was well-known for being a difficult person to work with. Hence, eight engineers (the “traitorous” eight) led by Robert Noyce and Gordon Moore left Shockley Semiconductor Laboratory in 1959. The same year they started to work at Fairchild Semiconductor, a new division of Fairchild Camera and Instruments. A number of talented people soon left Fairchild Semiconductor to start new companies. In 1961 two of them founded Amelco. The same year, four more researchers left the company and founded Signetics. Other followers quit and founded National Semiconductor in 1967 and Advanced Micro Devices in 1969. Robert Noyce and Gordon Moore founded Intel in 1968, where the *microprocessor* was invented in 1971. Three years later, Intel introduced the second-generation microprocessors that made the personal computer possible. The “offspring” of Fairchild Semiconductor, the so-called “Fairchildren”, contributed significantly to the Silicon Valley “phenomenon” and the development of the C&C technology.

One may talk about four “milestones” of technological development, which each initiated new generations of computing: (1) the vacuum tube, (2) the transistor, (3) the integrated circuit and (4) the microprocessor (see Eliasson & Eliasson 1996a). The *first* generation of computers, based on vacuum tubes, was intended for research, and they were built and used by researchers at universities and technological institutes. The *second* generation of computers (from about the 1950s), based on transistors, was manufactured and sold on a commercial basis. They were mainly used by customers with a need to carry out huge (but not always complex) computations, e.g., banks, insurance companies and the government administration. The military was one important single customer. One of the first applications of the computer was to calculate the course of ballistic missiles. Later on, the U.S. program to be the first nation to put a man on the moon required large computing capacity. The Minuteman ballistic missile program was a huge initial customer of integrated circuits, and so on. The launching of the IBM system 360 in 1964 is considered to be the beginning of the *third* generation of computers. The third generation of computers broadened the market and was widely used in industries. Integrated circuits were used on an industrial scale. The *fourth* generation of computers uses large-scale integration technology (the microprocessor – a computer on a chip) and has become the “tool of everybody”.

Many actors predicted that very advanced supercomputers and the further development of memory chips would become the *fifth* generation of computers. Japan, for example, targeted their industrial policy according to these expectations. This prediction, however, turned out to be wrong. Instead, Eliasson (1996) argues that the merger of C&C technology into the Internet really is the *fifth* generation of computing. Even though the nature of the new technology was detectable, the explosive growth and use of the Internet was unexpected and came as a surprise to practically all. The development of the Internet illustrates the experimental character of a dynamic economy (see Eliasson 2001a).

The Internet (from the word internetworking) is a global network of networks interconnected and communicating with each other by the common protocol TCP/IP (Transmission Control Protocol/Internet Protocol). The Internet has a common structure of addressing information (see Olsson 1998, part two, p. 584). It descends from the establishment of ARPA (Advanced Research Projects Agency) in 1957, financed by the U.S. Department of Defence. The aim of ARPA was to develop ways to keep

communications open in case of a nuclear war. It also had the practical purpose of creating ways of sharing scarce computer resources. Twelve years later (1969) the project resulted in the precursor of the Internet, ARPANET – a network of communicating networks where no network dominated another. ARPA supported the development of the TCP/IP protocol that was adopted in 1980. The National Science Foundation then took over the financing of ARPANET and established a new network in 1986 with a similar structure connecting universities. The new network was also connected to the ARPANET, which was dismantled in 1988. In the beginning of the 1990s anyone could access the Internet, including those who intended to use it for commercial purposes. As late as in 1992, the Internet users were evenly distributed among governmental, educational, military, net-related, commercial and non-profitable organisations. Only three years later, commercial users totally outnumbered the others (see Ceruzzi 1998, p. 296). The explosive use of the Internet was fuelled by the development of the HyperText Transfer Protocol (HTTP), HyperText Markup Language (HTML) (for the movements of hypertext across networks) and the establishment of the World Wide Web (WWW). The WWW answered a need to navigate through the Internet and is basically a service for the search of information on the Internet. The initial version of the HTML and HTTP for the WWW was developed by Tim Berners-Lee at CERN, the European particle physics laboratory in 1990 to make it easier to search and share information. He was particularly interested in allowing communication over computers and software of different types:

The Web's major goal was to be a shared information space through which people and machines could communicate. This space was to be inclusive, rather than exclusive (Berners-Lee 1996, p. 70, taken from Ceruzzi 1998, p. 302).

The ideas behind the HTTP at least go back to an essay by Vannevar Bush in 1945 (see Ceruzzi 1998, p. 301). He was concerned about the over-abundance of information and how the development of new technology could be used to handle it.

In 1992, Marc Andreessen and Eric Bina at the University of Illinois began to develop MOSAIC, a browser that made it easier to search information on the WWW, and which helped to make the Internet popular. Two years later, they founded MOSAIC Corporation. However, the University of Illinois, where Andreessen studied when he developed the browser, claimed the right to the name MOSAIC and the company changed its name to Netscape Communications Corporation. At the moment, we are

right in the middle of the development of Internet, and the history of the fifth generation of computing has yet to be written.

This development makes many feel they are in the midst of an information and communications revolution that is changing the “whole world”. That may be true, but one should remember that this is not the first, and certainly not the last time the economic system is being transformed by new ways of producing and using information.

Throughout history, mankind has used some sort of C&C technology. The hand, the fingers, the joints and knuckles and the feet were among the earliest computing devices used. Later on, animal bones marked with notches were used as counting tools, the oldest found dating twenty thousand to thirty-five thousand years back. The word *calculation* probably originates from the primitive computation technique of using pebbles: the word for pebbles is *calculus* in Latin (see Ifrah 2000 for a survey of the use of numbers in history).

A revolution similar to today's took place in the Western World some 500 years ago. The triggering factor was Gutenberg's use of the printing press to print and distribute the bible on an “industrial” scale. Like today's computers, fax machines, etc., printing significantly lowered the cost of distributing information. This invention was in turn preceded by, and built upon, at least one additional major innovation, namely the invention and use of the printed word. The printed word followed different innovative paths in different societies with large consequences for economic development. The Europeans use about 25 characters in their written language, while the Chinese use thousands of characters. This made it more efficient to print and diffuse coded information in Europe than in China. It also made it easier to learn how to read (receive) and write (send) codified knowledge and messages. Among other things, this made it easier to build *receiver competence* (see Eliasson 1990b), i.e., expand the group of literate people that could read the printed word and act on the information. Altogether, the better use, exploitation, and development of the information and communications technology and C&C industry in medieval Europe helps to explain Europe's faster economic growth compared to that in, e.g., China. Crosby (1997), in fact, argues that the progress in the knowledge to quantify and calculate that took place in the 13th century in Europe explains why the Western World outperformed India and China, then the two richest societies in the World.

In the long run the invention of the printed word and the printing press radically changed the orientation of, and raised the rate of, technical progress, the accumulation of knowledge, and the organisation of work in society. It pushed and made widespread literacy possible, it changed the power balance between groups and countries and it made it possible to argue and diffuse new ideas and ideals. Then, as now, rulers and established pressure groups tried to restrict the flow of the free word (cf. the present policies of the rulers in, for instance, China, Cuba and North Korea). However, like today, societies that had the ability to enhance the use and development of the information and communications technology experienced faster economic growth and took on a leading position, both politically and economically. Thus, one must not forget that there are historical parallels to today's information "revolution", even though today's revolution may move faster. The art of printing was the same for 350 years, while today's information technology is characterised by a much faster technological turnover.

3.2 C&C TECHNOLOGY AND THE EXPERIMENTALLY ORGANISED ECONOMY

The theory of the EOE and Competence Blocs emphasises the role of information for the allocation of resources (see *Chapter 2*). Economic processes are based on the interaction of different actors that exchange information, the very special case of the lonesome Robinson Crusoe economy being the only exception. Economic actors need information to co-ordinate their plans and activities. Dynamic resource allocation may be described as the creation and use of information. The theory of the EOE and Competence Blocs, therefore, identifies a number of reasons to study C&C technology and the C&C industry that produces the hardware and software that carry C&C technology. C&C technology and industry:

- i) is a powerful device for the creation and allocation of knowledge and C&C technology plays a critical role in exploring and expanding the state space and the business opportunity set. Hence, it is a major source of innovation and creative destruction, and of industrial and economic development. The recent development of the C&C technology, for example, makes it possible to explore and exploit new fields of knowledge, like the human genetic code. The development of C&C technology does not only make it possible to open up previously unknown fields of knowledge, it also helps to speed up knowledge

generation and the diffusion of knowledge. This helps explain the accelerating development of new technologies. Thus, the theory of the EOE and Competence Blocs identifies the C&C technology (industry) as the perhaps most interesting technology and industry to study, since the allocation of resources is conditioned on C&C technology.

- ii) greatly influences the costs of information and communication processes, which are large. Eliasson (1990a) estimates information and communications costs to at least 50 per cent of all costs in large Swedish manufacturing firms. Wallis & North (1986) calculate the transactions sector in the U.S. to about the same size (more than 40 per cent). Information costs also dominate transformation costs because the costs for transformation of inputs to output depend on the information discovered and used to organise production and distribution.
- iii) is generic and used in all industries (see, for instance, Cortada 1996 for the generic application of the computer to different uses). This is an obvious conclusion in the theory of the EOE and Competence Blocs that is founded on the definition of the economic problem as a problem of information (and knowledge, competence and incentives as central components). Hence, all business activities *per definition*, involve information activities and then all organisations use C&C technology and C&C equipment. Therefore, the development of the C&C technology makes new organisations of production possible, and induces a radical change of production and distribution of goods and services in all industries.
- iv) is large and growing measured in terms of, e.g., employment (see *Chapter 4*).
- v) makes clear the distinction between, for instance, traditional static general equilibrium theory and theories recognising the importance of entrepreneurship, inventions etc. The former assumes information to be freely available at (almost) no cost, the latter makes unavailability of critical and costly information a central analytical theme. Static general equilibrium theory in its original form assumes perfect information and perfect foresight, i.e., everyone knows everything about the present and future, and no resource use is associated with this perfect knowledge. For obvious reasons, such assumptions leave no place for a C&C industry that builds its existence on the necessity of knowledge and information. This puts new light on the old debate about socialism and central planning between Friedrich von Hayek and Ludwig von Mises on the one side and Oskar Lange on the other. Oskar Lange used traditional general equilibrium arguments

when he advocated the advantages of central planning and socialism. Criticised, among others by Hayek, for not taking the problem of costly and complex information into account he argued that computers would solve the informational problems:

Were I to rewrite my essay today my task would be much simpler. My answer to Hayek and Robbins would be: so what's the trouble? Let us put simultaneous equations on electronic computer and we shall obtain the solution in less than a second. Lange (1967, p.158 in Caldwell 1997).

This is a logical theoretical conclusion of traditional equilibrium analysis, since this theory assumes a well-defined and limited state space. Computers and the C&C technology help agents to optimise and to choose the best solutions *within* a transparent (or almost so) state space. However, practical experience of the lack of information and the use of C&C technology tells the opposite story, namely that the modern information revolution has, in fact, made it much more difficult to carry out central planning. Traditional equilibrium theory, thus, is misleading (see, e.g., Caldwell 1997 for arguments). The paradox that the C&C technology makes it more difficult to centrally plan the economy is easily explained within the theoretical framework used in this thesis. It takes its starting point in the problem of information and knowledge. It emphasises the economic process as an open-ended process, where the traditional concept of equilibrium becomes misleading. Modern C&C technology expands the state space at such a high rate and in such unpredictable directions that a central planner cannot foresee the development. In fact, the standard argument that C&C technology and the Internet will make the economy and its markets increasingly transparent may all be wrong, since the same technology simultaneously and radically changes the state space (Eliasson 1999a). Furthermore, the new technology works as a catalyst on the knowledge-generating process, speeding up the creation and diffusion of new knowledge. However, the ability (see Simon 1990) of the human brain to receive, analyse and act on information has been the same for thousands of years, in spite of the development of the C&C technology. Hence, the C&C technology reduces the costs for each individual to get informed, implying that each individual has access to more information than ever, while at the same time the ability of individuals to understand and act on the information is the same due to limitations of the brain. In other words, the information processes outside the human brain goes faster and faster while the brain's C&C technology remains

constant. Information is created and changed faster than the individual can learn. He or she will steadily get more educated in an absolute sense, but increasingly ignorant in a relative sense (cf. the knowledge paradox in the previous chapter).

Note that it is only with a theory that recognises the fundamental role of information (allowing for dynamic changes of the state space) that the critical importance of C&C technology can be fully understood.

3.3 SUMMARY

C&C technology comprises two families of technologies; the telecommunications technology, that makes it possible to transmit information by electromagnetic or optical systems, and computing technology that encompasses a number of technologies based on the semiconductor technology. The theory of the EOE and Competence Blocs motivates the study of the C&C technology and the C&C industry that produces and carries the C&C technology in several ways, for instance:

- i) The C&C technology is a device to create and allocate knowledge, i.e., to explore and enlarge state space.
- ii) Information (transactions) costs are large and the development of the C&C technology has a major bearing on these costs. Information costs also dominate transactions costs in the sense that transaction costs depends on the information discovered and used to organise production.
- iii) It is also interesting from a theoretical point of view because different theories represent divergent views of the role of information on resource allocation.

CHAPTER 4 THE DEFINITION AND SIZE OF THE SWEDISH COMPUTING AND COMMUNICATIONS INDUSTRY

4.1 THE DEFINITION OF C&C AND IT INDUSTRIES

There is no generally or internationally accepted definition of the C&C industry. Ongoing work, e.g., in the Nordic countries aims at developing internationally comparable definitions (Nordic Councils of Ministries 1998a,b). Statistics Sweden (SCB) and The National Board for Industrial Development (NUTEK) used the following definition when they first gave IT firms and IT industry a statistical identity (SCB 1992, p. 5):

By information technology is meant technology that utilises microelectronics for collecting, storing, working upon and retrieving as well as the communication and presentation of data, text, pictures and sound.

This definition excludes certain activities, e.g., traditional postal services, but it covers the C&C technology. According to this definition, the IT industry (see NUTEK 1996a) can be divided into:

- i) C&C manufacturing firms,
- ii) telecommunications firms,
- iii) firms that trade in C&C equipment, and
- iv) data consulting and data services firms.

One can discuss whether firms that trade in C&C equipment should be included in the IT industry or not. This is, however, currently the case and there seems to be no good reason to depart from that definition. If firms that trade in C&C equipment are excluded we get the "core" C&C industry that produces and carries C&C technology.

Statistics Sweden compiles data on the number of firms and employment in different industries. The measurement of the size of the C&C industry is based on these data. For later years, data are published, but not for earlier years. Statistic Sweden has provided me with data from published as well as unpublished sources (Statistics Sweden 1973-1999).

Until 1993, data were classified according to SNI69,³⁰ which corresponds to the ISIC classification system of the United Nations.³¹ However, ISIC is not used by the European Union, and Sweden, therefore changed classification systems to SNI92 in 1993.³² SNI92 is the Swedish counterpart to the industrial classification system used in the European Union, NACE³³ Rev. 1. The change of classification systems makes it difficult to make any detailed analysis of the C&C industry before 1993. *Section 4.3*, however, studies the growth of the C&C industry since the beginning of the 1970s by chaining the two data sources at a high level of aggregation. 1973 is the first year data are classified at a level sufficiently disaggregated to make it possible to identify the industries comprising the C&C industry as we define it.

SNI92, like SNI69, is an *activity*-based industry classification. That means that units of production – establishments and firms – are classified in industries according to the *activity* conducted in the production unit. Activity is defined as the *process* where different factors of production (raw material, real capital, labour etc.) and combinations of these are used to produce goods and services. Hence, the firms (and establishments) are classified into industries according to the nature of the process of production. In practice, however, one generally lets the goods and services (the output) represent the process of production (SCB: MIS 1992:6).

The empirical chapters that follow either use the definition of the C&C industry or the definition of the IT industry, depending on the problem and the availability of data. As will be discussed in *Section 4.3*, data on the industry that trades in C&C equipment are not available prior to 1993. It is, hence, impossible to measure the IT industry prior to 1993. The historical analysis in this chapter on data before 1993, therefore, uses the C&C-industry definition. The econometric analyses carried out in *Chapters 5* and *6* are based on a data set beginning in 1993, and thus use the IT-industry definition. Even so, data on the C&C industry will often be presented separately.

³⁰ "Standard för svensk näringsgrensindelning" established 1969.

³¹ International Standard Industrial Classification of All Economic Activities.

³² "Standard för svensk näringsgrensindelning" established 1992.

³³ Nomenclature Générale Activités Economiques dans les Communautés Européennes.

4.2 THE SIZE OF THE SWEDISH C&C AND IT INDUSTRIES

The manufacturing C&C industry includes the manufacturing of office machinery (SNI92: 30010), computers (SNI92: 30020), electronic components (SNI92: 32100), television, radio transmitters and telephones (SNI92: 32200), television and radio receivers (SNI92: 32300), instruments for measuring (SNI92: 33200) and industrial process control equipment (SNI92: 33300); see *Table 4.1*.³⁴

The telecommunications industry includes network stations (SNI92: 64201), broadcasting stations (SNI92: 64202) and cable television companies (SNI92: 64203).

The data consulting and data services industry consists of hardware consulting companies (SNI92: 72100), software consulting companies (SNI92: 72201), software supply companies (SNI92: 72202), data processing companies (SNI92: 72300) data base companies (SNI92: 72400), repair shops for computing machinery (SNI92: 72500) and other data service companies (SNI92: 72600).

The industry that trades in C&C equipment includes reproduction of computer media (SNI92: 22330), agents selling computer equipment (SNI92: 51142), wholesale of radio and TV goods (SNI92: 51432), wholesale of office equipment (SNI92: 51640), wholesale of telecommunications equipment (SNI92: 51653), radio and television stores (SNI92: 52452), stores for computers (SNI92: 52493), stores for telecommunication equipment (SNI92: 52494) and companies for renting office equipment (SNI92: 71330).

³⁴ Numbers in parentheses refer to industry code according to the Swedish industrial classification system established in 1992 (SNI92).

Table 4.1 The Swedish C&C and IT industries 1993 and 1999, definition and size (employees)

Industry code	Industry	1993	1999	Change 1993-99	Change 1993-99 (%)
Manufacturing C&C industry					
30010	Office machinery	1,559	1,372	-187	-11.99
30020	Computers etc	5,419	2,420	-2,999	-55.34
32100	Electronic components	4,037	7,184	3,147	77.95
32200	Television, radio trans., telephones etc.	24,157	32,089	7,932	32.84
32300	Television and radio receivers, etc	1,133	3,984	2,851	251.63
33200	Instruments for measuring, etc	8,227	12,813	4,586	55.74
33300	Industrial process control equipment	1,518	2,030	512	33.73
Total: Manufacturing C&C industry		46,050	61,892	15,842	34.40
Industry that trade in C&C equipment					
22330	Reproduction of computer media	19	114	95	500.00
51142	Agents: Sale of computer equipment	222	422	200	90.09
51432	Wholesale: Radio and TV goods	2,088	1,790	-298	-14.27
51640	Wholesale: Office equipment	19,930	23,021	3,091	15.51
51653	Wholesale: Telecommunication eq.	5,096	7,006	1,910	37.48
52452	Retail: Radio and television stores	4,321	4,778	457	10.58
52493	Retail: Stores for computers etc.	1,031	2,302	1,271	123.28
52494	Retail: Stores for telecommunication eq.	102	1,349	1,247	1,222.55
71330	Companies for renting office eq.	969	227	-742	-76.57
Total: Industry that trade in C&C equipment		33,778	41,009	7,231	21.41
Telecommunications industry					
64201	Network stations	38,657	23,837	-14,820	-38.34
64202	Broadcasting stations	19	898	879	4,626.32
64203	Cable television companies	644	376	-268	-41.61
Total: Telecommunications industry		39,320	25,111	-14,209	-36.14
Data consulting and data services industry					
72100	Hardware consulting companies	1,153	3,115	1,962	170.16
72201	Software consulting companies	18,288	42,053	23,765	129.95
72202	Software supply companies	3,462	10,537	7,075	204.36
72300	Data processing companies	5,346	8,155	2,809	52.54
72400	Data base companies	843	918	75	8.90
72500	Repair shops for computing machinery	2,464	1,930	-534	-21.67
72600	Other data service companies	369	710	341	92.41
Total: Data consulting and data services industry		31,925	67,418	35,493	111.18
Total: C&C industry		117,295	154,421	37,126	31.65
Total: IT industry		151,073	195,430	44,357	29.36

Note: The C&C industry is defined as the sum of manufacturing C&C industry, telecommunications industry, and data consulting and data services industry.

Source: Statistics Sweden (Bastakta, various years) and own calculations.

Swedish C&C industry employed somewhat more than 154,000 persons in 1999, *Table 4.1*. Employment increased with close to 37,000 persons or more than 31 per cent from 1993. The Swedish IT industry employed some 40,000 person more, i.e., about 195,000

employees in 1999. That is an increase by more than 44,000 persons (about 30 per cent) from 1993, when this industry employed about 151,000 employees.

Data consulting and data services industry reports the fastest growth, both in terms of the number of employees (more than 35,000 persons) and in terms of the percentage change (more than 100 per cent). The rapid growth of data consulting and data services industry has made it the largest C&C industry, employing more than 67,000 persons in 1999 (in 1993 it was the smallest). Software consulting companies (SNI92: 72201) comprise the bulk of employment in data consulting and data services industry, more than 42,000 employees.

Manufacturing C&C industry and industry that trade in C&C equipment employed about 62,000 and 41,000 persons, respectively in 1999. Firms manufacturing television sets, radio transmitters and telephones (SNI92: 32200) employed 32,000 persons in 1999 and dominates the manufacturing C&C industry. Wholesale of office equipment (SNI92: 51640) is the largest industry within the industry that trades in C&C equipment (23,000 employees).

The telecommunications industry employed the fewest persons, or about 25,000 employees in 1999, and is totally dominated by network stations (SNI92: 64201) that employed about 24,000 persons.

The manufacturing C&C industry has also grown fast. Employment increased by more than 15,000 persons, more than one third. Employment also increased in firms that trade in C&C equipment – by more than one fifth (about 7,000 persons). The telecommunications industry shows a very different development, and employment decreased by more than one third, or 14,000 persons, during the six-year period.

The growth pattern at a more detailed level is very different. The highest growth in per cent (more than 4,000 per cent) is reported in the industry for broadcasting stations (SIN92: 64202). This is explained by quite a modest increase in the number of employees (less than 900 employees) from a very low starting point (19 employees). Software consulting industry (SNI92: 72201) reports the largest growth of the number of employees, some 24,000. That is also a substantial relative increase of more than 100 per cent. This is an extraordinary growth rate for such a large industry – it employed almost

20,000 persons in 1993. Another large industry, manufacturing of television, radio transmitters and telephones (SNI92: 32200), increased employment by one third (some 8,000 employees) from 24,000 to 32,000 employees. The industry for manufacturing of computers (SNI92: 30020) decreased the most in per cent and lost more than half of its workforce. The largest decrease in number of employees is reported in the industry for network stations (SNI92: 64201), close to 15,000 persons (about 40 per cent). Among the 26 industries, only five showed negative growth during the studied time period.

The fast growth of C&C- and IT-industry employment stands in sharp contrast to the growth of total employment in the whole economy, which increased about 1.5 per cent, or the growth of total employment in total manufacturing, which increased about 4 per cent during the same six-year period.³⁵

The C&C industry accounted for about 4.4 per cent and the IT industry for about 5.5 per cent of total employment in 1999 (see *Table 4.2*). That is an increase by about 30 per cent since 1993.³⁶

Table 4.2 The share of the C&C and IT industries of total employment

	1993	1999	Change (%)
C&C industry	3.33	4.38	31.65
IT industry	4.29	5.55	29.36

Source: Statistics Sweden (BASFakta, various years) and own calculations.

Since there are no unambiguous definitions of the C&C and the IT industries in the literature, research abounds with different definitions, and there are many different estimates of their size. Early contributions to the discussion and understanding of the economic importance of the new technology were made by e.g., Machlup (1962) and Machlup & Mansfield (1983). Porat (1977) suggested a definition of the IT industry according to occupation, later used by the OECD (1987), which observed a steadily

³⁵ Total employment was 3,467,579 in 1993 and 3,523,834 in 1999. Total employment in manufacturing was 688,275 and 715,031 the same years (*Source:* SCB BASFakta 1993 and 1999). That means that C&C industry was about one fifth of the size of manufacturing industry and IT industry about one fourth of the size of manufacturing industry.

³⁶ To my knowledge, data on value added in the Swedish C&C and IT industries are only published for the single year 1998. This year, the C&C industry accounted for about 5.3 per cent and the IT industry for about 6.5 of total GDP (*Source:* Statistics Sweden 2001, Table 241, p. 222 and own calculations).

increasing share of the information sector so defined.³⁷ Eliasson (1990b, p. 13 and *Table I*), on the other hand, defines the IT industry according to the fundamental information activities performed, that is co-ordination, innovation, selection and learning. By this definition he estimates the IT industry to be at least 50 per cent of GDP in 1985. Through more refined measurement he argues almost all economic activities will become information- and communications-based (op. cit. p. 57).

4.3 HISTORICAL GROWTH OF THE SWEDISH C&C INDUSTRY - STATISTICS

The change of classification system in 1993 makes it difficult to study the historical development of the IT- and C&C-industry, particularly at a disaggregated level. To carry out such an analysis, industries defined as IT and C&C industries in the SNI92 classification system have to be approximated with and linked to the corresponding industries in the SNI69 classification system. This is generally a tricky task and sometimes impossible (see Eliasson & Johansson 1999, pp. 164-168 for details).

However, the telecommunications industry (comprising SNI92: 64201, SNI92: 64202 and SNI92: 64203) corresponds to SNI69: 72002 (telecommunications industry) exactly.

The manufacturing C&C industry in the SNI92 classification system, on the other hand, is approximated with SNI69: 382510 (manufacture of computer equipment), SNI69: 38590 (manufacture of other office and accounting machinery), SNI69: 383200 (manufacture of radio, television and communication equipment and apparatus) and half of employment in SNI69: 385100 (manufacture of professional and scientific, and measuring and controlling equipment not elsewhere classified).

Finally, data consultants and data services is approximated with SNI69: 83230 (data processing and tabulating services).

³⁷ OECD also found large differences in the size of the information sector between countries, mainly due to differences in the number of information processors. For example, the information occupations accounted for about 45 per cent of all economically active persons in the USA, but less than 35 per cent in Germany.

SNI92 industries that trade in C&C equipment are so mixed up with other industries in the SNI69 classification system that it is impossible to identify them in the SNI69 classification system. Hence, it is impossible to study the industry that trades in C&C equipment before 1993. Therefore, it is also impossible to follow the IT industry, which is defined as the C&C industry and industry that trade in C&C equipment, further back in time than 1993.

Figure 4.1 shows the historical employment in the Swedish C&C industry between 1973 and 1999. The total C&C industry was quite large already in 1973, when it employed about 100,000 persons. The industry expanded during the 1980s, to employ close to 130,000 persons in the end of the 1980s. In the beginning of the 1990s, Sweden was hit by the worst recession since the 1920s and GDP growth was negative three years in a row. This is reflected in C&C-industry employment, which decreased to some 112,000 persons in 1994. Employment started to recover in the mid-1990s and is now larger than ever, employing some 155,000 persons in 1999.

Figure 4.1 Employment in the Swedish C&C industry, 1973-1999

Note: Man = manufacturing C&C industry, Tele = telecommunications industry, Data = data consulting and data services industry, and C&C = total C&C industry, i.e., the aggregate of manufacturing C&C industry, telecommunications industry and data consulting and data services industry.

Source: Statistics Sweden (Baskfakta various years) and own calculations.

Growth of the C&C industry has mainly occurred in the data consulting and data services industry. In 1973, it employed some 4,000 persons. Twenty-six years later it employed about 67,000 persons, i.e., it grew by more than 63,000 persons or a remarkable 1,500 per cent. The data consulting and data services industry did not grow so much during the 1970s. Growth levelled off during the 1980s and continued to rise during the 1990s. Employment was about 7,000 at the end of the 1970s, about 25,000 in the end of the 1980s and close to 70,000 persons in 1999. The remarkable strength of the development of the data consulting and data services industry was demonstrated in the beginning of the 1990s, when it continued to expand in spite of the recession. The continuous and forceful expansion made this industry the largest C&C industry in 1999. That is a profound difference compared to 1973, when it was negligible in terms of employment. This is not surprising, considering that the software industry was newly established in 1973. The industry began to develop in December of 1968, when IBM, under pressure from the U.S. government, decided to sell software and hardware separately, i.e., to “unbundle” software from hardware (Ceruzzi 1998, pp. 106-108). A rapid expansion was initiated with the PC revolution. The development of software also had limited priority in the beginning of the computer era. The first computers were slow and the capacity was very limited. At first, the hardware was the bottleneck, and the first decades of computing resources were mainly used to develop the hardware. Only when hardware capacity had been significantly improved in the late 1960s, software became a critical factor.

The manufacturing C&C industry is slightly larger in 1999 than in 1973. Employment has increased by about 7,000 persons, to 60,000 from 53,000. Employment reached a peak (close to 60,000 persons) in the mid-1970s, to fall back and reach a new peak at about the same level of employment in the mid-1980s. The recession at the beginning of the 1990s hit manufacturing C&C industry hard, and employment decreased to 46,000 persons in 1993. The industry recovered and expanded its employment from the mid-1990s, to reach its highest employment level ever, close to 62,000 employees, in 1999.

Employment in the telecommunications industry has decreased almost constantly since 1973. The telecommunications industry employed about 40,000 persons during the 20-year period 1973 to 1993; thereafter, employment decreased sharply (more than one third) to about 26,000 persons in the mid-1990s. After that, employment first increased a

little but once again to fell back to the current level of about 25,000 persons. This reflects the variation in Telia's (previous *Televerket*) employment.

Total C&C employment has grown more than 50 per cent since 1973 (see *Table 4.3*). This is more than total employment in the whole economy, which has grown by 48 per cent. Employment growth in the whole economy is largely due to expansion of the public sector, while employment growth in the C&C industry is mainly due to expansion in private firms.³⁸ The growth of manufacturing C&C industry by 16 per cent stands in contrast to the decline of the total manufacturing industry, where employment has fallen by about one fourth. The telecommunications industry lost about 40 per cent of employment. Data consulting and data services industry has grown by about 1,500 per cent, an exceptional growth rate. It is also remarkable to observe that there are no signs of a slowdown of the growth rate in the data consulting and data services industry. On the contrary, growth seems to have accelerated during the last years, cf. *Figure 4.1*.

Table 4.3 Employment in the whole economy, in total manufacturing and in the C&C industry in 1973 and 1999

	1973	1999	Change	Change (%)
Manufacturing C&C industry	53,464	61,892	8,428	16
Telecommunications industry	42,372	25,111	-17,261	-41
Data consulting and data services industry	4,226	67,418	63,192	1,495
C&C industry	100,062	154,421	54,359	54
Total manufacturing	961,507	715,031	-246,476	-26
Total employment, all sectors	2,377,203	3,521,852	1,146,631	48

Source: Statistics Sweden (Bastakta, various years) and own calculations.

The number of firms in the Swedish C&C industry was about the same to the end of the 1970s (somewhat more than 1,000 firms); see *Figure 4.2*. Thereafter, it increased steadily to about 9,000 firms at the end of the 1990s. There is a small decrease in the number of firms in the beginning of the 1990s reflecting the severe economic crisis that hit the Swedish economy 1991-1993. The end of the crisis, however, initiated a new period of growth in the number of firms, which peaked in 1998 with more than 20,000 firms.

Figure 4.2 clearly shows that the large increase in the number of C&C firms is primarily due to the increase in the number of data consulting and data services firms. In 1973, there were less than 400 such firms. Twenty-six years later there were more than 18,000

³⁸ Since 1950 all employment growth (net) has taken place in the public sector (see Jacobsson 1998).

of them (an increase exceeding 4,500 per cent), making up 90 per cent of all C&C firms. This is a profound increase since 1973, when data consulting and data services firms comprised about one third of the total number of C&C firms.

The number of manufacturing C&C firms increased about 100 per cent (from about 800 to about 1,700 firms), and the number of telecommunications firms increased about 1,100 per cent (from 25 to 300 firms) between 1973 and 1999. That means that manufacturing C&C industry decreased its share of the total number of C&C firms from two thirds to less than one tenth. The telecommunications industry decreased its share of the total number of firms from about 2 per cent to less than 1.5 per cent.

Figure 4.2 The number of firms in the Swedish C&C industry, 1973-1999

Note: Man = manufacturing C&C industry, Tele = telecommunications industry, Data = data consulting and data services industry, and C&C = total C&C industry, i.e., the aggregate of manufacturing C&C industry, telecommunications industry and data consulting and data services industry.

Source: Statistics Sweden: (BASFakta, various years) and own calculations.

An interesting question is whether the recent turmoil in the C&C industry that has occurred after the time period studied in this thesis is the industry shake-out of a mature industry that Klepper discusses (see, e.g., Klepper & Grady 1990, Klepper 1996 and Klepper & Miller 1996).

4.4 SUMMARY

There is no unambiguous definition of the C&C industry. This thesis defines it as the aggregate of firms in the economy that produce computing and communications equipment and services. That is, the term here refers to firms that produce equipment and services based on the C&C technology. This technology utilises microelectronics to collect, store, work with and retrieve as well as to communicate and present data, text, pictures and sound. So defined, the C&C industry comprises firms that manufacture C&C equipment, telecommunications firms and data consulting and data services firms. The IT industry, in addition to this, also includes firms that trade in C&C equipment besides the C&C industry.

In 1999, the C&C industry employed some 154,000 persons and the IT industry some 195,000 persons. Data consulting and data services industry was the largest C&C industry (a bit more than 67,000 employees), followed by manufacturing C&C industry (close to 62,000 employees) and telecommunications industry about (25,000 employees). The industry for trade in C&C equipment employed 41,000 persons. The C&C industry employed ca. 4.4 per cent of total employment and the IT industry about 5.5 per cent of total employment.

The data consulting and data services industry grew tremendously since 1973 (the first year data exist) from 4,000 to 67,000 employees or 1,500 per cent. This industry started to grow rapidly when IBM was forced to unbundle its software from hardware in the end of the 1960s. Also, in the beginning of the computer era hardware was the bottleneck. By the end of the 1960s development of hardware had gone so far that software started to become the bottleneck, thus, initiating an industry for the development of software.

Telecommunications industry reports an opposite development and declined by 41 per cent, or more than 17,000 persons. Manufacturing C&C industry increased employment slightly by a bit more than 8,000 persons to some 62,000 from 53,000 (16 per cent). Hence, growth is very heterogeneous within the C&C industry. During the 26-year

period from 1973 to 1999 the C&C industry grew by 54 per cent (about 54,000 employees) from 100,000 employees to 154,000 employees.³⁹

It is to be noted that the number of C&C firms increased sharply during the same time period, notably data consulting and data services firms. In 1973, there were about 1,200 C&C firms and in 1999 more than 20,000, an increase exceeding 1,600 per cent.

The number of data consulting and data services firms increased by more than 4,500 per cent (from less than 400 in 1973 to more than 18,000 in 1999).

³⁹ Sweden changed classification system in 1993 and it is not possible to approximate the industry that trades in C&C equipment with any industry in the preceding classification system. Therefore, it is impossible to report the growth of the IT industry further back than 1993.

CHAPTER 5 FIRM SIZE, FIRM AGE AND FIRM GROWTH

5.1 INTRODUCTION

For a long time many economists neglected the role of new and small entrepreneurial firms in generating employment and economic growth. Entrepreneurship and new entry was often considered to be of little relevance. The so-called Bolton report (HMSO 1971) was one of the first international studies to emphasise the lack of small-firm dynamics as an explanation to the economic problems in Great Britain (see also Stanworth & Gray 1991). However, only when Birch (1979; see also Birch 1981 and 1987) published his results, the role of small- and medium-sized firms was thoroughly placed on the current research agenda. *First*, Birch compiled a database that made it possible to study the role of small and medium-sized firms in the growth process. *Second*, he found - at the time an unexpected “discovery” - that small and medium-sized firms were major job contributors.

Birch’s result triggered numerous studies, several of which were critical to his method and results; see, e.g., Storey & Johnson (1987), Brown, Hamilton & Medoff (1990) and Haltiwanger, Schuh & Davis (1994). Later research has, however, confirmed his major results that small firms create most of the new jobs.⁴⁰ Mounting evidence currently supports the importance of small firms for employment, industrial renewal and economic growth. One early and well-known example is the success of mini mills in the U.S. steel industry that expanded their businesses rapidly, while large established firms in the steel industry declined (Acs 1984) – at that time a striking empirical finding considering the theoretical emphasis on economies of scale. Further research documents a negative relationship between firm age and firm growth and between firm size and firm growth (see, e.g., Evans 1987a, b; Dunne *et al.* 1987). In line with this result, numerous studies conclude that small firms create a disproportionately large share of new jobs, on net (see, e.g., Davidsson *et al.* 1994a, b, 1996; US Small Business Administration 1987). Kirchhoff

⁴⁰ The relationship between firm size and firm growth has also been studied in the tradition of Gibrat (1931) who postulated that an increase in a firm’s size would be proportional to its current size; see Sutton (1997) for an overview.

(1994) observes that especially small high-tech firms⁴¹ (e.g., pharmaceutical preparations and data processing services) stick out as high performers.⁴² Expanding new and small firms contributed most to net job creation in the beginning of the 1990s in Europe. Large firms, on the other hand, dominated contractions and layoffs (Commission of the European Communities 1998). A recent study shows a positive relationship between the proportion of small-business employment in U.S. States and total employment (see Robbins *et al.* 2001). See, e.g., Eliasson (1991b), Storey (1994), Acs (1996b), Admiraal (1996), OECD (1996), and Whittaker (1997) and Acs *et al.* (1999) for reviews of and empirical evidence on the importance of small firms in macroeconomic growth. In line with this, research has, furthermore, documented a shift towards an increased share of production carried out by small firms in the Western World the last three or so decades (see, e.g., Brock & Evans 1986; Brock & Evans 1989; Carlsson 1989, 1992; Loveman & Sengenberger 1991; Acs 1996a; OECD 1996).

A shift towards small-scale production has also been documented in Sweden. For example, Davidsson *et al.* (1994a,b, 1996) find that small firms generated an unproportional share of net jobs compared to their share of total employment from 1984 to 1996. However, Sweden seems to differ from the international pattern in some respects. Carlsson (1992) and Henrekson (1996), for example, argue that the shifts towards smaller firms occurred much later in Sweden than in other countries. The Swedish size distribution of firms and employment is also skewed towards larger firm compared to other countries (see, e.g., Johansson 1997; Henrekson & Johansson 1999a). For a long time, a few very large and old multinational firms have dominated Swedish industry, practically all of them founded around the beginning of the 20th century or earlier. This is not only so in traditional manufacturing and basic industries, but surprisingly it also seems to be the case in the IT industry, where the brightest shining star Ericsson was founded in 1876.⁴³ One would expect the dynamic and innovative IT industry, if any industry, to provide the right environment for small and innovative firms

⁴¹ Defined as firms with above-average shares of scientists and engineers of total employment and spending above average percentages of total revenues on research and development.

⁴² This was so in spite of the fact that he excluded firms with extreme growth to make a careful investigation of the role of new and small firms, e.g., Apple Computers— one of the most successful and fast growing newcomers. Thus, Kirchhoff's investigation actually underestimates the role of new and small firms.

⁴³ In 1998, Ericsson together with Telia, which was founded in 1853 and then called Telegrafverket, accounted for more than one third of employment in the IT industry (see NUEK 2000, p. 51 and own calculations).

to become large rapidly. In the United States, for example, most fast-growing and successful IT firms are quite young and small (measured by the number of employees), e.g., Cisco, Microsoft and Intel. A number of studies also indicate that the generation and growth of new and small firms lag behind in Sweden (see *Chapter 8*).

In this chapter I mainly analyse the effects of firm age and firm size on firm growth in the Swedish IT industry. The chapter is organised as follows: *Section 5.2* gives a brief review of some of the literature on the importance of new and small firms. Data for the empirical analysis are introduced in *Section 5.3*. Descriptive statistics on employment in new and small firms is presented in *Section 5.4*. The next section (*Section 5.5*) introduces the econometric model used to test the hypotheses derived in *Chapter 2*. The econometric results are discussed in *Section 5.6*. The chapter ends with a summary (*Section 5.7*).

5.2 NEW AND SMALL FIRMS

Several explanations have been put forward for the (increased) importance of small firms for employment and GDP growth.

- In line with the analysis made in *Chapter 2* it is argued by for instance Acs (1992) that small firms work as “agents of change”. In many industries small firms are more innovative than large firms (Acs & Audretsch 1987a, 1987b, 1988, 1993), particularly in new and successful industries like computing equipment, where small firms contributed the bulk of innovations (Acs & Audretsch 1990a, b). They also seem to be more prone to explore new technological fields, while large and established firms explore and deepen established areas (see, e.g., Almeida 1999). For instance, start-up and smaller firms explore new and less crowded areas while large firms, on the other hand, deepened existing innovations and technological fields in the semiconductor industry (Almeida & Kogut 1997). There is also evidence that large firms dominate process innovations while small firms are better represented in product innovation. This is interesting since product innovations seem more important for long run growth (see, e.g., Acs *et al.* 1999).
- There is also a division-of-labour argument that small firms carry out some economic activities more efficiently than large firms. For example, large firms dominate markets where economies of scale are important, but there are markets for low-volume and

high-quality products that are more efficiently produced by small firms than by large firms (see, e.g., Pratten 1991). The argument also applies to the production of intangibles, such as innovations. Small firms have a higher productivity in research than large firms in some industries (see, e.g., Acs & Audretsch 1990a). This is partly explained by empirical findings suggesting that small firms exploit university-based research more efficiently than do large firms due to a less bureaucratic organisation (see, e.g., Link & Reese 1990 and Link & Bozeman 1991).⁴⁴ Another reason might be that there is a risk that the original idea of the inventor is watered out if it is separated from the inventor in too early a phase of the development, which is often the case when a large firm acquires and commercialises inventions (Stankiewicz 1986). Hence, research has shown that small firms have been the source of considerable innovative activity and enhanced industry evolution.⁴⁵

- One reason for the success of some small firms relative to large competitors is that old and large firms develop bureaucratic inertia, which increases with firm size and firm age (Hannan & Friedman 1984). The larger and older the firm, the more difficult to change the competence base of the research department, or the whole organisation.⁴⁶
- Acs *et al.* (1997) also presents evidence that small and new firms provide a better incentive structure than large and old firms. They argue that small firms are more prone to make radical innovations since they protect the property rights of innovators better (and are less affected by bureaucratic inertia) than larger firms.
- Coase (1937) introduced transactions costs in the analysis of firms and firm size. He stated that firms choose between organising their activities within the firm or using the price mechanism depending on relative transactions costs. The development of information and communications technology has lowered transaction costs. This has enhanced the scope for outsourcing and downsizing and increased the possibility for small-specialised firms to carry out production.

⁴⁴ This argument is supported by Nooteboom (1994) who argues that small firms do not have the resources to compete with large firms in routinised research. Instead, there are a number of reasons why they are more suitable for exploring radically new innovations and diversity, e.g., due to organisational differences.

⁴⁵ See Acs & Audretsch (1990a) and Acs (1996b) for a summary of the literature on innovations and small and large firms.

⁴⁶ Leastadius (2000) refines the argument and writes that radical technology very well can be accepted in large organisations provided that it is in line with, and enhances the current competence of the organisation and its employees. However, if the new technology challenges or destroys the competence base of the organisation it will meet resistance.

- Several authors suggest that global change in the world economy during the last decades favours small-scale production. Piore & Sabel (1984) argue that increased market instability promotes competitiveness, flexible specialisation and small firms. Carlsson (1992) is of the opinion that the nature and direction of technological change has generally favoured small-scale production and shows, in the case of flexible automation, that technological progress favoured small firms. Davis *et al.* (1996) conclude that production has shifted from industries dominated by large firms and establishments, e.g., manufacturing, to industries with small production units, e.g., services. Also, the demand for specialised and differentiated products typically produced by small firms increases with the wealth of the population, particularly in the Western World (see, e.g., Carree & Thurik 1999). The increased supply of labour (particularly in the U.S.) and the abolishment of regulations disfavouring entry and small-firm production also seem to have contributed to the re-emergence of small firms during the last decades (see Brock & Evans 1989 and Loveman & Sengenberger 1991).

Smallness has been demonstrated to be important. However, it might not always be the case that size is what makes small firms successful, but age. The majority of new firms is small, or very small. There are also a very large number of old firms that are (still) small. Hence, the effects of age and size tend to be blurred. It looks as if new firms are important for industrial renewal and innovative competitiveness. Entrants introduce new innovations and new firms play a critical role in the early life cycle of many industries, e.g., in electronics and biotechnology (see Baldwin & Johnson 1999).⁴⁷ However, when it comes to radical reshaping of industries the importance of new firms is revealed. Numerous studies document that new (and small) firms have introduced many of the radically new innovations that have created new industries and transformed others. Revolutionary inventions like the incandescent lamp (Edison), the microcomputer (Altair and Apple) and the microprocessor were introduced in new, small start-up firms. It is interesting to note that large and established firms were often offered the ideas but rejected them (Scherer & Ross 1990). The classical example is the haloid copying method that was presented to IBM by its inventor Chester Carlsson, but rejected. The haloid method was the technical foundation of Xerox. Hence, former employees established

⁴⁷ In line with this conclusion, Mölleryd (1999) shows that new firms played an important role in the development of Swedish mobile telephony.

many of the most successful firms in the U.S. when they could not get support for new ideas from their own employer. The transistor, for example, was invented at Bell Laboratories in AT&T. William Shockley left Bell Labs and started Shockley Semiconductors in Palo Alto in California. Several of his co-workers in turn left Shockley Semiconductors to establish Fairchild Semiconductors in 1957. Bob Noyce was employed at Fairchild Semiconductor and wanted to introduce changes in the organisation. Among other things he wanted to introduce a more “relaxed” corporate culture and an incentive structure including stock options for all employees. The owners, however, disapproved of his suggestions: “The formation of Intel in 1968 was the ultimate result of the divergence in beliefs about how to organise and manage a firm.” (Audretsch 1999, p. 28).⁴⁸

Geroski (1995, p. 431) summarises the empirical literature on new entry:

Numerous case studies have suggested that entry is often used as a vehicle for introducing new innovations (frequently because incumbents are more interested in protecting existing rents than seeking out new profits), and many show that entry often encourages incumbents to drastically cut slack from their operations (this is particularly the case in newly deregulated industries).

Many of the findings emphasise the complementary roles of small and large established firms. Large established firms, in particular, appear to succeed in traditional technological fields already based on large innovative activities, while new firms explore new technological areas with less innovative activities (see Almeida & Kogut 1997). Start-ups explore variety and diversity and new technological fields. Old firms explore technological fields with higher density of actors and activities:

While semiconductor startups continue to drive new design technologies, larger firms dominate in the manufacture of integrated circuits and the development of more mature segments of the industry. Thus, though innovation is driven by firms of all sizes, the entry of new firms continues to play an important role in new technology development (Almeida 1999, p. 41).

Researchers conclude that new and small firms contribute to diversity and the creation of radically new technologies and that they provide an understanding and flexible milieu for entrepreneurs (see, e.g., Acs *et al.* 1999).

Baldwin (1995) writes that traditional literature has treated entry either as an error-correcting mechanism or as a dynamic evolutionary process, but usually the former has

⁴⁸ Thus, the creation of Intel can be seen as a consequence of bureaucratic inertia.

been studied. He concludes, however, from theoretical and empirical studies that the latter is economically most important. Kirchhoff (1994) is of the opinion that the theory and methods of the dominant general equilibrium paradigm mislead (and still misleads) the economics profession into ignoring the importance of new and small firms. Therefore, economists make systematic theoretical and empirical mistakes in evaluating their importance for job creation, innovation etc. Acs (1984, 1999) who emphasises small firms as “agents of change” presents similar arguments. Since general equilibrium theory ignores change in the form of innovations, it cannot recognise the importance of new and small firms. This critique is shared by many other (small firm) researchers, e.g., Admiraal (1996).

It is interesting to note that Sweden has a long tradition in studying industrial dynamics. As early as 1950 Dahmén (1950) made a thorough and encompassing analysis of the dynamics of Swedish industry. It was advanced even compared to today’s empirical studies that use modern C&C technology. His pioneering investigation covered the full size-distribution of firms and all private industries, except services, and he summarised his results in the form of his theory of development blocks. He studied a variety of problems of current interest, for example, the spatial concentration of production, the origins of new firms, the importance of greenfield versus incumbent entry, the entrepreneurial background (previous occupation, social class, education, age etc.), the number of entrants and exits, the growth and decline of new and established firms, the importance of product versus process innovations, the financing of firms in their initial and later phases. Recent research has confirmed his findings, e.g., the importance of industrial dynamics (entry, expansion, contraction and exit of firms) and that product innovation is more important than process innovation in the long run. Du Rietz (1973, 1975, 1980; see also Hause & Du Rietz 1984) has carried out impressive empirical research on new firm establishment.

This empirical tradition based on microeconomic dynamics has largely faded away at Swedish university departments of economics. There might be a number of reasons for this. *First*, the increasing dominance of static general equilibrium theory killed theoretical interest in these types of research questions. There was no role for entrepreneurship in the original general equilibrium model. *Second*, since general equilibrium theory declares industrial dynamics to be uninteresting, researchers in this tradition do not study it empirically. For example, in the 1970s Eliasson was advised by his professional

colleagues to “turn off” the entry function from his empirical model of the Swedish economy (MOSES) - which he also did – because entry was considered “unimportant”.⁴⁹ Also, the methods applied in the general equilibrium model are not adequate for analysing dynamics. Moreover, the harder pressure to graduate within a certain time, together with the pressure to publish many articles brings no reward to the time consuming collection and analysis of empirical data that is required to understand industrial dynamics empirically (cf. Kirchhoff 1994 and others on the first and second point). *Third*, Dahmén, one of the “founding fathers” of the Swedish industrial dynamics tradition, was involved in industry as a senior advisor in Stockholms Enskilda Bank controlled by Wallenberg family. He never left research completely, but his research career very much ended with his appointment in the Wallenberg group. *Fourth*, large firms have long dominated the Swedish manufacturing industry, and it took a long time for both advocates for industry and politicians to understand the importance of small and new firms for industrial dynamics and growth. Tayloristic thinking emphasising large-scale production dominated the mindset of many. Hence, there was no interest in these types of questions and there was little financial support for studying industrial market dynamics. *Fifth*, one can also speculate about ideological reasons. During the 1970s and large parts of the 1980s the political climate was “leftist” and society adopted a mindset negative to entrepreneurship and, hence, to industrial dynamics uncontrolled by central government. Also, there was a strong belief in economies of scale and, hence, a positive attitude towards large firms. Accordingly, legislation and industrial policy increasingly favoured larger firm development and concentration. New organisations and institutions to secure controllability and economic efficiency were introduced, for instance, a ministry of industry in 1970. The tax take of the economy increased rapidly, rigid labour market regulations and the so-called “wage-earners” funds were introduced, the latter after intense lobbying from the central labour union (LO) which entertained the ambition to wrest power from the capitalists. In its original proposal the purpose of the “wage-earners” funds was to socialise all private Swedish industry. However, when the funds were finally introduced that purpose had been sufficiently watered down to give the central trade union (note: not its members, but their representatives) more influence in firms. In that political climate, the study of industrial dynamics was out of fashion. The importance of entrepreneurship and private equity ownership was hardly mentioned in the economic debate, and Keynesian macroeconomics with central government in

⁴⁹ Needless to say, the entry function has now been reintroduced.

control was the ruling ideology. Politicians should manage the firms, the firm managers should be responsible for employment. Private property rights were increasingly ignored. *Sixth*, the early contributors in this tradition mainly wrote in Swedish, which obviously restricted the interaction with the international research community.

A few economists, especially some associated with the IUI (the Research Institute for Industrial Economics), have been active in this Swedish tradition. Today, this tradition is mainly kept alive at the institutes of technology, e.g., at Chalmers and the Royal Institute of Technology (KTH).

5.3 THE DATA

The descriptive statistics and econometric analysis conducted in this chapter are based on a data set compiled by Statistics Sweden (*Statistiska Centralbyrån*; SCB) that comprises data sets from two registers of SCB: The Central Register of Firms and Establishments (*Centrala Företags- och Arbetsställeregistret*; CFAR) and Enterprises: Financial Accounts (*Företagen Finansstatistiken*; EFA). CFAR covers *all* firms (sizes, industries, legal forms etc.) in Sweden. This register, however, includes only limited information on individual firms, e.g., age and employment. It has mainly been used as a population register when conducting surveys on firms. Therefore, CFAR is supplemented with EFA that includes financial variables (income statements and balance sheets) on individual firms. EFA, however, only covers all firms from 1995 and onwards.⁵⁰ Before 1995 it excludes the bulk of manufacturing firms with less than 20 employees and the bulk of services firms with less than 50 employees. Until 1995 only a limited number of small firms were surveyed by a questionnaire. From 1995 and onwards, all firms are covered.

The data set covers 1993 to 1998 and contains yearly observations on individual firms in the IT industry. Sweden changed its classification system when adapting to the standards of the European Union in 1993. This makes it costly to follow individual firms further back in time. 1998 is the latest year for which data are available. Financial data were not available for 1997 and 1998.

⁵⁰ Note that sole proprietorships are not included in EFA, since they do not have income statements or balance sheets.

A firm is identified through its unique and permanent identification number, which is given to it when founded.⁵¹

Each firm has an “activity code” taking on three values, 0 – the business activity has not yet started, 1 – the firm has started its business activity, i.e., it is an active firm, and 9 – the firm has closed its business activity. To be considered active a firm has to be registered for value-added tax payments *or* registered as an employer. I define a firm as new the first year the activity code is set to 1. Similarly, a firm is defined as having exited when the activity code is changed to 9. The activity code is changed to 9, i.e., the firm has exited, when a firm is deregistered for value-added tax payments *and* deregistered as an employer. Firms that exited in 1993 are not included in my data set. Therefore, I cannot report any exit rates for 1993.

Observe that this definition of exit means that the legal unit – the firm – has exited, but not necessary that the production unit – the establishment – is closed down. The firm may, for instance, have been acquired by another firm that closed the legal form (i.e., an exit in my data) but kept the establishment for production. In fact, my data cannot tell what happens with the production unit, since my data do not cover establishments. SCB has got data on establishments, and it is possible to take establishments into account in the analysis of exit but this is very expensive and requires huge amounts of work involving experts from SCB. To my knowledge, Davidsson *et al.* (1994a, b, 1996) are the only researchers who have conducted such an analysis on Swedish data.

When taking the effects of establishment into account in the analysis of exit, researchers run into a number of new difficulties in defining exit and making new adjustments of data. For instance, is it an exit if an establishment for software consulting is closed, but employees immediately take their computers and start a new firm in the next building with the same customers? Compare this with the situation when the closedown of the establishment leads to unemployment for the employees at first, thereafter to them becoming employed at different employers with other customers, with new co-workers

⁵¹ SCB identifies firms according to their unique organisational number. By law, SCB is not allowed to give out the organisational numbers or the name of the firms because of secrecy. Therefore, SCB gives each firm a unique identification number equivalent to the organisation number. Hence, it is possible to identify and follow individual firms in my data set but not to identify the firms by name or organisational number.

and organised in another way. Certainly, the former “exit” is something different from the latter “exit”, which is more in line with what we usually mean with an exit. Obviously, there is a point in distinguishing between them, which is not possible when one only has data on establishments (and firms). One needs data on individual employees to be able to distinguish between these two examples of an exit. Actually, such data are available in Sweden. However, including them in the analysis requires much more computational work and is much more expensive than including establishment data into the analysis. To my knowledge no analysis on exits including data on individual employees have been carried out.

In fact, considering the importance of organisational change and of ownership and control according to the theory of the EOE and Competence Blocs, exit defined in the way of this thesis is a quite satisfactory alternative. An exit of a firm most probably reflects an exit of an owner and, thus, a change of ownership of resources. It always means an organisational change, since a closedown of the legal form of a “firm” is a type of organisational change itself. Since both changes in ownership and organisation affect growth, the definition of exit used in my analysis captures something in the economy that we are interested in.

The data set consists of annual observations on individual firms over the period 1993 to 1998. In other words, the data set consists of cross-sectional time-series data, so called panel data. The panel, however, is unbalanced, i.e., there are not observations on all firms all years. This is so because of the dynamics of firms, particularly the entry of firms. Many of the firms do not exist in the beginning of the period.

There are at most six observations on each firm (the firm has existed all six years), and one observation at least (the firm entered in 1998). In total, the sample includes 34,656 firms, whereof less than 10,000 have existed throughout the whole time period. There are six different “types” of observations (see *Table 5.1*) with a bearing on the econometric analysis (firm growth is calculated as the percentage change in the number of employees; see *Section 5.5*).

Table 5.1 Different types of observations on firms

Firm	1993	1994	1995	1996	1997	1998
1						
2						
3						
.						
.						
.						
i)	X	X	X	X	X	X
ii)			X	X	X	X
iii)	X	X	X			
iv)		X	X	X		
v)						X
.						
.						
.						
34,655						
34,656						

Source: Own figure.

- i) Firms existing all the period. There are no difficulties in calculating growth in employment for these firms.
- ii) Firms established after 1993 and existing by the end of the period. There is a problem how to relate to the year of entry.⁵² Since there is no previous observation on a firm before the year of entry, there will be no observation on growth that year. It is an open question whether this effect should be taken into account or not. I have chosen not to. However, I have run regressions where the data are adjusted for this effect (available on request). The results are robust for this change of specification.
- iii) Firms that existed in 1993 and exited during the period. There is generally no problem in calculating growth for these firms.
- iv) Firms entering after 1993 and exiting before 1998. A combination of ii) and iii).
- v) Firms entering in 1998. This is similar to ii) and dealt with in a similar way.
- vi) Calculating growth in per cent for firms with 0 employees poses a general problem. Several adjustments have been made to test the robustness of the results. *First*, firms without any employees have been excluded. *Second*, I have run regressions with the change in the *number* of employees as dependent variable instead of the change of employees in *per cent*. *Third*, I have added one employee to all observations. The results are robust for these adjustments.

⁵² This was pointed out to me by Roger Svensson in a late stage of the thesis work.

It is worth underscoring that all Swedish firms are obliged to register by law. The Swedish statistics on firms therefore are encompassing and covers *all* firms in the *whole* economy, i.e., CFAR covers all size classes from the smallest firms without any employees to the largest firms with tens of thousands of employees, and all industries, manufacturing as well as services. This makes the Swedish data more complete than most international data. For example, U.S. statistics do not cover all firms (see Kirchhoff 1994 for a thorough description of U.S. statistics of enterprises and employment). Also, many international studies on small and new firms exclude the smallest firms and are limited to manufacturing due to lack of data. My thesis includes the smallest firms and data on manufacturing as well as data on trade and services. Moreover, Swedish statistics on firms are generally more detailed than available international data, e.g., Swedish statistics registers the time (month and year) when firms are established.

5.4 THE SIZE DISTRIBUTION AND JOB CONTRIBUTIONS OF NEW AND SMALL IT FIRMS

5.4.1 The Size Distribution of Firms and Employment

The total number of firms in the IT industry increased by some 11,000 (about 68 per cent) from about 16,300 firms to close to 27,400 firms between 1993 and 1998; see *Table 5.2*. The number of firms increased in all size classes. Firms with no employees increased the most with more than 8,000 firms, i.e., this group almost doubled from 9,000 to close to 18,000 firms. The largest size class (firms with more than 500 employees) reports the smallest increase in the number of firms (12 firms). However, large increases in per cent can be reported for all size classes. The smallest increase in per cent (27.47 per cent) is observed in the 5-9 size class and the largest increase in per cent is observed in the 100-199 size class (104 per cent). Notably, the number of the largest firms increased about 44 per cent.

Table 5.2 The number of firms by size class in the Swedish IT industry, 1993 and 1998

<i>Size class</i>	<i>0</i>	<i>1</i>	<i>2-4</i>	<i>5-9</i>	<i>10-19</i>	<i>20-49</i>	<i>50-99</i>	<i>100-199</i>	<i>200-499</i>	<i>500+</i>	<i>Total</i>
<i>Firms, 1993</i>	9,157	2,219	2,506	1,165	614	353	147	46	52	27	16,286
<i>Firms, 1998</i>	17,825	3,084	3,198	1,485	861	542	193	94	68	39	27,389
<i>Change</i>	8,668	865	692	320	247	189	46	48	16	12	11,103
<i>Change (%)</i>	94.66	38.98	27.61	27.47	40.23	53.54	31.29	104.35	30.77	44.44	68.18

Source: Statistics Sweden (CFAR) and own calculations.

Most IT firms are small. In 1998, about 65 per cent had no employees and close to 11 per cent one employee; see *Table 5.3*. Large firms (500 or more employees) comprised 0.14 per cent of the total number of firms the same year. The firms with 0 employees increased their share of the total number of firms by ca 16 per cent and firms with 100-199 by about one fifth. All other size classes decreased their share of the total number of firms, the 2-4 and 5-9 size classes the most by close to one fourth.

Table 5.3 The size distribution of firms in the Swedish IT industry (%), 1993 and 1998

<i>Size class</i>	<i>0</i>	<i>1</i>	<i>2-4</i>	<i>5-9</i>	<i>10-19</i>	<i>20-49</i>	<i>50-99</i>	<i>100-199</i>	<i>200-499</i>	<i>500</i>	<i>Total</i>
<i>Dist. 1993</i>	56.23	13.63	15.39	7.15	3.77	2.17	0.90	0.28	0.32	0.17	100.00
<i>Dist. 1998</i>	65.08	11.26	11.68	5.42	3.14	1.98	0.70	0.34	0.25	0.14	100.00
<i>Difference (%)</i>	15.75	-17.36	-24.12	-24.21	-16.62	-8.70	-21.93	21.51	-22.24	-14.11	0.00

Source: Statistics Sweden (CFAR) and own calculations.

Total employment in IT firms increased by some 31,000 persons (one fifth) during the same time period; see *Table 5.4*. The 100-199 size class reports the largest increase in absolute numbers (somewhat more than 6,000 employees) as well as in per cent (close to 100 per cent). The smallest percentage increase is observed in the largest size class (less than 4 per cent). The many employees in this size class make the increase in the number of employees quite substantial, or about 3,000 persons. However, this is still less than the increase in several smaller size classes. The 20-49 size class increased by about 5,700 persons (more than 50 per cent), the 200-499 size class by about 4,500 persons (more than one fourth), the 10-19 size class by 3,500 persons (more than 40 per cent), and the 50-99 size class by some 3,000 persons (close to one third). The 1-employee size class reports the smallest change in the number of employees, less than 1,000 persons. Still, that is an increase of close to 40 per cent. The data show that employment increased the most (close to 23,000 persons) in firms with less than 200 employees - defined as small firms in many investigations - while employment in firms with more than 200 employees increased by more than 7,000 persons.

Table 5.4 Employment by size classes in the Swedish IT industry, 1993 and 1998

<i>Size class</i>	<i>0</i>	<i>1</i>	<i>2-4</i>	<i>5-9</i>	<i>10-19</i>	<i>20-49</i>	<i>50-99</i>	<i>100-199</i>	<i>200-499</i>	<i>500+</i>	<i>Total</i>
<i>Employment, 1993</i>	0	2,219	6,724	7,548	8,082	10,678	10,123	6,544	16,567	82,588	151,073
<i>Employment, 1998</i>	0	3,084	8,459	9,634	11,582	16,434	13,206	12,933	21,045	85,600	181,977
<i>Change</i>	0	865	1,735	2,086	3,500	5,756	3,083	6,389	4,478	3,012	30,904
<i>Change (%)</i>	0	38.98	25.80	27.64	43.31	53.91	30.46	97.63	27.03	3.65	20.46

Source: Statistics Sweden (CFAR) and own calculations.

All size classes, except the largest, increased their share of total employment; see *Table 5.5*. The largest increase by far, or by 64 per cent, is found in the 100-199 size class and the second and third largest increases in the 20-49 size class (more than one fourth) and the 10-19 size class (close to one fifth). The share of the largest firms decreased by 14 per cent. The largest firms are, however, major employers. In 1998, they employed somewhat less than half of the workforce. Together with firms in the 200-499 size class, they employed close to 60 percent of the IT workforce in 1998, implying that smaller firms (less than 200 employees) employed about 40 per cent of the IT workforce. Ericsson and Telia alone employed more than one third of the total IT workforce in 1998 (NUTEK 2000, p. 51 and own calculations). The share of employment follows the size classes, with less employment in the smaller size classes and more employment in the larger size classes. The 0, 2-4 and 5-9 size classes employ the smallest share of total employment; 0, less than 2 and less than 5 per cent, respectively.

Table 5.5 The size distribution of employment in the Swedish IT industry (%), 1993 and 1998

<i>Size class</i>	<i>0</i>	<i>1</i>	<i>2-4</i>	<i>5-9</i>	<i>10-19</i>	<i>20-49</i>	<i>50-99</i>	<i>100-199</i>	<i>200-499</i>	<i>500+</i>	<i>Total</i>
<i>Dist. 1993</i>	0.00	1.47	4.45	5.00	5.35	7.07	6.70	4.33	10.97	54.67	100.00
<i>Dist. 1998</i>	0.00	1.69	4.65	5.29	6.36	9.03	7.26	7.11	11.56	47.04	100.00
<i>Difference (%)</i>	0.00	15.38	4.44	5.96	18.97	27.77	8.30	64.07	5.46	-13.95	0.00

Source: Statistics Sweden (CFAR) and own calculations.

The aggregate results presented in *Table 5.2 – Table 5.5* give only limited information on the underlying dynamics that has generated the statistics presented. One obvious example is the job contribution of firms without any employees. Per definition, firms in the 0 size class will never have any employees and will, therefore, not contribute to employment at all when using aggregate data to analyse employment contribution of different size classes. Similarly, this type of aggregated data does not show the contributions of new firms (since the data do not include information on the age of firms). In the following, I

will, therefore, present disaggregated data on the dynamics of job contributions of new and small firms.

5.4.2 *Job Contributions of New and Small Firms*

Table 5.6 presents the job contribution of the 1993 size classes over time, i.e., the table identifies individual firms of different sizes in 1993 and studies employment growth in these 1993 size classes through 1998. A quite different picture emerges here, compared to that presented in the aggregate tables in the previous section.

In 1998, employment originating in the firms existing in 1993 had decreased by about 5,000 employees (3 per cent), down from 151,000 to about 146,000 employees. The largest firms (500+ employees) were important for total employment because of their size. Their importance, however, decreased profoundly during the five-year period. In 1993, the largest firms employed more than 80,000 persons - more than 50 per cent of total employment. Five years later employment in the largest 1993 firms had declined by one fourth. This means that they had lost more than 21,000 jobs during the five-year period, to employ about 60,000 persons by the end of 1998. Hence, their share of total employment in the 1993 firms decreased to 42 per cent. Firms with 200-499 employees in 1993 were also major job losers; they lost close to 2,000 jobs (more than 10 per cent) between 1993 and 1998. Their share of total employment in the 1993 firms decreased to less than 10 per cent in 1998. A few jobs (about 350) were also lost in firms that had 20-49 employees in 1993. Hence, almost all jobs were lost in larger firms.

The firms in all other 1993 size classes created jobs. Notably, *firms without any employees in 1993 were outstanding job creators and created almost all the new jobs*. They increased employment by more than 13,000 persons. Firms with 10-19 and 5-9 employees came second and third as job creators, with net increases of 1,265 and 1,145 jobs, respectively.

The 1993 firms gained about 19,000 jobs (of which firms with originally 0 employees contributed more than 70 per cent) and lost some 23,000 jobs. In total, the 1993 large firms, defined as firms with more than 200 employees, lost jobs between 1993 and 1998, implying that small firms (with less than 200 employees) created all new net jobs during that period.

Table 5.6 Employment by 1993 size classes, Swedish IT industry, 1993 and 1998

<i>1993 size class</i>	<i>1993</i>	<i>1998</i>	<i>Change 1993-98</i>	<i>Change (%)</i>
0	0 (0.00)	13,697 (9.36)	13,697	
1	2,219 (1.47)	2,443 (1.67)	224	10.09
2-4	6,724 (4.45)	7,415 (5.07)	691	10.28
5-9	7,548 (5.00)	8,693 (5.94)	1,145	15.17
10-19	8,082 (5.35)	9,347 (6.39)	1,265	15.65
20-49	10,678 (7.07)	10,320 (7.05)	-358	-3.35
50-99	10,123 (6.70)	10,811 (7.39)	688	6.80
100-199	6,544 (4.33)	7,613 (5.20)	1,069	16.34
200-499	16,567 (10.97)	14,576 (9.96)	-1,991	-12.02
500+	82,588 (54.67)	61,459 (41.99)	-21,129	-25.58
<i>Total</i>	151,073 (100.00)	146,374 (100.00)	-4,699	-3.11

Note: Employment shares (%) in parentheses. It is impossible to calculate the percentage change of employment in firms without any employees in 1993 since that includes division by zero. However, if firms with 0 and 1 employees in 1993 are defined as one size class employment growth in the 0-1 size class was 627.35 per cent between 1993 and 1998. Observe that this table studies the job contribution of firms in different size classes active in 1993, i.e., firms entering after 1993 are not included in the table. The total number of employees reported in 1998, therefore, differs from the total number of employees in 1998 reported in *Chapter 4*, which covers all firms.

Source: Statistics Sweden (CFAR) and own calculations.

The change in the number of firms in the 1993 size classes indicates that significant firm turmoil underlies employment changes; see *Table 5.7*. Of the total number of firms in 1993, more than 40 per cent were gone by 1998, which is a decrease from about 16,000 firms to less than 10,000 firms. The group of firms with no employees in 1993 decreased the most; about 50 per cent (or 4,700 firms of about 9,200) remained by the end of 1998. The survival rate is higher in the other size classes. The 100-199 size class report the highest survival rate, 80 per cent. Recall that a firm exit does not imply that an establishment is closed down. Particularly for the larger firms, it can be assumed that firm exit rates are higher than establishment exit rates, because of, for instance, mergers and acquisitions. For smaller firms, however, it is reasonable to assume a higher correspondence between firm exits and exits of establishments.

Table 5.7 The number of surviving firms in 1993 size classes, Swedish IT industry, 1993 and 1998

1993 size class	1993	1998	Change	Exit rate (%)	Survival rate (%)
0	9,157	4,708	-4,449	-48.59	51.41
1	2,219	1,484	-735	-33.12	66.88
2-4	2,506	1,827	-679	-27.09	72.91
5-9	1,165	860	-305	-26.18	73.82
10-19	614	407	-207	-33.71	66.29
20-49	353	233	-120	-33.99	66.01
50-99	147	96	-51	-34.69	65.31
100-199	46	37	-9	-19.57	80.43
200-499	52	34	-18	-34.62	65.38
500-	27	19	-8	-29.63	70.37
Total	16,286	9,705	-6,581	-40.41	59.59

Source: Statistics Sweden (CFAR) and own calculations.

In 1993, firms established prior to 1993 dominated as employers, with about 146,000 employees (about 97 per cent of total employment), while new firms entering in 1993 employed about 5,000 persons (about 3 per cent of total employment); see *Table 5.8*. Firms established prior to 1993 declined throughout the period and employed about 138,000 persons in 1998. Their share of total IT employment decreased profoundly to about 75 per cent in 1998. However, new firms entered and expanded to employ more people than were lost in established firms during the period. Therefore, total IT employment increased to more than 180,000 persons by the end of 1998. New firms have a significant effect on employment the year they enter as well as during the succeeding years. In 1998, firms that entered in 1993, 1994, 1995, 1996, 1997 and 1998 comprised about 5, 4, 5, 5, 3 and 2 per cent of total employment, respectively. In total, firms established 1993 and after accounted for about one fourth of total IT employment in 1998.

Table 5.8 Employment by cohorts, Swedish IT industry, 1993-98

Year of est.	1993	1994	1995	1996	1997	1998
-1993	146,043 (96.67)	132,001 (91.97)	131,401 (88.90)	127,918 (83.32)	138,495 (81.72)	138,511 (76.11)
1993	5,030 (3.33)	8,586 (5.98)	9,541 (6.45)	9,481 (6.18)	9,250 (5.46)	9,345 (5.14)
1994		2,945 (2.05)	4,908 (3.32)	5,996 (3.91)	6,194 (3.65)	6,476 (3.56)
1995			1,964 (1.33)	6,751 (4.40)	6,776 (4.00)	8,560 (4.70)
1996				3,382 (2.20)	6,156 (3.63)	9,154 (5.03)
1997					2,609 (1.54)	6,116 (3.36)
1998						3,815 (2.10)
Total	151,073 (100)	143 532 (100)	147,814 (100)	153,528 (100)	169,480 (100)	181,977 (100)

Note: Employment shares (%) in parentheses. The number of employees in the -1993 and 1993 cohorts in 1998 (138,511 + 9,345 = 147,856) is higher than reported in *Table 5.6* (146,374). This is because *Table 5.6* follows IT firms through 1993 to 1998, while *Table 5.8* reports employment in IT firms in each respective year. That implies that *Table 5.8* includes firms, which have been active in other industries but, which have changed activity codes to become IT firms, while *Table 5.6* does not. That is also why total employment in the 1993 cohort in 1998 in *Table 5.8* (9,345) exceeds employment in 1998 due to firms founded in 1993 in *Table 5.12* (8,613). Bold figures are employment due to new firms and are analysed further in *Table 5.10*.

Source: Statistics Sweden (CFAR) and own calculations.

The dynamic approach I have used demonstrates that new firms have grown spectacularly during their first years of existence. For example, firms entering in 1994 grew by 67 per cent, and firms entering in 1995 grew by about 240 per cent, during their first year; see *Table 5.9*. Thereafter their growth flattened out to normal rates. For example, new firms in 1993 grew by 70 per cent (3,556 employees) in 1994 and by 11 per cent (955 employees) in 1995. They show negative growth the following two years, and slightly positive growth in 1998.

Table 5.9 Employment growth by cohorts, Swedish IT industry, 1993-98

Year of est.	1993	1994	1995	1996	1997	1998
-1993	-14,042 (-9.61)	-600 (-0.45)	-3,843 (-2.65)	10,577 (8.27)		16 (0.01)
1993	3,556 (70.70)	955 (11.12)	-60 (-0.63)	-231 (-2.44)		95 (1.03)
1994		1,963 (66.66)	1,088 (22.17)	198 (3.30)		282 (4.55)
1995			4,787 (243.74)	25 (0.37)		1,784 (26.33)
1996				2,774 (82.02)		2,998 (48.70)
1997						3,507 (134.42)
1998						
Total	-7,541 (-4.99)	4,282 (2.98)	5,714 (3.87)	15,952 (10.39)		12,497 (7.37)

Note: Changes from the preceding year. Per cent in parentheses.

Source: Statistics Sweden (CFAR) and own calculations.

Since new entry has been demonstrated to have contributed significantly to job generation during the period 1993 to 1998, let us dig deeper into the data and ask if new small firms create more jobs than new large firms. The analysis of new employment reported in *Table 5.8* is expanded further in *Table 5.10*, which shows new employment by size classes. New small firms created most of the new jobs, except in 1993. Firms with less than 200 employees created between 42 per cent (1993) and 82 per cent (1994) of the

jobs created by new firms. Correspondingly, new firms with more than 200 employees created between 18 per cent (1994) and 58 per cent (1993) of the jobs created by new firms.

Table 5.10 New employment by size classes in the Swedish IT industry, 1993-98

<i>Size class</i>	<i>1993</i>	<i>1994</i>	<i>1995</i>	<i>1996</i>	<i>1997</i>	<i>1998</i>
<5	392 (7.79)	499 (16.94)	440 (22.40)	391 (11.56)	453 (17.36)	667 (17.48)
<200	2,130 (42.35)	2,414 (81.97)	1,217 (61.97)	1,766 (52.22)	1,889 (72.40)	2,257 (59.16)
200-499	880 (17.50)	0 (0.00)	208 (10.59)	964 (28.50)	0 (0.00)	871 (22.83)
>500	2,020 (40.16)	531 (18.03)	539 (27.44)	652 (19.28)	720 (27.60)	687 (18.01)
Total	5,030 (100.00)	2,945 (100.00)	1,964 (100.00)	3,382 (100.00)	2,609 (100)	3,815 (100.00)

Note: Per cent in parentheses. Bold numbers are from *Table 5.8*.

Source: Statistics Sweden (CFAR) and own calculations.

Many of the new jobs were created in new independent firms; see *Table 5.11*. In new firms with less than 5 employees, independent firms contributed more than 90 per cent of the new jobs created. Also, independent firms were major job contributors in new firms with less than 200 employees; at the least 47 per cent in 1994 and at the most 80 per cent in 1997 of new jobs had their origin there. Independent firms contributed nothing to new employment in the larger firms, with the exception of 1997 (two thirds of new employment in new firms with 200-499 employees) and in 1994 (100 per cent of employment in new firms).

Independent firms were major contributors to total new employment all years. In 1993, they contributed about one fourth of new employment (the smallest share of new employment due to independent firms during the studied time period) and close to 60 per cent in 1998 (the highest share of new employment in firms due to independent firms).

Table 5.11 New employment by size classes, independent firms, Swedish IT industry, 1993-98

<i>Size class</i>	<i>1993</i>	<i>1994</i>	<i>1995</i>	<i>1996</i>	<i>1997</i>	<i>1998</i>
<5	366 (93.37)	456 (91.38)	416 (94.55)	352 (90.03)	423 (93.38)	631 (94.60)
<200	1,339 (62.86)	1,145 (47.43)	842 (69.19)	1,087 (61.55)	1,502 (79.51)	1,681 (74.48)
200-499	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	576 (66.13)
>500	0 (0.00)	531 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Total	1,339 (26.62)	1,676 (56.91)	842 (42.87)	1,087 (32.14)	1,502 (57.57)	2,257 (59.16)

Note: Share of total new employment due to independent firms in respective size class in parentheses (%).

Source: Statistics Sweden (CFAR) and own calculations.

The two preceding tables (*Table 5.10* and *Table 5.11*) show the yearly job contribution of new firms. Does employment in new small firms grow faster than employment in new

large ones? *Table 5.12* shows employment by size class in firms that entered in 1993. Employment in these firms is shown for 1993 and 1998 by their original size classes. In total, employment in firms that entered in 1993 increased from about 5,000 persons to about 8,600 persons, i.e., by about 71 per cent. However, the job contribution of different size classes differs critically. Large firms that entered in 1993 were major job losers during the period. The largest firms (500+ employees) lost 12 per cent of their employment, and the second largest firms (200-499 employees) lost more than 50 per cent of their employment between 1993 and 1998. New firms in 1993 with 50-99 employees also lost a major share of initial employment, or 42 per cent. No firms with 100-199 employees were founded in 1993. That means that new firms in 1993 with less than 50 employees not only created jobs to compensate the losses in the larger size classes, but also increased the total number of employees created by firms founded in 1993. Large increases in per cent are reported in the 20-49 size class (48 per cent) and the 2-4 size class (86 per cent). However, the number of new employees between 1993 and 1998 in these size classes were quite few, 276 and 238, respectively. The 1 size class lost 33 jobs (close to one third) during the period. Firms entering without any employees in 1993 are remarkable job creators. They created more than 4,000 jobs between 1993 and 1998. If we had excluded them, employment would have fallen in firms founded in 1993. Indeed, new small firms, especially the smallest ones entering without any employees, are shown to be most important for employment growth.

Table 5.12 Employment by size classes in the 1993 cohort, IT firms, 1993 and 1998

1993 size class	New employment 1993	Employment 1998	Change	Change (%)
0	0 (1826)	4,011	4,011	
1	109 (109)	76	-33	-30.28
2-4	283 (111)	312	29	10.25
5-9	275 (43)	513	238	86.55
10-19	343 (27)	356	13	3.79
20-49	567 (18)	843	276	48.68
50-99	553 (8)	316	-237	-42.86
100-199	0 (0)	0	0	0.00
200-499	880 (3)	414	-466	-52.95
500+	2,020 (1)	1,772	-248	-12.28
Total	5,030	8,613	3,583	71.23

Note: The number of new firms in parentheses. Observe that a new firm might be a new subsidiary to an old firm. This is probably the case to a large extent in the larger size classes.

Source: Statistics Sweden (CFAR) and own calculations.

Also, the new firms with no employees in 1993 created the bulk of new jobs the first year after entrance; see *Figure 5.1* (cf. *Tables 5.8 and 5.9*). The first year (1994) after entering,

they employed about 3,700 employees. Employment reaches a peak of 4,200 people three years after entrance (in 1996). Thereafter, employment decreases to about 4,000 employees. This suggests that a massive yearly entrance of new small firms is of great importance for a high long-term growth rate for the whole industry, and quite plausibly, for the whole economy as well.

Figure 5.1 Employment growth in firms entering in 1993 with no employees, Swedish IT industry, 1993-98

Source: Statistics Sweden (CFAR) and own calculations.

5.4.3 Conclusions

Using a static method, aggregate data show that small firms have a larger positive net effect on job creation than do large firms in the Swedish IT industry. Such simple method cannot, however, be used to study the importance of *new* firms, since age is not reported in published aggregate statistics. Nor can it be used to study the job contribution of firms that change size class. When individual firms of different size classes and cohorts are studied, new facts about the importance of age and size emerge and tell a significantly different story about the respective job contributions of small and large firms as well as of new and old firms. Because of their size, large firms account for a large share of total employment at each point in time. However, while large firms have declined over time, new and small firms have created new jobs to such an extent that the

total IT industry has expanded. Thus, small and young firms have created jobs, while large and old firms have lost jobs during the observation period.

Hence, the findings in this section are that total employment growth benefits from a high and continuous flow of new small firms into the economy because: i) new firms create many jobs when established; ii) surviving new firms show a spectacular growth the first years of life and iii) it is mainly the small new firms that grow fast.

This section supports the idea that it is misleading to use a static method to analyse the job contributions of firms of different sizes and ages. Static aggregate analysis conceals the dynamic growth patterns of individual firms of different sizes and ages, which move the aggregates. Comparing the job contributions of different size classes using a static method and macro data underestimates the role of small firms and exaggerates the contribution of large firms, since some small firms grow into large firms and some large firms decline to become small. The smallest firms, i.e., firms without any employees in our data set, illustrate this point nicely. Studying the job contribution of those firms using a static method and aggregate data will give them no role at all, *per definition*, since the number of employees in the 0 size class is zero. On the contrary, the dynamic approach I use show them to be outstanding job creators. Hence, the analysis conducted in my thesis supports the conclusion made by, e.g., Kirchhoff (1994), Admiraal (1996), Eliasson (1991b, 1996), Acs *et al.* (1999), Audretsch & Thurik (1999) and others that it is a major mistake not to take dynamics explicitly into account in the study of employment growth.

5.5 ECONOMETRIC ANALYSIS

Two econometric models have been used to test the hypotheses of age and size. The first model is based on CFAR and includes all IT firms in the 1993 to 1998 period. However, this data set does not include any financial variables. The second model is based on a merged data set from CFAR and EFA. This data set includes financial variables for all IT firms in 1995 and 1996. However, it excludes the bulk of manufacturing firms with less than 20 employees and the bulk of service firms with less than 50 employees in 1993 and 1994, since they are not covered in the EFA these years. It also excludes sole proprietorships because such firms do not have any income statements or balance sheets.

Financial data for 1997 and 1998 were not available for this thesis. Hence, these years are excluded when testing the second model. The first model can be written as:

$$(5.1) \quad GROWTH_{i,t} = \beta_0 + \beta_{age} * AGE_{i,t-1} + \beta_{size} * SIZE_{i,t-1} + \beta_{age^2} * AGE_{i,t-1}^2 + \beta_{size^2} * SIZE_{i,t-1}^2 \\ + \beta_{entg} * ENTG_{i,t-1} + \beta_{owner} * OWNER_{i,t-1} + \beta_d * Z^d + u_{i,t}$$

where $GROWTH_{i,t}$, $AGE_{i,t-1}$ and $SIZE_{i,t-1}$ are vectors on the growth, age and size of IT firm i at time t , $t-1$ and $t-1$, respectively. In addition to the main explanatory variables age and size, the model includes two explanatory variables ($ENTG_{i,t-1}$, $OWNER_{i,t-1}$) on enterprise group (independent or belonging to an enterprise group) and ownership (private or government owner), respectively.⁵³ For simplicity, I refer to these two variables as non-financial explanatory variables. Z^d represents a vector with dummy variables. $AGE_{i,t-1}^2$ and $SIZE_{i,t-1}^2$ are the quadratic form of the age and size vectors. The variables are defined as follows:

Dependent variable:

$GROWTH_{i,t}$: The change in the number of employees in firm i between time $t-1$ and t (per cent). Remark: The percentage growth of firms with zero employees in period $t-1$ cannot be calculated since it involves division with a denominator of zero. Therefore, growth is defined as zero if the number of employees is zero in period $t-1$ and period t . Moreover, growth is approximated with 100 per cent if the number of employees is zero in period $t-1$ and more than zero in period t . This is the lowest rate of growth for firms with one employee in time $t-1$ that expand their employment. Thus, this approximation underestimates the percentage employment growth of firms with zero employees.

Main explanatory variables:

$AGE_{i,t-1}$: The age of firm i at time $t-1$. CFAR registers the firm when it becomes active (the first time the activity code becomes 1) by month and year. A firm established at time $t-1$ is defined to be 1 year old, a firm established in time $t-2$ to be 2 years old and so on.

$SIZE_{i,t-1}$: The size (number of employees) of firm i at time $t-1$. Available data do not allow enterprise groups to be explicitly taken into consideration in the sense of studying the enterprise group as one firm. However, it is possible to tell whether firms are independent or not since my data set includes a dummy variable that takes on the value 1

⁵³ See, e.g., Variyam & Krybill (1992) and Dewenter & Malatesta (2001) for empirical investigations of ownership and the economic performance of firms.

if the firm belongs to an enterprise group and 0 if it is an independent firm. The data set, however, does not allow me to identify which enterprise group the firm belongs to.⁵⁴ Therefore, I cannot adjust for enterprise groups in the survey carried out in this section. Hence, the analysis will overestimate the contribution of small firms and underestimate the contribution of large firms to total employment at a single point in time, because large firms usually have many small subsidiaries. However, the analysis will not overestimate (underestimate) the job contribution of small (large) firms over time to the same extent, since the bulk of new jobs are created in small and independent firms (see *Section 5.4*).

$AGE_{i,t-1}^2$: The age of firm i at time $t-1$ raised to the second power. It is reasonable to expect a non-linear relationship between firm age and firm size, on the one hand, and firm growth on the other. In line with practice in other similar studies, I, therefore, introduce a quadratic form of age and size as explanatory variables.

$SIZE_{i,t-1}^2$: The size (number of employees) of firm i at time $t-1$ raised to the second power.

Non-financial variables:

$ENTG_{i,t-1}$: A dummy that takes on the value 1 if firm i belongs to an enterprise group at time $t-1$, otherwise 0. A firm is defined as a subsidiary firm if another firm (the parent firm) controls more than 50 per cent of the votes of the firm. Parent firms, as well as, subsidiary firms are defined as belonging to an enterprise group.

$OWNER_{i,t-1}$: A dummy for ownership at time $t-1$, 1 if firm i is governmentally owned and 0 if it is privately owned. A firm is defined as governmentally owned if government controls more than 50 per cent of the votes of the firm.

Dummy variables:

$ITMAN$: A dummy taking on the value 1 if firm i manufactures IT equipment, otherwise 0.⁵⁵

$DATA$: A dummy variable taking on the value 1 if firm i is a data consult or a data service firm, otherwise 0.⁵⁶

$TELEC$: A dummy variable taking on the value 1 if firm i is a telecommunications carrier, otherwise 0.⁵⁷

⁵⁴ Statistics Sweden can identify enterprise groups and subsidiary companies. However, that involves extensive and expensive computations. The costs and time for that are beyond the scope of the thesis.

⁵⁵ That is, if firm i is classified within industry code 30010, 30020, 32100, 32200, 32300, 33200 or 33300.

⁵⁶ That is, if firm i is classified within industry code 72100, 72201, 72202, 72300, 72400, 72500 or 72600.

The error term $u_{i,t}$ can be decomposed in a firm-specific (μ_i), a time-specific (λ_t), and a random error term ($v_{i,t}$); see, e.g., Baltagi 1999:

$$(5.2) \quad u_{i,t} = \mu_i + \lambda_t + v_{i,t}$$

The stochastic disturbances ($v_{i,t}$) are assumed to be independent and identically distributed with mean zero and constant variance (σ_v^2).

The second model can be written as:

$$(5.3) \quad GROWTH_{i,t} = \beta_0 + \beta_{age} * AGE_{i,t-1} + \beta_{size} * SIZE_{i,t-1} + \beta_{age^2} * AGE_{i,t-1}^2 + \beta_{size^2} * SIZE_{i,t-1}^2 + \beta_{entg} * ENTG_{i,t-1} + \beta_{owner} * OWNER_{i,t-1} + \beta_{fin} * Z_{i,t-1}^{fin} + \beta_{finch} * Z_{i,t-1}^{finch} + \beta_d * Z^d + u_{i,t}$$

where $GROWTH_{i,t}$, $AGE_{i,t-1}$, $SIZE_{i,t-1}$, $AGE_{i,t-1}^2$, $SIZE_{i,t-1}^2$, $Z_{i,t-1}^{nonfin}$ and Z^d are defined as in the first model. The $Z_{i,t-1}^{fin}$ vector represents financial variables. For simplicity, these variables are called financial explanatory variables. All these variables are commonly used in empirical studies when available. Also, the changes in the financial variables are included ($Z_{i,t-1}^{finch}$). The variables not defined above are defined as follows:

Financial variables:

$PRODUCTIVITY_{i,t-1}$: Labour productivity of firm i at time $t-1$, defined as the total value added of firm i divided by the total number of employees of firm i .

$PROFIT_{i,t-1}$: The profit (in per cent) of firm i at time $t-1$. Profit is defined as profit (or loss) after financial income and expenses/(equity + 0.7 of untaxed reserves).⁵⁸

$TAX_{i,t-1}$: Firm i 's paid taxes (in per cent) in relation to turnover at time $t-1$.

$SDEPT_{i,t-1}$: Firm i 's short-term debt in per cent of the total balance sheet at time $t-1$.

$LDEPT_{i,t-1}$: Firm i 's long-term debt in per cent of the total balance sheet at time $t-1$.

$CAPINT_{i,t-1}$: The capital intensity (in per cent) of firm i at time $t-1$, defined as 1 – total labour costs/total value added.

$TURNOVER_{i,t-1}$: Turnover per employee at time $t-1$ in firm i .

⁵⁷ That is, if firm i is classified within industry code 64201, 64202 or 64203.

⁵⁸ Profitability can be measured in a number of ways, but this is the most common measurement of profitability used by researchers analysing Swedish data. It is said to best reflect the underlying profitability of the firm.

$PRODUCIVITYCh$, $PROFITCh$, $TAXCh$, $SDEPTCh$, $LDEPTCh$, $CAPINTCh$ and $TURNOVERCh$ represent the change (in per cent) in productivity etc. between time $t-1$ and t .

The literature discusses three basic frameworks for estimating models including cross-sectional time-series data: i) The Ordinary Least Square (OLS) approach, ii) the fixed-effect approach and iii) the random-effects approach (see, e.g., Baltagi 1999; Greene 2000; Hsiao 1999). Ordinary least square estimation assumes no individual-specific effect (μ_i) or time-specific effect (λ_t). The fixed-effect model assumes the individual specific effects (μ_i) to be constant across time and the time-specific effects (λ_t) to be constant across individuals. The random-effect model, on the other hand, assumes the effects to be random. Furthermore, the random-effect model assumes the disturbances (u_{it}) and the explanatory variables to be uncorrelated (see, e.g., Baltagi 1999, pp. 27-30).

An F-test applied to the data used here rejects the poolability of the data, i.e., an OLS analysis is not appropriate. A Hausman test rejects the hypothesis that the disturbances (u_{it}) and the explanatory variables are uncorrelated. Thus, I apply a fixed-effect model. Extreme values, firms with a growth exceeding 2,000 per cent, are excluded.⁵⁹

In accordance with the previous discussion I particularly test the hypotheses:

$$H_0: \beta_{age} \geq 0 \text{ and}$$

$$H_0: \beta_{size} \geq 0.$$

In addition, I also test the hypotheses:

$$H_0: \beta_{entg} \geq 0 \text{ and}$$

$$H_0: \beta_{owner} \geq 0.$$

According to the theory of the EOE and Competence Blocs, all hypotheses are expected to be rejected. Firm age and firm size are expected to be negatively related to firm

⁵⁹ Several other thresholds on firm growth have been used, above as well as below 2,000 per cent. The results are robust.

growth. Firms in enterprise groups and governmentally owned firms are expected to grow slower than independent firms and private firms.

Moreover, productivity, profit and turnover are expected to have a positive effect on firm growth. High productivity indicates competitiveness and profitability enhances the possibility for investments. A high turnover indicates a large demand for the firm's products. Taxes are expected to have a negative effect on firm growth. Capital intensity and short-term debt are expected to have a positive effect on firm growth, while long-term debt is expected to have negative effect. It has been argued in the economic literature that short-term debts indicate a growth potential. On the other hand, it has been argued that long-term debts restrain growth.⁶⁰

Furthermore, the rich data set including all firms makes it possible to address the effects of sampling (i.e., the exclusion of certain firms from the analysis) – a question that used to puzzle and make research in this area difficult. Sutton (1997) writes that one main theme of the research literature since the 1980s is to study the effects of sample censoring. A number of well-known articles studying the relation between firm growth conditional on size and age has this problem. For example, Dunne *et al.* (1988, 1989), like many others, use data from Dun & Bradstreet. They point out that this data set differs from Census data in a number of ways. For instance, their data set excludes firms with less than five employees.⁶¹ Thus, in addition to testing the effects of firm size and firm age on firm growth the chapter investigates the effects of excluding small firms (sample selection effects).

The second model merges the data set used in the first model (CFAR) and EFA. Since EFA includes fewer firms than CFAR the number of observations in the second model is less than in the first model. *Table 5.13* shows the difference in the number of firms in different size classes between the two data sets 1993-1996. Recall that financial data for 1997 and 1998 were not available for this study. In 1993 and in 1994, the number of firms in the merged data set is a fraction of the total number of firms (the firms in CFAR), 4.75 per cent and 4.44 per cent, respectively. Mainly small firms are excluded,

⁶⁰ A double-sided test is used in the hypotheses related to the financial variables, e.g., H_0 : Productivity has no effect on firm growth etc.

⁶¹ This is not always observed. E.g., Sutton (1997) incorrectly writes that Dunne *et al.* (1988, 1989) use the full size-distribution of firms.

e.g., less than 2 per cent of firms with no employees are included in the merged data set in 1993. The correspondence in the larger size classes is better, in several cases close to 100 per cent. In 1995 and in 1996, the number of firms in the merged data set comprises about 80 per cent and 75 per cent of the number of firms in CFAR, respectively. It is mainly the smallest firms (with zero employees) that are excluded. In 1995 about one third and in 1996 some 40 per cent of the smallest firms are excluded. The merged data set covers at least 90 per cent of the total number of firms in the other size classes (except in the largest size class). We conclude that the correspondence between the two data sets is better in 1995 and in 1996 than in 1993 and in 1994 and that mainly small firms are excluded in the merged data set.

Table 5.13 The number of firms in different size classes, CFAR merged with EFA, 1993-96

	1993	1993	1993	1994	1994	1994	1995	1995	1995	1996	1996	1996
Size class	All firms	Merged data	Per cent	All firms	Merged data	Per cent	All firms	Merged data	Per cent	All firms	Merged data	Per cent
0	9,157	135	1.47	10,309	69	0.67	11,225	7,545	67.22	13,151	7,768	59.07
1	2,219	48	2.16	2,506	77	3.07	2,728	2,634	96.55	2,830	2,710	95.76
2-4	2,506	80	3.19	2,661	94	3.53	2,851	2,790	97.86	2,887	2,825	97.85
5-9	1,165	88	7.55	1,188	85	7.15	1,286	1,275	99.14	1,332	1,314	98.65
10-19	614	63	10.26	588	71	12.07	663	655	98.79	731	722	98.77
20-49	353	102	28.90	376	139	36.97	426	423	99.30	480	471	98.13
50-99	147	139	94.56	140	133	95.00	153	143	93.46	160	149	93.13
100-199	46	43	93.48	54	51	94.44	58	54	93.10	75	68	90.67
200-499	52	51	98.08	53	52	98.11	52	49	94.23	58	54	93.10
500+	27	24	88.89	25	24	96.00	33	28	84.85	34	25	73.53
Total	16,286	773	4.75	17,900	795	4.44	19,475	15,596	80.08	21,738	16,106	74.09

Note: The columns "Per cent" show the number of firms in EFA in relation to CFAR. 1997 and 1998 are excluded since financial data for this year was not available for this study. "Size class" refers to the number of employees.

Source: CFAR, EFA and own calculations.

The correlation between the variables is low. The only exception, of course, is the correlation between, the non-quadratic and quadratic forms of AGE and SIZE (see *Table 5.14*).

Table 5.14 Table of correlation

	GROWTH	AGE	SIZE	AGE ²	SIZE ²	ENTG	OWNER
GROWTH	1.00						
AGE	-0.0322	1.00					
SIZE	-0.030	0.035	1.00				
AGE ²	-0.026	0.94	0.0315	1.00			
SIZE ²	-0.0014	0.011	0.91	0.0080	1.00		
ENTG	0.0069	0.18	0.073	0.16	0.022	1.00	
OWNER	-0.0004	0.014	0.12	0.0071	0.091	0.15	1.00

Source: Statistics Sweden and own calculations.

The main explanatory variables, their mean, standard deviation and expected effect on growth, are summarised in *Table 5.15*.

Table 5.15 Summary statistics

<i>Variable</i>	<i>Description</i>	<i>Mean</i>	<i>Std. dev.</i>	<i>Expected effect on growth</i>
<i>GROWTH</i>	Growth of employees (per cent)	15.52	162.43	
<i>AGE</i>	Age of firm (year)	5.95	5.31	-
<i>SIZE</i>	Size of firm (employees)	7.40	197.33	-
<i>AGE²</i>	The quadratic form of age	63.55	118.08	+
<i>SIZE²</i>	The quadratic form of size	38,991.92	4,498,307	+
<i>ENTG</i>	The firm belongs to an enterprise group	0.11	0.32	-
<i>OWNER</i>	The firm is government owned	0.0045	0.067	-

Source: CFAR and own calculations.

As for the specification of the model, I have used other functional forms of the explanatory variables, such as a linear form of age and size; I have included interaction variables as well as other explanatory variables; and I have used industry dummies at a more disaggregated level etc. I have also applied log-linear models, random-effects models and pooled-data models. I have run separate regressions on manufacturing C&C firms, telecommunications firms, firms that trade in C&C equipment and data consulting and data services firms, among other things, to take economies of scale into account. I have run additional models adjusted for heteroscedasticity and autocorrelated errors. Moreover, I have used the change of the *number* of employees as dependent variable instead of the *percentage* change of the number of employees. This because it is possible for the effects of small firms to have been exaggerated when using the *percentage* change of the number of employees as the dependent variable instead of the change of the *number* of employees. I have excluded firms with no employees and I have made a number of other adjustments to test the robustness of my results. The main results are robust, whichever model version I use. Notably, the effect of size is strengthened when the change of the *number* of employees is the dependent variable. The model presented is chosen because it is parsimonious and simple, therefore to be preferred.

5.6 RESULTS

Table 5.16 presents the results from six regressions on the effects of firm size and firm age on firm growth. The first two regressions are based on the first model and the other four regressions on the second model. Thus, *Regression 1* and *Regression 2* are based on CFAR data including all firms but no financial variables, while *Regression 3* to *6* are based on the merged data set of CFAR and EFA which does not include all firms but which does include financial variables. *Regression 3* and *Regression 4* use the merged data set but exclude financial variables to see if the merger and the resulting poorer coverage of small firms affects the results. *Regression 5* and *Regression 6* include the financial variables.

The analysis also investigates the robustness of the results when small firms are excluded. *Regressions 2, 4* and *6* exclude firms with less than 5 employees. This threshold is used because several studies only cover firms with more than 5 employees due to statistical limitations.

The number of observations drops from 95,970 (*Regression 1*) to 8,964 (*Regression 3* and *Regression 5*) when CFAR and EFA are merged. Mainly small firms are excluded; see *Table 5.13*. The number of observations drops to 12,091 (*Regression 2*) and to 3,287 (*Regression 4* and *Regression 6*) when firms with less than 5 employees are excluded.

Table 5.16 Regression results

	<i>Regression 1</i>	<i>Regression 2^a</i>	<i>Regression 3</i>	<i>Regression 4^a</i>	<i>Regression 5</i>	<i>Regression 6^a</i>
Dependent variable	GROWTH	GROWTH	GROWTH	GROWTH	GROWTH	GROWTH
AGE	-4.12*** (-13.23)	-4.07*** (-5.38)	-8.06** (-2.02)	-3.81 (-0.99)	0.58 (0.12)	-5.80* (-1.46)
SIZE	-0.057*** (-10.29)	-0.051*** (-7.52)	-0.11*** (-4.33)	-0.11*** (-6.06)	-0.11*** (-4.55)	-0.11*** (-6.29)
AGE ²	0.092*** (6.40)	0.10*** (3.76)	0.17 (1.23)	0.023 (0.21)	0.045 (0.32)	0.048 (0.44)
SIZE ²	1.15e-06*** (8.28)	9.23e-07*** (6.21)	2.10e-06*** (3.49)	2.13e-06*** (5.042)	2.20e-06*** (3.79)	2.21e-06*** (5.27)
ENTG	-12.81*** (-8.84)	-1.24 (-0.56)	-30.53*** (-3.19)	-8.88 (-1.16)	-27.31*** (-2.81)	-8.46 (-1.11)
OWNER	-4.00 (-0.80)	-14.91*** (-2.94)	-28.10** (-2.14)	-16.35** (-1.66)	-26.88** (-2.10)	-17.37** (-1.79)
PRODUCTIVITY	-	-	-	-	0.0042 (0.51)	-0.0056 (-0.88)
PROFIT	-	-	-	-	0.00017 (0.20)	0.00033 (0.49)
TAX	-	-	-	-	0.41 (0.53)	0.14 (0.21)
SDEPT	-	-	-	-	-0.54 (-1.52)	-0.032 (-0.16)
LDEPT	-	-	-	-	-0.25 (-1.09)	-0.22 (-1.06)
CAPINT	-	-	-	-	0.045 (1.56)	0.024 (1.08)
TURNOVER	-	-	-	-	0.0021 (1.073)	0.0018 (1.01)
PRODUCTIVITYCh	-	-	-	-	-0.0017 (-0.31)	-0.0056 (-0.94)
PROFITCh	-	-	-	-	0.00062 (0.80)	0.00014 (0.24)
TAXCh	-	-	-	-	-0.00029 (-0.67)	-0.00029 (-0.91)
SDEPTCh	-	-	-	-	-0.049 (-1.88)	0.0026 (0.087)
LDEPTCh	-	-	-	-	0.00025 (0.22)	0.00052 (0.65)
CAPINTCh	-	-	-	-	0.00029 (0.45)	6.44e-06 (0.01)
TURNOVERCh	-	-	-	-	-0.0032 (-0.67)	-0.053** (-2.09)
CONSTANT	38.16*** (16.75)	34.06*** (6.26)	51.92** (2.22)	54.95* (1.90)	38.65 (1.16)	79.21** (2.32)
R ²	0.019	0.022	0.049	0.049	0.076	0.11
F-value	60.57	8.51	3.25	3.25	2.27	2.61
Number of observations	95,970	12,091	8,964	3,287	8,964	3,287

Note: ^a Firms with less than 5 employees are excluded. *Regressions 1 and 2* are based on CFAR. *Regressions 3-6* are based on a merged data set of CFAR and EFA. Data on dummies are available on request. ***, **, * signifies that the coefficient is significant at the 1 per cent, 5 per cent and 10 per cent level respectively. t-values in parentheses. A one-sided test is used in the hypotheses related to AGE, SIZE, AGE², SIZE², ENTG and OWNER. For the other variables a double-sided test apply.

Source: Statistics Sweden and own calculations.

The coefficient of age is significantly negative at the 1 per cent significance level in the first two regressions. The effect is still significantly negative in the third regression, but the significance level drops to the 5 per cent level. The effect is also negative in *Regressions 4* (insignificant) and *6* (at the 10 per cent significant level), but turns positive (but insignificant) in *Regression 5*. In total, the econometric analysis rejects the hypothesis that age has no, or positive effect on firm growth. The effect of AGE² is positive in all regressions. It is, however, only significant in the first two regressions. The results suggest that firm age has a decreasingly negative effect on firm growth.

The effect of firm size on firm growth is clearly established. The tests reject the hypothesis that size has no, or positive effect on firm growth. The coefficient of size is negative and highly significant (at the 1 per cent level) in all regressions. The effect of SIZE² is significantly positive at the 1 per cent level in all regressions. The results suggest that firm size has a decreasingly negative effect on firm growth.

The marginal effect of age is significantly negative at the 1 per cent level in the first two regressions, significantly negative at the 5 per cent level in *Regression 3* and significantly negative at the 10 per cent level in *Regression 6*. It is insignificant in *Regression 4* and *5*, see *Table 5.17*. The marginal effect of size is significantly negative at the 1 per cent level in all regressions.

According to the estimates in the first regression, an increase of firm age by one year decreases firm growth with about 3 percentage points. An increase of firm size by one employee decreases firm growth with about 0.06 percentage points. The results, thus, contradict Gibrat's (1931) law, which is in line with recent empirical research (see Caves 1998, p. 1949).

Table 5.17 Marginal effects of age and size on growth

	<i>Regression 1</i>	<i>Regression 2</i>	<i>Regression 3</i>	<i>Regression 4</i>	<i>Regression 5</i>	<i>Regression 6</i>
<i>Age</i>	-3.03*** (-14.49)	-3.88*** (-4.68)	-6.00** (-1.90)	-3.53 (-1.20)	1.13 (0.32)	-5.22* (-1.65)
<i>Size</i>	-0.057*** (-10.24)	-0.051*** (-7.47)	-0.11*** (-4.32)	-0.11*** (-6.17)	-0.11*** (-4.49)	-0.11*** (-6.22)

Note. The marginal effect of age on growth is calculated as: $dGROWTH/dAGE = \beta_{age} + 2 * \beta_{age^2} * AGE_{avg}$, where AGE_{avg} is the average age of firms. The standard error used to calculate t values is calculated as: $\sigma_{dGROWTH/dAGE} = [\text{var}(\beta_{age}) + 4 * (AGE_{avg})^2 * \text{var}(\beta_{age^2}) + 4 * AGE_{avg} * \text{cov}(\beta_{age}, \beta_{age^2})]^{1/2}$. The marginal effect of size on growth is calculated in similar way.

Source: Statistics Sweden and own calculations.

Firms in enterprise groups exhibit a slower growth rate than independent firms. The coefficient is negative in all six regressions and significant in three of them. Interestingly, it is highly significant (at the 1 per cent level) in the three regressions including firms with less than 5 employees. It is significant in the first regression including all firms but no financial variables and in the third regression based on the merged data set including firms with less than 5 employees but excluding financial variables. It is also significant in the fifth regression including firms with less than 5 employees as well as financial variables.

These findings are in line with other empirical research about the dynamics of the Swedish economy. For example, Olofsson & Szymne (1995) find that small independent firms exhibit better performance than subsidiaries to large firms. Firms acquired by large firms performed worst. For supplementary results, see, e.g., Davidsson *et al.* (1994a, 1996) for Sweden, and Carlsson (1999) and Wennekers & Thurik (1999) for international results. These results are in line with the theory of the EOE and Competence Blocs in which flexibility is important and the less bureaucratic organisation of independent firms should contribute to increased performance.

In line with expectations, government ownership has a negative impact on firm growth. The sign is negative in all six regressions and significantly negative in all but the first regression. It is significant at the 1, 5, 5, 5 and 5 per cent levels, respectively.

Sample size and the inclusion/exclusion of financial variables do not generally affect the sign or significance level of the non-financial variables - with two exceptions. *First*, the sign of the non-financial variables is the same in all regressions, firm age being the only exception. In *Regression 5* the effect of age turns positive. The reason is unclear. The effect is negative when the same regression is run if firms with less than five employees (*Regression 6*) or financial variables (*Regression 3*) are excluded. The effect from AGE² seems to be affected when the number of observations drops (compare *Regressions 1* and *2* to *Regressions 4-6*). Also, the F-value drops to critical levels when the number of observations drops (compare *Regression 1* and *2* to *Regression 3-6*). *Second*, the effect of enterprise groups becomes insignificant when firms with less than five employees are excluded. One explanation might be that many young, independent fast-growing firms are excluded when the number of observations drops, particularly when firms with less than five employees are excluded.

The financial variables are all insignificant with the exception of the change of turnover in *Regression 6* (at the five per cent level).

R^2 is low, varying between 0.019 (*Regression 1*) and 0.11 (*Regression 6*). Other related studies also report low R^2 s, e.g., Evans (1987) reports 0.14. This clearly indicates that important explanatory variables are missing. The low R^2 is not surprising. According to the theory of the EOE and Competence Blocs, a number of important explanatory variables have had to be excluded because no data are available. For example, some measure of firms' innovativeness and management competence should have been included as explanatory variables. The theory of the EOE and Competence Blocs, particularly, suggests that the skills of the actors in, and the function of, the competence bloc should be taken into account. All these variables are notoriously difficult to measure, even at the disaggregated level of this study.

The econometric analysis largely supports other empirical studies on Swedish industry (see, e.g., Davidsson *et al.* 1994a, b, 1996; Heshmati 2001) as well as those of numerous international empirical studies finding smallness and youth of firms to have positive effects on firm growth.⁶² That is to say, new- and small-firm formation raises employment and economic growth.

5.7 SUMMARY

This chapter investigates the importance of firm age and firm size on firm growth in the Swedish IT industry. *First*, empirical facts about new and small firms in current literature were presented. *Second*, new and small firms in the Swedish IT industry were surveyed statistically. *Third*, the effects of firm age and firm size on firm growth were tested econometrically. In addition, the effects of firm independence and firm ownership on firm growth were tested econometrically.

⁶² For example, Liu *et al.* (1999) in an investigation of determinants of firm growth in the Taiwanese electronics industry find that size (large) and age (old) have negative effect on firm growth. Also, see the references in *Section 5.2*.

The chapter draws on the theory of the EOE and Competence Blocs that emphasises the experimental nature of the economic process and the critical importance of human-embodied competence to create industrial dynamics and economic growth. The theory predicts that radically new technology is primarily introduced by new firms. Established old firms often do not understand radically new ideas, and, even if they do, they still have great difficulties in adjusting their competence base to exploit the business opportunities offered by radically new ideas. Furthermore, small firms probably provide a better entrepreneurial milieu than do large firms. Hence, young and small firms tend to be more flexible than old and large firms. They will therefore tend to grow faster.

The findings of the chapter strongly support the hypotheses that firm age and firm size affects firm growth. Young and small firms grow faster than do old and large firms. These results are in line with previous results in the empirical literature.

The descriptive statistics shows that new and small firms are major job creators. Large firms are important employers due to their size. However, new and small firms are shown to be the major job contributors on net, because large firms decline over time, while young and small firms expand. Particularly, firms without any employees in the beginning of the studied period are shown to be outstanding job creators over time. The analysis suggests that employment growth is facilitated by constant high entry of small firms since: i) new firms create many new jobs when established; ii) they grow spectacularly during their first years of existence, and iii) it is mainly the small new firms that grow fast.

The econometric analysis confirms the findings in the descriptive statistics that young and small firms generate employment growth. It is also shown that independent firms and private ownership have positive effects on firm growth.

CHAPTER 6 THE TURNOVER OF FIRMS AND INDUSTRY GROWTH

6.1 INTRODUCTION

The theory of the EOE and Competence Blocs suggests (see *Chapter 2*) that entry is important because new firms are more prone to introduce radically new projects than established firms. Exit, furthermore, is necessary to “kill” the entrants that the market test rejects and in general to set resources free for expanding firms. Moreover, the theory concludes that the number of entries and exits taken together has a positive effect on employment and economic growth, since a high turnover of firms increases competition and the possibility to create, identify and select winners. A high turnover of firms increases the number of business experiments and, thus, increases the possibility that some experiments turn out successful.⁶³

Recently, interest in the role of new-firm formation and the growth performance of small firms has increased, and a large number of studies have been carried out (see, e.g., Sigfried & Evans 1994 for a survey of the literature on entry and exit, see also *Chapter 5* for references). These studies have investigated the number of jobs generated by new and small firms. However, much fewer studies have been devoted to the relationship between firm *turnover* (here defined as the rate of entry and exit out of the total number of firms), job generation and economic growth. This is a different problem than that investigated in most earlier studies. The question is whether the rate of entry and exit is important in itself. As previously stated, the idea is that a high turnover i) increases competition, ii) increases the possibility to discover and select winners, iii) frees resources for expanding firms and, hence, iv) facilitates industrial transformation and economic growth. The general conclusion from studies on the turnover of firms is that turnover is positively related to economic performance (see, e.g., Davidsson *et al.* 1994a,b, 1996; Kirchhoff 1994, Reynolds 1994, 1997, 1999; Griliches & Regev 1995; Dunne *et al.* 1988, 1989; Foster *et al.* 1998; Callejón & Segarra 1999). For instance, Audretsch (1995a) writes that

⁶³ There is, probably, an upper limit of turnover, beyond which the market begins getting disorderly, the risk of misallocation increases and the role of growth is reduced. This probability is further analysed through simulation experiments in *Chapter 7*.

gross entry and exit is more important than net entry in generating jobs, probably because a lot of the entries are aimed at a search for new opportunities.⁶⁴

The purpose of this chapter is to test the hypothesis that the turnover of firms has no, or negative effect on employment growth in the Swedish IT industry econometrically.

The rest of the chapter proceeds as follows: The next section (*Section 6.2*) introduces the data and the econometric model. The following section (*Section 6.3*) presents the results. *Section 6.4* concludes this chapter with a summary.

6.2 DATA AND ECONOMETRIC MODEL

The econometric analysis is based on data from CFAR, i.e., the same data set that was used in connection with the first model in *Chapter 5*. However, this chapter is focused on industry growth instead of firm growth, i.e., the perspective here is more macro-oriented. Industries are defined at the 6-digit level in the SNI92 classification system. In total, the IT industry comprises 26 industries at this level of aggregation (see *Table 6.3* in *Section 6.3*).

The model is similar to that of *Chapter 5*. The dependent variable is industrial employment growth. The main explanatory variables are the rate of entry and exit and an interaction variable of entry and exit. The interaction variable is supposed to capture the positive effects from turnover. Similar non-financial variables are used as in the previous chapter, defined at the industry level and not at the firm level. The financial variables are excluded to make it possible to cover a longer time period and more firms. Recall that the financial variables did not have any significant effect in the regressions carried out in *Chapter 5*. The industrial dummies are also excluded, since they turned out insignificant in the regressions. The following model is used to analyse the effects of firm turnover on industrial growth.

⁶⁴ Note that this argument is very similar to the conclusions made in the theory of the EOE and Competence Blocs.

$$(6.1) \quad GROWTH_{i,t} = \beta_0 + \beta_{ENTRY} * ENTRY_{i,t} + \beta_{EXIT} * EXIT_{i,t} + \beta_{ENTEX} * ENTEX_{i,t} + \\ + \beta_{nonfin} * Z_{i,t-1}^{nonfin} + u_{i,t}$$

where $GROWTH_{i,t}$ is a vector on the growth of IT industry i at time t . $ENTRY_{i,t}$ and $EXIT_{i,t}$ are vectors on entry and exit in industry i at time t . $ENTEX_{i,t}$ is an interaction variable of $ENTRY_{i,t}$ and $EXIT_{i,t}$. $u_{i,t}$ is the error term. $Z_{i,t-1}^{nonfin}$ represents a vector with non-financial variables, including the average age of firms in each industry, the average size of the firms in each industry, the quadratic form of age and size, the share of employment due to enterprise groups and the share of employment due to governmentally owned firms. The period 1994 to 1998 is covered.

The variables are defined as follows:

Dependent variable:

$GROWTH_{i,t}$: The change in the number of employees in industry i between time $t-1$ and t (per cent).

Main explanatory variables:

$ENTRY_{i,t}$: The share of new firms out of all firms in industry i at time t (per cent). A firm is defined to be new when it is registered to have started its business activities, i.e., when its activity code becomes 1.

$EXIT_{i,t}$: The share of firms that exited out of all firms in industry i at time t (per cent). A firm is defined to have exited the same year the register reports that the firm has ended its business activity, i.e., when its activity code becomes 9.

$ENTEX_{i,t}$: An interaction variable defined as $ENTRY_{i,t} * EXIT_{i,t}$.

Non-financial variables:

$AGE_{i,t-1}$: The average age of the firms in industry i at time $t-1$. A firm established at time $t-1$ is defined as 1 year old, a firm established in time $t-2$ as 2 years old and so on.

$SIZE_{i,t-1}$: The average size (number of employees) of the firms in industry i at time $t-1$.

$AGE_{i,t-1}^2$: The average age of the firms in industry i at time $t-1$ raised to the second power.

$SIZE_{i,t-1}^2$: The average size (number of employees) of the firms in industry i at time $t-1$ raised to the second power.

$ENTG_{i,t-1}$: The share of employment in firms belonging to an enterprise group in industry i at time $t-1$ (per cent).

$OWNER_{i,t-1}$: The share of employment in publicly owned firms in industry i at time $t-1$ (per cent).

A fixed-effect model, i.e., the same model as in *Chapter 5*, is used. In the regression, industries are interpreted as individuals. The panel is balanced, i.e., there are observations on all industries all years. An F-test rejects poolability and a Hausman test rejects the assumption that the disturbances and explanatory variables are independent.

Entry is expected to have a positive effect on industry growth. The expected effect of exit is unclear; it can be positive, negative or neutral. In the short run, exit will have a negative effect on growth since firms are closed down. In the long run exit is supposed to have a positive effect on growth since it sets resources free to be reallocated and used in more efficient business ventures. That is part of the process of transformation presented in *Chapter 2*. The total effect (captured by the interaction variable) of entry and exit, however, is expected to have a strong positive effect on industry growth. As discussed in *Chapter 2*, age and size is expected to have a negative, but decreasingly negative effect on growth. The employment share of publicly owned enterprises and the employment share in enterprise groups are also expected to have negative effects on industry employment growth. The variables are summarised in *Table 6.1*.

Table 6.1 Summary statistics

<i>Variable</i>	<i>Description</i>	<i>Mean</i>	<i>Std. dev.</i>	<i>Exp. effect on growth</i>
<i>GROWTH</i>	Growth of employees (in per cent)	44.28	336.40	
<i>ENTRY</i>	The number of entering firms (per cent)	15.90	10.22	+
<i>ENTEX</i>	The interaction variable of ENTRY and EXIT	113.09	84.49	+
<i>EXIT</i>	The number of exits in industry (per cent)	7.28	3.53	?
<i>AGE</i>	Average age of firms in industry	6.27	2.06	-
<i>SIZE</i>	Average size of firms in industry	26.02	59.11	-
<i>AGE</i> ²	The quadratic form of age	43.59	26.67	+
<i>SIZE</i> ²	The quadratic form of size	4144.81	15601.18	+
<i>ENTG</i>	The share of employment in enterprise groups (per cent)	65.01	26.89	-
<i>OWNER</i>	The share of employment in publicly owned firms (per cent)	13.01	24.59	-

Source: Statistics Sweden (CFAR) and own calculations.

The correlation of the variables is presented in *Table 6.2*. The correlation between AGE and AGE² is high, as is the correlation between SIZE and SIZE². Also, the correlation between ENTRY and ENTEX is high.

Table 6.2 Table of correlation

	<i>GROWTH</i>	<i>ENTRY</i>	<i>ENTEX</i>	<i>EXIT</i>	<i>AGE</i>	<i>SIZE</i>	<i>AGE</i> ²	<i>SIZE</i> ²	<i>ENTG</i>	<i>OWNER</i>
<i>GROWTH</i>	1.00									
<i>ENTRY</i>	0.066	1.00								
<i>ENTEX</i>	0.023	0.80	1.00							
<i>EXIT</i>	-0.024	-0.034	0.30	1.00						
<i>AGE</i>	-0.20	-0.50	-0.40	-0.050	1.00					
<i>SIZE</i>	-0.060	-0.045	-0.043	-0.022	0.067	1.00				
<i>AGE</i> ²	-0.16	-0.48	-0.38	-0.042	0.99	0.099	1.00			
<i>SIZE</i> ²	-0.040	0.047	0.022	-0.014	0.051	0.96	0.083	1.00		
<i>ENTG</i>	-0.27	-0.10	-0.16	-0.39	0.059	0.42	0.065	0.32	1.00	
<i>OWNER</i>	-0.077	-9.6e-4	0.051	-0.060	-0.34	0.45	-0.32	0.33	0.32	1.00

Source: Statistics Sweden and own calculations.

As in *Chapter 5*, after estimated the core model, I have run regression on the change of the number of employees, applied log-linear models, applied random effects-models, run

models making adjustment for heteroscedasticity and autocorrelation and made a number of other adjustments to test the robustness of the results. The results are robust.

6.3 RESULTS

6.3.1 *Description*

Average employment growth in 1994 to 1998 varies a lot between the different industries (see *Table 6.3*). The industry for broadcasting stations (SNI92: 64202) shows the fastest average employment growth (more than 700 per cent), followed by the industry for the reproduction of computer media (SNI92: 22330) and stores for telecommunications equipment (SNI92: 52494), with an average employment growth of 147 and of 114 per cent, respectively. These three industries are small employers and comprise few firms. This, of course, is one major explanation for the high growth. They employ 641 (10), 73 (49) and 740 (172) employees on average respectively (the average number of firms in parentheses). There are a few industries that show negative average growth in employment. Employment fell the most, about one fifth on average, in companies renting office equipment (SNI92: 71330). It fell the second and third most in the industries for the manufacturing of computers (SNI92: 30020) and network stations (SNI92: 64201), 17 and 6 per cent, respectively.

Table 6.3 Average employment, average employment growth, average number of firms, and average gross entry and exit of firms, Swedish IT industries, 1994-98

SNI92 Industry	Employment	Growth (%)	Firms	Entry (%)	Exit (%)
Manufacturing C&C industry					
30010 Office machinery	1,529	-1	63	4	4
30020 Computers etc.	3,232	-17	367	9	9
32100 Electronic components	4,749	21	253	14	6
32200 Television, radio transmitters, telephones etc.	29,038	6	118	12	8
32300 Television and radio receivers etc.	2,155	18	150	10	7
33200 Instruments for measuring etc.	11,638	9	455	12	5
33300 Industrial process control equipment	951	50	129	18	3
Trade in C&C equipment industry					
22330 Industry for the reproduction of computer media	73	147	49	34	5
51142 Agents: Sale of computer equipment	264	4	132	17	10
51432 Wholesale: Radio and television goods	1,607	-5	431	6	10
51640 Wholesale: Office equipment	20,472	4	2,895	10	9
51653 Wholesale: Telecommunication equipment	6,051	5	1,102	9	6
52452 Retail: Radio and television stores	4,269	2	1,625	4	9
52493 Retail: Stores for computers, computer programs etc	1,657	15	1,100	25	9
52494 Retail: Stores for telecommunication equipment	740	114	172	22	8
71330 Companies for renting office equipment etc.	522	-21	219	5	13
Telecommunications industry					
64201 Network stations	26,520	-6	201	21	9
64202 Broadcasting stations	641	736	10	7	7
64203 Cable television companies	585	-2	58	8	4
Data consulting and data services industry					
72100 Hardware consulting companies	1,871	21	813	26	7
72201 Software consulting companies	25,385	14	9,545	22	7
72202 Software supply companies	6,469	21	1,228	28	6
72300 Data processing companies	5,972	3	635	13	6
72400 Data base companies	1,008	4	84	29	9
72500 Repair shops for computing machinery	1,388	-4	304	17	9
72600 Other data service companies	482	14	206	25	5

Note: The numbers in the table are calculated as average employment etc. for the period 1994 to 1998. Firms that exited in 1993 are not included in the data set.

Source: Statistics Sweden (CFAR) and own calculations.

Firm average gross entry is high in many industries. More than one third of the industries report gross entry rates exceeding 20 per cent per year on average. The industry for the reproduction of computer media (SNI92: 22330) reports an average gross entry rate of about one third, and data base companies (SNI92: 72400) and software supply companies (SNI92: 72202) 29 and 28 per cent, respectively. The industries for the manufacturing of office machinery (SNI92: 30010) and radio and television stores (SNI92: 52493) report the lowest average gross entry rate (4 per cent).

The exit rates are much smaller than the gross entry rates. The highest exit rates are observed in companies that rent office equipment etc. (SNI92: 71330), agents involved in

the sale of computer equipment (SNI92: 51142) and wholesale of radio and television goods (SNI92: 51432); 13, 10 and 10 per cent, respectively. The exit rates in the other industries are less than 10 per cent. The lowest exit rate (3 per cent) is reported in the industry for the manufacturing of industrial process control equipment (SNI92: 33300).

New-firm formation has been (surprisingly) active in many industries. It has been impossible to determine from the statistics why this is so. As already mentioned, one reason is probably the low number of firms in some industries. In these, small changes in the number of firms give rise to large changes in per cent. Another reason could be that the IT industry was “booming” during the studied time period and that new-firm formation and the business cycle are correlated (this can also explain the low exit rates). The thresholds for entering firms in terms of real capital requirements etc. are also extremely low in many of these industries. Many of the high-entry industries, furthermore, carry out typical outsourcable activities, thus offering incentives for employees to earn more from selling the services to his former employer and to other customers in their own companies. Also, aggregated data show a large increase in the total number of firms in the C&C industry since the 1970s (see *Chapter 4*). High entry rates are in accordance with that fact.

6.3.2 Regression Results

Turning to the regression results, *Table 6.4* reports six regressions on the relationship between entry, exit and turnover and industry growth.

The first regression includes all observations and all explanatory variables. The correlation between ENTRY and the interaction variable ENTEX is high, close to 0.80. This implies multicollinearity, which gives high variances and increased standard errors, thereby making the t-values smaller. Because of multicollinearity one will, therefore, increasingly accept the null hypothesis. The second regression excludes the ENTEX variable and the third regression excludes the ENTRY variable to overcome the problem of multicollinearity.

There are a few observations where industry employment growth is reported to be very high. Some studies exclude “extreme values” and *Regressions 4* to *6* exclude observations where employment growth exceeds 100 per cent to study the effects on the results of the regressions of these observations. *Regressions 4* to *6* correspond exactly to *Regressions 1* to 112

3, the excluded extreme values being the only difference. In general, I think that “extreme values” should be included when studying firm effects on growth, if one cannot identify some probable statistical errors. The extreme values might explain much of the variation observed in the dependent variable, cf. the previously referred studies that have found that a very small number of firms have generated the bulk of new net jobs.

Table 6.4 Regression results

	<i>Regression 1</i>	<i>Regression 2</i>	<i>Regression 3</i>	<i>Regression 4^a</i>	<i>Regression 5^a</i>	<i>Regression 6^a</i>
Dependent variable	GROWTH	GROWTH	GROWTH	GROWTH	GROWTH	GROWTH
ENTRY	2.78 (0.96)	9.18*** (4.06)	-	-0.62 (-1.24)	-0.21 (-0.61)	-
EXIT	-3.22*** (-4.83)	-2.65*** (-3.61)	-3.17*** (-5.36)	-1.04 (-0.92)	-0.44 (-0.44)	-0.67 (-0.62)
ENTEX	1.12*** (3.30)	-	1.34*** (5.31)	0.070 (1.12)	-	0.013 (0.32)
AGE	-75.31 (-0.70)	-192.99** (-1.81)	-67.63 (-0.63)	-3.61 (-0.22)	-3.52 (-0.21)	-0.52 (-0.032)
SIZE	-30.37*** (-8.27)	-28.31*** (-7.45)	-30.69*** (-8.39)	-1.98*** (-2.86)	-1.76*** (-2.64)	-1.93*** (-2.79)
AGE ²	5.80 (0.72)	13.90 (1.72)	5.30 (0.66)	0.13 (0.11)	-0.14 (-0.12)	-0.054 (-0.045)
SIZE ²	0.063*** (7.54)	0.058*** (6.73)	0.064*** (7.74)	0.040*** (2.64)	0.0034*** (2.41)	0.0038*** (2.52)
ENTG	-0.37 (-0.28)	-1.01 (-0.74)	-0.47 (-0.36)	-0.31* (-1.33)	-0.36* (-1.59)	-0.33* (-1.42)
OWNER	-6.38*** (-3.93)	-4.78*** (-2.93)	-6.48*** (-4.00)	-0.092 (-0.35)	0.037 (0.16)	-0.047 (-0.18)
CONSTANT	980.51*** (2.77)	1307.96*** (3.67)	997.91*** (2.83)	87.80 (1.54)	81.62 (1.43)	71.27 (1.28)
R ²	0.76	0.73	0.76	0.22	0.21	0.21
F-value	33.68	33.11	37.81	2.85	3.04	3.00
Number of observations	130	130	130	124	124	124

Note: ^a Observations with growth exceeding 100 per cent are excluded. ***, **, * signifies that the coefficient is significant at the 1 per cent, 5 per cent and 10 per cent level respectively. t-values in parentheses.

Source: Statistics Sweden and own calculations.

The main explanatory variables show the expected signs in the first three regressions including all observations. ENTRY is positive but insignificant in the first regression. This is most certainly due to multicollinearity because the effects of entry turn significant (at the 1 per cent significance level) when the interaction variable is dropped in the second regression. EXIT is significantly negative at the one per cent level in all three regressions. The interaction variable is significantly positive at the one per cent level in the first regression and significantly positive at the one per cent level in the third

regression, when ENTRY is dropped. Hence, the empirical results support the hypothesis that the rate of turnover has a positive effect on employment growth.⁶⁵

The average age of firms in different industries has the expected negative effect on industrial growth. The effect is, however, insignificant except in the second regression where it is significant at the 5 per cent level. AGE² has insignificantly positive effect on growth.

The average firm size of industries has a significantly negative effect on growth in all regressions. The effect is significant at the one per cent significant level in all regressions. Also, the effect of SIZE² is highly significant (at the one per cent level) in all regressions.

The marginal effect of age is negative in all regressions (see *Table 6.5*). The effect, however, is insignificant. The marginal effect of size is also negative in all regressions (at the one per cent level), except in the fourth regression. The estimates, however, seem unreasonable large. An increase of the average size of firms in an industry with one employee increases growth by about 25 percentage points.

Table 6.5 Marginal effects, age and size

	<i>Regression 1</i>	<i>Regression 2</i>	<i>Regression 3</i>	<i>Regression 4</i>	<i>Regression 5</i>	<i>Regression 6</i>
<i>Age</i>	-2.58 (-0.079)	-18.68 (-0.55)	-1.17 (-0.036)	-1.95 (-0.39)	-5.31 (-1.05)	-1.21 (-0.24)
<i>Size</i>	-27.09*** (-8.32)	-25.29*** (-7.50)	-27.36*** (-8.18)	0.20 (0.32)	-1.57*** (-2.68)	-1.72*** (-2.81)

Note: The marginal effect of age on growth is calculated as: $dGROWTH/dAGE = \beta_{age} + 2 * \beta_{age^2} * AGE_{avg}$, where AGE_{avg} is the average value of the AGE variable. The standard error used to calculate t values is calculated as: $\sigma_{dGROWTH/dAGE} = [\text{var}(\beta_{age}) + 4 * (AGE_{avg})^2 * \text{var}(\beta_{age^2}) + 4 * AGE_{avg} * \text{cov}(\beta_{age}, \beta_{age^2})]$. The marginal effect of size on growth is calculated in similar way.

Source: Statistics Sweden and own calculations.

The share of employment in enterprise groups also shows a negative effect on industry employment growth in all regressions.

The share of employment in publicly owned firms shows the expected negative sign. Notably, the effect is significant at the 1 per cent level in the first three regressions.

The R² is high; 0.76, 0.73 and 0.76, respectively.

⁶⁵ I have also run regression where the interaction variable is defined as the sum of ENTRY and EXIT (in

The exclusion of observations where employment growth exceeds 100 per cent has a large impact on the results. All explanatory variables turn out insignificant, with the exception of size. The effect of entry also changes sign and becomes negative. The fact that entry – the introduction of new firms into the economy contributing to employment – shows a negative effect on employment growth discredits the second model. The interaction variable is still positive. It is, however insignificant in both *Regression 4* and *Regression 6*. The R^2 drops to 0.22, 0.21 and 0.21, respectively. The F-values become critical. I conclude that the first three models including all observations are better for estimating the effects we are interested in. It should be recalled, however, that my *a priori* hypothesis was that extreme values should be included if it was not obvious that they were extreme because of statistical errors.

6.4 SUMMARY

This chapter tested the hypothesis that the turnover rate of firms has no, or negative effect on industry employment growth econometrically. The hypothesis was not accepted.

The results in *Chapter 5* and in this chapter support the theoretical conclusions made in the theory of the EOE and Competence Blocs. Taken together the results show the importance of new and small firms for employment growth. The analysis also confirms the importance of the experimental process for employment growth and shows that employment growth is positively related to the turnover of firms. This is in line with other international and Swedish empirical research.

CHAPTER 7 FIRM TURNOVER, NEW TECHNOLOGY

INTRODUCTION AND THE RATE OF MACROECONOMIC GROWTH*

7.1 INTRODUCTION

The macroeconomic effects of firm turnover are studied. The positive effects of entry and a fast and efficient allocation of resources through exits are balanced against the efficiency of price signalling in markets in a non-linear micro-based simulation model of the EOE. In this model increasingly rapid reallocation of resources over markets moved by entry and exit (the rate of firm turnover) first generates faster growth in output but eventually, if too fast, affects the reliability of price signalling in all markets. We also consider the possibility that unbalanced turnover may raise factor prices for expanding firms and, hence, slow growth.⁶⁶

To test for a long-run and non-linear negative influence of a very fast, and (perhaps) unbalanced, firm turnover process very long time-series data that are not available are needed. It may even be so that the firm turnover rate needed to generate disturbances in the price system has to be so extreme that it “cannot occur” in reality. If so, the negative relationship will never be observed in reality and simulation will be the only way of establishing the possible existence of this phenomenon.

In this chapter we discuss the dynamics of resource allocation in the EOE in principle and in a model representation of the EOE, the Swedish micro-to-macro model MOSES. The presentation is in terms of a Schumpeterian creative destruction process. The allocation dynamics created by new firm formation and the exit of firms are studied through simulation experiments on the model (*Section 7.2*). In *Section 7.3* the new firm

* This chapter is co-authored with Professor Gunnar Eliasson, Royal Institute of Technology, Sweden, and Professor Erol Taymaz, Middle East Technical University, Turkey. This chapter also exists in a somewhat more technical form as three separate papers co-authored by the three of us (Eliasson *et al.* 2001a,b,c).

⁶⁶ With unbalanced firm turnover is meant large differences between entry and exit rates prevailing for a long time.

database on the C&C economy (described separately in a *supplement*) is used to demonstrate the existence of, and the emergence or non-emergence of a so called “new economy” based on C&C technology. The success or failure in capturing the new opportunities of the new economy is experimental in terms of the dynamics of the creative destruction process, or the firm turnover process. Both sections are basically theoretical, the ambition being to demonstrate the existence of certain economic phenomena and explaining them in terms of the micro-to-macro model framework. There is no claim here of empirical verification even though the model has been calibrated on Swedish data. The purpose of this chapter is only to demonstrate the possible existence of certain phenomena through simulation of an empirically implemented micro-to-macro model over the Swedish economy that approximates an EOE. The hypotheses that we “test” through simulations, however, has been derived directly from the previous theoretical and econometric analyses.

7.2 THE DYNAMICS OF RESOURCE ALLOCATION IN THE EOE

As discussed in *Chapter 2*, the EOE is characterised by an extremely large and heterogeneous state space and business opportunity set into which boundedly rational individuals guided by tacit knowledge search for opportunities. This search is also an act of both creative discovery and learning such that new opportunities are created and the opportunity set expands, with the paradoxical result that the individuals may become increasingly ignorant about all that can be learned. Hence, the economy behaves at each point in time as a for all practical purposes (extremely large) open-ended system. Growth occurs through experimental selection, e.g., through the entry of new firms forcing reorganisation and rationalisation or exit of incumbent firms.

Schumpeterian creative destruction

We study the macroeconomic effects of firm turnover (entry, exit) in this Schumpeterian creative destruction process in which macroeconomic growth is moved by the introduction of new profitable combinations. We use a model approximation of the EOE, the Swedish micro-to-macro model, called MOSES. For our purposes this model economy has two fundamental properties:

- (1) With a huge and complex state space the opportunities for very large systems productivity effects through dynamic reallocation of resources are significant. Much of that reorganisation occurs through the entry and exit of firms (see Eliasson 1991a,b; Eliasson & Taymaz 2000).
- (2) The faster resources are being reallocated through entry and exit, and also through other forms of organisational change, however, the more unreliable price signalling in markets, causing in turn an increase in costly mistaken business decisions with a small learning content, and a negative effect on growth (see Eliasson 1983, 1984, 1991b). Hence, there are *increasing negative returns to increased search* (“learning”) of state space and the business opportunity set (see Eliasson 1990a) as agents attempt to probe state space faster in the short run to reach even higher economic systems productivity levels (see Eliasson 1989). These negative returns to too fast learning occur because the co-ordination mechanism of the model economy (price signalling in markets) is disturbed, price signals becoming increasingly unreliable and causing an increased rate of mistaken decisions. We want to demonstrate the existence of this effect in this chapter.⁶⁷

Starting from zero entry of firms and increasing the rate we would, hence, expect an increasingly positive outcome to begin with, which will eventually begin to decline. When almost all firms are changed through entry and exit each period output might even be smaller than in the no turnover case. Somewhere in between there is a maximum. In the short run the hypothesis of positive effects of firm gross turnover can be tested econometrically. The long-run curvature hypothesis, however, is not tractable by econometric analysis and for two reasons. *First*, time series data of sufficient length to reveal the non-linear property are simply not available. *Second*, over the time span we now consider a real world experiment, which will include so many interactive influences that the model needed to capture them and keep them apart will probably be beyond econometric analysis. It may be the case that the negative influences begin to show so early that agents, including policy makers, begin to react to counter these effects. If so,

⁶⁷ A brief presentation of the micro-to-macro model tailored for our particular experiments is found in Eliasson & Taymaz (2000). A more principal presentation is found in Eliasson (1977, 1978 and 1991a, 1991 being, perhaps, the best fast introduction that is easily available). In addition there are five MOSES books: (1) *The Firm and Financial Markets in the Swedish Micro-to-macro Model* (Eliasson 1985), (2) *MOSES Handbook* (Bergholm 1989), (3) *MOSES Code* (Albrecht *et al.* 1989), (4) *MOSES on PC – Manual, Initialization*

the analysis is a pure theoretical inquiry into the possible existence of such a negative effect in a controlled experiment. However, we might have a situation of chaotic behaviour, the system sending no alarm discernible signals until a strong surge of negative macroeconomic influences begin to show.

This long-run dynamic property of the EOE becomes analytically tractable in the model approximation to the EOE, i.e., in MOSES. We would, hence, expect a non-linear relation between the rate of firm turnover and long-run economic growth under certain, perhaps quite general circumstances. For low rates of turnover and short time periods the relationship should appear positive and approximately linear as demonstrated in econometric tests (see, e.g., *Chapter 6*). The same relation should, however, be non-linear over the longer term, eventually to turn negative, when the rate of (unbalanced) firm turnover increases.

This hypothesised non-linear relationship has been econometrically tested on data generated by repeated simulation experiments on the MOSES micro-to-macro model of the Swedish economy. Incentives for entrepreneurial entry have been gradually raised and the long-run effects on total output simulated. The hypothesis is that the relation changes from a positive to a negative one somewhere in between no entry and a complete turnover of all firms each period. We also hypothesise that the negative influence on long-run growth will occur faster (1) the faster firm turnover and (2) the more unbalanced the entry and exit process.

To carry out these experiments we have used the latest version of the MOSES model of the EOE with endogenous R&D generation of innovations and genetic learning of firms from one another (see Ballot & Taymaz 1998).

On non-duality and unreliable price signalling

The experiments we are considering can only be performed on a model economy that is operationally defined outside static equilibrium and that has no exogenous equilibrium.

and Calibration (Taymaz 1991) and (5) *MOSES Database* (Albrecht *et al.* 1992); all five published by IUI, Stockholm.

Its equilibrium properties have to be defined differently and should rather be discussed in terms of economic systems stability (see Eliasson 1983, 1984). In static equilibrium duality prevails. Prices map exactly into quantities and quantities map exactly into prices. Non-duality can only be analysed on the static general equilibrium model for infinitesimal departures from that same equilibrium to which the system always returns (converges) i.e., to the original (same) equilibrium, or almost there (“practical stability”; see La Salle & Lefschetz 1961). This rubber-band fixed point based equilibrium analysis does not recognise time and the possibility that the system, because of its departure from static equilibrium may go “elsewhere”.⁶⁸ This non-convergence property is, however, to be expected in an economy where information use and communication activities dominate resource use and where technological change in C&C technology dominates total productivity change through constant systems reorganisation (see Eliasson 1990b). Hence, to analyse the systems instabilities generated by endogenously disturbed price signalling in markets that remove price-taking behaviour of individual agents from the model, we need a very different non-linear micro-to-macro model such as MOSES.

When entrants are characterised by very large diversity of performance, and not necessarily better than incumbents on the average, new (and young) firms tend to perish at a higher rate than the older incumbents. This property of the model is compatible with evidence reported in literature (see, e.g., Granstrand 1986).

When entrants are very much better and very large and variance in performance low, the incumbent firms will soon perish and only the new and very superior firms remain. Such a structure is vulnerable to unexpected change. It leaves a permanent change in the economy (non-reversibility) and easily turns fast growth into low growth (see Eliasson 1983, 1984). This phenomenon, however, can only be “observed” through model simulations.

In fact, earlier model experiments have uncovered a conflict between static and dynamic efficiency in the sense that considerable diversity of characteristics at the firm level are a necessary requirement for stable and sustained macroeconomic growth. This does not

⁶⁸ For a discussion of this “chaotic property” see Eliasson (1983, pp. 274 ff.).

only mean (see Eliasson 1984, pp. 263 ff.) diversity in the sense of different, but also diversity in the sense of more or less efficient firms (the existence of slack) and constant change at the micro-firm level. “Steady state like” macroeconomic growth, thus, has to be supported by constant and “substantial Brownian motion at lower levels” (op. cit., p. 266), and vice versa. If that microeconomic dynamics is blocked, e.g., if exit is prevented by policy, negative long-run macroeconomic effects will eventually begin to show. This is part of the phenomenon we study in this chapter that is difficult to demonstrate by traditional econometric methods.

Stylised facts about firm turnover

Entry, and even more so exit, has been a neglected problem in economic theory, partly because of the difficulties of dealing with the subject in neoclassical theory, partly because of the difficulties in getting the statistical data. As an empirical phenomenon it, however, unmistakably exists, and some early, empirically oriented economists (see Orr 1974; Du Rietz 1975; Baldwin & Gorecki 1989; Acs & Audretsch 1989) defined the theoretical problems and launched the empirical inquiries that have contributed significantly to our knowledge of the firm turnover process. The econometric models estimated, however, are only loosely related to mainstream economics, and often conflict with the Walras-Arrow-Debreu model. Eventually, empirical facts have spurred a neoclassical awakening and several studies, recently within the so-called new growth theory movement, have addressed the phenomenon. They have even begun to use terms such as “Schumpeterian models”, “selective” and “creative destruction”. In these models, however, industries operate on their (well-known) production possibilities frontiers and “price taking” is imposed by assumption.

Generally speaking the direct effects of entry on aggregate output in those studies are not very large, and slow in coming (for a survey see, e.g., Eliasson 1991a). The important long-term effects of new entry are indirect and systemic and should be expected to be even slower in coming. They may, however, be very large in the long run. To quantify them you need a full-scale dynamic, micro-based model of the entire economy (see Eliasson & Taymaz 2000).

The stylised facts are that rates of entry and exit develop parallel but vary between economies (see Geroski 1995; Siegfried & Evans 1994; Caves 1998). Furthermore, there

is econometric evidence of rates of entry being dependent on rates of return in the firm and/or in the market entered but the evidence varies between studies. The reason for the absence of such relationships in some studies might be that entrants are generally overoptimistic and believe their technology to be superior to that of their incumbent competitors in the market and be independent of the situation at large in the market. In reality then, entry depends on expected profitability on the part of the entrant, which is difficult to measure. But even so, it is hard to believe that there should be no relationship between the aggregate profitability situation in a market and the rate of entry in the same market. Most probably this is where one should begin to look for the absence of an econometric relationship. Stylised facts, in fact, are that entry increases and exit decreases with profitability and growth in the local markets (see Siegfried & Evans 1994).

Another stylised fact is that the average performance of entrants is lower than that of incumbents but that the variation in performance in the entry sample is very much larger (see Granstrand 1986). This would suggest that new establishment has a much higher exit rate than older ones. This property, in a stylised way, is also part of the Jovanovic's (1982) model and supported by Audretsch & Mahmood (1994, 1995) and Caves' (1998) survey of empirical literature. For some, trained in standard micro production analysis this may seem counter intuitive, since for them old and obsolete plants should exit first.

Honjo (2000) finds that new firms have greater difficulties surviving than old firms, notably in markets with a high entry rate and (therefore) intense competition. Age, however, also has a linearly independent positive effect on business failure, but the square of age a negative effect. This non-linear effect means first positive and then (with larger age) negative effects of age on the failure rate. Audretsch (1995b) observes that survival rates (over a decade) are lower in highly innovative than non-innovative markets, but entrants that have survived exhibit higher growth rates than other firms. Also Baldwin (1995) finds that firms that survive exhibit fast growth rates.

Acs & Audretsch (1989) find that small firm entry is held back in concentrated markets, that they are competence intensive and "highly innovative". The opposite appears to be the case for large-firm births, but together new firm entry should be an important competitive force in the industry.

Several studies using linear (regression) models (beginning with Du Rietz 1975 and Baldwin & Gorecki 1989, 1990) show that entry adds significantly to growth.

The higher exit rate of new firms than of incumbents have been demonstrated to be a property of the MOSES model and for exactly the reasons given above in Eliasson & Taymaz (2000).

7.2.1 The Entry and Exit processes

Firm turnover involves the four firm activities entry, reorganisation, rationalisation and exit of projects, together inducing the process of Schumpeterian creative destruction. This process, which is explicit in the micro-to-macro simulation model MOSES may or may not generate macroeconomic growth, depending on economic circumstances endogenous in the model.

One could say that the simulation experiments directly perform the transformation of *Table 2.3* into *Table 2.4* in *Chapter 2*, firms being guided in their (long-term) investment decisions by a profitability criterion (the expected return to capital over the market interest rate).⁶⁹ Firms may temporarily be inferior performers, but the profitability criterion forces them to improve their performance over time. Hence, if firms cannot meet their own short-term profit standards they may decide to contract operations rather than invest and expand. In this particular set of experiments unreliable price signalling in the market may lead to mistaken production and investment decisions and tilt an increasing number of firms onto a negative growth path. Similarly, unbalanced growth with too few exits may raise factor prices and tilt expansive firms onto lower growth paths.⁷⁰

⁶⁹ The criteria used is called Maintain or Improve Profit (MIP) and approximates a net present value calculation, only that firms do not maximise value but constantly strive to raise (MIP) expected profit performance. Hence, reorganising firms may contract or expand depending on the circumstance. Each firm has access to all internal data to make such calculations on the basis of expected external market data. Recorded simulation experience includes calculated experience of the reliability of (variance in) such expectations. The less reliable the more cautious firms in terms of their expectations. Since the state space or business opportunity set of the MOSES model constantly changes because of firm activities firm behaviour is characterised by “profit hill climbing” in a landscape subjected to constant earth quakes that may any time remove the “expected profit hill. For a brief introduction to MIP, see Eliasson (1977).

⁷⁰ These negative effects on growth came out clearly in early model experiments on the Swedish industrial subsidy program (see Carlsson 1983).

One could also say that the four firm activities update a set of performance characteristics represented each period through the rankings of Salter curves. Under positive circumstances the Salter curves are shifted outwards. Economic growth occurs (see *Chapter 2*).

The concepts of entry and exit

The concepts of entry and exit are well defined in the MOSES model as “whole” firms or divisions that enter or leave. Also, factors used in exiting firms (labour and machines) are recycled over the market to other firms. In reality, however, entry and exit take on more diverse forms. Jenner (1966), in fact, wants to see the launching of a new product as a new entry, and firms may acquire parts of other firms, or spin off parts of itself as new entrants. Similarly, the shut down of a factory in a big firm should count as an exit. This is perfectly compatible with our theory as expressed in the four firm activities, but such a fine statistical resolution takes us beyond availability of data, even though some empirical studies look at corporate spin-offs (see, e.g., Du Rietz 1975).

The actual occurrence of the phenomenon becomes difficult to define on the exit side. A complete reorganisation of a firm with many subsidiaries, including divestitures and new acquisitions should count as a complex entry and exit process, and may to some extent appear in statistics as the disappearance of old, and the opening up of new, firm identification numbers. Only part of this activity will, however, be captured statistically. The MOSES model, as it is currently constructed, cannot deal with this.

Entry

In this analysis we use the following entry rate specification.

$$\text{Entry} = s(\alpha, \pi),$$

where Entry is the number of new firms in the economy per quarter, $s(\cdot)$ is a stochastic function, α is the exogenous entry parameter, and π the average rate of return in the market.

Moreover, we assume a uniform distribution of size around the average entry size that is assumed to be less than the average of incumbents. In our experiments the size of new entering firms can vary from five percent of the average size of incumbents (in terms of

number of employees) to 25 percent. Hence, the average size of entrants is around 15 percent of the average size (measured by labour employed) of incumbents.

Firm performance is measured by labour and capital productivity and by the rate of return. To specify the characteristics of new firms we use the observation (see Granstrand 1986) that average labour productivity performance of a sample of new firms is lower than the same average of incumbent firms.

It is, however, not possible to induce the high rates of entry that we need to destabilise the price system endogenously through indirect incentives only. Hence, the very high rates of entry in some experiments have been exogenously imposed by changing the characteristics of the entering firms and modifying the stochastic algorithms that determine the rate of arrival of new entrants.

In the entry experiments, the value of the exogenous entry parameter, α , has been increased gradually to test for the effects of the entry rate on long-run macroeconomic performance.

The size of new firms in terms of the number of employees is drawn randomly from a uniform distribution. As mentioned, the boundaries of the distribution are set at the 5 percent (lower limit) and 25 percent (upper limit) of the average size of the incumbent firms.

The technological characteristics of the new firms are also determined randomly, using genetic algorithms. The model features 100 technologies that are potentially available to firms. These technologies are numbered from 0.1 to 10.0 by 0.1 increments. The higher the number, the higher (not linearly) the potential labour and capital productivity. Firms can adopt anyone of these technologies and (thereby) get closer to potential labour and capital productivity levels by incremental innovation/imitation. At the beginning of a simulation, all firms use technology 1.0. They change their technology level by radical innovations and/or imitation. The index of technology, therefore, represent the average of potential labour and capital productivity levels (see further Ballot & Taymaz 1998, pp. 309-314).

The probability that the i^{th} firm will enter with technology j is defined as follows:

$$p_{ij}^T = f(|j - T_{ave}|, p_j)$$

where T_{ave} is the average technological level for all firms in the market and p_j the proportion of incumbent firms using technology j . In other words, new firms tend to enter with technologies that are close to the market average and adopted by many firms. However, it is still probable that a new firm may enter with the best technology, i.e., technology 100. Therefore, entry encourages diversity that is likely to include better technologies. On the other hand, increasing returns to adoption generated by the imitation process force firms to cluster around the same technology, and reduces diversity. The entry process, therefore, has a tendency to raise the rate of technological change by creating diversity, but it also causes reallocation of resources towards, in some cases, low tech new firms (see Ballot & Taymaz 1998).

Exit

The *exit* process is more easy to specify. It is fully endogenized and occurs when firms have been experiencing a bad profit development for considerable time. The model allows for a continuum of exit behaviour between fast exit when a firm has recorded profitability below targets for a number of years and, at the other end, at the latest (slow exit) when net worth has vanished. This means that the exit rate should be negatively correlated with the general profitability in the market (which in fact has been econometrically established to be the case, see Siegfried & Evans 1994) because firms operating in low-profit markets generally tend to show lower profitability. Exit, hence, can be slow or more or less fast. Exit can be forced by competition and competition is enhanced by the entry of superior firms.

The positive macroeconomic effects of a faster exit rate may demand a separate explanation. How come the disappearance of firms add to output? This paradoxical effect is generated in a highly non-linear fashion over the longer run, but only under particular circumstances, i.e. it is positive if released resources are reallocated to growing firms, and the more so the more productive the receiving firms and the less productive the disappearing firms. We have an example of the macroeconomic output effects of dynamic resource allocation. This effect is difficult to demonstrate econometrically on the short time series data available. We have not seen any references to such a study. It has been demonstrated to be a property of the MOSES model by Eliasson & Taymaz

(2000). The clear result of that study was that a *long term*, positive outcome of entry required a significant exit rate and a fast reallocation of labour over the market. Furthermore, as we will soon see, the experimental design that generated the negative long-run effects of fast entry was a slowing of the exit process.

Exit, hence, is an integral part of the firm entry and reorganisation process that together induces Schumpeterian creative destruction. Exit is necessary to release resources for non-inflationary new firm formation and growth. Exit is a natural consequence of the business mistakes that occur constantly in the model of the EOE. Stable macroeconomic growth, however, requires some balance between entry and exit frequencies.

7.2.2 Results from Simulations

Each experiment is rerun by gradually increasing the entry parameter (α), so that the entry rate is steadily increased. Experiments run (by quarter) for 75 years. Micro relationships are partly determined econometrically. The model is, furthermore, based on a separate firm survey carried out by the Federation of Swedish Industries and IUI since 1975 (see Albrecht *et al.* 1999), and supplemented with a similar survey carried out to C&C firms. The new database is presented in the supplement. The remaining parameters in the model have been calibrated on historic data (see Albrecht *et al.* 1992 and Taymaz 1991, section 3 on calibration). The exit rate is completely endogenised, but faster and slower exit can be specified in terms of the criteria model firm management applies to close down a firm.

Figure 7.1 shows the entry rate defined as the proportion of net entrants at the end of the simulation (year 75). As may be expected, the entry rate increases almost monotonically by the value of the entry parameter (α) to reach some 80 per cent.

Figure 7.2 shows the effects of the entry parameter on the exit rate that is defined as the ratio between the number of exits and the number of firms at the beginning of the simulation. As expected, the entry rate also increases the exit rate because of the tough competition it imposes in the markets.⁷¹

⁷¹ This effect has been a property of the model through all its versions. See Eliasson 1978, pp. 52 ff.

The endogenised balance between entry and exit is shown in *Figures 7.3*.

Figure 7.1 Number of net (surviving) entrants in per cent of 75-end year population of firms for different entry specifications

Figure 7.2 Number of exits during 75-year simulations in per cent of initial number of firms

Figure 7.3 Number of entrants and exits per year in per cent of stock of firms (number) for different entry specifications

To demonstrate the change over from the approximately linear to the non-linear macroeconomic response to firm turnover we present four sets of figures showing the GNP levels after 15, 35, 55 and 75 years respectively (*Figures 7.4, 7.5, 7.6 and 7.7*). The curve shows the average value of GNP in the experiments, and the trend line shows the regression “curve” estimated by regressing the GNP level on the entry parameter

Up to 15 years the levels of GNP increase proportionally with the rates of entry (and exit). Decreasing returns to further entry begin to show as a small down-bending of the trend curve after 35 years, which becomes pronounced after 55 years and very striking at 75 years. The downward bending at year 75 also comes at a lower turnover rate than at years 31 and 55.

Figure 7.4 GNP level at year 15 for different entry rate specifications

Source: MOSES simulations.

Figure 7.5 GNP level at year 35 for different entry rate specifications

Source: MOSES simulations.

Figure 7.6 GNP level at year 55 for different entry rate specifications

Source: MOSES simulations.

Figure 7.7 GNP level at year 75 for different entry rate specifications

Source: MOSES simulations.

For our purposes it is sufficient to establish the existence of this non-linear negative effect under the dynamic assumptions of the simulation. The negative effects take a long time in coming but the final surge can become very strong.

It is not meaningful at this stage to draw any further quantitative conclusions: for practical reasons the number of firms populating the model is, of course, only a tiny fraction of the number of firms of the real Swedish economy. The long-term growth to the 75-year horizon peaks at an entry parameter between 100 and 150. At that turnover level some 60 percent of the end population of firms is new. Many new entrants, however, have exited during the 75-year period.

On the exit side (*Figure 7.2*) long-term (75 years) output peaks when exits number some 43-44 per cent of the initial (year 0) population. While both the number of entrants and exits increases, the number of entrants is much larger than the number of exits. On the entry side, the “optimal” number in the model simulation amounts to some 1.1 per cent of the stock of firms per year, which is slightly above the average of just below 1 percent in the 1970s and 1980s in Swedish manufacturing (see Andersson *et al.* 1993, p. 95). We have no corresponding data on real exit rates. Apparently the exit rate simulated is much lower (*Figure 7.3*). We can only say that if the scale would be calibrated to the level of the real economy the proportion of firms replaced through Schumpeterian creative destruction each period would be very large as you go to the right in *Figures 7.1-7.3*. There is, however, the possibility, indicated earlier in the text, that the strong negative bend on the growth curve at high rates of entry after 50 years also depends on a too low exit rate (unbalanced turnover) and would go away if we speed up the rate of exit by making management more profit conscious. This experiment has not been run but the hypothesis indicated will be tested later. Hence, the extreme bending down in *Figure 7.7* may be extremely unlikely in reality because such unbalanced rates of turnover rarely occur for such long periods. But the effect is there to show. To capture it in a time series analysis on entry, exit and growth rates, generated by the model over a 75-year period, a very different model than the standard linear regression model would, however, be needed.

7.3 SIMULATING THE NEW ECONOMY

The New Economy was a catchword of the late 1990s (see Kelly 1998). Its lustre however, faded almost as fast as it arrived with the dot.com deaths of the first years of the new millennium. Before that, up to the mid 1990s the catchword was the “productivity paradox” (see Berndt & Malone 1995; Brynjolfsen 1993) coined by Robert Solow, who stated in 1987 that “computers are everywhere visible, except in the productivity statistics”. The New Economy apparently has something to do with IT or the C&C technology.

With this analysis we demonstrate that the two paradoxes above are perfectly compatible within a consistent micro-based macro theoretical framework of endogenous growth. Within the same model framework also another “paradox” can be resolved, namely the fact that the previous major New Industry creation, the Industrial Revolution, only involved a handful of Western nations that had got their institutions in order (see North & Thomas 1973; Eliasson 1991a). If the New Economy exists, and there are sceptics (see Gordon 2000a,b) among all the enthusiasts, one cannot take for granted that all industrial economies will participate successfully in its introduction. It all depends on the local *receiver competence* (see Eliasson 1985, 1986, pp. 47 ff., 57 ff., 1990a) or absorptive capacity (see Cohen & Levinthal 1990). We also demonstrate the existence of the possibility of an entire national economy failing to capture the opportunities of a New Economy within the same model. Finally, there is also the worrisome collapse of some of the C&C industry beginning in late 2000 that has caused a discontinuation of much of the New Economy hype. We will also discuss the sustainability of the New Economy in terms of the experiments. Hence, in this chapter we demonstrate through simulations on the Swedish micro-to-macro model MOSES that the three paradoxes are fully compatible within the same comprehensive modelling framework;

1. the productivity paradox
2. a sustainable New Economy based on the generic C&C technology
3. provided the necessary local receiver competence exist.

Hypothesis 3 means, that a sustainable, new and fast growing economy will not appear if the requisite institutions and other circumstances are not in place.

The base hypothesis is that the technology has been created in the C&C industry, but that the growth mover will be its introduction in the old industry through the establishment of new firms, the reorganisation of incumbent firms and through the exit of failing firms.

The new economy simulations have been made possible with the introduction of the C&C industry micro (firm) database in the MOSES model (the new micro database is presented in a *Supplement* to this chapter). We have *demonstrated the existence* within our model framework *of the phenomena discussed in the context of the New Economy* and this is all we intended to do in this part of the chapter.

The Swedish micro-to-macro model

The most salient features of the model to be emphasised in the context of the simulations to follow are:

- A Schumpeterian creative destruction model of growth (EOE)
- The creation and selection of new technology (Competence bloc)
- The diffusion of new technology through learning from successful introductions (genetic algorithms; see Ballot & Taymaz 1998).

The new economy scenario

This is the sequence of events that we envision in reality and have explicitly represented in the model.

New generic C&C technology is developed within the C&C industry and forms the base for rapid expansion of the C&C industry. The same technology is carried to the incumbent firms in existing industry through their investments in hardware and software produced in the C&C industry. The successful introduction and realisation of productivity gains from those investments, however, require particular *local receiver competence* that is rarely present. The early successful introductions are, therefore, preceded by sequences of failed introductions. Once a success has been registered learning sets in among other firms as modelled through genetic algorithms in the model (see Ballot & Taymaz 1998).

The main thing however, is that the diffusion of successful new technology introductions take a very long time before the opportunities to learn become plentiful. We have a

strongly non-linear introduction process beginning with the productivity paradox and culminating with a surge in productivity advance as the new technology takes hold of the entire production system, forcing firms that have not been able to accommodate the new opportunities to exit. The fast movers/introducers are the new entrants. Incumbents respond later. Once the new technology has established itself in the form of some successful technology introductions (the technology index in the simulations) other firms will find it easier to learn, and the more firms that have learned, the faster other firms learn and technology diffuses at an accelerating rate. Eventually, the entire economy should have shifted to a higher growth path, that is, however, not necessarily faster than the earlier growth path. This takes care of the first two paradoxes.

The third paradox involves failure on the part of the entire economy to introduce the new technology. There are many possible explanations to this. Our analysis will, however, only demonstrate “theoretically” that simple economic, or economic policy circumstances associated with the institutions of a national economy may be sufficient to prevent the successful transformation of an old economy to a New Economy.

From Eliasson & Taymaz (2000) and simulations in this chapter we know that a balanced entry and exit process and a mobile labour market are required for new technology introductions through the entry of new firms to be successful. If a viable exit process and a mobile labour market do not facilitate the transfer of resources, notably labour, to the entering and growing firms, the whole growth process might stall. There may not be any New Economy experience.

The design of simulation experiments

Experiments have been designed to show the successful and innovative introduction of C&C technology (reflected in the index of the potential technology level curve in the graphs) to be learned by other firms at fast, medium fast and slow rates. These, introductions occur through firm investments, in which we vary the share of C&C investments exogenously. Two things now occur. *First*, C&C industry investment increases the probability of successfully innovating firms. *Second*, productivity of new investments in the C&C investing firms increases strongly.⁷²

⁷² That is, labour and capital productivity in new investment vintages increases, and the more so the larger the share of C&C investment in total firm investments. For an explanation how technology affects the

The experiments also distinguish between fast and slow innovative entry, and fast and slow exit. In this model setting, a (a) low level of, and a slow rate of technology level increase and (b) a slow introduction of C&C technology are taken to reflect a low receiver competence on the part of the firm population of the economy. The slow increase in successful new and innovative C&C technology introductions can also be taken to reflect a badly functioning competence bloc in the sense that radically new and innovative technology is not identified and supported commercially, e.g., because of lack of competent venture capital (cf. *Chapter 8*). Similarly, the whole economic system can be more or less well adopted for facilitating the introduction of new technology through new entry etc. In our simulation experiments this is crudely represented by a more or less speedy exit process that releases resources more or less early for fast growing new entrants and incumbents. In the slow case, firms exit when they have used up their equity. In the fast case they exit after so and so many years of below market interest rates of return. One problem should, however, be mentioned right away. The successful introduction of new C&C technology (the technology level curve) is all endogenous. We cannot keep that factor constant, and vary other parameters to see how fast the diffusion mechanism works.

7.3.1 Simulation Experiments

The *Figures 7.8, 7.10 and 7.13* show cumulative developments of (1) C&C industry output, and (2) manufacturing output, (3) the C&C technology level and (4) (labour) productivity in manufacturing. In the first round of experiments exit is fast, releasing resources fast (fast exit).

The reader should, however, note one particular thing. Towards the end of the simulations productivity growth in manufacturing is quite fast and total demand does not keep pace with growth in potential output. Unemployment reaches fairly high levels in most experiments (see *Table 7.1*). This means that the experimental design is not that of a full employment economy. This has consequences for the interpretation of the simulation results that were not anticipated when designing the experiments (see below).

Table 7.1 gives key “end of 55 years” data for three of the 16 simulation runs. For each of the 16 simulation experiments five Monte Carlo variations⁷³ have been run to test for robustness (see Figures 7.9 and 7.11). The Table 7.1 and Figures 7.8 and 7.10 give average outcomes. The *Worst Growth* case experiment features (a) no entry, a slow diffusion of C&C technology and a high exit rate. The *Best Sustainable Growth* case experiment (b) features significant entry, a fast diffusion of C&C technology and fast exit of low performing firms. If we vary the parameters of the entry function in the model we find that the fast growth scenarios are obtained when rates of entry and exit are fairly balanced (cf. Section 7.2). While the rate of turnover of firms in the best sustainable growth case is far above that in the best growth case it apparently has not been so high as to generate the negative market disturbances discussed in the previous section. The higher turnover rate has rather generated a larger number of “productivity winners”.

With sustainability we mean that the circumstances are such that fast growth most probably will continue beyond the simulated long run horizon (see below). Figures 7.8 and 7.10 show the evolution over time of C&C industry output, total manufacturing output, the level of technology and labour productivity in the best sustainable and the worst growth scenarios respectively. The 7.9 and 7.11 Figures show the Monte Carlo variations in manufacturing output for the same scenarios. The technology level is an index of the potential productivity levels achieved in the most successful new technology introductions from which all other firms can now learn (see Section 7.2).

The Worst Growth case experiment has been designed to show the absence of a successful New Economy introduction. The negative institutional circumstances that prevent the introduction of a New Economy are very crudely represented by the absence of new entry (instead of fast or very fast entry) and a slow diffusion of C&C technology. But this is sufficient to generate a remarkable difference in long term industrial development, best shown in the Figures 7.9 and 7.11. The *Best Sustainable Growth* case shows (Figure 7.9) a rapid phase shift onto a faster growth path after some 30 “productivity paradox” years. The Monte Carlo experiments show a significant spread of the new economy introductions, but the whole “fan” points strongly upward. Nothing of the kind can be registered in Figure 7.11. The economy “misses the fan”, or the New Economy, entirely. Figures 7.8, 7.10 and Figure 7.12 tell why. Figure 7.12 compares the four

⁷³ Varying the four stochastic seeds in the model (see Eliasson & Taymaz 2000).

indexes in the two runs using the Worst Case as a benchmark (i.e. as index 1). The technology level rushes away dramatically in the Best Sustainable Growth scenario compared to the worst growth case. There are plenty of successful new technology introductions for firms across industry to learn from (learning is modelled by genetic algorithms, see Ballot & Taymaz 1988; Eliasson & Taymaz 2000). Labour productivity in all manufacturing firms surge ahead but only after some 25 years of “productivity paradox” have passed. With a delay of several more years manufacturing output surges ahead.

We should also carefully observe that the Best Growth successful New Economy introduction scenario features a very balanced entry and exit process (see *Table 7.1*).

The only peculiar circumstance to observe is that C&C industry output in the Best Successful New Economy introduction case grows much more slowly than in the worst growth case. The reason appears to be the productivity of C&C equipment. The larger the share of C&C equipment in total investment the higher the probability of radical innovation and successful imitating raising productivity levels in the investing firms. Since C&C equipment is very productive, demand for the C&C equipment expressed in volume terms decreases.

Finally we have (*Figure 7.13*) the Best 55-year Growth case. It differs from the *Best Sustainable Growth* case only in one way. Both entry and exit have been slowed down. Fast exits mean that rational firms shut down after some years of below market average rates of return, and release their resources (physical capital and labour) in the market. Slow exit means that firms do not exit until their net worth is turning negative (bankruptcy). This means that badly performing firms on the average stay on longer in production in the low exit than in the fast exit simulations, locking in resources and presumably raising factor prices for the fast growing successful firms, thus, lowering growth. Such was the common sense hypothesis based on earlier model experience (Carlsson 1983; Eliasson & Taymaz 2000). But here the model comes up with a surprise.⁷⁴ Capacity utilisation and employment are completely endogenous in the model and the new economy experiments all turned out to be significantly less than full employment scenarios. We have encountered something of a “Keynesian demand deficiency situation”. Keeping the low

performing firms alive longer meant a significantly reduced labour productivity across manufacturing (cf. *Figure 7.8* with *Figure 7.13*) but much less unemployment (see *Table 7.1*). Apparently, the lowered supply of factors was not sufficient to raise factor prices significantly and the positive “Keynesian” demand effect dominates over the factor reallocation effect. Manufacturing output becomes higher than in the best sustainable growth scenario. On the macro surface we can observe the emergence of a strong upward shift in growth. Also the C&C industry grows rapidly. But new technology introductions are negatively affected (the technology index) and there will not be much in the form of successful new technology introductions to learn from. Compared to the fast entry, fast C&C diffusion and fast exit case (see *Figure 7.8*), this faster growth case is not at all well positioned for continued faster growth beyond the 55 year simulation horizon. Could the sudden unexpected emergence of fast growth after many “productivity paradox years” in the U.S. economy and then the sudden collapse of parts of the C&C industry have anything to do with this “sustainability” issue. More slack in the economy (cf. *Figure 7.8*) caused by a faster exit process would have paved the way for a better very long term sustainable future than the slow exit case (cf. *Figure 7.13*).

Table 7.1 Key end of 55 year simulated data

	(a) worst growth case	(b) best sustainable	c) best growth case
GNP	100	152	175
Manufacturing output	100	141	171
Entry	0	242	114
Exit	191	225	69
Technology level	100	212	160
Unemployment	100	158	89

Note: For items 1, 2 and 5 and 6 column 1 in the worst growth case has been indexed 100 for reference. Exit and entry are expressed in terms of number of firms. The absolute numbers do not relate to similar registered numbers for the Swedish economy because the total number of firms in the MOSES firm population is much lower than the real population of firms.

⁷⁴ Which it frequently does because of its extreme complexity.

Figure 7.8 Best sustainable growth case

Source: MOSES database.

Figure 7.9 Manufacturing output in best sustainable growth case – Monte Carlo simulations

Figure 7.10 Worst growth case

Figure 7.11 Manufacturing output in worst growth case – Monte Carlo simulations

Figure 7.12 Relative performance of best sustainable over worst growth case

Figure 7.13 Best 55 year growth case

Source: MOSES database.

7.4 SUMMARY

Long-term sustained, fast and stable growth in macroeconomic output is a desired ambition of economic policy. We have demonstrated a positive relationship between firm turnover and macroeconomic growth. However, the aggregate effects at the macroeconomic level turn negative beyond a certain level of the rate of firm turnover. This critical level is influenced by the balance between the rates of entry and exit. The output growth curve begins to bend down (“show its non-linearity”) after about half a century at entry rates that are not far above recorded entry rates during the past 20 years. One reason for this observation is that the exit process is much slower than the entry process, what we in this chapter call unbalanced turnover. The intuitive explanation is that structural tensions and instabilities occur when resources are set free to slowly from exiting firms and move to slowly to expanding firms.

Endogenous market correction mechanisms that eliminate long-run effects from fast and unbalanced turnover of firms will probably be developed in a free market. However, such mechanisms can be put aside by economic policy. One such example may be the Swedish experience during the 1970s, when the exit process was slowed by subsidies to prevent a negative employment effect from the industrial transformation out of an increasingly obsolete industrial structure, notably by subsidising the worst performers that were also paying the highest wages (steel and shipyards; see Carlsson 1983).

SUPPLEMENT: MOSES 1997 DATABASE - INCLUDING THE C&C INDUSTRY*

Creating an initial database for the Swedish micro-to-macro model MOSES (see Eliasson 1977, 1978, 1985, 1991b) is a major research undertaking. Not only has data for a consistent micro firm to macro GNP level database to be collected (see Albrecht *et al.* 1992) and adjusted for complete consistency. The model also has to be dynamically calibrated/estimated (see Taymaz 1991). This is no minor research effort. The same initial databases, therefore, have to be used for years. The previous initial databases were compiled for the years 1968, 1974, 1976 and 1982. They increasingly meant the creation of a complete and consistent micro-to-macro national accounts system.⁷⁵ 1976 was the first year planning survey data on firms and divisions of firms specifically designed for the MOSES model were used (see Albrecht *et al.* 1992). A “synthetic” (deidentified) data base for outside use was put together for 1990. Only for 1976 was it possible to get a complete input output table for the end use industrial classification that we use (see Ahlström 1978).

From 1997 a new micro firm based industry, the C&C industry has been introduced. This motivated the creation of a completely new database for 1997. The initial database has, therefore, been shifted from 1982 to 1997 and the model has been completely recalibrated.

Here, we present value added and employment shares for the sectors used in the 1997 version of the model. This has to been done to make future comparisons possible. Value added and employment shares for the 1982 database have been included for comparisons.

* This supplement is co-authored with Professor Gunnar Eliasson, Royal Institute of Technology, Sweden, and Professor Erol Taymaz, Middle East Technical University, Turkey.

⁷⁵ See Albrecht *et al.* 1992.

To our knowledge, official value added data on the C&C industry have only been published by Statistics Sweden for the year 1998. We have, therefore, used the official data for 1998 to approximate value added for the C&C industry in 1997. Assuming the same relation between value added per employee in 1997 and 1998, the ratios of employees in the different industries have been used to approximate the 1997 shares of value added with value added data for 1998.

We also include Salter curves on the rate of return and on labour productivity of the real firms included in the model. These firm data are based on firm surveys.

The supplement is concluded with a brief comparison of the Swedish C&C industry share with the computations for the U.S. economy by Jorgenson (2001), even though Jorgenson use a different method for calculating value added by the industry. Since most writing on the New Economy, which we simulated for Sweden in *Section 7.3* above, originates in the U.S. this comparison of the size of the C&C industries in the two economies is of interest to understand the magnitudes involved.

Table S.1 gives the size of the Swedish C&C industry as almost 5 per cent of GDP in 1997 (5.33 per cent in 1998; see *Table S.3*). The corresponding employment share in 1997 (see *Table S.2*) is 3.82 per cent, or significantly smaller, telling that labour productivity is higher in the C&C industry than in the rest of the economy on average. The same conclusion has also been drawn from the Salter curve comparisons in *Chapter 2*. The C&C industry employment share has also increased since 1982 (from 2.88 per cent to 3.82 per cent, an increase with about one third; cf. the analysis in *Chapter 4*). Reduction in employment shares between 1982 and 1997 have been reported for raw materials and investment goods producing industries, agriculture, mining, construction and electricity. The interesting thing is the reduction in the investment goods producing industry and a corresponding large increase in the labour share of intermediary products producing industries. Technically this means that the firms that we have classified as intermediate goods producers have grown faster on average than the firms classified as belonging to the investment goods industry.

Table S.1 Value added distribution, per cent of GDP in 1997 and in 1982, with and without the C&C industry

Sector	1997	1997	1982
Raw	3.78	3.78	1.7
Intermediary	6.56	6.56	6.8
Investment	3.65	5.76	9.04
Consumer	4.98	4.98	6.07
C&C	4.92	-	-
Agriculture	2.17	2.17	3.15
Mining	0.30	0.30	0.38
Oil	0.17	0.17	0.2
Construction	3.45	3.45	7.67
Electricity	2.51	2.51	3.59
Other Services	67.52	70.32	61.4
Total	100	100	100

Note: The sectors are defined as in Bergholm 1989. The only difference is that the C&C industry has been “broken out” from other services (telecommunications firms and data consulting and data services firms) and from investment (manufacturing C&C firms) and is presented separately. There are no value-added data available on the C&C industry in 1982.

Source: Statistics Sweden 2001, MOSES database and own calculations.

Table S.2 Labour distribution, per cent of total in 1982 and in 1997, with and without the C&C industry

Sector	1997	1997	1982	1982
Raw	2.88	2.88	4.20	4.19
Intermediary	6.51	6.51	4.75	4.74
Investment	3.69	5.37	6.73	8.31
Consumer	5.68	5.68	5.28	5.27
C&C	3.82	-	2.88	-
Agriculture	0.99	0.99	1.43	1.42
Mining	0.28	0.28	0.37	0.37
Oil	0.05	0.05	0.05	0.05
Construction	4.96	4.96	6.55	6.54
Electricity	0.75	0.75	1.06	1.06
Other Services	70.40	72.55	66.70	68.04
Total	100.00	100.00	100.00	100.00

Note: The sectors are defined as in Bergholm 1989. The only difference is that the C&C industry has been “broken out” from other services (telecommunications firms and data consulting and data services firms) and from investment (manufacturing C&C firms) and is presented separately.

Source: Statistics Sweden and own calculations.

The total share of the C&C industry of GDP is about the same in Sweden and the U.S., the U.S. C&C industry being only slightly larger (see *Table S.3*). It is interesting to note that the Swedish share of manufacturing C&C industry is much larger than the U.S. counterpart, while the U.S. software and services industry is much larger than the Swedish counterpart. Telecommunications industry is of about the same size. The C&C services industry is newer and expands much faster than the old manufacturing C&C industry (see *Chapters 3* and *4*). This indicates a lack of renewal and slow industrial transformation of the Swedish industry (compatible with the analysis in *Chapter 8*).

Table S.3 C&C industry share of GDP, Sweden and the U.S., 1982

Manufacturing C&C industry (Computer)	2.08	0.93
Telecommunications industry (Communications)	1.48	1.50
Data consulting and data services firms (Software and services)	1.77	3.49
Total	5.33	5.92

Note: Notations used by Jorgenson 2001 in parentheses. The large share of manufacturing C&C industry in Sweden is partly explained by the fact that Ericsson is classified as manufacturing C&C equipment.

Source: Statistics Sweden 2001, Jorgenson 2001 and own calculations.

The Salter curves of manufacturing industry (*Figures S.1 and S.2*) also show strong increases for labour productivity and (also in rates of return across the entire manufacturing industry). This tells the story that the initial 1997 database is more on the top of the business cycle than the 1982 database, but also the fact that the same period has seen a return of manufacturing rates of return to more normal levels compared to the depressed level in the 1970s and early 1980s.

Figure S.1 Rates of return (per cent), 1982 and 1997

Note: Swedish manufacturing industry.

Source: MOSES database.

Figure S.2 Labour productivity 1982 and 1997

Note: Swedish manufacturing industry. Labour productivity is calculated as value added (100 SEK; 1997 prices) per employee.

Source: MOSES database.

CHAPTER 8 INDUSTRIAL DYNAMICS, ECONOMIC GROWTH AND INSTITUTIONS

8.1 INTRODUCTION

The empirical results in *Chapter 5* and *Chapter 6* show that young, small, independent and private firms contribute positively to firm and industry growth. The service industry (data consulting and data services industry) has grown faster than other C&C industries and has done so since the beginning of the 1970s (see *Chapter 4*). Industry growth is also positively related to the turnover of firms (see *Chapter 6*). These results are in line with the predictions made from the theory of the EOE and Competence Blocs in *Chapter 2*. They are also in line with international and other Swedish empirical research. Moreover, the simulations in *Chapter 7* indicate that to have a positive effect on macroeconomic performance turnover has to be balanced, i.e., exits of firms are necessary to set resources free to new and expanding firms. Otherwise, there is a risk for structural tensions and instability that destabilise the economy, eventually leading to stagnation or negative growth.

My empirical results are interesting in the light of Swedish economic policy over the last decades. Important policy programs and institutions have systematically discriminated against those firms that have been shown in this study to be the largest contributors to growth and employment, while the other firms have been favoured by regulation, legislation and policy.⁷⁶ Research identifies a number of Swedish institutions that close or restrict entrepreneurs' access to markets, that disfavour the financing of new and small firms and that introduce risks on the labour market that bear heavily on small, fast-growing firms. Economic policy has also introduced distortions that impede flexibility and dynamics.

Section 8.2 accounts for the institutions of this kind that have also had a direct or indirect bearing on the development of the C&C industry. Thereafter, in *Section 8.3*, I comment

⁷⁶ These contributions can, then, be said to have been made *despite*, rather as a result of much of the economic policies that have been undertaken.

upon the effects of institutions on industrial dynamics and macroeconomic performance. *Section 8.4* concludes the chapter.

8.2 ECONOMIC POLICY AND INSTITUTIONS

The Swedish institutional set-up can be described as characterised by large and centralised institutions that dominate society. Important features of Swedish institutions are (see Lindbeck 1993, p. 12):

i) large public spending sector and high taxes, reflecting ambitious welfarestate arrangements and large-scale interventions in the economic lives of individual and households; ii) a strongly interventionist stabilisation policy, originally designed to “fine-tune” full employment, with so-called active labour market policy as an important tool; iii) government interventions to influence aggregate saving, credit supply, as well as their allocation, by public-sector saving, capital market regulations, taxes and subsidies; iv) increased centralisation within the public sector; v) centralised wage bargaining at a national level; and (vi) highly centralised decision-making in the private sector, where a small group of large firms, predominates on the production side, and holdings of financial assets, including shares, are highly concentrated to a few large institutions – three or four banks, half a dozen insurance companies, and a few investment corporations. These centralist structures have, however, been combined with vii) a pronounced free-trade regime.

With a few exceptions, for instance the organisation of wage bargaining and Keynesian demand policy, the strongly centralised characteristics of Swedish institutions were not created or accentuated until the late 1960s and the beginning of the 1970s. Hence, Swedish institutions did not diverge from that of other Western countries to such an extent that it is correct to talk about a Swedish model until then (accordingly to Lindbeck 1993, p. 14).⁷⁷

Sweden has experienced several crises since the early 1970s, which have forced reforms of the Swedish economy. Since the mid-1980s a number of institutional changes and deregulations have been carried out to improve the working of the Swedish economy, several of which most probably have contributed positively to the growth of new and small firms observed in *Chapters 5* and *6*.

Capital markets were deregulated in steps and were freed by the end of 1987.

⁷⁷ One can also say that the “Swedish model” functioned quite well as long as the characteristics that Lindbeck emphasises were not there (see Eliasson & Ysander 1983).

The *tax system* was reformed during the 1980s and the beginning of the 1990s. Sweden had a tax share of GDP similar to that of other Western countries until the mid-1960s. Thereafter, taxes were rapidly increased and Sweden has for long periods had the highest tax share of GDP in the world. During the 1980s, even some of the leading Social Democrats were beginning to recognise that the tax system was destructive to the economy. The former Minister of Finance, Kjell-Olof Feldt (1991), went so far as to describe the Swedish tax system as a “perverted” system. The extremely high marginal taxes on capital and income were identified as major obstacles to economic efficiency and economic growth. The declared intention of the tax reforms of the 1990s was to make the tax system more neutral, reducing the large distortions inherent in the earlier system. It did not, however, decrease the total tax share of GDP. The ambition was to keep the total tax share and the large public sector at the same level, while limiting the devastating marginal effects. This was basically done through a decrease of the marginal taxes, which was financed by a broadened tax base. Increased mobility due to the deregulation of capital markets also induced significant decreases of company taxes and taxes on capital incomes, a “requirement” that also came with Sweden joining the European Union. Company tax rates are down from 50 to 28 per cent and capital income taxes are 30 per cent today. This is a profound decrease from nominal tax rates on dividends and capital that exceeded 90 per cent for many. Some income earners faced real tax rates above 100 per cent in the 1970s, because of the combined effect of high marginal taxes and high inflation rates (about 10 per cent). Since then inflation rates have fallen substantially.⁷⁸ This, together with the tax reforms, has decreased the marginal effect on productive activities and savings.

A number of other institutional changes have also been introduced, notably (see Davidsson & Henrekson 2001):

- Deregulations of a number of product markets, e.g., the market for telecommunications in 1993, which have opened up the markets for entrepreneurs and increased their way of functioning.
- Parts of the public sector have been privatised, and today private firms produce some of the goods and services earlier produced by the public sector alone under a regime of no competition.

⁷⁸ In the beginning of the 1990s economic policy was also reoriented from the prime goal of full employment to the prime goal of *price stability*.

- Some of the rigidities in the labour markets have been removed, e.g., tenure-priority rules in case of employment reductions have been eased. These changes were introduced in 1997.
- Wage bargaining is now more decentralised than before. Hence, individual competence of employees and local conditions of firms influence individual wages.

Still, researchers identify a number of institutions impeding economic growth, particularly new firm formation and growth of small firms (see, e.g., Henrekson 1996 and Davidsson & Henrekson 2001). According to this research, it is mainly entrepreneurs' access to product markets, financial markets and the labour market that is affected by these institutions (see below).

8.2.1 Entrepreneurial Access to Markets and the Public Sector

In Sweden, large parts of the service sector are more or less closed by law or regulation to entry and growth by private firms.

First, the government has monopolised a large part of the markets for services that could very well be produced privately, such as healthcare and childcare.

Second, private entrepreneurs are given unequal access to markets supported by governmental purchases. The potential markets for private-business production of services monopolised by government and for governmental purchases are large, in total about 30 per cent of GDP.⁷⁹ Recently, the markets for the public production of these private goods have partly been opened up for private competition. However, most impediments to private competition still remain and private firms produce just a fraction of the total output of these services (see Werenfels Röttorp 1998).⁸⁰ Many of the activities carried out by publicly owned firms and organisations in these markets are high-tech and information-intense by nature, e.g., health care. Deregulating these markets would, therefore, quite plausibly have positive spillover effects on the C&C industry.

⁷⁹ The costs for schooling, child-care and care of the elderly exceed 10 per cent of GDP. The health care sector is almost as large. Public sector purchases of goods and services (besides education, health and welfare services) also exceed 10 per cent of GDP.

Third, the high tax pressure combined with high marginal taxes on labour income (today the highest marginal tax is about 58 per cent) make it impossible or very expensive for most income earners to buy consumer-related services, e.g., repair services.⁸¹ Thus, the tax system prevents entrepreneurial activities in the market for household-related private services and the development of specialised markets for these types of services. The high payroll taxes and social-security fees (about 35 per cent) on labour worsen this. As a consequence this type of service production is very small in Sweden compared to, e.g., the U.S. (see Davis & Henrekson 1999). This has a negative effect on labour diversification and specialisation. Highly productive and skilled employees substitute household services (e.g., painting the house) for ordinary work because they cannot afford to hire a professional worker (e.g., a painter). Such effects of the economic system have extra strong negative effects on rapidly expanding industries, such the C&C industry, with a shortage of skilled and experienced employees (and managers).

8.2.2 *Financial Market Regulation*

Numerous studies demonstrate a positive relationship between private wealth and new firm formation and growth (see, e.g., Holtz-Eakin *et al.* 1994; Lindh & Ohlsson 1996; Blanchflower & Oswald 1998). Personal capital is an important source of finance for most firms in the start-up and in the early phases. Three policy areas have had large effects on the entrepreneurial access to capital: i) tax policy, ii) pension savings policy and iii) capital market policy.

i) Tax policy

For about three decades, beginning in the 1960s, the tax system was extremely distortive regarding sources of funding and ownership. Individuals and households were taxed more heavily than any other owner. The tax system favoured debt before retained earnings and strongly disfavoured new share issues.

Södersten (1984, 1993) and Henrekson (1996) conclude that the tax system consequently favoured large, real-capital-intense, well-established firms financed by debt and with

⁸⁰ The markets for public sector purchases are dominated by municipally owned companies. Less than 11 per cent were bought from private actors in the beginning of 1990s (see Bergdahl 1995).

⁸¹ According to Henrekson (1998), the hourly wage of the buyer has to exceed that of the seller by a factor of 2.7-4.1 to make it profitable to buy the service. In the USA, the same factor is 1.4-1.9.

institutional owners. In other words, the Swedish tax system has long disfavoured young, small, independent and less capital intensive (e.g., service) firms, i.e., exactly those firms that this thesis shows to be most important for firm and industry growth.⁸² In an international perspective, the distortions created by the Swedish tax system were extreme (see Södersten & Lindberg 1983; King & Fullerton 1984; Fukao & Hanazaki 1987).

The 1991 and 1994 tax reforms reduced the distortions. However, in 1995, changes were made that once again increased the distortions. Also, total tax pressure (together with Denmark) is the highest in the world, in effect making it difficult for individuals to save. Particularly, marginal taxes on labour income is high, even in low-income brackets.⁸³ Taxes on wealth, current returns to capital, capital gains and inheritances are high in an international perspective. To take one example, many industrial countries do not tax wealth at all.

According to the theory of the EOE and Competence Blocs, a particularly severe effect of the Swedish tax system is the prevention of well-functioning and diversified venture-capital markets (see Eliasson 1997). It has generally been difficult for competent entrepreneurs to accumulate private wealth in Sweden. This has probably lead to a relative absence of entrepreneurs who have acquired industrial knowledge and accumulated private wealth through earlier business activities related to the new ventures in need of competent venture capital support. This prevents well functioning venture-capital markets from developing. The relative shortage of competent venture capitalists in Sweden is made worse by the fact that active venture capitalists that provide both competence and capital are taxed more heavily than passive investors who only provide capital (see Braunerhjelm 1999, 2000). The negative effects on industrial development from these institutional impediments are probably large. Research has demonstrated that a large and competent venture capital market made the rapid development of the U.S. C&C-industry, as well as the modern U.S. biotechnology industry, possible. Almost all major enterprises within biotechnology, semiconductor and computer hardware industry were funded by venture capital in their early stages of development (see Brav & Gompers 1997). Institutional changes in the early 1980s were necessary for the creation and growth

⁸² *Chapter 4* shows that the service industry (data consulting and data services industry) has grown faster than other C&C industries. *Chapters 5 and 6* show that young, small and independent firms have grown faster than old, large firms and than firms belonging to enterprise groups.

of the venture-capital market. Among other things, taxes on capital gains were significantly reduced and the taxation on options to employees changed (see, e.g., Fenn *et al.* 1995; Zider 1998; see Henrekson & Rosenberg 2000 for a discussion of the implications for Sweden).⁸⁴

A peculiar feature of the Swedish tax system is that foreign owners are favoured compared to Swedish owners. A number of researchers (see, e.g., Henrekson & Jacobsson 2000; Norrman 2000) argue that such distortions have had a profound negative effect on ownership and the efficiency of firms in Sweden.

ii) Capital market policy

The effects of the tax system were strengthened by the capital market regulations that rationed credit to firms, which favoured the house-building industry and large established firms with good contacts with banks and other creditors. Also, the market for foreign capital was heavily regulated. The capital market regulations were abolished by the end of the 1980s.

iii) Pension savings policy

The bulk of total savings that actually takes place is carried out within the system for compulsory savings for pensions, a pay-as-you-go system. This system has accumulated huge funds, the so-called AP funds, as a buffer towards an expected decrease in private savings when they were introduced and unexpected events. The funds are not owned by individuals and are administrated by officials appointed by government. The investment policy was restrictive favouring government bonds, investments in residential property and large firms yielding a low regulated interest. One reason for the chosen investment policy was that the government wanted to borrow cheaply to cover budget deficits and to stimulate house building through subsidised loans.⁸⁵ Today, these restrictions have been eased but not abolished. Since 1995, the pension system is reorganised and individuals

⁸³ However, they are lower than they were in the 1970s and 1980s when they often exceeded 100 per cent (after correcting for inflation).

⁸⁴ Stock options to employees have been a very successful instrument for the remuneration of employees in the U.S. The Swedish tax system makes compensation by option schemes less useful.

⁸⁵ The consequence has been huge losses to the pensioners compared to the value the same resources would have had, if the funds had been professionally managed, losses that now have to be covered by increased charges (“taxes”) and/or reduced benefits.

have the right to invest a minor part of compulsory savings in a variety of funds. However, individuals are not allowed to invest these savings in own firms.

The conducted policy has brought about a situation where Swedish private wealth per capita is among the lowest in the OECD; see *Table 8.1*. This probably has a negative effect on new-firm formation and firm growth, according to the analysis carried out in this thesis.

Table 8.1 Financial wealth net, dollar per capita in nine OECD countries, 1990 and 1995

<i>Country</i>	<i>1990</i>	<i>1995</i>
Canada	28,233	33,359
France	23,580	41,347
Germany	28,463	45,328
Italy	32,374	35,790
Japan	39,707	94,038
Norway	2,857	5,179
Spain	9,345	12,084
<i>Sweden</i>	<i>7,152</i>	<i>13,516</i>
USA	51,827	76,760

Source: Pålsson 1998.

8.2.3 Labour-Market Legislation

In the early 1970s, a number of laws were introduced on the Swedish labour market that broke a long and successful tradition where the employers and the trade union movement (*Landsorganisationen*, LO) made agreements through negotiations without interference from the government. The new legislation was a result of a profound radicalisation of the central union and the Social Democratic Party (and the “whole” society). According to the OECD (1994), which surveyed labour market legislation in 18 countries, Sweden was the most regulated, Greece excepted. Davidsson & Henrekson (2001) write that *de facto* legislation is much higher because of collective agreements between employers and unions. They conclude that this definitely is the case in Sweden and exemplifies with stipulated minimum wages and extended employment protection. The rigidities in the labour market imposed by regulators can be regarded as one of the major problems of the Swedish economy today. Particularly, the Swedish Employment Security Act (*Lagen om anställningskydd*, LAS), introduced in 1974, is regarded as negative

for the working properties of the labour market and for new and rapidly expanding firms (Davidsson & Henrekson 2001).⁸⁶

For a number of reasons Davidsson & Henrekson (2001) write that the burden of rigid labour market legislation falls most heavily on new, small, entrepreneurial and high-growth firms. For example, Davidsson *et al.* (1996), Davis *et al.* (1996) and Reynolds (1999) show that net job creation results from a turmoil process of entry, expansion, contraction and exit of firms. It is estimated that a net increase of one job requires that 7 to 10 gross jobs are created. The bulk of adjustment does not take place between firms, but within firms and establishments. Gross flows are larger in young, small and highly specialised firms and in firms showing high productivity growth. The rate at which employees quit from and, employers settle job positions, declines with the employer's age, size and capital intensity (see Brown & Medoff 1989). These findings suggest that entry and growth of firms requires *flexibility* in labour contracts and that this is particularly important for new, small, less capital-intense and high-growth firms.⁸⁷ Hence, legislation like the Swedish one that imposes rigidities on the labour market is generally supposed to have a negative effect on industrial dynamics and economic growth. The negative effects are probably worsened by the fact that the rigidities hit the firms most important for industrial renewal most severely.

Rigid labour market legislation also increases *transaction costs* for hiring, since it becomes more important to match employees and jobs correctly when hiring new staff (cf. Nooteboom 1993). This should bear down more severely on small entrepreneurial firms for at least three reasons: i) In particular, employees in small firms have fewer opportunities to find an alternative job if the initial match turns out to be a mismatch. Employers, therefore, would probably have to evaluate potential employees more thoroughly. ii) It is likely that the absolute costs for employing new staff are about the same over the size distribution of firms. Thus, the relative costs (in relation to profits, sales etc.) are higher for small firms. iii) Many large firms have been able to adjust the rules stipulated in LAS by local agreements with the unions. Henrekson & Johansson (2000) argue that labour-market legislation imposing increased transactions costs for

⁸⁶ LAS regulates the period of notice before a dismissal, requires objective grounds for dismissal, contains time limits on temporary employment, and strict tenure rules at dismissals.

⁸⁷ Also, cf., Haltiwanger (2000) who surveys empirical literature and concludes that reallocation of labour and capital contributes significantly to aggregate economic growth implying the importance of flexibility.

hiring is one explanation for the lack of high-growth firms in Sweden. It is simply impossible for Swedish firms to grow as fast as U.S. high-performing firms because of the time and costs it takes Swedish firms to screen and select employees. They abstain from recruiting rather than raise their employment-risk exposure.

Also, the *egalitarian wage policy* carried out in Sweden from the mid-1960 to 1983 (when centralised wage bargaining broke down; see Hibbs 1990; Edin & Holmlund 1995), probably also had a negative effect on new and small firms. Wages are reported to increase with age, capital intensity and the size of employers (see, e.g., Brown & Medoff 1989; Davis & Haltiwanger 1991, 1996). An egalitarian wage policy that increases wages in the lower tail of the wage distribution and decreases the wages in the upper tail of the wage distribution will disfavour new, less capital-intensive and small firms, and favour old, capital-intensive and large firms (see, e.g., Henrekson 1996). Davis (1992) shows that the Swedish wage structure was extremely compressed in an international comparison.

8.2.4 Industrial Policy

Most research shows that industrial policy has generally not had beneficial effects on economic performance. For example, Carlsson *et al.* (1981) find that the government subsidised production (notably shipyards) with billions of crowns in the 1970s that produced a *negative* value added. Bergström (1998, 2000) shows that regional support to strengthen local businesses in Northern Sweden has had negative effects on employment and productivity. The main part of Swedish industrial support has been allocated to traditional mature industries such as farming, construction and manufacturing (Barkman & Fölster 1995). It has, furthermore, been shown that subsidies to industries generally favour large and established firms.

8.3 INSTITUTIONS, INDUSTRIAL DYNAMICS AND ECONOMIC GROWTH

A number of researchers conclude that Swedish economic policy has made the Swedish economy less flexible and that it has had a conserving effect on the industrial structure (see, e.g., Andersson *et al.* 1993). Myhrman (1994) dubs the Swedish economy “the petrified economy”.

As early as in the beginning of the 1980s Utterback & Reitberger (1982; see also Utterback *et al.* 1988) documented a low propensity to grow among Swedish technology-based firms. In a later study of all technology-based firms that entered the Swedish economy during 1975-93 Rickne & Jacobsson (2000) found that the new technology-based firms had a small effect on employment and growth, e.g., out of all new technology-based firms no single firm employed more than 300 employees in 1993. It is also of interest to note that of two similar innovations in medical equipment launched in a Swedish and U.S. competence bloc environment, the U.S. innovation very fast became a commercial winner, while it took very long for the Swedish innovation to be brought to industrial scale production (Fridh 2000).

The lack of high-growth firms seems to be a general problem in Sweden. Davidsson & Delmar (2000; see also Davidsson & Henrekson 2001) found the job contribution of Swedish high-growth firms to be modest. The organic growth of the fast growing firms was even *negative* during 1987-96. This is a remarkable difference compared to the USA and the United Kingdom, where a few very fast-growing firms have generated the bulk of new jobs. High-technology firms, in particular, have been shown to be growing fast (see Birch & Medoff 1994; Kirchoff 1994; Storey 1994; Birch *et al.* 1995). One reason for the lack of firm growth is that many firms do not want to grow despite ample opportunities. NUTEK (1996b) reports that in the mid-1990s, about 50,000 firms in Sweden had the opportunity to grow but choose not to because they did not want to.⁸⁸ A micro-level analysis of the Swedish and U.S. biomedical and polymer cluster also shows that new Swedish firms have grown much more slowly than their U.S. counterparts (Braunerhjelm *et al.* 1998; see also Braunerhjelm & Carlsson 1999 and Braunerhjelm *et al.* 2000).

Recent research, furthermore, documents few self-employed (see, e.g., Henrekson 1996), a falling rate of new entries in industry (see Braunerhjelm & Carlsson 1993), few nascent entrepreneurs (see Delmar & Davidsson 2000). One consequence is the lack of variety in the Swedish industrial structure required for creating a healthy dynamics (see Eliasson 1991b).

⁸⁸ One reason given was the labour market legislation, particularly among small-sized firms.

New evidence on the size distribution of firms and employment are consistent with the Swedish institutional set-up and with the empirical studies documenting few new and fast-growing firms (which the previous view on the size distribution of firms and employment was not). The Swedish industrial structure has been compared to a snaps-glass, i.e., as having a broad base of many small firms, few medium-sized firms and many large firms (see, e.g., Confederation of Swedish Industries 1995). The dominant view has been that the problem appears to be that the many small firms do not grow, but that Sweden has a potential in the many small firms. Henrekson & Johansson (1999b) question the view that Sweden has many small firms and cite evidence that this is not the case. They argue that the snaps-glass metamorphose comes from bad analysis and incorrect treatment of data (see also Lodin 1999 and Henrekson & Johansson 1999c). Rather, a more thorough analysis shows a lack of small firms and a dominance of large firms. *Figure 8.1* shows the size distribution of employment in Swedish manufacturing adjusted for enterprise groups in 1997. It is shown that the larger firms dominate employment totally. Firms with more than 500 employees employ more than 60 per cent of total employment. Together with firms with 200-499 employees they employ 70 per cent of the manufacturing workforce. Firms with 1 employee employ less than 0.5 per cent of the workforce and firms with 2-4 employees and firms with 5-9 employees about 2.5 and 3.5 per cent, respectively. It is difficult to recognise a snaps-glass in the figure.

Figure 8.1 The size distribution of employment (%), manufacturing, adjusted for enterprise groups, 1997

Source: Henrekson & Johansson (1999b).

Compared to other countries, Sweden has a very skewed size distribution of firms and employment. Large firms dominate the Swedish industrial structure and there are few small firms (see Henrekson & Johansson 1999a).

Sweden also has a low density of firms (calculated as the number of firms per million inhabitants) in an international perspective. *Table 8.2* reports the density of firms in different size classes for countries in the European Union. It also shows the rank of the countries in different size classes calculated in ascending order, where the country with the highest density of firms is ranked as number one and the country with the lowest density of firms as number fourteen. Sweden has the second lowest rank (rank 13) in the smallest (0) and the second smallest (1-9) size classes. Sweden is also ranked below average in the other size classes, with a ranking of 10, 8 and 9 in the 10-49, 50-249 and 250+ size classes, respectively. Notably, Sweden has the lowest average ranking of all countries. The low density of firms (particularly in the smallest size classes) is consistent with the fact that institutions have disfavoured dynamics, particularly new-firm formation and small-firm growth.

Table 8.2 The density of firms, EU countries, whole economy, 1995

<i>Size class(# of employees)</i>	<i>0</i>	<i>Rank</i>	<i>1-9</i>	<i>Rank</i>	<i>10-49</i>	<i>Rank</i>	<i>50-249</i>	<i>Rank</i>	<i>250+</i>	<i>Rank</i>	<i>Average Rank</i>
Austria	9,814	14	16,051	8	2,867	4	650	2	177	1	6
Belgium	41,216	1	15,052	9	2,117	11	294	12	118	5	8
Denmark	29,191	6	12,743	14	2,711	6	452	6	90	8	8
Finland	19,038	8	14,058	12	1,766	13	318	11	106	7	10
France	18,781	9	15,032	10	2,111	12	364	9	73	10	10
Germany	14,302	11	20,212	6	4,137	2	630	3	158	4	5
Greece	38,326	2	31,592	2	1,504	14	215	14	0	14	9
Italy	26,837	7	26,837	3	2,843	5	284	13	57	13	8
Luxembourg	16,452	10	20,458	5	4,996	1	1,034	1	172	2	4
Portugal	30,535	5	32,205	1	3,408	3	535	5	67	11	5
Spain	34,457	4	22,472	4	2,577	8	360	10	60	12	8
<i>Sweden</i>	<i>11,826</i>	<i>13</i>	<i>13,070</i>	<i>13</i>	<i>2,266</i>	<i>10</i>	<i>387</i>	<i>8</i>	<i>83</i>	<i>9</i>	<i>11</i>
Netherlands	13,915	12	14,614	11	2,541	9	540	4	159	3	8
U.K.	37,951	3	16,355	7	2,707	7	403	7	115	6	6

Note: The density of firms is calculated as the number of firms per million inhabitants. Data for Greece, Italy, Luxembourg, the Netherlands and Austria are from 1994.

Source: European Commission (1998) and own calculations.

It is to be noted that the number of firms has been shown to have a dynamic effect on economic performance. For instance, Nickell (1996), Nickell *et al.* (1997), and Lever & Niewenhuijsen (1999) find a positive relationship between the number of firms in an industry and productivity growth. Davidsson *et al.* (1994a, b, 1996) also report that the number of entrepreneurs have a positive effect on regional economic growth in Sweden.

Several of the institutions with negative influence, and making Sweden diverge from other countries, were introduced in the 1970s, e.g., increased taxes and rigid labour market legislation. Policy that prevented or obstructed new-firm formation and firm growth, hence, is the most likely explanation for the slow economic growth in Sweden relative to other countries. Since the 1970s, Swedish gross domestic product (GDP) has lagged behind that of other OECD countries; see *Figure 8.2*.

Figure 8.2 GDP in Sweden, OECD and OECD-Europe, 1960-2000

Source: Figure 1.2 in Andersson *et al.* 1993 (updated), based on OECD, National accounts.

This explanation is in line with evidence presented by North & Thomas (1973), Rosenberg & Birdzell (1986), North & Weingast (1989), Mokyr (1990), De Long & Schleifer (1993), de Vanssay & Spindler (1994, 1996), Knack & Keefer (1995), Barro (1997), de Haan & Siermann (1998), Norton (1998), Olson *et al.* (2000), Berggren *et al.* (2001) to mention a few, who all conclude that the success and prosperity of nations is due to institutions and institutional changes that allow and promote productive entrepreneurship and economic growth.

8.4 SUMMARY

The empirical analysis has shown that: i) new, small, private and independent firms have a positive effect on firm growth; ii) industries with a large share of employment in independent and private firms have grown faster than industries with a large share of employment in enterprise groups and publicly owned firms; iii) firm turnover supports employment growth; iv) service firms (data consulting and data services firms) are the

major job creators in the Swedish C&C industry. Similar results have been reported from other Swedish and international empirical research.

At the same time, Swedish institutions and policy have placed the firms and industries contributing to growth at a disadvantage. They also tend to counteract industrial dynamics and transformation – Sweden has as a result been described as “the petrified economy”. The logical conclusion is that this has prevented structural change and held back growth.

Research has identified the tax system, lack of competent venture capitalists, restricted private entrepreneurial access to the production of private services and markets for public purchases, rigidities in the labour market and active industrial policy carried out by government as causes of the slow macroeconomic performance of the Swedish economy since the beginning of the 1970s.

CHAPTER 9 CONCLUSIONS

9.1 INTRODUCTION

This thesis studies firm and industry growth in the Swedish C&C industry. Growth is seen as generated by a dynamic process involving the entry, expansion, contraction and exit of firms, together constituting the Schumpeterian process of creative destruction.

Two main questions are addressed in the analysis: i) Do some firm-specific factors (such as the age and size of firms) systematically affect firm growth? and ii) Does the turnover rate of firms affect growth?

The analysis has been founded on the theory of the EOE and Competence Blocs. Several hypotheses derived from this theory have been tested econometrically and in simulation experiments.

9.2 EMPIRICAL RESULTS

The empirical analysis clearly demonstrates the importance of new and small firms, and of the turnover of firms, for the observed growth of the C&C industry. They have created a disproportionately large share of the observed growth in employment. More specifically:

- i) firm growth decreases with firm age;
- ii) firm growth decreases with firm size;
- iii) firm growth increases with firm independence;
- iv) firm growth decreases with government ownership;
- v) industry growth increases with firm turnover;
- vi) furthermore, simulations of the Swedish economy show a non-linear relationship between firm turnover and aggregate economic growth. Economic growth increases with firm turnover. The effect, however, turns negative beyond a critical level because the market price-signalling system becomes unreliable. The negative effect shows up after a long time and is also due to an unbalanced turnover, i.e.,

entry rates are higher than exit rates. This causes instabilities (e.g., factor-price inflation) when resources are not set free fast enough from exiting low-performing firms to support the growth of new and expanding firms.

The results, when interpreted in terms of the theory of the EOE and Competence Blocs, indicate that radically new innovations with a large economic potential are predominantly introduced in the economy through new entry. Old firms tend to explore established fields of industrial knowledge and are active in mature and slowly growing markets. Small firms tend to provide a more suitable organisation for entrepreneurial activities. A high turnover of firms increases the possibility of discovering and selecting winners, holding everything else constant.

Moreover, the statistical analyses have shown that,

- a) The Swedish C&C industry is large. In 1999, it employed 154,000 persons, which is somewhat less than 5 per cent of the total Swedish workforce and about one fifth of the workforce involved in manufacturing. It has grown with about 50 per cent from 1973 (the first year data are available). The increased employment is mainly due to the growth of data-consulting and data-services firms that have increased employment with 1,500 per cent between 1973 and 1999. Employment dropped significantly (more than one third) in telecommunications firms during the same period.
- b) Studying employment by the 1993 size classes, *small firms* (less than 200 employees) *generated all new jobs* on net. Large firms (more than 200 employees) were important employers because of their size. They were, however, major job losers during the period. Notably, firms that had no employees at all in 1993 were outstanding job creators and generated almost all new jobs, on net (more than 70 per cent).
- c) Studying employment by cohorts, new firms are demonstrated to be important job generators. In 1998, firms established 1993 or later employed about one fourth of the total labour force in the IT industry. The analysis also suggests that employment growth is facilitated by a constant high entry of small firms since i) new firms create many new jobs when established; ii) they grow spectacularly when established; and iii) it is mainly small, new firms that grow fast.

- d) Significant firm turmoil underlies observed employment changes. *Of the total number of firms in 1993, more than 40 per cent were gone by 1998.* The smallest firms show the lowest survival rate. The total stock of firms, however, grew rapidly due to new entries. The number of data-consulting and data-services firms has increased dramatically since 1973.

Hence, the empirical results demonstrate that new, small, private and independent firms and firms in the service industry (data-consulting and data-services firms) are the major job creators. The rate of firm entry and firm exit (firm turnover) taken together has a positive effect on employment growth. It has also been shown that net employment growth is associated with large changes in the number of employees in firms of different sizes and ages. This implies that macroeconomic stability requires microeconomic instability. These results are in line with other Swedish and international empirical research and they suggest that the flexibility of markets, particularly financial and labour markets, is critical for fast and sustainable employment growth.

9.3 POLICY IMPLICATIONS

I observe that Swedish economic policy during the post-war period has disfavoured exactly those firms (new, small, private, and independent) and industries (service) that have been shown to generate most growth. This systematic negative treatment of the young and small firms etc. has primarily taken place in four policy areas: entrepreneurs' access to product markets, financial markets, the labour market and through industrial policy. Legislation has made entry difficult for private entrepreneurs and has blocked access for new firms to large parts of the markets for services (due to, among other things, public-sector monopolies). The tax system has long disfavoured young, small, less capital-intense, independent and privately owned entrepreneurial firms. Incentives and opportunities to accumulate private wealth, which is important for start-ups, are poor. Wage-setting institutions and labour-market legislation has discouraged small, potentially high-growth firms from hiring new people. Exit and contraction have also been counteracted, e.g., through industrial subsidies to declining or dying firms and industries. Furthermore, there are institutions that have impeded the flexibility of markets (particularly labour). This policy has made the Swedish economy petrified. Reforms have

been carried out, and they have been instrumental for the dynamics and growth that can be observed, but major distortions and obstacles prevail.

Many of the institutions identified as growth-obstructing were introduced in the 1970s. Since 1970, Swedish GDP has lagged behind other OECD countries, and today Sweden is ranked as number 18 out of 25 OECD countries (including Mexico and Turkey) in terms of GDP per capita, compared to number 4 thirty years ago (OECD 1999, 2000). The question is where Sweden would have been with a different policy orientation.

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