Incentives for Academic Entrepreneurship and Economic Performance: Sweden and the United States*

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Abstract: The recent 'scientification' of commercial technology has brought the interface between universities and industry into sharp focus. In particular, academic entrepreneurship, i.e., the variety of ways in which academics take direct part in the commercialization of research, is widely discussed. The purpose of this paper is to compare academic entrepreneurship in the US and Sweden and attempt to explain why the US academic system appears to have been more successful in spawning academic entrepreneurship compared to its Swedish counterpart despite large levels of R&D spending and comprehensive government support schemes in Sweden. Our analysis points to weaknesses in the Swedish incentive structure in key respects: the rate of return to human capital investment, incentives to become an entrepreneur and to expand existing businesses, and insufficient incentives within the university system to adjust curricula and research budgets to outside demand. Several policy measures during the 1990s have reduced the weaknesses in the Swedish incentive structure. The current emergence of a more vibrant entrepreneurial culture in Sweden in some areas is consistent with these changes, although the rules of the game are still unfavorable relative to the US. Our analysis suggests that further measures favoring entrepreneurial activity would encourage academic entrepreneurship even further.

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> Entrepreneurship is more than a constellation of skills or an individual aptitude. It is a way of life, a culture. It thrives in some groups, and is almost wholly absent in others. Many academic communities, particularly in Europe, have traditionally belonged to the second category. It is hard to see how this state of affairs can be changed without transforming the academic monoculture into a more pluralistic one (Stankiewicz, 1986, p. 93).

1. Introduction

One of the most striking developments of the post World War II decades has been the growing prominence of academic research in contributing to economic performance of the advanced industrial countries (essentially OECD member states). More recently, an even more striking development has begun to take place, primarily in the United States. This development might be called ”academic entrepreneurship.”[1] We use this term in a broad generic sense to refer to a variety of ways in which academics go beyond the production of potentially useful knowledge. They also undertake a variety of initiatives to facilitate the commercialization of that knowledge, that is to say, they become active participants in designing new marketable products and take some sort of leadership role in ensuring successful commercialization.

Nowadays, academic entrepreneurship also looms large in the public discussion. This is quite natural given the recent ’scientification’ of technology; in particular, the most rapidly growing and wealth-creating industries such as biotechnology, computers and telecommunications are progressively more science based. There are also a number of spectacular examples of new firms that within a decade or less have become large multinationals. Furthermore, since the production of scientific results to a large extent takes place at universities, the interface between universities and industry necessarily comes into sharper focus. Policymakers in many developed countries have also responded, notably by erecting an extensive infrastructure that is intended to facilitate the commercialization of scientific research. This phenomenon has not evolved uniformly across countries.

The United States has captured a great deal of attention epitomized by the favorable developments in Silicon Valley and Stanford University. This region is characterized by a vibrant entrepreneurial culture, which has produced both a large number of small highly dynamic firms and spectacular examples of new multinationals with tens of thousands of employees and seemingly exorbitant stock market values. Recent research has documented in great detail the instrumental role played by prominent scientists in this development. It is now widely recognized that the superior ability of the US in commercializing the fruits of academic research is an essential contributing factor to its extraordinary return to technological leadership during the 1990s.[2]

In this chapter we will compare academic entrepreneurship in Sweden and the US. A comparison between these two countries is especially interesting for two reasons. First, the US and Sweden share a common organizational feature: in both countries the bulk of frontier research is done in teaching universities. By contrast, in continental Europe a much higher proportion of such research is concentrated in government-financed

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[1]See Slaughter and Leslie (1997) for a comprehensive examination of the phenomenon in question.
[2]A new *défi américain* (Servan Schreiber, 1967).

institutes that, historically, have been geographically and organizationally separate from the universities. Second, there has been a growing dissatisfaction with the performance of the Swedish economy. The question naturally arises whether an important contributing factor to the Swedish decline is some failure in its university system to make the kinds of research contributions upon which advanced industrial economies have become increasingly dependent.

It is true that there are immense differences between the US and Sweden, to which we will call attention. But here we are interested primarily in the functioning of the university/industry interface, and we pinpoint these larger economic differences in order to identify important background conditions that have shaped the US interface.

Our purpose is to explain why the US academic system seems to have been so much more successful in spawning academic entrepreneurship, even after taking into account vast differences in size. As a result it is likely that the US university system has played a more important role for commercial innovations, new firm formation and employment creation than the universities in Sweden. Our null hypothesis is that the reasons behind this should be sought in differences in key institutions and rules of the game in the two countries.

The paper is organized as follows. In section 2 we compare economic performance in terms of economic growth, employment creation and the aggregate performance of the high-tech sector in Sweden, the US and most other OECD countries. Should it turn out that the Swedish performance is weak in relevant respects, this provides a rationale for our study, although it should be emphasized that the functioning of the university/industry interface is but one building block in the national economic system. Section 3 contains a comparison of the R&D effort, its distribution between universities and other sectors as well as some comparisons of measurable R&D output across countries. In section 4 we examine the government support schemes and other bridging arrangements between universities and industry in Sweden and the US. Sections 5 to 8 contain in depth examinations of the relevant incentive structures in Sweden and the US. We identify four key areas in this respect: (1) human capital formation, the incentives to (2) become an entrepreneur and to (3) expand existing businesses and (4) the incentives within the university system to adjust the lines of study and the allocation of research budgets to the demand in the private sector and to facilitate faculty bridging of the gap between academia and the industrial sector. Section 9 contains a brief analysis of the recent and highly visible entrepreneurial revival in some sectors of the Swedish economy, and whether this revival is consistent with our long-term analysis. Section 10 concludes.

The main conclusion of our study is that a lack of an entrepreneurial culture is the major explanation for the limited importance of academic entrepreneurship in Sweden compared to the US. The weak entrepreneurial culture is not surprising given that the pertinent incentive structures have not rewarded entrepreneurial behavior to any great extent by comparison with the US.

2. Economic Performance

In this section we will briefly outline the relative performance of Sweden and the US in terms of overall growth, employment growth and the performance of the high-technology sector. The two countries will be compared to one another as well as to other OECD countries or a broad aggregate of OECD countries. Of course we understand that a country's economic performance is responsive to a multitude of possible forces, some of which are only dimly perceived and certainly not readily measurable. Nevertheless, we believe that this attention is warranted here, inasmuch as it involves a cluster of Swedish institutions that may be failing to contribute as much as it might to the country's economic performance. Additionally, we have been motivated to undertake this study because of an awareness that the Swedish economy has fallen considerably below its former preeminence among OECD member countries.

2.1 Aggregate Economic Growth

Sweden and the US share the common feature that they came out of World War II as very rich relative to almost all other industrialized countries. No doubt, the US was, in many respects, the technological leader but, by the late 1960s, Sweden was not far behind.[3] Given the relatively high income levels of the two countries by the late 1960s, both the catching-up effect[4] and the tendency towards income convergence among countries[5] would lead us to expect a low Swedish growth rate relative to the OECD average in subsequent periods. *Table 2.1* indeed shows that Sweden has grown slowly relative to the OECD since 1970. However, this is not so for the US. From 1970 up to the present the US growth rate has been comparable to the OECD average, and if the comparison is limited to the more recent period, US performance is markedly superior to the OECD average. In particular during the 1990s, the US economy grows at a very rapid rate compared both to Sweden and the OECD as a whole.

Table 2.1 The Growth Rate of GDP and GDP Per Capita in Sweden, the US and the OECD excluding the US for Different Periods, 1970–98 (%).

	1970–98		1980–98		1990–98	
	GDP	GDP per capita	GDP	GDP per capita	GDP	GDP per capita
Sweden	1.7	1.3	1.6	1.2	1.0	0.5
the US	2.7	1.7	2.6	1.7	2.7	1.7
OECD excl. the US	2.8	1.9	2.4	1.6	1.8	1.1

Source: OECD, *National Accounts 1960–1997 Vol. 1*, 1999; OECD, *Main Economic Indicators*, January 1999.

The slow economic growth rate in Sweden since 1970 has had a highly significant impact on the Swedish income level vis-à-vis that of other countries. It is well-known that comparing income levels is more difficult than comparing growth rates across

[3]For a useful discussion of technological leadership, see Nelson and Wright (1992).
[4]The catching-up hypothesis states that when the productivity level is substantially higher in one or more countries as compared with a number of other countries, it is possible for the countries in the latter group to start a catching-up process by adopting more advanced production technology from the more developed countries (Abramovitz, 1986; Dowrick and Nguyen, 1989).
[5]Convergence implies a reduction in the variance of income across countries. Convergence does not necessarily imply catching up, since a decreased variance may occur even if the other countries do not approach the income level of the technologically leading country (Barro and Sala-i-Martin, 1995).

countries. The most suitable method is probably to use the OECD's purchasing-power-parity adjusted measures of GDP per capita. In such a comparison Sweden had the fourth highest GDP per capita in the OECD area in 1970, with per capita GDP 13 percent above the OECD average (5 percent above excluding Mexico and Turkey). By 19 90 Sweden had fallen to a tied ninth position, 5 percent above the OECD average (6 percent below excluding Mexico and Turkey). In 1998 Sweden was ranked 18th together with the UK, with a GDP per capita 4 percent below the OECD average (15 percent below excluding Mexico and Turkey).[6]

The US, on the other hand, has retained its position as the second richest country per capita throughout the period. *Figure 2.1* clearly shows that Sweden and the US both lagged behind the OECD to an equal extent until the 1990s. Since then the two countries have developed in different directions: While Sweden continued to lag behind, the US economy has developed strongly during the 1990s, which has led to a rebound relative to the OECD average. It should be noted that the US rebound in the 1990s has taken place while the income level was 43 percent above the Swedish level in 1990.

Figure 2.1 Purchasing Power Parity Adjusted GDP per Capita in Sweden and the US Relative to the OECD, 1970–1998 (OECD = 100).

Enclosed

Source: OECD, *National Accounts Main Aggregates 1960-–1997 Vol. 1,* 1999 and OECD, *Main Economic Indicators*, January 1999.

2.2 *Employment Performance*

As shown in *Figure 2.2*, employment adjusted for population growth rose by approximately 27 percent in the US between 1970 and 1998, while it decreased by 8 percent in Sweden during the same period. In essence, the private and public sectors in the US experienced equally rapid employment growth. The number of US private service sector jobs rose by 90 percent in 1970–93, compared with 16.7 percent in Sweden.[7] It is also noteworthy that US employment has risen a good deal more quickly than population, despite rapid (30 percent) population growth.

Figure 2.2 Population-Adjusted Employment Trends in Sweden, the US and OECD excl. the US, 1970–98, Index 1970 = 100.

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Note: The index series have been defined as (index for employment/index for total population x 100).
Source: OECD, *Economic Outlook*, December 1998 (data on disk), OECD, *National Accounts 1960–1997*, 1999.

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[6]*Source*: OECD, *National Accounts Main Aggregates 1960-–997 Vol. 1,* 1999 and OECD, *Main Economic Indicators*, January 1999.

[7]The private service sector is defined as total private employment minus private employment in agriculture, forestry, hunting and fishing, mining, manufacturing, electricity, gas, steam and water works, and construction.

Furthermore, the OECD employment rate, calculated as the ratio of people employed to the total working-age population, does not differ widely between Sweden and the US in 1998. However, when these figures are adjusted for hours worked we find a striking difference. US adjusted work hours jumps 12 percent during this period, while Swedish adjusted work hours declines 6 percent (see OECD, *Employment Outlook*, July 1995, July 1996 and July 1999 and OECD, *Economic Outlook*, June 1999).

2.3 Performance of the High-Tech Sector

In our context it is of course of particular interest to study the performance of the high-tech manufacturing sector in the two countries. *Figure 2.3* shows the evolution of the production and employment share of high-technology industries since 1970 in the US, Sweden and 12 OECD countries. Throughout, the high-tech production and employment share has been sizably higher in the US than in Sweden and other OECD countries. However, since 1990 the high tech share has soared in Sweden; the production share increased from 11 to 19 percent between 1990 and 1996, which put Sweden on par with the share in other OECD countries. At the same time, it should be noted that this increase is not the result of increased production in a large number of new firms. Virtually the whole increase is attributable to the commercial success of Ericsson's cellular phone systems and to a smaller extent Astra's drug sales, notably Losec.[8]

Figure 2.3 Production and Employment Share of High-Technology Products in Manufacturing, 1970–96.

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Note: The 12 OECD countries are Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, the Netherlands, Norway, Sweden and the UK. Due to lack of data Germany is not included until 1976. Denmark and the UK are excluded in 1995. The choice of countries is governed by data availability.
Source: OECD, *DSTI* (STAN Industrial Base), 1998.

The view that the increased high-tech production is driven by a strong development in a few large firms is supported by complementary evidence showing a low growth rate among new technology-based firms. Utterback and Reitberger (1982) made a comprehensive interview study of 60 firms, based on new technology, that had been founded between 1965 and 1974. The 60 firms constituted roughly half of the total population of such firms founded during that period. By 1980 total employment in the 60 firms was 4,640 in Sweden and 970 abroad. This should be compared to total manufacturing employment of close to 900,000 at the time. Thus, the studied firms contributed roughly 0.5 percent of total manufacturing employment. Rickne and Jacobsson (1996) update the Utterback and Reitberger study by following the 53 firms still fulfilling the original selection criteria through 1992. Of the 53 firms only nine had

[8]The pattern is similar if we look at high-tech exports. Since the mid 1980s the US high tech export share has been approximately 37 per cent. Sweden's share was at about half the US level until the late 1980s. During the 1990s the Swedish high-tech export share has increased to 27 per cent in 1996, which is roughly the average level in the OECD excluding the US.

grown to have more than 200 employees in 1992. Taken jointly, the 53 firms employed no more than 3,400 persons in Sweden in 1992.

Rickne and Jacobsson (1999) study all new technology-based firms founded between 1975 and 1993 (and still in existence in 1993) in Sweden. The main results from their study are summarized in *Table 2.2*. The employees of the new technology-based firms represented 0.9 per cent of manufacturing employment in the selected industries and 6.2 per cent of employment in manufacturing-related services in 1993. In total they accounted for 2.2 per cent of employment in the industries they belonged to (either manufacturing or manufacturing-related services). Thus, their share of total employment is very small and, perhaps even more importantly, not a single one of the firms had more than 500 employees. As a comparison to the US, and granting the far greater size of the US economy, one may mention that Sun Microsystems alone, founded in 1982, has in excess of 25,000 employees, i.e., more than the sum of all the new technology-based firms founded since 1975 in Sweden.

Table 2.2 The Distribution of the Stock of New Technology-Based Firms by Size in 1993 (all firms covered by the definition were founded in 1975–93).

Size	Number of firms in the category	Number of employees in the category	Percentage of employees
3–19	1,022	7,702	39.5
20–49	196	5,886	30.2
50–99	48	3,187	16.4
100–199	15	2,009	10.3
200–499	3	704	3.6
Total	1,284	19,488	100.0

Source: Rickne and Jacobsson (1999).

There are also a few Swedish studies that focus exclusively on technology-based firms founded by university faculty. The most extensive of these studies is Olofsson and Wahlbin (1993). The study consists of 569 firms started between 1974 and 1989. They find that some 60 percent of these firms remain very small (total annual sales below SEK 2 million), and approximately 30 percent of the firms have total sales exceeding SEK 5 million. Unfortunately, the study is purely descriptive and no attempt is made to compare the performance of these firms with an appropriate benchmark. However, it is clear that the direct employment and production effects of the activities of these firms are small: Total sales were approximately SEK 3 billion and the firms employed only 3,500 persons.

Lindholm Dahlstrand (1997a, 1997b) specifically address the issue how new technology-based firms with their roots in universities perform relative to firms with a different origin. This is done by identifying all spin-off firms in the Utterback and Reitberger (1982) sample (among the 60 firms there are 30 spin-off firms) and by including all spin-offs from the Chalmers Institute of Technology in Göteborg. It is found that university spin-offs consistently grow much more slowly than other spin-off firms.

2.4 Summary and Conclusions

In this section it has been documented that the rate of growth in Sweden has been slow relative to almost all other OECD countries during the last three decades. As a result, Swedish relative income has dropped sharply from the 4th highest in 1970 to the 18th highest in 1998. The US per capita income relative to the OECD average also dropped at a similar rate until the late 1980s, although the drop took place from a much higher level to begin with. The US also remained the 2nd richest country throughout this period of relative decline. During the last decade, however, the US economy has grown faster than the OECD average. Regarding employment there has been a great difference between the rapid rate of job creation in the US compared to Sweden and Europe, where employment has been stagnant since the 1970s. This has resulted in an hours-adjusted employment level in the US on the order of 35 per cent higher than in Sweden and other European countries. The US high-tech production share has consistently been higher than in Sweden, but the Swedish share has increased sharply during the 1990s. However, there is ample evidence pointing towards a weak performance of new technology based firms.

3 Investment in R&D and Output from the University Sector

Both Sweden and the US spend a very large share of GDP on R&D. Both countries have consistently held the top position together with Japan. Since the mid 1980s, Sweden has in most years had the highest R&D/GDP ratio of all countries, although it should be noted that part of the sharp increase in the Swedish ratio during the first half of the 1990s is due to the sharp decline in Swedish GDP during the 1990–93 depression (SOU 1996:70). See *Table 3.1* and *A.1* for details.

Table 3.1 Total R&D Expenditures and in the University Sector as a Percentage of GDP in Sweden, the US and the OECD, 1981–95.

	Sweden		the US		OECD weighted		OECD unweighted	
	Total	Univ.	Total	Univ.	Total	Univ.	Total	Univ.
1981	2.29	0.69	2.42	0.35	2.09	0.36	1.52	0.32
1983	2.55	0.77	2.66	0.35	2.25	0.37	1.63	0.34
1985	2.89	0.79	2.87	0.37	2.43	0.37	1.77	0.35
1987	2.99	0.86	2.82	0.41	2.44	0.40	1.84	0.37
1989	2.94	0.90	2.73	0.42	2.43	0.40	1.87	0.38
1991	2.89	0.79	2.81	0.40	2.49	0.41	1.93	0.41
1993	3.39	0.87	2.61	0.40	2.38	0.43	1.98	0.43
1995	3.59	0.79	2.54	0.39	2.34	0.42	2.01	0.43

Note: Due to data limitations OECD is defined as the following 15 countries: Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Netherlands, Norway, Spain, Sweden, the UK, and the US.
Source: OECD, *Basic Science and Technology Statistics on diskette*, 1997; OECD, *National Accounts 1960–1997 Vol. 1*, 1999; OECD, *Main Economic Indicators*, January 1999.

One should also keep in mind that international comparability regarding spending is not always straightforward, since reporting conventions may vary across countries. There is some suspicion that the Swedish R&D/GDP ratio exaggerates the Swedish position somewhat. Therefore, we also compare R&D efforts in terms of full-time man-years in 1995 in *Table 3.2* for complementary evidence. Here Sweden no longer ranks at the top. In particular, man-years of R&D by research scientists and engineers is not so high in an international comparison. Unfortunately, this measure was unavailable for the US.

Table 3.2 Personnel in R&D Activity in 1995 per 1 000 Persons in the Total Population, Full-time Equivalents (rank in parentheses).

	Total R&D Personnel	Research scientists and engineers
Japan	7.55 (1)	5.36 (1)
Australia	7.29 (2)	4.77 (2)
Sweden*	7.08 (3)	3.31 (5)
Finland	6.58 (4)	N.A.
Iceland	6.34 (5)	4.02 (3)
Denmark	5.78 (6)	3.05 (6)
Germany*	5.76 (7)	2.82 (7)
Norway	5.51 (8)	3.66 (4)
France	5.48 (9)	2.60 (8)
Netherlands	5.13 (10)	2.20 (12)
Belgium	3.79 (11)	2.26 (11)
Ireland	3.44 (12)	2.36 (10)
New Zealand	2.95 (13)	1.71 (13)
Italy	2.51 (14)	1.32 (14)
Spain	2.04 (15)	1.21 (15)
Portugal	1.57 (16)	1.17 (16)
Turkey	0.30 (17)	0.26 (17)
UK	N.A.	2.53 (9)

*The figures for research scientists and engineers are from 1993. The corresponding figures for total R&D personnel is 5.87 in Germany and 6.50 in Sweden.
Source: OECD, *Basic Science and Technology Statistics on diskette*, 1997; OECD, *National Accounts 1960–1997 Vol. 1*, 1999; OECD, *Main Economic Indicators*, January 1999.

Perhaps even more importantly for our purposes is the fact that R&D conducted in the university sector as a share of GDP (*Table 3.1* and *A.2*) is consistently the highest in Sweden. The importance of the university sector for total R&D in Sweden is even higher when looking at labor input rather than expenditure, see *Table 3.3*. As a matter of fact, an extremely large share of R&D conducted by persons holding a Ph.D. is carried out in the university sector in Sweden – in 1993 the total volume of R&D conducted by Ph.D.'s in Sweden amounted to 9,650 man years, and 52 per cent (5,000 man years) of this volume was carried out at universities (SOU 1996:70 p. 32).[9]

[9]According to the same source 76 percent of total R&D at universities was in technology, natural sciences, biomedicine and agricultural sciences.

Table 3.3 Share of Total R&D Attributable to the University Sector in Sweden, 1981–1997.

Share of	1981	1983	1985	1987	1989	1991	1993	1995	1997
Expenditure	30.0	30.2	27.4	28.9	30.6	27.4	25.7	22.0	21.5
Personnel	27.2	26.9	27.4	26.4	31.4	31.4	30.8	27.6	27.8

Note: See *Table A.3* in the Appendix for a more detailed breakdown.
Source: Statistics Sweden (1996) for 1981–93, data received directly from Statistics Sweden and OECD, *Basic Science and Technology Statistics on diskette, 1997.*

The regular Swedish R&D statistics do not include R&D conducted at firms with less than 50 employees. It turns out that the R&D volume in these highly specialized (mostly consultancy) firms is sizeable: 28 percent of all R&D in private industry in 1993 (13,700 of a total of 48,700 man years) was carried out in these firms (SOU 1996:70, p. 32). The main clients of these small firms are the large multinational corporations, which also carry out the bulk (more than 50 per cent) of all industrial R&D in Sweden. As shown by Braunerhjelm (1998) industrial R&D among multinationals is also highly concentrated to a few firms; in 1994 four multinationals carried out more than 70 per cent of total R&D among multinationals. Thus, directly and indirectly, large multinational corporations tend to dominate private R&D activities in Sweden. Generally, Swedish multinationals have so far carried out a large share of their R&D in Sweden, while an increasingly large share of their production takes place outside of Sweden. In 1994 roughly 60 per cent of total production and employment in Swedish multinationals was located outside of Sweden (Braunerhjelm and Ekholm, 1998).

Finally, the question naturally arises whether an important contributing factor to the Swedish decline is some failure in its university system to make the kinds of research contributions upon which advanced industrial economies have become increasingly dependent. One way of exploring this question is to apply the usual measures of academic research productivity to the Swedish university community. When productivity is measured in terms of publications (in recognized professional journals) per billion US dollars of GDP, Sweden fares very well. As shown in *Figure 3.1*, Sweden was second to Israel in 1995 in terms of publications relative to the size of the economy, while the US is ranked 20th at less than half the Swedish level. Sweden has also consistently ranked very high in the biology-based disciplines, including especially clinical medicine and biomedical research – a preeminence that owes much to Karolinska University (formerly Karolinska Institute). See *European Science and Technology Scoreboard, 1999*, pp. 34-35).

Figure 3.1 Scientific and Technical Article Output in 20 Rich Countries, per Billion USD of GDP in 1995.

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Source: *Science & Engineering Indicators – 1998.*

The conclusion of this section is that, in terms of sheer volume, the Swedish R&D effort is impressive by international standards. The publication rate in international scientific journals is likewise high. At the same time, there is little doubt that Sweden does not get full mileage out of its R&D effort in terms of production and job creation in high-tech, high value-added industries. It seems fair to hypothesize that the commercialization of the R&D efforts is a weak link. Most basic research is carried out in the university sector, and there is evidence that spillovers in the form of new viable business ventures tied to the universities are fairly modest in the aggregate. Regarding applied research (development), this is dominated – directly and indirectly – by a handful of extremely large multinational corporations. Much of the commercialization of this R&D takes place abroad and the spillovers to new businesses are limited (Braunerhjelm, 1998).[10] In 1994, roughly 60 percent of total production and employment in Swedish multinationals was carried out abroad. Furthermore, Swedish firms now frequently license their new technologies overseas in ways that provide little of commercial value to Swedish industry. Such licensing is very much a "second best" alternative.

So why hasn't the large Swedish R&D effort paid off as might reasonably be expected? Has the government provided insufficient support? Have the incentives for private agents been insufficient? We will now in turn look at the most important aspects of the university/industry interface. Throughout, the Swedish picture will be contrasted to the US situation.

4. Government Support Schemes and other Bridging Arrangements between Universities and Industry

As we saw in the previous section, R&D spending as a share of GDP is very high in Sweden compared to almost all other countries including the US. In addition, it is quite clear that a very large share of (academic) research, in particular research carried out by individuals holding a Ph.D. degree, is carried out at universities.[11] In a country where a large share of research is carried out at universities it becomes even more important that the interface between university research and commercial exploitation is well developed, in order to reap large commercial benefits from research. In this section we will examine in some detail the bridging arrangements between universities and industry in Sweden and the US.

4.1 Sweden

The Swedish government has been keenly aware of the importance of an efficient university/industry interface for some time, and the point is emphasized in several recent government commissioned reports (e.g., SOU 1996:70 and SOU 1996:89). This changed view of the role of universities in society at large has been codified in legislation. Before the 1975 university reform, universities was stipulated to "teach and do research based on a scientific foundation" (SFS 1964:461 1 kap. 2 §). In 1975 a third

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[10]The Swedish situation can be better understood by refering to Saxenian's (1994) comparison of the entrepreneurial and highly dynamic business environment of Silicon Valley to the hierarchically organized and closed business environment of Route 128 on the perimeter of Boston. Sweden and the Route 128 culture forfeit the benefits that the entrepreneurial culture of Silicon Valley obtains from flexibility, nonhierarchical structures, networking, labor mobility across firms and so forth.
[11]As used here the term universities also includes colleges.

objective was added to the agenda of universities, namely, to communicate to the surrounding society results emanating from university research and how they can be applied. Gradually this third objective came to be interpreted more broadly as collaboration between the universities, on the one hand, and private industry and the public sector, on the other. In the new regulation of the universities effective from 1998 (SOU 1998:128, pp. 153–154) this is spelled out explicitly. The universities are exhorted to be open to influences from the outside world, disseminate information about their teaching and research activities outside academia, and to facilitate for the surrounding society to gain access to relevant information about research results. Each university is also obligated to draw up and implement its own plan for collaboration with the surrounding society. This plan has to be submitted for approval to the Ministry of Education.

This collaboration has taken many forms. Swedish universities have engaged in offering courses to non-degree students since 1996. However, more interestingly, there has been a focus on developing university-industry collaboration. This collaboration has taken at least six forms: (i) research projects commissioned and paid for by an outside agent for commercial reasons; (ii) industry consulting by university personnel, university staff whose salaries are subsidized by an outside firm and adjunct professorships, as well as doctoral studies hosted inside industrial labs (*industridoktorander)*; (iii) university employed contact secretaries who act as mediators between university and small and medium size firms. (iv) research institutes and other organizations jointly run by universities and private industry; (v) the set up of firms for commercial exploitation of research; and (vi) financial and advisory aid to research-based firms and to individual researchers in order to facilitate the patenting, licensing or direct commercial exploitation of knowledge and research results originating from universities. In what follows we will briefly describe the most important arrangements and their results.

After being discouraged for many years, commissioned research has been encouraged since the early 1980s. Currently, industry-funded university research has reached US levels, approximately 5 percent. Industry is able to solicit university input directly as university personnel are allowed to consult at one day a week. These programs are modestly successful. In contrast, the contact secretary program is generally regarded as a failure. They have become “more of sales managers for projects dreamt up by university researchers” (Olofsson and Stymne, 1995b, p. 9) than anything else.

The government has endeavored to set up institutions designed to facilitate knowledge transfer and knowledge development. The government and private industry have financed 30 independent research institutes, which are geared towards specific industries (e.g., forestry, corrosion, fiber optics *et cetera*). About 2,000 researchers are affiliated with these institutes, although few of them hold Ph.D.’s. In addition, NUTEK, the Swedish National Board for Industrial and Technical Development, universities and private firms have established several “competence centers” since 1992. These facilities conducted about 500 man-years of research in 1996 with the involvement of roughly 150 firms. Although still modest, this form of organization is growing.

In Sweden, university personnel receive full patent rights for their inventions. The government has been developing a legal and financial infrastructure aimed at facilitating exploitation of these patents and other university ideas. For example, between 1983 and 1997, 17 science parks which host small startups and R&D departments of large multinationals were established. In 1997 these parks employed

10,000 people. However, it is unclear how many of these startups are university spinoffs. In a more direct approach, universities have been allowed to set up their own wholly-owned companies for the commercial exploitation of research since 1993. It is yet unclear to what extent universities have exploited this new privilege. In addition, all major universities run patent corporations (*forskarpatentbolag)* which are intended to facilitate exploitation of patentable innovations emanating from the university. Again, it is unclear what success these patent corporations have enjoyed.

The government has been active in providing seed financing to technology-based firms through NUTEK. In 1997 almost 200 high-tech firms received soft loans under this scheme (Landell *et al*., 1998). In addition, since 1994 seven broker institutions called Technology Bridging Foundations (*Teknikbrostiftelser)* have been established in major university regions. Their task has been to mediate commercialization of R&D from universities, SMEs and individual inventors by facilitating the patenting process, matching up VC funding *et cetera*. In addition, four foundations, such as the Foundation for Knowledge and Competence Development, have been established which, among other things, are intended to bridge between the university and industry. Again, it is too soon to determine if these foundations have been successful towards this end.

This brief overview of public sector measures aiming at strengthening ties between universities and industry shows that these measures are extensive in Sweden. In particular, in terms of sheer manpower there seems to be no lack of resources in this respect, although the kronors are controlled by the public sector.

4.2 The United States

In the course of the twentieth century, extensive networks of interaction between universities and the private sector were established, taking a variety of forms. Consulting arrangements on the part of faculty proliferated, as did other forms of cooperation, involving joint research projects, student fellowships in particular fields, *et cetera*. In industries such as petroleum refining and pharmaceuticals, consulting and other regularized connections became quite intense.[12]

The postwar era marked a drastic departure from earlier years by providing huge budgets to support university research, including basic research. An essential feature of this support is that it was, overwhelmingly, dispensed by mission-oriented agencies of the federal government such as the Departments of Defense, Health, Energy and Agriculture and NASA.

Another distinctive feature of federal government policy in the postwar years was an increasingly solicitous concern for the interests of small business. This concern was reflected, not only in a continuing exercise of anti-trust activity (with some variation among different administrations), but in various other forms, such as government procurement policies and, especially, new legislation to advance the interests of small business. In 1953, Congress established the Small Business Administration (SBA), the purpose of which was to provide assistance to small business in a variety of ways – in securing government loans and contracts and in acquiring technical and professional

[12]See Rosenberg (1998) on petroleum refining and Swann (1998) on pharmaceuticals.

managerial know-how. The thrust of this legislation was strengthened in 1958 by a requirement that government agencies should conduct a ”representative” share of their business with small firms. In addition, in the same year Congress passed the Small Business Investment Act, which encouraged the creation of Small Business Investment Companies (SBICs) that could provide small businesses with risk capital. In 1976, in response to the discontent of small businesses with the effects of health and safety regulations that had been introduced in the early 1970s, a new Office of Advocacy was created at the SBA. Its responsibility was to ”measure the direct costs and other effects of government regulation on small businesses and make legislative and nonlegislative proposals for eliminating excessive or unnecessary regulations of small businesses” (Brock and Evans, 1986, pp. 22–23).

The SBICs were the most conspicuous and consequential outcome of congressional concern with the problems confronting small businesses. This is so because they became part of a significant experiment in government efforts to provide finance for new, high-risk enterprises. It was the ultimate *failure* of this experiment that created the conditions that led to the eventual rapid growth of the venture capital industry as it now exists in the US. The venture capital (VC) firm in its present form is a major institutional innovation in the financial sector. It is now embedded in a legal and regulatory environment that is closely attuned to the unique features of high technology industries in which small new firms now play a dominant role. This VC industry, in turn, has come to play an indispensable role in building bridges between universities and industry in America in recent years.

The SBICs can be defined as ”private corporations licensed by the Small Business Administration (SBA) to provide professionally-managed capital to highly risky companies. To encourage their formation, SBICs were allowed to supplement their private capital with SBA loans and were eligible for certain tax benefits. In return, SBICs were subject to certain investment restrictions, including limitations on the size of the companies in which they invested and restrictions on taking controlling interests in companies” (Fenn, Liang and Prowse, 1995, p. 7). Although the SBICs did, in fact, provide substantial amounts of equity financing to small, fast-growing companies, their further growth came to suffer from serious defects. Since they were heavily dependent upon the leverage provided by low-interest SBA loans, they had to concentrate their activities on debt financing to small companies that were already generating cash flows. Thus, they were seriously restricted in the effort to accommodate the early-stage financial needs of new, start-up firms. Entrepreneurs were financed with debt rather than with equity. Moreover, the availability of government guarantees created familiar moral hazard problems as some SBICs chose to make very high risk investments. The SBICs also suffered from adverse selection; they attracted mainly poorly informed individuals who did not understand the nature of the risks in private equity investments, whereas better-informed institutional investors showed little interest. Finally, the program did not prove attractive to the most talented investment managers. The reason was both simple and compelling: most private equity professionals could be paid only salaries; the provisions of the Investment Company Act of 1940 did not allow them to receive performance-based compensation, including stock options.

During the turbulent economic shocks of the 1970s (especially the first oil shock of 1973–74), many companies failed to meet their obligation to make interest payments on SBIC loans. Numerous highly leveraged SBICs, in turn, could not meet their own repayment schedules, and had to liquidate. Their role as providers of financial support for early-stage entrepreneurs went into a steady decline. The crisis was reinforced by the depressed state of the IPO market, which had served as the most attractive way of exiting an investment. The decline of the SBICs resulted in part from their inability to make long-term equity investments when they themselves are financed with debt. In addition, many of the SBICs were listed and it turned out that the long-term nature of private equity investing was not compatible with the short-term investment horizons of stock analysts and public investors (Fenn *et al.*, 1995, p. 4).

As we will discuss at length in section 7, a number of institutional changes, which paved the way for the development of the VC industry, were made around 1980. This industry works very differently from the SBICs, which are comparable to many of the government-financed support schemes in Sweden.

4.3 Conclusions

Our description of the efforts to bridge the gap between universities and industry in Sweden clearly revealed an extensive engagement by the State in this area. Underlying this engagement is the explicitly spelled out premise that government involvement can enhance efficiency and economic growth; left to themselves the scientific research community and the market are likely to achieve less in terms of economic value and new jobs.

The idea that more of top-down orchestration of research and its subsequent applications promote economic development has also been raised by social scientists. For example, Michael Gibbons *et al.* (1994, p. 162–163) maintain that:

> During the last two decades not only politicians and civil servants, but economists, marketing experts and industrialists, have become involved in the genesis of science and technology policy. This intrusion of the wider interests of society is sometimes resented by scientists because it is felt to erode the independence of the 'Republic of Science'. But there are good reasons for the shift in the locus of authority in the development of science …[13]

Gibbons *et al*. claim that a transfer of the control of research activities to financiers and commissioning bodies will lead to greater efficiency than the traditional system. However, this may distort the production of knowledge in the sense that the financiers get to define what relevant research is.

Gibbons's view is very much related to John Kenneth Galbraith's thinking some three decades earlier in a slightly different context. In particular in *The New Industrial State* (1967) he provided an important rationale for an economic policy oriented towards the large corporation. Galbraith forcibly argues that in the modern industrial society innovative activity as well as improvements in current products and production processes are most efficiently carried out within the realm of the large industrial corporation. Individual efforts, and hence individual incentives, dwindle in importance. Key decisions are said to be taken in groups or by the organization, which Galbraith calls the technostructure. Galbraith's vision entails a much more vital role for the government in economic development:

> The industrial system has brought its supply of capital, and in substantial measure also its labor supply, within its control, and thus within the ambit of planning. And it has extended its influence deeply into the state. Those policies of the state that are vital for the industrial

[13]Quoted from Brulin (1998).

> system – regulation of aggregate demand, maintenance of the large public (if preferably technical) sector on which this regulation depends, underwriting of advanced technology and provision of an increasing volume of trained and educated manpower – are believed to be of the highest social urgency. This belief accords with the needs of the system (Galbraith, 1967, p. 318).

This quotation succinctly brings out the key message in Galbraith's book, which contained so many central elements of the Swedish model: The large corporations and the public sector as engines of economic development, the unimportance of individual incentives for entrepreneurship, effort and human capital investment, and the claim that not just large-scale production but also innovative activity and renewal could be subordinated to Fordist organizational principles.[14]

So if Sweden largely adopted a top-down model, which included extensive direct involvement by the government in the transfer of knowledge with commercial potential from universities to industry, the US adopted much more of a bottom-up model. Central elements of this model included the institution of a legal framework that promoted the transfer of knowledge to small and new firms and eventually, as we will see in section 7, the introduction of a broad set of rules which paved the way for the evolution of the VC industry, which has turned out to be a highly effective institution to bridge the gap between academia and industry.

One can also point to other countries in addition to the US, where there is substantially more academic entrepreneurship despite very little of bridging institutions and other government support – see, for example, Klofsten and Jones-Evans (1998) for a comparison between Sweden and Ireland. One may also note that Etzkowitz *et al.* (2000) conclude from their interviews: "One opinion is that centralized organizations for external contacts are highly overrated."

So what are the missing links? What factors could account for the apparent superiority of the American system in creating economic value from R&D activities at the universities? Our hypothesis is that the answer has to be sought through an in-depth examination of the relevant incentive structures in the respective countries. The most likely ones are:

1. The incentives to invest in human capital (intensity of studies/line of study).

2. The incentives to become an entrepreneur rather than to remain a salaried employee; in particular, the relative pay-off for academics to become entrepreneurs.

3. The incentives to expand an existing business.

4. The incentives within the university system; to adjust the lines of study to demand in the private sector, to facilitate the transfer from academia to the entrepreneurial sector.

The next four sections will now be devoted to each one of these issues. Throughout the exposition particular emphasis will be put on how the incentive systems in Sweden and the US are likely to influence the supply of academic entrepreneurship.

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[14]One indication of Galbraith's great impact on Swedish policy makers is that shortly after the publication of *The New Industrial State* he was invited by the then Prime Minister Tage Erlander to his official summer residence *Harpsund* to give a two-day seminar on his book to the members of the government.

5. Incentives to Invest in Human Capital

5.1 Human Capital and Economic Growth

In the literature on economic growth human capital has been assigned several roles. First, it is often seen as a separate factor of production, e.g., Mankiw, Romer and Weil (1992). Second, it is a source of innovative activity, and therefore an important input in the production of basic knowledge (Nelson and Phelps, 1966). Third, a larger stock of human capital makes it easier for a country to absorb the new products or ideas that have been discovered elsewhere, and hence the catching-up potential may be better exploited (Abramovitz, 1986; Hansson and Henrekson, 1994). Fourth, there may be an external effect of human capital, i.e., human capital embodied in a worker may raise the productivity of colleagues (Lucas, 1988). Fifth, in advanced countries human capital tends to be complementary rather than substitutable to physical capital (Berman, Bound and Griliches, 1994).

In cross-country studies of economic growth, human capital has also proven to have significant explanatory power; see for example Barro (1991) and Mankiw, Romer and Weil (1992). Although the accumulation of human capital is of vital importance for economic growth, it is as yet unclear how important each of the hypothesized mechanisms are. In our analysis we take as given that human capital is important for growth rather than specifying exactly through which routes.

Noting that human capital investment is important for economic development raises a number of more specific issues. First and foremost, years of schooling is a highly imperfect measure of human capital investment. Given a certain number of years of schooling, the degree to which this translates into human capital investment is given by (i) to what extent the chosen field of study is valued in the market place and (ii) given the chosen field, how much actual knowledge the individual has acquired during the period of study. The latter is in turn a function of innate talent, the intensity of the studies and the quality of the educational system. Second, formal schooling is but one way to acquire human capital. Perhaps of equal importance is the potential for continuous learning of new productive skills more informally, notably through on-the-job training (OJT).

5.2 Human Capital Investment and Utilization

Given the overall purpose of the present study, we feel justified to focus almost wholly on human capital investment at the university level. As shown in *Figure 5.1* the US has the highest share of the active population with a university degree in the OECD; in 1996 26 per cent of the population aged 25–64 had a university level education. Sweden, on the other hand, is in an intermediate position at exactly half the US level. An interesting age pattern underlying these averages can be discerned in *Figure 5.2*, where the share of the population with a university level education is displayed for different age groups. For the OECD as a whole we find the expected pattern, i.e., the share with a university degree tends to decrease with age. In Sweden this pattern does not show up. The university share peaks in the 45–54 years age group, while the ratio for the 25–34 year olds only marginally exceeds that of the 55–64 year olds. The propensity to acquire a university degree has dropped precipitously in the most recent generation, from a ratio of 16 percent among the 45–64 year olds to a ratio of 11 per cent in the youngest group. Consistent with the data in Figure 5.1 the US level is consistently higher. Just as in Sweden, university level education is most common among 45–54 year olds. On the other hand, in contrast to Sweden the US has not experienced a decline of the ratio in the youngest age group.

Figure 5.1 Share of Population Aged 25–64 with a University Level Education in OECD Countries, 1996.

Enclosed

Source: OECD, *Education at a Glance*, 1998.

Figure 5.2 Share of Population with a University Level Education in Sweden, the US and the OECD in Different Age Groups, 1996.

Enclosed

Source: OECD, *Education at a Glance*, 1998.

The recent decline in the propensity to acquire a university degree in Sweden is illuminated in even more detail in *Figure 5.3*. The share of a cohort with a university education of a duration of at least three years peaked in cohorts born in the late 1940s, while the ratio for those born in 1969 was no higher than for the cohort born in 1930. Likewise the share of an age group holding a Ph.D. degree peaked among cohorts born in the 1940s.

Figure 5.3 Share of Each Cohort in Sweden with a University Degree (= 3 years) and with a Ph.D. Degree.

Enclosed

Source: Statistics Sweden.

Figure 5.4 Number of Science Graduates per 100,000 Persons Aged 25 to 34 in OECD Countries, 1992.

Enclosed

Source: OECD, *Education at a Glance*, 1995.

As regards the line of study some internationally comparable data are available. In particular, there are data showing the number of science graduates per 100,000 inhabitants aged 25–34. This comparison is made for 1992 in *Figure 5.4*. In this regard there is tremendous variation across countries. The number of science graduates per 100,000 inhabitants is roughly five times higher in the U.K. at the top compared to Italy at the bottom. Sweden is also close to the bottom and the US figure is roughly 50 per cent above the Swedish level.

As regards the allocation of academically trained people it is not just that there was a low inclination among Swedish students to specialize in the natural sciences, there was also a very strong tendency to pursue a career in the public sector. This fact stands out clearly from *Figure 5.5*. During the 1970s two thirds of all academically trained people worked in the public sector. Although this share has decreased somewhat since then, it is still roughly 55 per cent. As a result, the share of academics in total employment is extremely high in the public sector relative to the private sector. In the early 1970s it was roughly six times higher (16 versus 2.5 per cent), and in the late 1990s it was still three times higher (22 versus 7.5 per cent).

Figure 5.5 Share of Employment with a Tertiary Education (> 2 years) in the Private and Public Sector In Sweden, and the Share of all Employees with a Tertiary Education in the Public Sector (right scale), 1971–1998 (percent).

Enclosed

Note: Tertiary education degree is defined as having completed a post high school educational program of a duration exceeding two years. The right scale measures the share of total employment with a tertiary education that work in the public sector.
Source: Zetterberg (1994) and Statistics Sweden, *Labour Force Surveys*.

But it is well-known that international comparisons of educational levels are imperfect measures of human capital, and therefore a more direct test of the rate of human capital accumulation in Sweden relative to other OECD countries may be obtained by studying changes in the pattern of specialization. Hansson and Lundberg (1995, Ch. 3) show that during the 1980s the structure of industrial production was shifted towards industries with a low level of human and physical capital per employed. They also examine how the use of human capital per unit of output has changed in Swedish imports and exports during the period 1969–92. The exports/imports ratio remained virtually unchanged during the 1970s, but at the end of the 1970s imports started becoming relatively more human capital intensive. Lundberg (1999) finds that this tendency was further reinforced during the 1990s. These studies show that Sweden appears to have successively lost its comparative advantage in human capital-intensive production.

5.3 The Return on Human Capital Investment

According to human capital theory (Becker, 1964; Schultz, 1960), the decision to acquire human capital should be analyzed as an individual investment decision. In other words, the individual decision to acquire and use human capital is governed by the rate of return on human capital. Thus, one hypothesis is that the incentives to accumulate human capital have fallen since the 1960s.

Table 5.1 Before-Tax Educational Premiums (Annualized Mincerian Rates of Return) in Sweden, 1968–91 (per cent).

Study	1968	1974	1981	1984	1986	1988	1991
Björklund (1986)	7.8	4.3	3.5	3.9			
Fornwall (1991)				4.2† 2.0‡			
Palme and Wright (1992)	7.6		3.6				3.5
Kazamaki Ottersten *et al*. (1994)				4.4	3.8	3.2	3.6
University/high school premium							
Zetterberg (1994)							
15 vs. 12 years		7.8	4.5				6.7
16 vs. 12 years		7.7	5.3				7.0
Edin and Topel (1997)							
15 vs. 12 years	13.4	8.0	4.4	5.0	6.8	5.7	6.6
16 vs. 12 years	16.1	7.4	5.1	5.1	5.9	5.7	6.6

Note: †Concerns individuals born before 1950. ‡Concerns individuals born in 1950 or later.

If the direct costs of education are small and the individual has an infinite time horizon, the rate of return is approximately equal to the educational premium, i.e., the relative increase in the wage that can be attributed to an additional year of schooling (Willis, 1986). The educational premium is conventionally estimated using Mincer's (1974) method. A number of such studies have been performed on Swedish data for selected years during the period 1968–91.[15] Comparable estimates are also available for the US covering the same period. The results, reported in *Tables 5.1 and 5.2*, are noteworthy. First, it is obvious that the educational premium fell dramatically from the end of the 1960s to the early part of the 1980s in Sweden. Since then the rate of return has stabilized at a low level according to Palme and Wright (1992). Edin and Holmlund (1995) and Zetterberg (1994), on the other hand, find an increase in educational premiums during the latter half of the 1980s and early 1990s, when they compare the evolution of high school/compulsory education and college/high school premia. Second, the sharp increase in the college/high school premium experienced in the US between 1979 and 1989 (see also Murphy and Welch, 1989) cannot be detected in Sweden. Third, since the 1970s the rate of return on education has consistently been much higher in the US than in Sweden. We conclude that the rate of return on education fell to very low levels in Sweden in the early 1980s, and as Fornwall (1991) shows, the fall was larger for young people. But, there is evidence indicating a modest increase in the late 1980s.

[15]No reliable data set has been collected in Sweden for a date later than 1991. The next *Level of Living Survey* (LNU) will not be available until 2001.

Table 5.2 Before-Tax Educational Premiums for a Year of High School and a Year of College (Annualized Mincerian Rates of Return, percent) in the US, 1969–95.

	1969	1979	1989	1995
High School	5.9	6.6	7.8	8.1
College	9.9	8.9	12.4	12.9

Note: Concerns full year, non-farm, male workers.
Source: Goldin and Katz (1999).

Surely, the educational premium before tax is but an imperfect measure of the rate of return on education. The rate of return is also determined by the following factors: the progressivity of the tax system, the availability of scholarships and subsidized loans, tuition fees, the age at the time of examination and the change in the unemployment risk. Taking account of all these factors would make it possible to calculate the internal rate of return for university training. Accounting for the effect of taxes Edin and Holmlund (1995) and Björklund and Kjellström (1994) found an even steeper drop in the rate of return in Sweden (compared to educational premia) between 1968 and 1981. The rate of return on higher education was approximately zero in both studies in 1981. The combined effect of higher educational premia and lowered progressivity in the tax system led to a rebound in the mid to late 1980s. In 1991 the internal rate of return after tax was found to be 4.5 per cent.[16]

The effect of subsidized loans and scholarships on human capital investment is much more difficult to assess. It is of course trivially true that, *ceteris paribus*, the rate of return to attending university is increased (Björklund and Kjellström, 1994; Edin and Holmlund, 1995). On the other hand, loan subsidies and scholarships boost the rate of return by giving rise to income during studies, as opposed to educational premia which give rise to (higher) income after completion of the studies. Thus, loan subsidies and scholarships that are not correlated with the rate of return to the training are likely to lower the incentives to choose the type of education that provides the most human capital investment as measured by the rate of return in terms of relative wages. This effect is reinforced by the fact that no tuition is paid at Swedish universities.

As shown by Fredriksson (1997) and Edin and Topel (1997) the propensity to enroll at universities has been highly correlated to the educational premium – see *Figure 5.6*. This provides further evidence that the willingness to invest in human capital is greatly affected by the rate of return.

Figure 5.6 The University Enrollment Rate and the University/High School Wage Premium for Males, 1968–91 (Percent).

Enclosed

Source: Edin and Topel (1997).

[16]Björklund and Kjellström (1994) find a much higher rate of return for women than for men (9.7 versus 2.7 per cent in 1991). This is due to the fact that women with higher education work longer hours than women with less education. On the other hand, there are no studies that take account of the marginal effects caused by income-dependent transfers and fees, such as housing allowances and day care fees. Generally, that would lower the rate of return on education.

Why did the rate of return to schooling decrease so much in Sweden? Since the Swedish labor force cannot be said to have considerably more schooling than in other countries, it can probably not be explained by a lower scarcity value. Another possibility is that the successful implementation of the solidaristic wage policy resulted in lower educational premiums. Support for this thesis is given by Hibbs (1990) and Edin and Topel (1997). The latter are very explicit on this point (p. 197):

> Compared to market outcomes, egalitarian wage policies reduced pay differences along virtually every dimension of skill, to different degrees. This was an important component, perhaps the most important component, of Sweden's sharp decline in income equality. … we do not believe that wage bargains simply tracked what would have occurred in an unconstrained market.

A third potential explanation for the decline in the rates of return is that the quality of education has deteriorated, despite the fact that Sweden has one of the highest ratios of educational expenditure to GDP of all OECD countries (Fägerlind, 1991; OECD, 1998). This may very well be the case, particularly considering that the incentives to acquire human capital have become weaker. If the rate of return on schooling is low, the individual can adjust to this situation to some extent by consuming education rather than investing in human capital. Hence, human capital investment may be endogenous, in the sense that the individuals have adjusted their actual investment in human capital (as opposed to the number of years of schooling) to the institutionally given rate of return.[17] A further factor that may lead to lower quality in the educational system is the sharp drop in relative wages of educators. As shown by OECD (1995) and Landell (1996) Sweden has the lowest wage for experienced teachers (high school) relative to PPP-adjusted GDP per capita of all countries compared.

Empirical research also shows that there is a positive correlation between formal education and informal human capital investment in the form of on-the-job training (OJT), *et cetera* (Mincer, 1984; Heckman, 1998). At the same time, strong incentives for OJT may be a partial substitute for weak incentives to formal education, and the wage structure may also encourage intensive and efficient use of the individual's human capital. As shown theoretically by Lazear (1979, 1981) a steep age/wage profile, often called a deferred payment contract, may enhance productivity. Such a wage profile can be important in motivating employees to deliver maximum effort, to continue to invest in human capital and to accept technical change that increases the employer's chances of long-run survival (Henrekson, 1993).

Substantial evidence indicates that the age/wage profile has become considerably flatter since the 1960s. Jonsson and Siven (1986) and Skedinger (1991) document a considerable reduction in the effect of age and experience on the wage for both blue-collar and white-collar workers. This development is also evident from two econometric studies. Edin and Holmlund (1995) show that, holding other factors constant, the wage of 18–19-year olds rose from 55 per cent of the level for 35–44-year olds in 1968 to 80

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[17]Although it should be noted that Edin and Holmlund (1995) argue that the decline in the rate of return to education can be explained by an increased supply of individuals with a tertiary education. However, we find it unlikely that the general tendency towards a sharp drop in educational premiums during the 1970s was not to a large extent influenced by ideological factors. This does not preclude the possibility that a free-market wage formation would have led to lower educational premiums as well, but we agree with Edin and Topel (1997) that it is likely that the size of the drop would have been substantially smaller.

per cent in 1986. For blue-collar workers in manufacturing, in particular, the age/wage profile has become strikingly flat. Edin and Topel (1997) compare the rate of return to experience in Sweden and the US. In 1969 the experience-wage profile was actually steeper in Sweden than in the US. By the mid 1970s the situation was reversed; the return to experience increased sharply in the US. while it dropped to low levels in Sweden.[18]

5.4 Conclusions Regarding Human Capital

Investment in human capital is crucial for economic growth. In an international comparison the level and rate of human capital investment at the university level is fairly low in Sweden. In particular, it is noteworthy that the propensity to study natural sciences has been low, the share of a cohort acquiring a university degree has declined substantially since the 1970s, and a disproportionately large share of people holding a university degree work in the public sector.

The analysis in this section has shown that the incentives for individuals to invest in human capital, formally or informally, declined in Sweden over time and became very low during the 1970s and 1980s. These incentives were further weakened by the high marginal tax rates on wage income. Furthermore, when the solidaristic wage policy was gradually reformulated into a desire for a general leveling of wages across professions (rather than equal pay for equal work), this had the unanticipated side-effect of a decline in the rate of return on investment in human capital. This is consistent with the observed specialization away from human capital intensive commodities in Sweden.

In the most recent decade the intensified phasing-out of old tayloristically organized production lines, has increased the need for continuous OJT and a high level of general training in order to achieve a high rate of productivity growth. Thus, weak incentives for human capital investments may have more detrimental effects for economic performance today than in the 1970s and 1980s.

6. Incentives to Become an Entrepreneur

A second important factor likely to determine the contribution of academia to economic performance is the relative payoff to becoming an entrepreneur rather than becoming and/or remaining a salaried employee, notably the relative payoff for academically trained people.

Self-employment in Sweden declined from 19 percent of employment in 1950 to 7 percent in 1991. A slight rise has been registered since then – a combined effect of the steep decline in total employment and a slight upturn in self-employment following the low point in 1991.[19] In an international context as well, self employment in Sweden

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[18]The results of this study are reinforced by two other studies: Le Grand (1994) finds that ten years of job seniority raised wages by as little as 2 percent in Sweden in 1991, while the effect in the U.S. was approximately ten times as large (Topel, 1991).

[19]Naturally, rising employment in the public sector helped to reduce self-employment because it attracted labor resources to a sector in which self-employment by definition does not exist, and because the public sector began to provide services such as health care, child care, care for the elderly, *et cetera* – i.e., services which would have been suitable for small firms and self-employment had they not already been provided by the public sector.

appears low. A 1992 OECD study (OECD, *Employment Outlook*, July 1992; see *Table A.4* in the Appendix) found that since the beginning of the 1970s throughout the 1980s, Sweden had the lowest rate of self-employment outside agriculture of all the OECD countries.[20] The European Observatory for SMEs (1995) found that in 1992, Sweden had a lower share of self-employed than any of the other 12 countries that comprised the EU at that time. The figures in *Table 6.1* indicate that self-employment as a share of total employment in Sweden was less than half of the average for the 12 EU countries.

Table 6.1 Self Employment as a Share of the Labor Force in the 12 EC Countries and Sweden in 1992 (%).

Country	*%*	*Country*	*%*
Belgium	14.1	Luxembourg	8.9
Denmark	8.0	Netherlands	9.6
France	11.2	Portugal	22.9
Germany	8.1	Spain	17.4
Greece	32.6	UK	11.3
Ireland	19.0	EU-12	13.8
Italy	23.2	*Sweden*	*6.8*

Source: The European Observatory for SMEs, *Third Annual Report 1995*.
Note: No data were available for Austria, Finland and Norway. Figures include agriculture.

Thus, the available data reveal a declining inclination over time to be self-employed in Sweden, and the self-employment rate is low by international standards. But does the propensity to be self-employed change with the level of education? Preliminary evidence by Utterback and Reitberger (1982, p. 92), for instance, shows that the level of education among entrepreneurs in new technology-based firms was extremely high in Massachusetts compared to Sweden around 1980. From the *Level of Living Surveys* it is possible to obtain more consistent evidence on this point between 1968 and 1991. This evidence is reported in *Table 6.2*. The share of self-employed with a university degree is about half as large as the share among employees, and again the earlier tendency towards a much higher share of university trained people in the public sector is confirmed. Hence, the educational level of the self-employed is considerably below the level of employees. In the US the rate of self-employment declined in a similar fashion from 19 percent in 1950 to 9 percent in 1968. However, it has stayed at that level ever since. Thus the US economy has not since then demonstrated the typical pattern of a declining rate of self-employment as the economy progresses (Fölster, 2000).

[20] The keen reader will observe that the self-employment rate is comparatively low in the U.S. as well. Here it should be noted that, in general, the rate of self-employment tends to be negatively correlated with the per capita income level. Fölster (2000) calculate self-employment rates adjusted for per capita income. It then turns out that this income-adjusted self-employment rate is much higher in the U.S. than in Sweden and many other OECD countries.

Table 6.2 Share of Self-Employed and Employees with a University Degree, 1968, 1974, 1981 and 1991 (percent).

	1968	1974	1981	1991
Self-employed	1.8	2.6	1.8	5.4
Employees, total	2.6	4.4	7.9	10.0
Employees, private sector	N.A.	2.2	4.4	6.3
Employees, public sector	N.A.	10.5	11.4	14.0

Note: University degree is defined as having completed a university program of a duration equal to or exceeding three years.
Source: *The Level of Living Survey*, LNU (Institute of Social Research, University of Stockholm).

To identify the crucial incentives that will induce a university-trained individual to become an entrepreneur is of course a formidable task. First, it should be noted that these incentives are very much linked to the incentives for extant entrepreneurs to expand their business, since the expected return from transferring from being a salaried employees to becoming an entrepreneur is greatly affected by the possibilities for expansion. This will be dealt with in the next section.

Second, a highly regulated labor market gives increased power to insiders, thus raising the opportunity cost of transferring to self-employment. Most importantly, the Swedish Employment Security Act (*Lagen om anställningskydd* or LAS) stipulates the ”last in – first out”-principle in case of dismissals caused by redundancy. This implies that tenure at the present employer becomes relatively more important for labor security than individual skill and productivity. This fact increases the individual’s opportunity cost of changing employers or of leaving a secure salaried job to become self-employed. This is likely to reduce the spill-over of knowledge between industries and firms. Such spill-overs contribute to a high social rate of return on R&D and training. This problem may be exacerbated by the fact that such a large part of all industrial R&D is carried out in four firms (see section 2 above).

Third, the costs of the unemployment insurance are almost wholly paid by the government, and this is only available for employees, and a host of other social security related benefits are more favorable for employees than for the self-employed. Among these one could mention the unconditional right to leave of absence for studies, the right to demand to work part-time as long as the employee has children below age 10, and generous rules for trade union work at the employer’s expense.

With a low propensity to become self-employed it is more likely that academic scientists in their dealings with industry adopts what Stankiewicz (1986, p. 34) has called ”the assistance mode”. This mode differs sharply from the entrepreneurial mode of university-industry interaction. In the latter mode, the academic scientist personally assumes the ultimate responsibility for a technical development project, in most cases when attempting to develop and commercialize his or her own invention.

A number of arguments have been put forth in favor of the view that it is often beneficial that the academic increasingly adopts the role of the entrepreneur. Stankiewicz (1986, p. 85) mentions three reasons. First, in many cases it is likely that small business units are more innovative than large established companies – see Acs and Audretsch (1990) for evidence. Second, small newly-created companies have certain market advantages as regards new technologies, notably that at early stages they tend to develop in low volume/high price niches that are less attractive for large firms. Olofsson and Stymne (1995a) find that independent firms perform better than subsidiaries to large firms in Sweden, *ceteris paribus*. Moreover, there is a great risk that innovative technological ideas atrophy when they are severed from the original innovator/researcher prematurely. Those who performed the worst were those that were bought up by large firms. For an overview of more recent studies providing corroborating evidence, see Wennekers and Thurik (1999) and Carlsson (1999).

7. Incentives for Entrepreneurs to Expand

In the previous section we argued that the incentives for a salaried employee to become an entrepreneur instead may be weak in Sweden. Of equal importance is the fact that, given that somebody chooses to become an entrepreneur, he or she has sufficient incentives to develop the business to its full potential. In practice, the incentives for expansion and the incentives to become an entrepreneur largely overlap. In fact, the incentives to become an entrepreneur are largely determined by the incentives for extant entrepreneurs to expand. Hence, the factors dealt with in this section in large part apply to the previous section as well.

7.1 Some Evidence on the Willingness to Grow among Swedish Firms

A number of studies have documented a weak inclination to grow among small firms in Sweden. For instance, Lundström *et al*. (1993) find that merely 10–15 percent of the small firms expand employment. But do small and newly started businesses want to grow? In order to shed light on this question a number of studies are useful to look at. Aronsson (1991) found (i) a lack of motivation among the founders of the firms; (ii) expansion was considered too costly in terms of after-tax capital requirements; (iii) many owners perceived that expansion would increase the risk due to more staff and cumbersome administration.

Roughly a decade earlier Utterback and Reitberger (1982) reached similarly dismal conclusions in their comprehensive interview study of 60 firms based on new technology. Rickne and Jacobsson (1996) update the Utterback and Reitberger study to 1992, finding that their sample of firms contributed little to Swedish industrial growth in the 1980s.

Lundström *et al.* (1993), in a survey of the willingness to grow of small firms written for the so-called Lindbeck Commission, single out a low desire to expand as the factor most responsible for thwarting growth. They claim that 19 out of 20 small firms simply do not want to grow. NUTEK (1994, pp. 97–100) report that there are 50,000 firms in Sweden that can, but do not want to grow. In the same report they also cite evidence that back in 1987 there was survey evidence showing that 28 percent of the firms saw a potential for expansion in their own market that ”they did not intend to take advantage of.”

European Foundation for Entrepreneurship Research (1996) found that Sweden’s share of the 500 fastest-growing SMEs in the EU member countries in the 1989–94 period was lower than any other country with the exception of Italy.

Thus, it is easy to point out a number of studies indicating a lack of motivation to expand among small firms. According to Birch, Haggerty and Parsons (1995) a few very fast-growing firms, what they call *gazelles* create the majority of jobs in the US. Storey (1994) argues that the small group of high growth SMEs, what he names *flyers*, are the main job creators. In contrast**,** Swedish researchers (Davidsson *et al.*, 1994, 1996) find little support for the gazelle/flyer hypothesis. Instead they find that the SME contribution to net job creation is largely the result of many small start-ups.

This is likely to show up as a weak evolution of intermediate-sized firms. The pool of firms in the intermediate size classes is tapped through mergers, take-overs and, at least in some cases, expansion into the group of large firms. At the same time, a low willingness to grow should lead to few firms growing out of the very smallest size classes. Thus a gradual depletion of the pool of intermediate-sized firms is likely. Henrekson and Johansson (1999) find this indeed to be the case.

Hence, the findings of a large number of studies provide direct evidence of a low willingness to grow. This provides strong evidence in favor of the hypothesis that the incentives for entrepreneurs to expand their businesses have been low in Sweden. In the remainder of section 7 we will attempt to identify the likely factors contributing to this situation, and make comparisons with the US situation.

7.2 Taxation of Entrepreneurial Income

Several features of the pre-1990 Swedish tax system disfavored younger, smaller and less capital-intensive firms and discouraged entrepreneurship and family ownership in favor of institutional forms of ownership. During an extended period of time, for three decades beginning in the early 1960s, there were extreme differences in taxation for different sources of finance and owner categories: (i) debt was the most favored and new share issues the most disfavored; (ii) households/individuals were taxed substantially more heavily than other owner categories. For example, an investment yielding a pre-tax real rate of return of 10 per cent financed by a debt instrument meant that the tax-exempt institution received a real rate of return of 18.3 per cent after tax. In contrast, a household investing in a newly issued share with the same real rate of return the situation was very different: 10 per cent before tax became –3.7 per cent after tax. See calculations in Södersten (1984, 1993) and Davis and Henrekson (1997). Naturally, tax rules benefiting debt financing relative to equity financing and institutional relative to individual ownership systematically favored large, real capital intensive, publicly traded and well-established firms.

Studies such as King and Fullerton (1984) and Fukao and Hanazaki (1987) also show that Swedish tax policy was extreme in these respects. Furthermore, the Swedish tax system generally subsidized housing investment and has historically had very high marginal tax rates (above 90 per cent in the highest income bracket in the late 1970s) on individual income.

The 1991 tax reform entailed a substantial “leveling of the playing field” for different types of owners and sources of finance, although the leveling was in no way complete. However, the respite was short-lived as a 1995 act reinstated a higher tax burden on equity financing. Although the tax reform act of 1991 reduced the distortion between debt and equity financing, there remains a substantial differential today. Furthermore, the tax code still implies a much higher tax burden for investments financed with equity owned by households rather than by institutions. See *Table A.5* in the Appendix for further details.

Marginal tax rates have been and remain above 50 percent for employee income, which to a considerable extent limits owners' ability to extract wealth from their firms. Furthermore, employee stock options are highly penalized and were taxed at a rate of 68 percent in 1999. In contrast, in the US high wage income has been taxed at approximately 50 percent of Swedish levels since the early 1980s.

In order to analyze how the tax system impacts on entrepreneurial behavior it is not sufficient to focus on the taxation of individual owners of firms. To a large extent the return on entrepreneurial effort is taxed as wage income. First, large part of income accruing from closely held companies has to be paid out as wage income. Secondly, a great deal of the entrepreneurial function is carried out by employees without an ownership stake in the firm or possibly with stock options giving them a potential future ownership stake in the firm should the stock options be exercised.

In order to give an overall picture of the total rate of marginal taxation of labor income we display the total marginal tax wedge for three categories of workers since the early 1950s – see *Figure 7.1*. The total marginal tax wedge measures all taxes paid as a percentage of total labor compensation paid by the employer. The tax measure therefore includes mandatory social security contributions, direct marginal income tax rates and indirect taxes on private consumption (assuming that all income is consumed).

For industrial workers the marginal tax wedge doubled from 38 to 76 percent from 1952 to the late 1970s. For executives it rose from roughly 50 percent to more than 90 percent during the same period. The marginal tax wedge for the average white-collar worker peaked at 85 percent. Minor tax reforms in the first half of the 1980s reduced tax wedges slightly, in particular for the highest income earners. The 1990/91 tax reform resulted in a great fall in the marginal tax wedges for all groups. For all three categories the wedges decreased by roughly 10 percentage points. If we instead focus on the marginal take-home rate (1 – the marginal tax wedge) the change was by far the largest for executives; their marginal take home rate more than tripled from 9 percent in 1979 to 28 percent in 1992.

Figure 7.1 Total Marginal Tax Wedge for Industrial Workers, White-Collar Workers and Executives in Sweden, 1952–97 (percent).

Enclosed

Source: Du Rietz (1994) and new calculations supplied by Du Rietz.
Note: The marginal tax wedges are evaluated at mean earnings each year. ”Executive” is defined as an individual in the management group (below the CEO) in a private firm. The tax rate includes mandatory social security contributions paid by the employer or the employee, the marginal income tax and indirect taxes on private consumption (all income is assumed to be spent for private consumption purposes). Property taxes are excluded. The tax wedges for executives and average white collar workers coincide after 1990.

The comprehensive tax reform in 1991 simplified and lowered the income tax schedule. Since then local and regional taxes have increased by 2 percentage points and the central government tax rate has increased from 20 to 25 percent for higher incomes. Beginning in 1993 mandatory social security fees are levied on employees. These fees are 6.95 percent (up to an income of roughly SEK 280,000) and they are not subject to income tax. For low income earners a basic deduction is gradually phased out when income rises which creates an additional marginal effect. Therefore in 1998 the marginal tax rate for average income earners was typically 39.6 percent and for high income earners 59.7 or 56.7 percent, which is a substantial rise compared to the 30/50 rates in 1991. Including indirect taxation on consumption as we did in Figure 7.1, taxation of labor did not come down that much after all in 1991, because VAT of 25 percent was now also levied on most services. Tax wedges remained very high and they have increased in the last few years. In 1998 they were on the order of 75 percent.

Finally, it should be noted that the use of stock options to encourage entrepreneurial behavior among employees is highly penalized by the tax system, since gains on options are taxed as wage income when the stock options are tied to employment in the firm. Thus they are subjected both to mandatory social security (33 percent) and the marginal tax rate. Since the marginal tax rate is roughly 57 per cent this entails a total tax rate of roughly 68 per cent in 1999. The firm that issues the stock options does not pay the social security tax until the stock options are exercised, and hence the firm cannot calculate the cost of its stock option plan. The only way to convert part of the gains on stock options to income of capital taxed at 30 percent is to tax the assessed value of the stock options at the time of receipt as wage income. The subsequent gains will be taxed as capital. However, this scheme has two negative side effects: (i) it cannot be used by wealth constrained employees, and (ii) the employees face a greater risk since taxes are paid even if the gains may not exceed the tax payments.

No doubt, taxation of entrepreneurial income was very high in the US as well before 1980, although it was in no way comparable to the Swedish level. *Table 7.1* reports effective total tax rates (capturing both corporate and personal income taxes) by ownership category for four countries. Here we see that Sweden was the only country where more than 100 percent of the real return was taxed away in 1980 for households making corporate investments.[21] Following the comprehensive tax reforms in the early 1980s, the playing field for different types of owners and sources of financing was largely leveled in the US (Jorgenson and Landau, 1993).

[21]This high figure comes about even though it may be presumed that, within each country, owners choose an asset distribution that is reasonably optimal relative to the tax system they face. Note that Sweden also exhibits the most favorable treatment of tax-exempt institutions.

Table 7.1 Actual Effective Tax Rates for Four Countries in 1980 (at 10% real pre-tax rate of return and actual inflation rates).

	U.K.	Sweden	Germany	U.S.
Households	42.0	105.1	71.2	57.5
Tax-exempt institutions	–44.6	–51.8	6.3	–21.5
Insurance companies	–6.7	18.9	–3.8	23.4

Note: The figures in the table constitute the averages for each category, given its specific investment pattern in the respective countries. See also Table 7.3 above.
Source: King and Fullerton (1984).

Perhaps even more important are the differences between Sweden and the US in the taxation of wage income, capital gains and stock options. The highest marginal tax rate (federal tax) in the US was extremely high until the mid 1960s (91 percent) and remained at around 70 percent until 1981. Since then it has been lowered precipitously, reaching a bottom of 28 percent in 1988–1989. The upper threshold for the highest marginal tax rate was set very low – to annual incomes of approximately USD 30,000. During the 1990s the highest marginal tax rate has been increased; in 1999 it was 39.6 percent. Mandatory social security contributions of 15 percent are also low compared to Sweden. Thus high wage income, which often result from entrepreneurial efforts are taxed at marginal rates that are approximately half the Swedish level.

As a result of the 1978 Revenue Act, the capital gains tax was reduced from 49.5 to 28 percent. In 1981 it was reduced again, to 20 percent. In Sweden the capital gains tax is normally 30 percent since 1991, but for small closely held firms it is in effect 43 percent since half of the capital gain is taxed as wage income (no social security payments are levied). Between 1976 and 1990 the effective capital gains tax was 30–35 percent in Sweden if the stock had been held for two years or longer.

The Incentive Stock Option Law of 1981 in the US allowed the use of stock options as compensation by deferring the tax liability to the time when the stocks were sold rather than when the options were exercised. In general, there are (i) no tax consequences to the employee upon the grant or the exercise of the option; (ii) the employee is taxed at capital gains rates when the stock acquired upon the exercise of the option is sold after a specified holding period; and (iii) there is no deduction available to the employer.[22] This change in the law shifted the tax risk in the options back to the government, and thus accomplished two things: it increased the potential profit from the stock options and it allowed budget-constrained individuals to sell stocks whenever they chose to do so.

In summary, we have noted in this section that the taxation of entrepreneurial income has been far more beneficial in the US during the last two decades. This emanates from several sources: more favorable taxation of individuals as equity owners, lower rates of capital gains taxes and a more favorable tax treatment of stock options.

[22]See Misher (1984, p. 357).

7.3 The Crucial Role of Savings Incentives

The availability of equity financing is a critical factor for both start-ups and the expansion of existing firms. In general, the riskier the business, the greater the reliance on equity relative to debt financing. The existence of collateral notwithstanding, a sizeable infusion of equity is often a prerequisite for obtaining comprehensive credits. The reasons for this fact are straightforward: outside creditors have difficulties assessing the owner's competence and the future viability of the firm. A large infusion of equity from the owner(s) signals that the project has a high expected rate of return, which makes it easier for a bank to grant the required credit.

The smaller and newer the firm, the more difficult for outside financiers to assess the viability and profitability of the proposed investment project. Thus, *ceteris paribus*, small and newly established firms are more dependent on equity financing than large, well-established firms. Low private savings exacerbate the inherent problem caused by asymmetric information, i.e., that the potential entrepreneur and his/her close associates have better information than external (often institutional) financiers about the entrepreneur's ability to render the proposed project profitable.

There is substantial scientific evidence supporting the idea that the individual wealth position has important effects for the probability of becoming an entrepreneur and for the propensity to expand. For example, Lindh and Ohlsson (1996, 1998) find that the likelihood of starting a business in Sweden increases significantly among those who receive an inheritance or a lottery gain.[23] They also find that a more unequal wealth distribution covaries positively with the share of self-employed. Similar evidence is found for the US by Holtz-Eakin, Joulfaian and Rosen (1994). In summary, there is overwhelmingly strong empirical evidence pointing to the importance of personal assets for the degree to which entrepreneurial talent is exploited. In fact, given the evidence of an often binding equity constraint, support is lent to Knight's (1921) view that risk bearing is one of the essential ingredients to entrepreneurship. This is in contrast to Schumpeter (1934) who argued that the functions of the entrepreneur and the risk-bearing capitalist can be separated in the modern economy.

One reason why greater wealth increases the likelihood of starting a business or expanding a risky activity is that the degree of risk aversion is likely to be negatively correlated with wealth (Kihlstrom and Laffont, 1979). Furthermore, it should be noted that Hutchinson (1995) argues that small firms have a lower efficient debt/equity ratio than large firms. Portfolio investors generally only have to be concerned with systematic risk, since specific risks can be diversified away. This does not apply to owners of small businesses, since they have a large part of their financial wealth as well as their human capital tied up in their own firm. These considerations call for a long-run survival objective resulting in a lower debt/equity ratio than in firms with a highly diversified ownership, where it is rational to choose a debt/equity ratio that maximizes the firm's market value. This tendency may be further strengthened if small firm owners desire independence in its own right. This latter desire also decreases the willingness to accept new equity capital from outsiders, since it reduces the owner's ability to remain independent and in control of the company.

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[23]Blanchflower and Oswald (1998) arrive at the same conclusion in an empirical analysis based on British data.

In the classical writings on entrepreneurship (Knight, 1921, Schumpeter, 1934; Kirzner, 1973; Baumol, 1990) it is assumed that entrepreneurial talent/business acumen is unevenly distributed in the population. In that case there does not exist an objective probability distribution governing business risks, and attitudes towards risk cannot be the main factor determining who becomes an entrepreneur. We subscribe to the classical view that entrepreneurial talent is unevenly distributed. In that case policies that increase the likelihood that the entrepreneurially talented are not equity constrained are likely to be beneficial. The only really efficient means of increasing this likelihood is to pursue economic policies that promote private wealth accumulation across the board, and in forms that do not preclude that the wealth may be used as equity in entrepreneurial ventures (see discussion below).

Welfare state provisions are likely to remove a number of savings motives as long as the state's commitments are considered credible by the general public. Compensation paid by the social insurance often discourages saving above and beyond the mechanisms discussed above. For instance, Hubbard, Skinner and Zeldes (1995) find that social assistance discourages saving because it is usually conditional on the individual not having any assets. Other studies find negative effects on precautionary saving of more generous unemployment insurance – see, for example, Engen and Gruber (1996). Countries like Sweden with large transfer programs tend to have pay-as-you-go pension systems. These tend to lower national savings and investment compared to funded systems (Feldstein, 1996). Thus, in the Swedish welfare state system, total savings motives are much reduced. This has the unfortunate side effect of decreasing the supply of entrepreneurial capital.

Furthermore, the real rate of taxation on financial savings was extremely high in Sweden for individuals before the 1990/91 tax reform. On interest income it typically exceeded 100 percent during the 1970s and 80s. Even today the rate of taxation on saving and wealth accumulation is very high in Sweden. First, the very high tax rates on wage income makes it very difficult to save a substantial portion of income that can subsequently be used for equity financing. Second, total taxation on accumulated wealth is high (1999): 30 percent on the nominal current return, 30 percent nominal capital gains tax and 1.5 percent wealth tax on real estate, interest-bearing instruments and prime stock listed on the Stockholm Stock Exchange (the so-called A-list).[24] The wealth is levied on all assessed wealth exceeding 900,000 kronor for the household.[25]

Also, given the level of wealth or national savings, the composition of national savings is not neutral in its impact on entrepreneurship and small business development. The manner in which savings is channeled to various investment activities influences the type of business organization that can obtain credit. Pension funds, for example, are less likely to channel funds to entrepreneurs than business angels or venture capital firms. This is of course particularly true in the case when pension funds are subject to legal restrictions on the scope of their investments. Hence, if the government forces individuals to carry out most of their savings through a national pension fund system, small business credit availability will suffer relative to an alternative policy and institutional arrangements that allow for greater choice by individuals regarding their savings and investments. In the Swedish case, institutionalized saving in the form of life

[24]On 80 percent of the market value.

[25]On a stock market investment yielding a real rate on return of 10 percent before tax, the real rate of return after tax is 5.3 percent for households at an inflation rate of 3 percent, a dividend ratio of 3 percent of the market value of the stock, a holding period of 5 years and full wealth tax.

insurance policies, where the funds are by definition withdrawn from the non-institutional venture capital market, was highly favored. The high marginal taxes and full deductibility created and still creates a strong incentive for individuals to save in the form of pension plans. This has channeled financial savings to large institutions and reduced the supply of equity financing for potential entrepreneurs and extant small businesses.

As a result of weak savings incentives due to a high rate of taxation and extensive welfare state, the savings rate of Swedish households fell to a very low level in comparison to other OECD countries. The data presented in *Table A.6* in the Appendix show that household savings as a share of disposable income has typically been in the 2–3 percent range since 1970 as compared to typical rates in the range of 10–20 percent in most other OECD countries. As a result of the consistently low household savings rates in Sweden for several decades, individual financial wealth is low by international comparisons. Such comparisons can only be made for a limited number of countries, but data presented by Pålsson (1998) based on OECD's *Financial Statistics* indicate that financial wealth per capita in Germany, Canada, France, Italy and Japan was generally 3–4 times larger than in Sweden by the mid 1990s. In the US it was approximately six times larger than in Sweden.

The combination of low private savings and an extremely even distribution (Lindh and Ohlsson, 1998) of these low savings implies that few people either themselves or from their associates, friends or relatives are able to raise the requisite equity to realize their business projects. This deficiency may to quite an extent be substituted for by a well functioning venture capital (VC) market. This is the subject to which we now turn.

7.4 The Role of the Venture Capital Industry

7.4.1 The United States

Before the 1980s the development of a VC industry in the US was severely hampered by two pieces of legislation passed in 1969.[26] First, the capital gains tax was sharply increased to 49.5 percent. Secondly, tax liabilities on employee stock options were imposed when the options were exercised rather than when the stock was sold. This reduced their incentive effect. If the employee wished to exercise the options and hold onto the stock, this was now a riskier venture, as a fraction of the stock value was paid in the form of taxes to the federal government before the ultimate stock value was known. Moreover, it might be difficult for the employee to finance the taxes he/she needed to pay when exercising the options. Most likely, part of the portfolio would need to be sold to finance the tax obligations – this would reduce the potential profit from the stock by reducing the number of shares in the portfolio. If the stock itself was not liquid, the cash-constrained employee might not be able to afford to exercise the options at all.

The subsequent transformation of the venture capital industry, beginning around 1980, took place against the backdrop of the poor performance of the SBICs (see section 4.2), including their failure to function as an effective bridging institution between universities and industry. The transformation to a new regime dominated by the limited

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[26]Much of the discussion in this subsention regarding the US is based on Fenn, Liang and Prowse (1995) and Zider (1998).

partnership, a central feature of the US venture capital industry today, took place in the late 1970s and early 1980s. The main elements of this transformation were as follows:

1. The reduction of the capital gains tax in two steps to 28 percent in 1978 and to 20 percent in 1981.

2. In 1979 the Department of Labor changed the "prudent man" provision of The Employee Retirement Income Security Act (ERISA). That provision had, in effect, prohibited pension fund investments in high risk securities issued by small or new companies and venture capital funds. The Department of Labor now ruled that such investments were permissible provided that they did not endanger an entire portfolio. The adoption of this provision led to an immediate response in the market for small-company stocks and the new issues market as pension fund managers exploited these newly-available high-yield opportunities. Indeed, public pension funds became the fastest growing and eventually largest investor group in the private equity market, with roughly 50 percent of the total by 1994 (Fenn *et al.*, 1995).

3. The stock option legislation of 1981 that made it possible to defer the tax liability to the time when the stocks were sold rather than when the options were exercised.

The collapse of the SBIC and the remarkable growth of the venture capital industry, in which the professionally-managed limited partnership served as the dominant institution, was made possible by these reforms. The genius of venture capital firms as a financial institution is that they converted high risk opportunities to a more acceptable risk level through portfolio diversification. This involved many changes in the regulatory environment, tax structure, *et cetera*. The basic rationale of these changes has been to align the incentives of the three agents – investors, venture capital firms and new high tech startups – in a way that accommodated high risk and, at the same time, minimized opportunity for insider trading, moral hazard and so forth.

The US venture capital industry experienced vastly-accelerated growth in the 1980s. The venture capital stock increased eightfold, from USD 4.5 billion in 1980 to USD 36 billion in 1990. This growth was driven not only by the changes in tax and regulatory environment just described, but also by the reported successes of several partnerships that had been established in the 1970s. "These partnerships were, by the late 1970s, reporting annual returns in excess of 20 percent. These high returns attracted the attention of institutional investors, especially pension funds, many of which had experienced sluggish public equity returns throughout the 1970s." The growth in the venture capital stock was also accompanied by a rapid growth in the proportion of the stock that was managed by partnerships. "In 1980, partnerships managed only 40 percent of the $4.5 billion in outstanding venture capital, while venture capital subsidiaries of financial and industrial companies (including bank-affiliated SBICs) managed 31 percent and independent SBICs 29 percent. By the late 1980s, the proportion of capital managed by partnerships grew to more than 80 percent, largely at the expense of independent SBICs, which saw their share of capital fall to virtually nothing." (Fenn *et al.*, 1995, pp. 11–13). Following a slump in 1990–91 the VC industry boomed in the 1990s. Annual commitments to VC funds increased from USD 1.7 billion in 1991 to a record 17.2 billion in 1998.

The role of venture capital in successfully bringing companies to maturity (i.e., to their IPOs) cannot be overstated. If we consider the IPOs that took place from 1991 to 1993, 45 percent of all new IPOs during this period were venture capital backed. However, the significance of this large venture capital role is revealed when we examine the specific sectors in which they played a role. If we consider the venture-backed IPO firms for the period 1991–1993, 65 percent of these firms were in the computer-related and medical and health sectors. By comparison, these sectors accounted for only 26 percent of the firms that had gone to their IPOs without prior venture capital backing. The firms without prior venture capital backing were concentrated in manufacturing and wholesale and retail trade. This distribution is strongly consistent with the view that the venture-capital backed firms were concentrated in the high tech, research-intensive sectors, sectors where American universities were extremely active.

What were the distinctive features of the venture capital firm, post-1980–81? It is useful to think of the venture capital firm as a financial intermediary with two sets of relationships, between potential entrepreneurs in search of capital to finance their innovative, high risk projects, on the one hand, and outside potential investors, now including pension funds, corporations, endowments and foundations, insurance companies, universities, and wealthy individuals, in search of (risk-adjusted) higher returns for their investment portfolios, on the other.

Within the limited partnership institutional investors enter into an agreement with a venture capital firm in which they are the limited partners, and the senior managers of the venture capital firm act as general partners. The lifetime of such partnerships is generally ten years, during which time the limited partners, as a condition of their limited liability status, are expected to refrain from any active role in the management of their investments. The usual arrangement is one in which the limited partners supply 99 percent of the capital whereas the general partners supply 1 percent. In the division of the capital gains, the general partners receive 20 percent and the limited partners 80 percent. The general partners, moreover, receive an annual management fee of between 2 to 3 percent of the total committed capital.

The first responsibility of the venture capital firm, after a partnership has been established, is to screen project proposals. This sorting process is obviously critical, since an outsider can hardly be – or become – as well informed about the true situation as the managers of the firm seeking financial support, and at least some degree of dissimulation is to be expected. Due diligence on the part of the venture capitalist at this point, and careful monitoring of the firms receiving equity commitments, are obviously vital preconditions for success, especially since little information is ordinarily available for firms that are not yet publicly traded. A frequently cited statistic is that the venture capital firm provides funding for about 1 percent of the business plans that are presented for their consideration. For firms that are supported after the screening process, the venture capital firm will typically play an active role in the day-to-day decision making process as well as shaping longer-term strategy. Venture capitalists sit on boards of directors, play a prominent role in recruiting key players, and in replacing them when, in their judgment, they are not performing satisfactorily. The leading figures in the startup firm are paid relatively modest salaries and their commitment to the financial success of the firm is established by the receipt of stock options and the prospect for large capital gains if the firm proves to be successful.

An extremely important feature of control in the hands of the venture capitalist is that financial support is doled out in stages, with no more money made available than is necessary for the firm to reach the next stage, so that there are multiple opportunities to evaluate performance at each stage and to terminate support if performance is deemed to be unsatisfactory. The arrangement is one that is calculated to discourage opportunistic behavior and to strengthen commitment to the firm's long-term prospects for success, or at least to a successful IPO that will create a profitable payoff to the VC firm.

At the same time, there are interesting parallels between the ways in which the VC firm discourages opportunistic behavior on the part of entrepreneurial firms in which they are investing, and the ways in which the limited partnerships constrain the behavior of the VC firms in which they have invested. First of all, the VC management receives 20 percent of the profits from the portfolio (far beyond the proportion of her initial investment, which is usually about 1 percent). Hence, a strong direct incentive is in place to encourage the venture capital firm to ensure the success of the funded firms. This provides an incentive very similar to stock options that a funded firm's managers receive. Second, limited partnerships are typically undertaken for a ten-year period, at which time the partnership is dissolved and the venture capital firm must seek new sources of investment funds. At this point its most critical asset is its established reputation, which will, presumably, reflect its recent track record.

Since, moreover, a mature VC firm may have 20 or more limited partnerships, each of eight to ten years duration, it must have recourse to establishing new partnerships, or renewal of old partnerships, every few years. Hence, the venture capitalist's performance is being continually subjected to market tests. The continual need of the VC firm for investible funds, combined with the finite life of the limited partnership, serve as powerful forces to limit opportunistic misbehavior on the part of the VC firm. Historically, such behavior has included devoting insufficient attention to monitoring its clients, reserving the potentially most profitable opportunities for themselves or their associates, and charging excessively high fees for their managerial services.

Venture capitalists would have far fewer companies to finance if it were not for *business angels*. VC firms hardly ever participate in the earliest stages of the development of new high tech concepts that eventually make it to the stage of successful commercialization. Venture capitalists are unlikely to be interested in a proposal until it is possible to see specific trajectories of activity leading to commercialization, i.e., once the chances of failure have been reduced. The earliest financial support is likely to come from affluent friends or relatives or, increasingly, wealthy individuals who have already become rich from similar earlier ventures. Hence, this so-called angel capital can essentially be divided into two classes, reflecting the different ways in which the moral hazard problem is dealt with.

If the original funds come from family or friends, kinship ties play a large role in preventing the firm founder/manager from squandering the money. If the original funds come from business people, moral hazard is reduced by screening (reputation, earlier business record) and by very close monitoring of the firm's progress. This procedure is similar to that employed by venture capitalists in the later stages of a firm's evolution.

The markets in which angels deal are entirely informal in nature, involving "informal matchmakers" such as lawyers or accountants who have extensive business connections. Knowledgeable insiders insist that the scale of angel activity is huge, and there is extensive anecdotal evidence to support that assertion – see Zider (1998). A key ingredient is that, in return for undertaking large financial risks, there should be some prospect of earning high rewards – *after* taxes. As a result of the informal nature of these markets, there are no systematic or reliable data on these activities. By some estimates, the angel capital and informal private equity markets are several times larger than the organized private equity market, and angel capital in particular is regarded as a critical source of seed capital (Fenn *et al.*, 1995, p. 3).

7.4.2 Sweden

The development of a VC industry in Sweden is of recent vintage, and as we will see it differs from its US counterparts in many respects. Utterback and Reitberger (1982) found a dramatic difference as far back as around 1980 between Swedish and US new technology-based firms. Ample supplies of equity capital from private sources outside the firm gave the US firms much lower debt equity ratios, which allowed them to grow faster. They also point out that in those days the large – highly tax favored – firms played the role ”that is more generally filled by venture capitalists and private sources of equity in the United States” (p. 104). To the extent that there is reason to believe that large firms are less suitable for assuming this role than venture capitalists, the performance of the new firms suffered.

During the 1980s a VC industry began to develop in Sweden as well, but at least until the mid 1990s these enterprises did not supply very much capital for the establishment of new firms or in the first critical phase of expansion in the firm’s development. In this context, NUTEK (1994, p. 113) has stated that “…capital [from the VC enterprises] goes primarily to the large firms.” The public sector has tried to offset the lack of private venture capital by introducing numerous support schemes. In 1998 there were more than 140 such schemes that can be utilized by Swedish firms. There is no coordination of the different schemes, and the net effect is far from clear (Landell *et al.*, 1998). Moreover, the major portion goes to firms undergoing expansion. Only a very small portion goes to the start up of new companies as seed financing. More systematic evidence on this point is provided by Isaksson (1998) and Braunerhjelm (1999). As shown in *Table 7.2* no more than 8 percent of the VC in Sweden in the late 1990s went to the seed and early expansionary phases. Over 50 percent of the VC was channeled to firms considered to be in the mature phase. Landström (1993) specifically looked at the behavior of business angels. He found that only 25 per cent of the business angels’ investments were seed capital in the early 1990s compared to more than 50 per cent in the US in the same period. At the same time, Lindström and Olofsson (1998) show that, in new technology-based firms that actually succeeded, business angels were instrumental.[27]

The above data reflect different uses of the term venture capital on both sides of the Atlantic. In the US, those that track the private equity market define venture capital as ”a professional, institutional ... limited partnership that generally manages over USD 20 million in assets and invests in privately held companies” (Riekert, 1999, p. 3). This definition excludes SBICs, angel investors as well as corporate investors unless they are partnered with a professional VC firm. In contrast, in Europe, venture capital is generally defined as the entire private equity market. Our interest lies in private equity that bankrolls risky ventures, which is a functional rather than an institutional classification. Neither the statistics in the US or Sweden are reported according to this classification. These problems make any comparison of the level of VC funding

[27]One must take these comparisons with a grain of salt, however. The interpretation of what constitutes seed capital may vary across countries and across the Atlantic.

difficult. However, even with these considerations in mind, a contrast of the levels of funding in the two countries is illuminating.

Table 7.2 Swedish Venture Capital Firms – Number, Size and Strategies, 1998.

	Investment phase				Total
	Seed	Early growth	Expansion	Mature phase	
No. of VC firms	5	22	22	8	57
Capital available	320	3,017	18,269	24,245	45,841
Capital available for each phase (%)	1	7	40	53	100
Capital invested	256	1,351	4,935	7,715	13,717
Share of capital available invested in each phase (%)	0.1	2.9	11	17	31
No. of investee firms	32	215	286	83	616
Share of total (%)	5	35	46	13	100

Note: All amounts are expressed in millions of Swedish kronor. The figures include all large venture capital firms (both privately and government owned). However, some small firms may be missing, which is likely to give a downward bias to the assessed size of the venture capital market in Sweden.
Source: Isaksson (1998).

It should be noted that according to two new studies – Isaksson (1999) and Karaömerlioglu and Jacobsson (1999) – there has been strong growth in the Swedish VC industry during the latter half of the 1990s. With more complete data Karaömerlioglu and Jacobsson (1999) find that the amount of VC capital in Sweden relative to GDP is the third highest in Europe after the UK and Ireland, and cumulative VC funds relative to GDP had reached 50 percent of the US level in 1998, up from 25 percent of the US level in 1983.[28] The amount invested in early phases is also found to be larger than in previous studies (11.6 percent in 1998). Thus, the Swedish VC industry is growing at a rapid rate, and by 1999 one cannot claim that lack of financial resources for VC purposes is the main problem. However, compared to their American counterparts Swedish VC firms lack in competence. Isaksson (1999) reports that at most one fifth of the firms that have received VC investment perceive that the VC firm has offered significant inputs in terms of strategic advice, networks and recruitment of key personnel. Similar results are reported for the biotech industry by Rickne (1999) and for a study of the IT industry by E-chron (1998). This latter finding is of course greatly disquieting, since competence rather than money is the crucial input provided by successful American VC firms (Zider, 1998).

In the long run it is also likely that a serious impediment to the growth of the VC market will come from the demand side, i.e., that there may be a lack of potential projects with a development potential due to the factors discussed throughout this study. In this context it is important to note that Gompers and Lerner (1999) find that a crucial factor behind the VC industry growth in the US is that the decrease of capital gains tax rates boosted demand for venture capital as more workers now had an incentive to become entrepreneurs.

[28]It should be noted, however, that Braunerhjelm (2000) is very skeptical of the Karaömerlioglu and Jacobsson study. He claims that they both exaggerate the size of the Swedish VC market and the degree to which funds are channeled to early investment phases.

In terms of taxation, VC firms in Sweden are at a disadvantage relative to other firms. Dividends are taxed threefold: at a rate of 28 percent in both the firm itself and the venture capital firm and at 30 percent at the owners' level. This high tax burden on VC firms is likely to endanger the future supply of VC capital from firms residing in Sweden. Yet another problem is that, according to the Swedish tax law, business angels that take active part in the management of the firms in which they invest are taxed at a higher rate. Active owners of unlisted firms are taxed at higher rates than passive owners. This implies that dividends above a fairly moderate threshold (some 9 percent) will be taxed as wage income, and half of the capital gains tax will also be taxed as wage income and not as capital income (up to capital gains of approximately SEK 3.5 million in each instance). Likewise the income of the general partners in VC firms will be taxed as wage income. See Braunerhjelm (1999) for details. Thus, the high rates of taxation of high-tech entrepreneurs, general partners of VC firms and the owners of the VC firms or the business angels result in a substantial reduction in the after-tax return on activities typical for VC firms in the US.

By contrast, in the US investments by venture capital firms are taxed at low rates. If the holding period exceeds five years, the total tax rate is 14 percent, and since 1997 the capital gains tax from sales of shares in unlisted companies may be deferred indefinitely, if the profits are reinvested within 60 days. Similar systems were introduced in the UK in the early 1990s (The Enterprise Investment Scheme [EIS] and the system of Venture Capital Trust [VCT]). These systems give full tax exemption on dividends from unlisted companies and capital gains are tax exempt if the holding period exceeds five years, or if the profits are reinvested in unlisted shares (Braunerhjelm, 1999).[29]

In summary, we note that around 1980 the legal framework in the US became highly conducive to the development of a sophisticated VC industry. The industry itself has then designed a number of efficient incentive schemes that helps to overcome many inherent conflicts of interest between innovators, entrepreneurs, fund managers and investors. In Sweden, on the other hand, the legal framework facilitating the emergence of a highly competent VC industry has not been in place. As a result, the Swedish VC industry has not been able to play the same crucial role in bridging the gap between universities and industry as its US equivalent, although there are signs that the situation has begun to improve.

7.5 The Functioning of the Labor Market

Swedish labor organizations successfully pursued egalitarian wage policies from the mid 1960s until the breakdown of centralized wage bargaining in 1983 (Hibbs, 1990; Edin and Holmlund, 1995). The strength of Swedish labor organizations and the centralized nature of the wage-setting institutions appear to have facilitated a remarkable compression of the wage structure during this period, judging by cross-country comparisons of wage inequality trends (Davis, 1992). To the extent that Swedish wage-setting developments drove up wages in the lower tiers of the distribution relative to outcomes under other institutional arrangements, they reinforced the concentration of economic activity in larger, older and more capital-intensive firms

[29]Furthermore, tax deductions of 20 percent are granted for investments up to GBP 100,000 if the holding period exceeds five years.

and sectors. This inference follows from the ample evidence that, ordinarily, wages rise with the age, capital intensity and – especially – the size of employers (e.g., Brown and Medoff, 1989; Davis and Haltiwanger, 1999). In sharp contrast to the evidence for the United States, Albæk *et al.* (1995) find that the employer size-wage effect is negligible in Sweden, which gives credence to the view that egalitarian wage policies have raised the relative labor costs of smaller businesses.

Centralized wage-setting institutions may also disadvantage smaller businesses and businesses aiming at promoting an entrepreneurial culture within the firm by implementing standard rate compensation policies that closely tie wages to easily observed job and worker characteristics such as occupation, education, experience and seniority.[30] This inference follows from evidence that larger employers evince a greater preference for standard rate compensation policies. This suggests that any efficiency losses associated with the imposition of standard rate compensation policies are greater for smaller employers. Since smaller and more entrepreneurial employers show greater preference for flexibility and idiosyncrasy in wage determination, so standard rate compensation policies are more costly to adopt. This suggests that centralized wage-setting institutions affected the industrial structure and the organization of business activity in Sweden most likely to the detriment of small firms, flexible organizations and firms wanting to remunerate entrepreneurial behavior within the firm (see Davis and Henrekson (2000) for evidence).

Another feature of the labor market that is important in our context is the existence of job security mandates. The Swedish Employment Security Act *(Lagen om anställningskydd* or LAS) from 1974 contains four types of regulations which have a significant impact on the functioning of the labor market. These are rules about the period of notice of dismissal, the requirement of objective grounds for dismissal, time limits on probationary employment, and rules about the order of dismissals. Of special interest for the issues in this study are the rules governing the order in which different employees are to be dismissed.

But are strict employment security provisions more harmful for smaller and potentially fast-growing employers? The likely answer is yes. One reason involves the gains from efficiently matching heterogeneous workers to a variety of tasks and positions. As an employer learns about a worker's abilities over time, or as those abilities evolve with the accumulation of experience, the optimal assignment of the worker to various tasks is likely to change. The scope for task reassignment within the firm is likely to rise with firm size. In an unfettered labor market, optimal task reassignment often involves mobility between firms, and such mobility is more likely when the initial employment relationship involves a small business. Thus, any inefficiencies induced by LAS in the assignment of workers to tasks are likely to be more severe and more costly for smaller firms. Furthermore, and for obvious reasons, one bad recruitment is proportionately more costly to bear for a small firm.[31]

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[30]Blanchflower and Freeman (1992) and Blau and Kahn (1996) provide evidence that unions and other centralized wage-setting institutions compress wages among observationally similar workers by promoting standard rate compensation policies.

[31]It should be pointed out that even if Sweden's labor security rules have discouraged the emergence of new firms, evidence of this would not show up in an interview study because of the selection bias, i.e., the companies that were never formed could not take part in the study.

Other evidence is also consistent with the view that employment security provisions fall more heavily on smaller firms and some other classes of firms. In the United States, both the rate at which workers separate from jobs and the rate at which employers destroy job positions decline with the size, age and capital intensity of the employer (Brown and Medoff, 1989; Davis *et al.*, 1996). These patterns in worker separation and job destruction rates suggest that any costs imposed by a regulation similar to the LAS are likely to fall more heavily on younger, smaller and less capital-intensive employers and to distort the distribution of employment towards industries characterized by more stable establishment-level employment and longer job tenures.

There are also theoretical models finding a likely negative growth effect of employment protection. Hopenhayn and Rogerson (1993) emphasize that the reallocation of labor from old and declining to new and dynamic industries is slowed down. Saint-Paul (1997) develops a model to analyze the implications of firing costs on international specialization. He finds that countries with a rigid labor market will tend to produce goods at a late stage of their product cycle with a relatively stable demand, while it is more advantageous to produce new goods where demand is more volatile in countries with a more flexible labor market.

What the new research, sometimes called "the new view of the labor market",[32] suggests is that, in order to understand in what ways labor market regulations impede growth and employment, one has to analyze the effects on the individual firm. For many firms – and in particular for firms with a good growth potential in terms of productivity and employment – there is a great need for flexibility both to increase the number of employees in response to rising demand and likewise to be able to rapidly contract when demand falls short of expectations. The road from small to large for a gazelle is far from straight, since the activities of new firms in particular are subject to genuine uncertainty. If, under such circumstances, rules are imposed that reduce the firms' leeway to rapid adjustment one should expect both a lower willingness to expand in general and that fewer firms, despite a good product or a viable idea, grow from small to large in a short period of time.

In addition, a strictly applied "last in – first out" principle in case of redundancies implies that tenure at the present employer becomes relatively more important for labor security than individual skill and productivity. This fact increases the individual's opportunity cost of changing employers or of leaving a secure salaried job to become an entrepreneur (compare section 6). This is likely to reduce the spill-over of knowledge between industries and firms. Such spill-overs contribute to a high social rate of return on R&D and training. This problem may be exacerbated by the fact that industrial R&D is so highly concentrated in a handful of firms.

The analysis in this subsection has mainly emphasized that small firms are disproportionately hit by labor market regulations. However, it is likely that the analysis largely carries over to entrepreneurial firms in general. First, it should be noted that most firms start out small, and it is mainly the entrepreneurial firms that grow into medium-sized and large firms. Second, labor market inflexibility is an element that is inherently inconsistent with the flexibility, nonhierarchical structures, networking and labor mobility across firms distinguishing an entrepreneurial business culture of the Silicon Valley type (Saxenian, 1994).

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[32]See Davis, Haltiwanger and Schuh (1996) for an overview of this research.

7.6 Summary and Conclusions

In this section we have documented a weak willingness to grow among small firms in Sweden. A number of likely factors contributing to this state of affairs have been identified: historically and currently a high tax burden on entrepreneurial income, weak incentives for private wealth accumulation, particularly in forms that promote the supply of venture capital, an unfavorable tax and regulatory system for the VC industry, inflexible wage-setting arrangements rendering the encouragement of entrepreneurial behavior more difficult and strict job security, which is likely to be most detrimental for small, entrepreneurial firms with a high growth potential.

8. Incentives within the University System

Even if all other elements favoring academic entrepreneurship are at hand – such as conditions encouraging human capital investment, entrepreneurship and firm growth – results in terms of economic performance are likely to be meager, unless the right incentive structure is in place within the university system itself. This structure is of course highly multidimensional. A number of factors are likely to be crucial: (i) the degree to which up to date research results and methods are communicated to students as part of the regular instruction and whether the internal reward systems, be they monetary or nonmonetary, encourage excellence in both teaching and research; (ii) to what extent and how quickly curricula are adjusted to changing demand; (iii) the efficiency with which research budgets can be reallocated across disciplines in response to changes in commercial potential; and (iv) the incentives in a broad sense for faculty to interact with industry in economically beneficial ways. Factors (i)–(iii) will be dealt with in section 8.1 and the fourth factor will be treated in section 8.2.

No doubt, as explained at length by Rothblatt, Eliasson and Thörn (2000), universities are currently undergoing radical changes due to the fact that the old linear model, in which research trickles down to close the gaps between scientific discoveries and commercial applications, is now obsolete in certain key high tech sectors of the economy. The new arrangements, rather, are characterized by simultaneous activity, in which university-based teams are often set up precisely for designing a new product or improving the performance of an existing product (such as the integrated circuit). In this process discovery and application are now likely to be conducted at the same time. This will often involve direct collaboration with researchers and other specialists from industry as well as academic entrepreneurship. Rothblatt *et al.* note that this:

> has profound implications for universities and is conceivably one of the most radical alterations in all of the history of universities with respect to internal governance and self regulation. It challenges virtually every value, no matter how loosely held, implicit in the university's corporate identity as a collection of free professions...The university's search for revenue involves close relations with a sector of activity highly commercial in character designed for constant change under market conditions.

These concerns are reinforced by a recent careful study by Cohen, Florida and Goe (1994) in which the authors concluded that 19 percent of American university research is now conducted in programs that involve close, direct links with private industry.

In this study we have been primarily interested in the role played by universities as producers and transmitters of economically useful knowledge. The efficiency of different systems in fulfilling this role will vary. It seems safe to assume, however, that the efficiency will be higher if the system can be made to be more responsive to the economic needs of society. At the same time, of course, improving that responsiveness raises some profound issues of university priorities and governance of the sort referred to by Rothblatt *et al*.

8.1 Incentives for Research and Teaching

We begin by examining the American system in this respect. American universities are highly decentralized and intensely competitive. The decentralization implies that American universities retain a high degree of autonomy in their own affairs, thus pursuing opportunities for solving their own problems and for building upon their own unique strength and aspirations. Competition takes place along several dimensions: (1) competition for students among universities (including competition between private and state institutions), and at the graduate level among professors for the best students; (2) competition among universities for the best professors in a cultural and economic context where the mobility of professors is very high; (3) competition among professors for research support, which provides released time from teaching and access to research assistants, equipment and other requisite materials. A university that can offer high quality teaching in fields for which there is a strong demand in labor markets can also charge higher tuition fees, which also leads to higher revenues. This has been, historically, a powerful force in driving the competition among American universities. It is readily and generally observable in the community of American business schools today, but most especially in the current fierce competition to claim "leadership" in the field of electronic commerce.

As a result of the decentralization and the competition that takes place at so many levels, the US university system has become more responsive to the economic needs of society. In order to justify high tuition fees, students expect a high degree of relevance of the offered curricula. Likewise, professors who are dependent upon research grants in order to be able to pursue a successful research career, are more likely to adjust their research interests to fields that have a high current or expected future economic value.

Because of the decentralization and the competition among universities for professors who are visibly productive, the system tends to result in greater salary dispersion, where salary differences are likely to reflect the economic relevance of the professor's field of specialization (and therefore opportunity costs outside the university) as well as his/her higher achievements as a researcher and teacher. Generally, professors active in research prefer to teach at the graduate level, where course content is closer to research at the frontier of the discipline and where graduate students may come to play crucial roles in advancing those frontiers. Rosenberg (1999, 2000a) presents evidence showing how rapidly entirely new fields as well as major breakthroughs in established fields have been introduced into the curricula at leading US universities over the years. In the US, therefore, universities can, to a considerable degree, be regarded as endogenous institutions which tend to be characterized by an impressive capability, as well as a strong incentive, to adjust to changes in the outside environment.

In these respects the Swedish and, for that matter, the corresponding systems in most other European countries, differ substantially from the American university system. Traditionally, European professors have, by and large, been civil servants working within the public sector, which implies that a high degree of national uniformity has been imposed on pay schedules, rules for promotion and recruitment and other working conditions. Essentially, this is still the case also in Sweden, although it should be noted that greater flexibility in terms of pay schedules has been introduced during the 1990s. Nevertheless, the Swedish system differs from the American system in a number of important respects that are likely to impact unfavorably on the inclination to introduce changes in curricula and research orientation in order to accommodate the changing needs of the economy.

First, there is a greater separation of teaching and research in Sweden. The bulk of undergraduate teaching at Swedish universities is carried out by lecturers who do not do research. There is reason to believe that this slows down the pace at which important new research findings are integrated into the curricula. If there are strong complementarities between teaching and research, teaching is likely to benefit when it is delivered by research-oriented faculty. Also, research is probably better when it is carried out in association with advanced students in an intellectual environment that encourages and rewards informed criticism.

Second, in contrast to the US, the Swedish university system is highly centralized. The central government is the body that grants charters to universities, and in practice it also decides on the rules of admittance and the size of a university (through budgetary allocations). Due to this strong influence from the central government there is also much less leeway for individual institutions to allow remuneration to track an individual professor’s research and teaching performances more closely and to vary the level of remuneration according to the economic value of the professor’s field of specialization. Moreover, greater centralization also makes it more difficult for individual universities to adjust the allocation of its research budget across fields in response to changing demand outside the university.

One way of illustrating this lesser ability to adjust to changing needs is given *in Figure 8.1*, where we compare the number of degrees awarded at the B. Sc. and M. Sc. levels in electrical/electronic engineering and computer science in Sweden and the US, relative to active-age population in the 1977–95 period. For a very long time there was an excess demand for engineers within this specialization in Sweden. Still, the university system was very slow to respond to this increased demand through an expansion in teaching. In the US, on the other hand, the number of degrees awarded tripled from 1977 to 1986, while the Swedish expansion did not really take off until the number of degrees awarded had already peaked and begun to decrease in the US “market driven” system. When the number of B. Sc. degrees began to decrease, the US experienced a dramatic upgrading, with a large increase in the number of M. Sc. and Ph. D. degrees awarded (National Science Board, 1997).

The point, then, is not that the Swedish higher education system simply failed to respond to a huge increase in the demand for trained personnel in the burgeoning fields of microelectronics and computer science. Rather, the point is that the response did occur, but it occurred, from a purely economic point of view, much too slowly. In considering universities in their specific role as suppliers of trained personnel in appropriate fields of study, timing is a crucial consideration. In competitive world markets, large economic rents are commonly available to those firms (and those countries) that can respond most quickly to economic opportunities opened up by new technologies (integrated circuits, microprocessors, PCs) or new disciplines (microelectronics, computer science or biotechnology). But very late arrivals are most likely to find that the large financial rewards have already been captured as competitive forces have driven prices down to much lower levels. Where learning curves were very steep, as in the case of the manufacture of integrated circuits, late arrivals were likely to be particularly disadvantaged. The social as well as the private returns to late-starting higher education in these spheres were, consequently, likely to be very low.

Figure 8.1 Number of Degrees Awarded at B. Sc. and M. Sc. Levels in Electrical/ Electronic Engineering and Computer Science in Sweden and the US Relative to Population Aged 15–64, 1977–95.

Enclosed

Note: University programs with a duration of three years or longer are included.
Source: Jacobsson, Sjöberg and Wahlström (1999).

Third, in Sweden and other European countries, university degree requirements are typically formulated as a fixed program rather than a flexible accumulation of requirements and credits as in the US. In such a system it is therefore more difficult to make changes than in the American case. Etzkowitz, Asplund and Nordensson (2000) present evidence from their interviews that it is very difficult to change courses quickly and introduce new fields in the old Swedish universities.

8.2 Incentives for Faculty to Interact with Industry

It deserves to be repeated that the American university system is powerfully driven by competitive forces, especially by competition for financial support to push out the envelope of research frontiers in disciplines that have come to produce useful knowledge. In recent years this has most notably been the case in microelectronics, computer science and molecular biology. An important dimension of American academic competition is reflected in a high degree of mobility on the part of faculty as universities compete for talent and, increasingly, prestige. Such competition has been taking place in an entrepreneurial culture that has encouraged or, at the very least, has not constrained, high levels of faculty involvement in business activities. These activities include high tech startups in which there are a variety of potentially high financial payoffs to university faculty whose research produces knowledge that may lead to new products and processes and their accelerated commercialization.

Most recently, as is made clear in chapter 4 of this volume (Rosenberg, 2000b), American academic entrepreneurship has reached its apogee as the powerful new methods of biotechnology emerged out of many years of scientific research in the realm of molecular biology. The possibilities for commercial exploitation of university research were strengthened by the passage of the Bayh-Dole Act of 1980, which allowed universities to appropriate the property rights to an invention resulting from university research that was financed by federal grants. But, in assessing the impact of the Bayh-Dole Act, it is important to remember that American universities had never been excluded from patenting activity. Indeed, the extremely lucrative Cohen-Boyer patent, jointly owned by Stanford and the University of California, was issued several years prior to the passage of Bayh-Dole.

As a result of the Bayh-Dole Act, universities can now, in effect, develop contractual arrangements for "profit-sharing" between individual faculty researchers, their departments, and the university. Moreover, universities now have strong incentives to set up their own organizations, variously referred to as "Office of Technology Transfer" or "Office of Technology Licensing." These offices, operating on a fully commercial basis with staffs of lawyers, technology specialists, marketing specialists, accountants, *et cetera*, facilitate the commercial exploitation of potentially valuable research findings. See Carlsson and Fridh (2000) for an evaluation of the effectiveness of these offices.

Thus, the broad picture that we have sketched here strongly suggests that the incentives within the US university system encourage active participation by faculty (and also university administrators) in commercial exploitation of research by faculty. What can be said of the corresponding situation in Sweden? At first sight incentives for faculty appear very strong: the 1949 law guaranteeing academic freedom also placed property rights emanating from their research entirely in the hands of faculty members (*lärarundantaget*). However, the outcome has been more complex. A consequence of full faculty ownership of property rights has been that the universities themselves have had little incentive to become involved in technology transfer to the commercial sector. In fact, as emphasized by Etzkowitz *et al*. (2000) it has often been in the interest of universities to discourage contacts between faculty members and industry, since rigid civil servant pay schedules and other constraints have made it very difficult for them to retain highly valued personnel who have established personal ties with industry. Procedures for academic leave have not been adjusted to make it easier for professors to take temporary leave to organize firms in the manner that has become widespread in the US (See also Stankiewicz, 1986, p. 90).

Under these circumstances, Swedish academics are more likely to confine their external involvement to consulting activities, since to proceed further may force them to take a binary decision to leave the university, and few are prepared to do that (Etzkowitz *et al*., 2000). In a system that discourages faculty involvement with industry beyond consulting and where the property rights rest with the researcher, there is a lower likelihood that the potential commercial benefits of academic research will be reaped. And, as emphasized by Vedin (1993), if the owner of the property rights shows little interest in exploitation, very little is likely to happen. This is also found by Etzkowitz *et al*. who conclude that "[s]ince most professors have little interest in commercializing their rights, or naively presume that discovery should somehow automatically produce rewards, relatively little use was made of these rights."

When property rights rest solely with the individual researcher, there is no "profit sharing" with his/her department. This has probably given rise to anti-entrepreneurial peer pressure at Swedish universities. Informal interviews as well as a recent government report on the collaboration between university and industry (SOU 1996: 70, pp. 158–59) point to the existence of such pressure. Anti-entrepreneurial peer pressure also results in tendencies among faculty to be less open about their contacts with industry and, in particular, about the private returns from these contacts. Such surreptitious behavior further reduces the much-needed presence of entrepreneurial role models.

Several scholars studying the Swedish university/industry interface emphasize that, analogous to what Zucker and Brewer (1998) and Audretsch and Stephan (1996) have found for the US, personal contacts are essential (e.g., Uhlin *et al*., 1992 and Etzkowitz *et al*., 2000). It is clear, however, that these contacts have been mainly with large firms, and it has turned out that the large firms have preferred that these contacts remain informal in nature (*Ibid*.). In particular, the large firms have been very unwilling to offer high-powered incentives to academics with whom they cooperate and, as a result, these academics tend to remain consultants. This is, of course, yet another reflection of the Swedish large-firm model of high tech innovation (Granstrand and Alänge, 1995; Lindholm Dahlstrand, 1997a).

We may conclude that there is much greater flexibility in the US system (a bottom up model) compared to a Swedish or European system. In particular, it should be emphasized that, whatever mode of cooperation between university and industry turns out to be the most suitable for a certain technology, it is more likely to prove more feasible in the more flexible US system (*cf*. the highly different modes of cooperation in semiconductors and biotechnology as described by Rosenberg (2000b) of this volume).

9. A Note on the Recent Entrepreneurial Upturn in Sweden

The analysis in this paper has been wholly long term, i.e., we have focused on the bleak performance of the Swedish economy in a thirty-year perspective and the substantially greater degree of academic entrepreneurship in the US compared to Sweden since the 1970s or so. At the same time, one should note the highly visible current upturn in entrepreneurial activity in Sweden at the time of finalizing this manuscript (March 2000). The GDP growth rate was 3.0 and 3.6 percent p.a. in 1998 and 1999, respectively, and aggregate employment grew at an average annual rate of 1.8 percent during 1998–99.[33] According to a narrow definition there were 58 IPOs in Sweden during 1999, and the majority of them were IT related.[34] According to a wider criterion applied by Nyhetsbyrån Ticker (www.ticker.se), the number of IPOs was as high as 105 in 1999. The stock market value of most of those firms soared exorbitantly, in several cases by more than 1000 percent in 1999. New entrepreneurial firms, in particular in the IT sector, are still formed at a rapid rate, and there are also a number of examples of spin-offs from Ericsson (Net Insight, Kipling, Dynarc, Bluetail, Wireless Solutions *et cetera*).

Should this favorable development be seen as a rejection of the thesis in this paper? We do not think so. First, the development is still of recent vintage, and hence it is too early to tell to what extent we are dealing with a cyclical phenomenon. Second, and much more importantly, a number of measures were taken during the1990s that can be expected to encourage the emergence of a stronger entrepreneurial culture:

[33]Statistics Sweden, *National Accounts* and *Labour Force Surveys*. To be updated after March 9, 2000.
[34]This includes all new listings in 1999 on the OM Stockholm Stock Exchange, Nya Marknaden, Aktietorget, Innovationsmarknaden and the SBI lists.

- The corporate tax rate has been cut in half and is now 28 percent, which strongly favors equity relative to debt financing.
- The highest marginal tax rate has been lowered from close to 90 percent around 1980 to roughly 56 percent, which has after all increased the after-tax rate of return on human capital investment.
- The capital market has been wholly deregulated since 1985.
- The wage bargaining system is now less centralized than before, and in particular wages in the upper decile has increase rapidly in the latter half of the 1990s (Davis and Henrekson, 2000).
- Certain deregulatory measures on the labor market have already been taken,[35] which in practice gives more room for flexibility than before, and more measures can be expected in the near future.
- The deregulation of several previously regulated markets, in particular the deregulation of the market for telecommunications, opened a new arena for entrepreneurial expansion.

Other factors are more fortuitous, but still in line with our thesis. The Stockholm stock exchange had the strongest development of all stock exchanges in the industrialized world during the 1980s and 90s,[36] and given that 60 percent of the population own listed shares, this strong wealth creation has made a large number of people wealthy. According to the analysis in section 7.3, this should spur entrepreneurial activity. For the first time since the interwar period, the deregulation of the credit market in the 1980s also paved the way for the formation of new family fortunes, and in many cases that wealth appears to have been instrumental as angel capital in today's new IT firms. Finally, fortunate timing is involved. The spectacular development in the Swedish IT sector would not have been possible without the existence of Ericsson and its success in wireless communications, which turned out to be perhaps the number one growth industry in the world in the latter half of the 1990s.

Thus, the current boom suggests that changes in the conditions facilitating the emergence of a strong entrepreneurial culture will, usually with some lag, lead to the expected result, although there are particular ancillary circumstances that has reinforced this pattern in Sweden today. On the other hand, compared to the US the rules of the game are still unfavorable: the taxation of entrepreneurial income (including stock options and the high overall taxation of VC firms) continues to be high, the steep rate of labor taxation reduces the rate of return on human capital investment and the labor market remains highly regulated. More specifically, academic entrepreneurship is still hampered by the unfavorable incentives within the university system as described in section 8. In 1999 the Swedish GDP growth rate exceed the OECD average by one percentage point (OECD, *Economic Outlook*, December 1999). However, it should be kept in mind that the recent upturn needs to be sustained for a long time in order for Sweden to substantially regain lost ground in terms of per capita income relative to the

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[35]In 1997 a new type of employment contract was allowed, so-called prearranged temporary employment (*överenskommen visstidsanställning*), which gives every firm an *unconditional* right to employ up to five persons for a maximum of one year. Another 1997 change was procedural. *Local* collective agreements that replace the regulations in the law can now be reached. This makes it possible, through local agreements, to annul tenure-based order of priority in case of dismissal and to annul the right to reemployment for dismissed workers, and to extend the duration of temporary employment beyond 12 months.

[36]*The Economist* (1999), "The Foresight Saga.," Vol. 353, No. 8150 (December 18th), pp. 65–67.

OECD average.[37] But if our analysis is correct, it is also likely that further measures encouraging entrepreneurial activity would make it possible for Sweden to shift to a long-run growth path that could bring the country back to its previous top position in terms of GDP per capita.

10. Concluding Remarks

In this study we have documented that Sweden is a country putting a great deal of resources into R&D; R&D spending relative to GDP has been the highest in the world for a decade or more. The country also hosts several world-leading firms with a high R&D intensity, it holds a world class position in terms of publication rates in leading academic journals per capita (or per billion dollars of GDP), and its government invests massively in the building of organizations to bridge the gap between university research and the commercial sector. At the same time, the performance record in recent decades has been dismal in many other respects: the growth rate of the economy relative to most other rich countries has been slow since the late 1960s, the employment rate fell sharply in the first half of the 1990s, few new jobs have been created in new technology-based firms (or, for that matter, in the private sector generally), there are few examples of rapidly expanding success stories, and in the last decade the large multinationals have painfully downsized their Swedish activities, *et cetera*.

So why, in contrast to the US, has the large volume of research given rise to comparatively little commercial activity? To come to grips with this question we have systematically studied the pertinent incentive structures in the two countries: for human capital investment, for becoming an entrepreneur, for expanding existing businesses and for universities themselves. We have shown that the various relevant incentive structures provide far less encouragement to academic entrepreneurship and entrepreneurial behavior generally in Sweden than in the US.

We conclude that a general lack of favorable institutions and pertinent incentive structures promoting the emergence of an entrepreneurial culture has been the major explanation for the modest role of academic entrepreneurship in Sweden as compared to the US. A regime switch in this respect is not likely to take place on a larger scale unless the incentive structures are altered so that they are supportive of this development. Several encouraging steps have been taken in that direction in the last decade. Consequently, the current burst of entrepreneurial activity in Sweden, in particular in the IT sector, is consistent with our thesis, but there is still a long way to go before an entrepreneurial culture has been fostered to the extent that the full commercial potential of Swedish university research can finally be enjoyed.

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[37]See section 2.1.

Appendix: Statistical Tables

Table A.1 Total R&D Expenditures as a Percentage of GDP in the OECD Countries, 1981–95 (Rank in Parentheses).

	1981	1983	1985	1987	1989	1991	1993	1995
US	2.42 (1)	2.66 (1)	2.87 (3)	2.82 (2)	2.73 (4)	2.81 (3)	2.61 (3)	2.54 (3)
UK	2.37 (2)	2.19 (6)	2.23 (7)	2.19 (7)	2.15 (7)	2.11 (7)	2.16 (7)	2.04 (8)
Japan	2.32 (3)	2.54 (3)	2.77 (4)	2.81 (3)	2.95 (1)	3.00 (1)	2.88 (2)	2.98 (2)
Sweden	2.29 (4)	2.55 (2)	2.89 (1)	2.99 (1)	2.94 (2)	2.89 (2)	3.39 (1)	3.59 (1)
Switzerland	2.25 (5)	2.27 (4)	2.88 (2)	N.A.	2.87 (3)	2.66 (4)	N.A.	N.A.
Germany	2.20 (6)	2.27 (4)	2.43 (5)	2.57 (4)	2.57 (5)	2.61 (5)	2.43 (5)	2.32 (6)
France	1.97 (7)	2.11 (7)	2.25 (6)	2.27 (5)	2.33 (6)	2.41 (6)	2.45 (4)	2.33 (5)
Netherlands	1.85 (8)	1.98 (8)	2.05 (8)	2.27 (5)	2.11 (8)	2.04 (9)	2.00 (8)	2.08 (7)
Norway	1.30 (9)	1.42 (10)	1.63 (10)	1.66 (9)	1.69 (10)	1.64 (11)	1.67 (10)	1.62 (11)
Canada	1.23 (10)	1.35 (12)	1.44 (12)	1.43 (11)	1.38 (13)	1.51 (14)	1.61 (12)	1.63 (10)
Finland	1.20 (11)	1.36 (11)	1.58 (11)	1.75 (8)	1.83 (9)	2.07 (8)	2.21 (6)	2.35 (4)
Austria	1.14 (12)	N.A.	1.25 (14)	N.A.	1.37 (15)	N.A.	1.49 (14)	N.A.
Denmark	1.06 (13)	1.15 (13)	1.20 (15)	1.37 (12)	1.50 (12)	1.65 (10)	1.73 (9)	1.81 (9)
New Zealand	1.01 (14)	0.93 (16)	N.A.	N.A.	0.88 (18)	0.99 (17)	1.03 (18)	0.97 (16)
Australia	1.01 (14)	1.14 (14)	1.30 (13)	1.27 (13)	1.38 (13)	1.64 (11)	1.67 (10)	N.A.
Italy	0.88 (16)	0.95 (15)	1.13 (16)	1.19 (14)	1.24 (16)	1.24 (15)	1.14 (17)	1.04 (15)
Ireland	0.70 (17)	0.67 (18)	0.79 (17)	0.86 (15)	0.83 (19)	0.96 (18)	1.21 (16)	1.38 (14)
Iceland	0.63 (18)	0.68 (17)	0.74 (18)	0.76 (16)	1.02 (17)	1.17 (16)	1.34 (15)	1.54 (13)
Spain	0.43 (19)	0.48 (19)	0.55 (19)	0.64 (17)	0.76 (20)	0.88 (19)	0.92 (19)	0.85 (17)
Portugal	0.31 (20)	0.35 (20)	0.39 (20)	0.42 (18)	0.53 (21)	0.63 (20)	N.A.	0.59 (18)
Greece	0.17 (21)	N.A.	0.27 (21)	0.30 (19)	0.38 (22)	0.37 (21)	0.48 (20)	N.A.
Belgium	N.A.	1.58 (9)	1.64 (9)	1.64 (10)	1.66 (11)	1.63 (13)	1.58 (13)	1.59 (12)
OECD[1]								
Weighted	2.09	2.25	2.43	2.44	2.43	2.49	2.38	2.34
Unweighted	1.52	1.63	1.77	1.84	1.87	1.93	1.98	2.01

[1]Average of 15 OECD countries: Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the United Kingdom and the United States.

Source: OECD, *Basic Science and Technology Statistics on diskette*, 1997; *OECD, National Accounts 1960-1997 Vol. 1*, 1999; OECD, *Main Economic Indicators*, January 1999.

Table A.2 R&D Expenditures in the University Sector as a Percentage of GDP in the OECD Countries, 1981–95 (Rank in Parentheses).

	1981	1983	1985	1987	1989	1991	1993	1995
Sweden	0.69 (1)	0.77 (1)	0.79 (1)	0.86 (1)	0.90 (1)	0.79 (1)	0.87 (1)	0.79 (1)
Japan	0.56 (2)	0.58 (2)	0.56 (2)	0.56 (2)	0.53 (3)	0.52 (4)	0.58 (3)	0.62 (2)
Switzerland	0.45 (3)	0.40 (4)	0.37 (5)	N.A.	0.57 (2)	0.66 (2)	N.A.	N.A.
Netherlands	0.43 (4)	0.50 (3)	0.48 (3)	0.49 (3)	0.45 (4)	0.61 (3)	0.60 (2)	0.60 (3)
Norway	0.38 (5)	0.37 (5)	0.36 (7)	0.35 (7)	0.41 (8)	0.44 (6)	0.46 (5)	0.42 (8)
Austria	0.37 (6)	N.A.	0.44 (4)	N.A.	0.44 (5)	N.A.	0.52 (4)	N.A.
US	0.35 (7)	0.35 (7)	0.37 (5)	0.41 (4)	0.42 (7)	0.40 (10)	0.40 (10)	0.39 (10)
Germany	0.34 (8)	0.33 (8)	0.33 (11)	0.37 (5)	0.37 (9)	0.43 (7)	0.44 (8)	0.44 (5)
Canada	0.33 (9)	0.36 (6)	0.34 (8)	0.34 (9)	0.34 (14)	0.39 (11)	0.39 (12)	0.37 (13)
France	0.32 (10)	0.33 (8)	0.34 (8)	0.34 (9)	0.35 (11)	0.36 (13)	0.39 (12)	0.39 (10)
UK	0.32 (10)	0.31 (11)	0.33 (11)	0.35 (7)	0.33 (15)	0.35 (14)	0.37 (14)	0.38 (12)
Australia	0.29 (12)	0.32 (10)	0.34 (8)	0.34 (9)	0.35 (11)	0.43 (7)	0.41 (9)	N.A.
Denmark	0.28 (13)	0.29 (14)	0.29 (15)	0.33 (12)	0.37 (9)	0.37 (12)	0.40 (10)	0.44 (5)
Finland	0.27 (14)	0.31 (11)	0.33 (11)	0.36 (6)	0.35 (11)	0.46 (5)	0.45 (6)	0.46 (4)
Iceland	0.17 (15)	0.18 (15)	0.22 (16)	0.20 (15)	0.25 (16)	0.34 (15)	0.32 (15)	0.42 (8)
New Zealand	0.16 (16)	0.14 (17)	N.A.	N.A.	0.17 (20)	0.28 (16)	0.29 (16)	0.30 (14)
Italy	0.16 (16)	0.18 (15)	0.22 (16)	0.24 (14)	0.25 (16)	0.27 (17)	0.28 (18)	0.26 (16)
Ireland	0.11 (18)	0.12 (18)	0.16 (18)	0.19 (16)	0.19 (18)	0.22 (19)	0.25 (19)	0.26 (16)
Spain	0.10 (19)	0.11 (19)	0.11 (20)	0.12 (18)	0.15 (21)	0.19 (20)	0.29 (16)	0.27 (15)
Portugal	0.06 (20)	0.09 (20)	0.12 (19)	0.14 (17)	0.19 (18)	0.27 (17)	N.A.	0.20 (18)
Greece	0.03 (21)	N.A.	0.06 (21)	0.07 (19)	0.13 (22)	0.12 (21)	0.20 (20)	N.A.
Belgium	N.A.	0.30 (13)	0.31 (14)	0.31 (13)	0.43 (6)	0.43 (7)	0.45 (6)	0.43 (7)
OECD[1]								
Weighted	0.36	0.37	0.37	0.40	0.40	0.41	0.43	0.42
Unweighted	0.32	0.34	0.35	0.37	0.38	0.41	0.43	0.43

[1]Average of 15 OECD countries: Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the United Kingdom and the United States.

Source: OECD, *Basic Science and Technology Statistics on diskette*, 1997; *OECD, National Accounts 1960-1997 Vol. 1*, 1999; OECD, *Main Economic Indicators*, January 1999.

Table A.3 Total R&D Attributable to Different Sectors in Sweden, 1981–1997 (Man Years), 1981–97.

	Private sector	Government	University	All sectors	University share
1981	27,443	3,271	11,500	42,214	27.2
1983	30,146	3,313	12,300	45,759	26.9
1985	33,176	2,823	13,600	49,599	27.4
1987	35,371	2,740	13,700	51,811	26.4
1989	35,209	2,637	17,283	55,129	31.4
1991	33,829	2,965	16,810	53,604	31.4
1993	35,900	3,289	17,438	56,627	30.8
1995	41,816	3,500	17,301	62,617	27.6
1997	43,964	3,334	18,200	65,498	27.8

Source: Statistics Sweden (1996) for 1981–93, data received directly from Statistics Sweden and OECD, *Basic Science and Technology Statistics on diskette, 1997.*

Table A.4 Non-agricultural Self-Employment as a Proportion of Civilian Employment in OECD Countries, 1973, 1979, 1986 and 1990.

Country	1973	1979	1986	1990
Australia†	9.5	12.4	12.7	12.4
Austria	11.7	8.9	6.1	6.4
Belgium	11.2	11.2	12.6	12.9
Canada†	6.2	6.7	7.2	7.4
Denmark	9.3	9.2	7.0	7.2
Finland	6.4	6.1	6.8	8.8
France†	11.4	10.6	10.5	10.3
Germany	9.1	8.2	7.6	7.7
Greece	N.A.	32.0	27.5	27.2‡
Ireland	10.1	10.4	11.3	13.3
Italy	23.1	18.9	21.6	22.3
Japan†	14.1	14	12.7	11.5
Luxembourg	11.1	9.4	8.4	7.1
Netherlands†	N.A.	8.8	8.2	7.8
New Zealand†	N.A.	9.5	13.3	14.6
Norway†	7.8	6.6	6.5	6.1
Portugal	12.7	12.1	16.9	18.5
Spain	16.3	15.7	17.9	17.1
Sweden	*4.8*	*4.5*	*4.2*	*7.0*
Turkey	N.A.	N.A.	N.A.	27.6
United Kingdom†	7.3	6.6	10.0	11.6
United States†	6.7	7.1	7.4	7.6

†Excluding owner-managers of incorporated businesses (in the UK data this category is partly included).
‡1989.

Note: The OECD finds that the share of employment in Sweden attributable to self-employment increased 67% between 1986 and 1990. This finding is a result of the fact that OECD gathers its data on Sweden from the *Labor Force Surveys* (AKU). Between 1986 and 1987, the AKU altered its definition of “self-employed“ which boosted the number of self-employed in that period by over 100,000, or 2.5 percentage points. The difference was that those who before 1987 had called themselves “self-employed“, but who ran their firm in the form of a limited company were re-classified as “employees“. However, if one uses the national accounts, where the definition of “self-employed“ remained unaltered (see Figure 6.1), this increase does not appear.

Source: *OECD Employment Outlook*, July 1992, p. 158.

Table A.5 Effective Marginal Tax Rates for Different Combinations of Owners and Sources of Finance, 1960, 1980, 1991, 1994 and 1995 (real pre-tax rate of return 10% at actual inflation rates).

	Debt	New share issues	Retained earnings
1960			
Households	27.2	92.7	48.2
Tax exempt institutions	–32.2	31.4	31.2
Insurance companies	–21.7	41.6	34.0
1980			
Households	58.2	136.6	51.9
Tax exempt institutions	–83.4	–11.6	11.2
Insurance companies	–54.9	38.4	28.7
1991			
Households	31.7	61.8	54.2
Tax exempt institutions	–9.4	4.0	18.7
Insurance companies	14.4	33.3	31.6
1994			
Households	32.0/27.0†	28.3/18.3†	36.5/26.5†
Tax exempt institutions	–14.9	21.8	21.8
Insurance companies	0.7	32.3	33.8
1995			
Households	32.0/27.0†	67.7/57.7†	48.0/38.0†
Tax exempt institutions	–3.5	25.7	25.7
Insurance companies	21.0	53.3	50.4

†Excluding wealth tax. The wealth tax on unlisted shares was abolished in 1992.

Note: All calculations are based on the actual asset composition in manufacturing. The following inflation rates were used: 1960: 3%, 1970: 7%, 1980: 9.4%, 1985: 5%, 1991: 5%, 1994: 3%, 1995: 3%. The calculations conform to the general framework developed King and Fullerton (1984). The average holding period is assumed to be 10 years.

Source: Calculations provided by Jan Södersten.

Table A.6 Household Net Savings as a Share of Disposable Income among OECD Countries, 1960–95 (%).

Country	1960–69	1970–79	1980–89	1990–95
US[a]	7.4	7.9	9.4	7.2
Japan	17.0	20.8	15.6	13.0
Germany[b]	16.0	14.8	12.3	12.5
France	12.1	13.7	9.8	9.3
UK[a]	5.5	7.5	5.2	6.1
Italy	17.3	21.7	20.1	15.9
Canada	5.7	9.4	13.0	9.1
Australia	9.8	14.3	7.8	4.1
Austria	9.8	9.9	10.0	10.9
Belgium	13.0	16.7	13.4	16.2
Denmark[c]	NA	NA	8.1	8.7
Finland	4.7	6.2	6.1	6.6
Greece[a, f]	11.4	19.1	19.0	19.3
Netherlands	14.0	14.3	13.1	12.8
New Zealand	NA	NA	7.1	7.5
Norway	NA	NA	1.1	5.1
Portugal[d, e, g]	3.7	14.7	24.5	15.4
Spain	9.1	10.4	7.1	7.3
Sweden	*6.1*	*4.0*	*1.1*	*5.6*
Switzerland	11.7	13.2	13.5	3.3
OECD	9.7	12.1	11.2	9.8
OECD Europe	12.0	13.6	11.6	10.9

[a]The last period only covers 1990–94. [b]Concerns Western Germany. [c]The 1980–89 period only covers 1988–89. [d]The last period only covers 1990–93. [e]Gross savings after 1977. [f]The 1970–79 period only covers 1970–74. [g]The 1970–79 period only covers 1970–76.

Source: OECD, *Historical Statistics* 1960–1980 and 1960–1995; OECD, *Economic Outlook*, Vol. 64, 1998.

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