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Förord

Sverige har under de senaste trettio åren haft en lägre tillväxt än genomsnittet för OECD-länderna. Frågor som rör långsiktig tillväxt har därför fått ökad uppmärksamhet i den politiska debatten. Även intresset för kunskaper om entreprenörer och entreprenörskap har därmed ökat. Det s.k. akademiska entreprenörskapet har tilldragit sig särskild uppmärksamhet eftersom kommersiella tillämpningar av ny kunskap, som utvecklas genom forskning, har betydelse för den ekonomiska utvecklingen. Kunskapen om det akademiska entreprenörskapet och i vilken omfattning det påverkar den ekonomiska tillväxten är emellertid begränsad.

I föreliggande studie undersöks hur samtliga individer med akademisk utbildning inom naturvetenskap, teknik och medicin är involverade i företagande. Dessa utbildningsgrupper anses ha hög sannolikhet för att bedriva akademiskt entreprenörskap. I rapporten analyseras dessa gruppers sammansättning och inblandning i företagande utifrån flera olika aspekter som exempelvis typ av utbildning, kön och region.

Studien har skrivits av Frédéric Delmar och Johan Wiklund vid Handelshögskolan i Stockholm samt Karin Sjöberg vid Internationella Handelshögskolan i Jönköping. Författarna ansvarar själva för rapportens innehåll liksom för de slutsatser som dras. Projektledare vid ITPS har varit Björn Falkenhall. Rapporten är författad på engelska, men den inleds med en sammanfattning på svenska. Studien utgör en del i ett större forskningsprojekt som bedrivs vid Handelshögskolan i Stockholm.

Stockholm i oktober 2003

Sture Öberg,
Generaldirektör

Sammanfattning

För att en ekonomi skall utvecklas och växa är det nödvändigt att nya företag skapas. Nya företag behövs för att konkurrera med existerande företag så att nya effektiva sätt att arbeta och producera nya varor och tjänster slår ut gamla och ineffektiva sätt (Schumpeter, 1934). Det är också nödvändigt för ekonomisk utveckling att den nya kunskap som utvecklas genom forskning och utveckling snabbt hittar kommersiella tillämpningar. Inget av dessa två påståenden är speciellt kontroversiella. Det är idag en accepterad sanning att höga nivåer av entreprenöriell aktivitet kopplad till starka offentliga och privata ansträngningar för att kommersialisera forskning är en viktig nyckel till ett lands ekonomiska tillväxt. I skärningspunkten mellan dessa två drivkrafter befinner sig de entreprenöriella aktiviteter som bedrivs av de individer som skapar eller använder ny kunskap, det vill säga vad vi här kallar för akademiskt entreprenörskap. Intresset för akademiskt entreprenörskap har under de senaste åren ökat kraftigt i Sverige eftersom det utgör en potentiell källa för framtida ekonomisk utveckling (Andersson et al., 2002). Dessvärre är vår kunskap om det akademiska entreprenörskapets faktiska bidrag till den svenska ekonomiska utvecklingen begränsad. Därför har vi som mål att i denna studie utforska centrala aspekter av detta fenomen. Mer precist undersöker vi dels hur de utbildningsgrupper som har störst sannolikhet att utnyttja ny kunskap är involverade i företagande, dels hur de använder sin vetenskapliga kunskap som bas för sitt företagande.

Detta mål uppnår vi genom att undersöka hela den svenska arbetskraften utbildad inom naturvetenskap, teknik och medicin (NTM). Alla som har minst en treårig utbildning på universitetsnivå inom dessa tre kunskapsområden inkluderas. Denna population passar vårt syfte perfekt eftersom den representerar den del av arbetskraften som har störst sannolikhet att bli involverad i akademiskt entreprenörskap. Det är de personer som genom sin utbildning har störst förmåga att transformera vetenskaplig kunskap till kommersiella aktiviteter genom företagande. Vi följer utvecklingen av denna grupp, dess inträde i och utträde från företagande under en elvaårsperiod från 1990 till 2000. I rapporten presenteras följaktligen:

- En beskrivning av NTM-arbetskraftens inblandning i företagande över tiden
- Ingång till och utgång från företagande
- Skillnader beroende på typ av och längd på utbildning samt kön
- Fördelningen av företagandet över olika branscher
- Fördelningen av företagandet över olika utbildnings- och boenderegioner
- Kopplingar mellan heltids- och deltidsföretagande
- Tiden spenderad som företagare

Det teoretiska perspektivet i arbetet är hämtat från humankapitalteori. Denna teori baseras på ekonomisk logik för att studera hur individers investeringar i kunskaper och färdigheter påverkar deras arbete, inklusive deras val att bli företagare eller inte. Det grundläggande argumentet är att en individ väljer ett yrke eller arbete som maximerar nuvärdet av de ekonomiska och psykiska intäkterna över sin livstid. Intresset för akademiskt entreprenörskap är lättförståeligt från ett humankapitalperspektiv, eftersom NTM-arbetskraften har tillgång till ett stort humankapital baserat på långa utbildningar och komplexa arbetsuppgifter. Detta humankapital ger individen unika kvaliteter för att engagera sig i entreprenöriella aktiviteter, som i sin tur har stora möjligheter att skapa tillväxt och ekonomiskt värde. I korthet menar teorin att individer med mera humankapital eller humankapital av högre kvalitet är bättre på att utföra vissa arbetsuppgifter. För entreprenörskap innebär mycket humankapital en bättre förmåga att upptäcka och tillvarata entreprenöriella möjligheter. Personer skiljer sig åt i sin förmåga att upptäcka entreprenöriella möjligheter därför att de har olika humankapital. De entreprenöriella möjligheter de har störst sannolikhet att upptäcka skiljer sig också åt därför att humankapitalets inriktning leder till personliga kunskaper och erfarenheter. Dessa erfarenheter innebär att man kan upptäcka vissa sorters entreprenöriella möjligheter samtidigt som man är blind för andra. Möjligheten att upptäcka och tillvarata entreprenöriella möjligheter är därför beroende av utbildning och arbetserfarenheter.

För att undersöka denna grupps engagemang i företagande har vi med hjälp av SCB konstruerat en databas som sträcker sig mellan åren 1990 och 2000. Databasen består av alla som 1990 hade en utbildning inom NTM eller som senare skaffade sig en sådan utbildning. Vi studerar därmed en population och inte ett urval och följer dessa människors aktiviteter under elva år. Det finns ca 222 000 personer som har de kvalificerande utbildningarna. Av dessa har ca 49 000 (22 procent) varit företagare ett år eller längre. Under perioden avslutade ca 44 000 personer (20 procent av det totala antalet) utbildningar inom NTM och av dessa var ca 4 800 (11 procent) företagare under ett år eller längre. Vi definierar företagare som en person som driver enskild firma, handelsbolag eller kommanditbolag oberoende om denna person får en inkomst från detta företag eller just då är anställd på ett annat företag. Vidare räknas en person som företagare om hon/han är ägare eller delägare av ett aktiebolag och har det som sin huvudsakliga inkomstkälla.

Tittar vi på populationens utveckling under den undersökta perioden kan vi konstatera att det handlar om en växande sådan. Det fanns ca 141 000 personer med en NTM-utbildning 1990 och 2000 var den siffran uppe i ca 186 000. Det motsvarar en ökning på ca 45 000 personer (32 procent) över hela perioden. Uppdelat på utbildningsgrupperna innebär det en ökning på 39 procent för teknik, 17 procent för medicin och 44 procent för naturvetenskap. Av alla de som ingår i populationen har ungefär 14 procent disputerat. Förhållandet ändrades inte nämnvärt under perioden. Det finns stora könsskillnader mellan de olika utbildningsgrupperna, även om klyftan tenderar att minska över tiden. Lägst andel kvinnor återfinner vi inom teknikområdet som år 2000 hade 17 procent kvinnor, inom naturvetenskap fanns det 34 procent och högst var medicin med 44 procent kvinnor. I hela populationen NTM är 28 procent kvinnor.

Vi undersöker denna populations engagemang i entreprenöriella aktiviteter genom att studera hur många som är företagare på årsbasis, dvs. blir företagare (ingång) eller försvinner från företagande (utgång), hur länge en person i genomsnitt är företagare och om företagandet är huvudsaklig inkomst eller inte. Ungefär 14 procent av populationen är företagare varje år. De har företag antingen som primär inkomstkälla eller som sekundär inkomstkälla. Det finns dock stora skillnader mellan utbildningarna och medicin har en högre andel företagare än de andra två grupperna (20 procent i medicin, 11 procent i teknik och 10 procent i naturvetenskap år 2000). Någon direkt jämförelse med andra utbildnings- eller yrkesgrupper kan inte göras, men siffrorna kan jämföras med Arbetskraftsundersökningens (AKU) skattningar för den svenska sysselsättningen. Enligt denna undersökning angav 10 procent av samtliga sysselsatta att de hade eget företag år 2000. För populationen i denna studie är motsvarande siffra 12 procent om uppgifterna räknas om så att de motsvarar de sysselsatta enligt AKU. Det innebär att NTM är något mer företagsam än befolkningen i stort. Skillnaden kan dock helt tillräknas medicin. Det två andra grupperna ligger på eller strax över AKU:s skattningar.

Vad gäller ingång och utgång från företagande finner vi ganska stora skillnader över tiden beroende på hur konjunkturen utvecklas. Arbetsmarknadspolitiska åtgärder, som satsningen på starta eget-bidraget 1994, verkar också ha haft en stark positiv påverkan. Under perioden tillkommer mellan 14 och 24 procent nya företagare till gruppen företagare medan 11 till 21 procent försvinner. Medicin intar en särställning med låga värden på ut- och ingång, vilket innebär en låg omsättning av företagare.

Det är också av intresse att studera hur länge en person är företagare. Vi mäter detta genom beräkna hur många år en person stannar i kategorin företagare innan han eller hon går tillbaka till någon annan form av yrkesställning (t.ex. arbetslös eller anställd). Vi kan konstatera att efter ett år är i genomsnitt 74 procent fortfarande aktiva medan övriga 26 procent har fått en annan yrkesställning. Efter fyra år återstår drygt hälften (53 procent) och efter tio år återstår 22 procent. Vi finner inga stora könsskillnader, men kvinnor stannar i genomsnitt något längre som företagare. Däremot finns stora skillnader mellan utbildningsgrupperna och medicinare särskiljer sig ännu gång genom att stanna betydligt längre som företagare.

En unik aspekt av vårt arbete är möjligheten att särskilja mellan de som har företagande som primär inkomst och de som har företagande som sekundär inkomst. Två resultat är värda att nämna. För det första så har ungefär 58 procent av alla företagare sitt företag som en sekundär inkomst, vilket innebär att deras huvudsakliga inkomst kommer från en anställning. För det andra kan vi observera stora könsskillnader och kvinnor tenderar att ha företagande som sekundär inkomst i betydligt högre grad än män (65 respektive 54 procent).

Vi finner också stora regionala skillnader och företagandet i denna grupp koncentreras främst till storstäderna. Detta beror huvudsakligen på att även anställda tenderar att koncentreras till dessa områden. Resultaten visar att NTM-arbetskraften följer samma regionala fördelning som befolkningen i stort.

Slutligen har vi undersökt hur branschfördelningen ser ut inom dessa tre utbildningsgrupper. I denna analys undersöks endast de som har företagande som primär inkomst. Vi finner ganska stora skillnader mellan vilka branscher NTM-populationen arbetar i och i vilka branscher de väljer att vara företagare. I genomsnitt för de undersökta åren återfinns 20 procent av det totala antalet anställda inom tillverkningssektorn, men endast 4 procent av företagarna. Företagarna är överrepresenterade inom kunskapsintensiva konsultbranscher där 24 procent procent av företagarna återfinns, men endast 11 procent av det totala antalet anställda. Företagare är också överrepresenterade i gruppen ”andra branscher”. Det vill säga sådana branscher som inte torde kräva denna typ av utbildning för att driva eget företag. Exempel på sådana branscher är hotell och restaurang samt detaljhandel. I dessa branscher återfinner vi 40 procent av företagarna, men endast 26 procent av de anställda.

Sammanfattningsvis skall vi antagligen inte ha allt för stora förhoppningar om att akademiskt entreprenörskap kan spela en avgörande roll för den framtida ekonomiska utvecklingen. Vi kan konstatera att gruppen inte skiljer sig nämnvärt åt från andra yrkesgrupper i sitt engagemang i företagande. I varje fall när det gäller deras antal. Vi kan dessutom konstatera att mycket av företagandet bedrivs som en sekundär inkomstkälla och om det bedrivs som primär inkomstkälla så ligger stora delar av företagandet i branscher, som ligger utanför dessa gruppers normala arbetsmarknader. Konsultverksamhet av olika slag dominerar. En invändning mot denna slutsats kan vara att det viktiga inte är att många startar företag utan snarare att företagen växer. Svaret på den invändningen är att det endast är en liten andel av alla företag som växer. För att tillväxtföretag ska skapas krävs en stor bas av individer som etablerar nya företag så att några av dessa kan växa. I vilken utsträckning som NTM-utbildade startar tillväxtföretag kan vi utifrån denna specifika studie inte uttala oss om, utan då måste de företag som skapas studeras närmare.

En viktig rekommendation till dem som vill stödja akademiskt entreprenörskap är att skaffa mer detaljerad kunskap. Denna studie har tydligt visat att det fortfarande finns mycket att göra för att ”få i gång entreprenörskapet” i denna population. Vi kan konstatera att det finns stora könsskillnader, stora skillnader mellan branscher och regioner och stora skillnader mellan olika gruppers engagemang i företagande. Vidare studier inom dessa områden bör fokusera på att klargöra orsakerna till dessa skillnader. Tidigare forskning visar tydligt att dessa yrkesgrupper många gånger skiljer sig åt från andra yrkesgrupper genom den typ av entreprenöriella möjligheter som de baserar sitt företagande på. Dessa vidare analyser bör baseras på att försöka ta fram policyinstrument som ger möjlighet till ”benchmarking” med andra länder och utbildningskategorier, men också mer detaljerade analytiska instrument för utformning av en effektiv entreprenörskapspolitik för dessa yrkesgrupper. Sådana analytiska instrument bör ta hänsyn till vilka risker och belöningar som företagare med denna utbildningsbakgrund ställs inför. För att företagandet skall öka i denna grupp måste de potentiella belöningarna som förknippas med företagande bli större. Det innebär att en marknadsstruktur måste skapas där kunskapsintensivt företagande kan innebära större potentiella vinster för den enskilde och därmed för ekonomin som helhet.

Contents

1 Abstract

Self-employment among the science and technology labor force (STLF) is argued to be a key to economic development. In this study we examine the whole Swedish STLF from 1990 to 2000 and its involvement in self-employment. Building on human capital theory, findings suggest that the majority operates their businesses as a sideline to a regular job, and the share of self-employed in this population decreases over time. The decrease can be attributed to more women and young people entering the STLF. Self-employment rates vary across types of education, with individuals educated in medicine being about twice as likely to enter self-employment as those educated in natural sciences.

The STLF has several other employment options in addition to self-employment, therefore, there is an opportunity cost associated with self-employment. Consequently, in regions where employment opportunities are scarce, self-employment becomes relatively more attractive and self-employment rates increase. During economic booms when self-employment opportunities abound, employment opportunities also do leading to high self-employment entries *and* exits. On the basis of these and other findings, the implications for policy and research are discussed.

2 Introduction

In order for an economy to be dynamic, develop and grow, new ventures are needed that compete with existing firms and processes, eventually replacing them (Schumpeter, 1934). At the same time, it is essential that new knowledge developed through research and development be applied to new commercial ends. At present, neither of these statements is controversial; it is widely accepted that high levels of entrepreneurial activity and substantial public and private activity directed toward the development and commercialization of new knowledge are associated with positive economic outcomes. At the intersection of these two statements lie the entrepreneurial activities of those individuals who create new knowledge, i.e., what we refer to as academic entrepreneurship. There is a worldwide interest in academic entrepreneurship due to expectations that it will be an important driver of the economy. In the face of substantial downsizing among large research-intensive Swedish companies such as Ericsson, ABB and Pharmacia-Upjohn, the interest in academic entrepreneurship has rapidly increased in Sweden as a potential source of economic development for the future (e.g., Andersson, Asplund, & Henrekson, 2002). However, at present, our knowledge about the extent and economic contribution of academic entrepreneurship in Sweden is scarce. Therefore, in this study we set out to explore important aspects of this phenomenon. More precisely, we examine how science is used to create self-employment, and how those becoming self-employed utilize their scientific knowledge as a base for their business activities.

As the empirical basis for the study, we have chosen the whole Swedish science and technology labor force (STLF), i.e., every one who has a three-year or longer education in engineering, science, or medicine and their involvement in self-employment. This population is ideal for our purposes, because it corresponds to the labor force most likely to become involved in academic entrepreneurship, i.e., the population most likely to transfer scientific knowledge into commercial activity through the start-up of new independent companies. We follow the development of this labor force and the entry into and exit from self-employment for the 1990 to 2000 eleven-year period.

We are interested in following both the stock of self-employed and the flow in terms of entries and exits over time. More specifically, this report includes:

- A description of the extent of self-employment in the science and technology labor-force over time.
- Entries into and exits from self-employment over time.
- Differences depending on type and length of education, and sex.
- Distribution of self-employed across industries.
- Distribution of self-employed across county of education and county of residence.
- The relationship between full-time and part-time self-employment.
- The duration in time of self-employment.

The study is structured as follows. In the next section, we develop a theoretical framework based on human capital theory to understand these particular groups of highly educated people's involvement in self-employment. Thereafter, we describe the method used. We discuss the strengths and limitations of the present design as well as the measures employed to analyze data. In the third section we present the results of the study. We discuss in details how education, educational length, sex, industry and regional affiliation affect self-employment. Finally, we offer our conclusions and discuss the implications of this study for research and for policy.

3 Theory

3.1 Human capital and career choice

This report has its theoretical foundation in human capital theory (Becker, 1975). Human capital theory uses economic logic to study individual's investments in productivity enhancing skills and knowledge such as education and training, as well as for understanding career choices, including entering into and exiting from self-employment. The basic logic is that individuals choose an occupation or employment that maximizes the present value of economic and psychic benefits over their life-spans. It should be stressed that it does not assume that human choices are always, or even primarily, made to maximize economic utility for the individual. Rather, it provides an analytical tool for understanding the decisions people make related to education and work. The interest in academic entrepreneurship is easily understood from a human capital theory perspective. Thanks to long education and advanced work experience, the science and technology labor-force possesses substantial human capital, which could provide unique qualities for starting and operating new ventures with the potential of creating substantial growth and economic value.

Human capital theory posits that individuals with more, or higher quality, human capital achieve higher performance in executing relevant tasks (Becker, 1975). In the entrepreneurial context, human capital refers to the knowledge and skills that assist people in successfully discovering and exploiting opportunities (cf. Davidsson & Honig, 2003; Snell and Dean, 1992). Depending on their levels of human capital, individuals differ in their ability to discover and exploit opportunities. People have access to different information and process it differently depending on idiosyncratic knowledge and preferences (Shane, 2000). Therefore, the ability to discover and exploit opportunities depends largely on previous education and work experience.

Applying human capital theory to entrepreneurship, we should expect a positive association between an individual's human capital and the likelihood that he or she discovers an opportunity. The reason is that greater human capital provides individuals with more knowledge that can assist them in identifying opportunities and knowledge of ways to best exploit opportunities given that they have been discovered. Thus, human capital increases the chances of opportunity discovery and reduces the cost of exploitation (Bates, 1995; Brüderl, Preisendörfer, & Ziegler, 1992; Dunn & Holtz-Eakin, 2000; Otani, 1996). However, the decision of whether or not to exploit an opportunity involves weighing the value of the opportunity against the costs of exploiting it, and comparing this to the outcomes of other possible courses of action (Shane & Venkataraman, 2000; Venkataraman, 1997). That is, because people have other work alternatives, there is an opportunity cost associated with the exploitation of an opportunity (Amit, Muller, & Cockburn, 1995). Highly educated individuals with relevant experience likely have many career options other than going into self-employment. Therefore, such individuals may be more likely to discover opportunities and better suited for exploiting them

once discovered, but the incentives for taking action and starting a new firm may be small unless the potential value of the business opportunity is substantial, because they have several other career options. This suggests that while the ability of discovering and exploiting business opportunities in independent businesses may be generally high among the science and technology labor-force, the incentives for doing so may be small unless the potential value of the business opportunity is substantial.

The same logic can be applied to exiting self-employment. Individuals may find alternatives other than self-employment more attractive and decide to leave their firm although the firm is not threatened by failure. Different people make different conjectures about both the value of self-employment and the value of other work alternatives. In other words, the performance threshold for leaving self-employment varies across individuals (Gimeno et al., 1997). Individuals with more human capital are more likely to find attractive alternatives to running their own firms, and, thus, place higher demands on the performance necessary for remaining self-employed. Thus, they likely have higher performance thresholds than individuals with less human capital. In other words, individuals in the science and technology labor-force may decide to leave their businesses when they are performing well, because they identify other even more attractive career options.

From a human capital theory perspective, then, we would expect the science and technology labor-force to primarily start businesses that have a high potential for providing substantial value for the individual, and to leave self-employment unless this potential is materialized. In essence, this is the theoretical argument for the interest in academic entrepreneurship.

3.2 General and specific human capital

Human capital can be divided into general and specific human capital. Each is now discussed. General human capital is valuable because it facilitates the integration and accumulation of new knowledge, which provides individuals with a larger opportunity set (cf. Gimeno et al., 1997) and assists them in adapting to new situations. The general human capital of an entrepreneur typically consists of his or her schooling (Rauch & Frese, 2000). Education provides the entrepreneur with general knowledge, skills and problem-solving abilities that are transferable across many different situations. The more education an individual has, the greater is his or her general human capital.

While general human capital is generalizable across contexts, specific human capital is not and, in this context, refers to the education, training and experience that are valuable to the start-up and running of a new independent firm, but have few applications outside of this domain (cf. Becker, 1975; Gimeno et al., 1997). It remains an open question whether individuals with extensive education have greater specific human capital than individuals who are less educated. In other words, it is not necessarily certain that educated people perform better in self-employment than less educated people do. The findings from empirical research on the relationship between education and the discovery and exploitation of opportunities are mixed. For example, Bates (1990) found that higher education was associ-

ated with business start-up in the service sector, but not in other sectors. Investigating two samples, Evans and Leighton (1989) found that education predicted start-up in only one of the samples. Davidsson and Honig (2003) found that while education had a positive influence on the chance that a person would discover new opportunities, education did not predict successful exploitation, while Delmar and Davidsson (2000) found that people with a university degree where more likely to start businesses than those without such a degree.

3.3 Socio-economic variation in self-employment

As mentioned above, we study the whole science and technology labor-force. Therefore, to a large extent, we control for the general human capital of these individuals by allowing little variation in this variable. However, there is some variation in terms of the three categories engineering, science, and medicine, as well as the two levels graduate and post-graduate education, which could influence aspects of self-employment. Further, we include the sex of the individual as another aspect of human capital, because previous research has found differences in self-employment between men and women. We also study regional aspects of self-employment. Due to economic structure, market size and so forth, different regions provide different opportunities for self-employment (cf. Davidsson, Lindmark, & Olofsson, 1994b). Different regions also affect other work alternatives. Therefore, there may be regional differences in the attractiveness of self-employment. Further, due to educational idiosyncrasies, some universities may provide educations that make individuals better equipped for self-employment. Finally, industry may affect both the attractiveness of self-employment and other work alternatives. Therefore, we also study differences across industries. In the following, these aspects of human capital and the attractiveness of self-employment are developed in more detail.

Type of Education. The three sub-categories of the science and technology labor-force likely differ in their opportunity structures, because their knowledge can be applied to different products and services, but it is difficult to anticipate how this will affect the likelihood of self-employment across the categories. Further, the labor-market alternatives differ across the types of education. Medical doctors have a tradition of working for the public sector and few alternatives for employment exist outside this sector. On the other hand, there is a long-standing tradition among medical doctors to run their own practice on the side while at the same time being employed. Thus, it is plausible that medical doctors by tradition are more likely to start their own business. Furthermore, the opportunity cost for doing so is likely to be lower than for the other categories, because there are fewer other career alternatives apart from the few public sector employers. Therefore, we would expect that those educated in medicine are more likely to be self-employed. The specific human capital applicable to running an independent business, which is obtained from education, training, and experience, might also differ between the categories. However, it is difficult to predict which of the three categories has more specific human capital.

Length of Education. In this study we compare those with post-graduate education to those without. Post-graduate studies equip the individual with substantial human capital, which can be exploited through self-employment. For example, university research can lead to the acquisition of knowledge that can be protected via patenting. One important way to exploit such knowledge is through the start-up of a new firm (cf. Shane, 2000). Also, many individuals with post-graduate education work at universities, and universities allow – and to an increasing extent even encourage – their employees to start businesses while remaining employed at the university. Therefore, we would expect those with post-graduate education to be more prone to become self-employed.

Sex. There are large differences between men's and women's probability of entering self-employment. Comparing the results from various studies, we can conclude that men on average are three times more likely to enter self-employment compared to women (Delmar & Aronsson, 2001). Possible explanations for these differences range from different gender roles and different access to financial and human resources to differences in education as well as presence on the labor market (Brush, 1992; Duchénaut, 1997; Holmquist & Sundin, 2002). Especially technology, mathematics and the natural sciences are interesting because there exist important gender difference in these educational groups, where women are strongly underrepresented (Correll, 2001; Eurostat, 2001). At the same time, technological change and scientific development instead represent the sets of entrepreneurial opportunities on which developed economies depend. However, medicine has a much more equal distribution between men and women. We can therefore expect to see differences among the educational groups and their involvement in self-employment based on whether they are men or women.

In other words, both the perceived feasibility in terms of the difference between the expected outcome and cost of pursuing a business opportunity as well as the opportunity cost of doing so might differ between the sexes. While we have chosen to study a population where differences in education are small between the sexes, we would still expect to find differences between men and women for the reasons stated above. The same probably applies to the performance threshold of the business at which self-employment is regarded as no longer feasible. Thus, not only would we expect differences between start-up rates, but among men and women who start businesses, we would also expect the duration of self-employment to differ.

Region. Rates of self-employment and new firm performance vary heavily with the characteristics of the region such as, for example, unemployment and population concentration (Butler & Hansen, 1991; Feldman, 2001; Malecki, 1994; Ostgaard & Birley, 1995). Generally speaking we tend to find more self-employed and new firms in regions with a long tradition of entrepreneurship (Sorensen & Audia, 2000), and in regions with a high concentration of people and firms such as larger cities (Acs, 2002). Also concentration of knowledge in the form of universities, research centers, and an educated work force positively affects self-employment and new firm performance, especially in sectors categorized as 'high-tech' (Romanelli & Bird Schoonhoven, 2001; Zucker, Darby, & Brewer, 1998).

Industry. Of course industry is related to regions as they tend to cluster, but industries also have unique effects on self-employment and new firm performance. New firms tend to concentrate to new, growing and large industries (Bates, 1995; Carroll & Hannan, 2000; Geroski, 1995). Also, individuals choosing self-employment tend to do so in industries where they have been working previously (Romanelli & Bird Schoonhoven, 2001). Barriers to entry and exit are likely to differ across industries; therefore, we would also expect the flow of entries and exits of self-employment as well as the duration of self-employment to vary across industries.

Economic Cycle. The period we study is 1990 to 2000. During this period of time, Sweden first faced a major recession; the most severe since the 1930s. More than 550,000 jobs were wiped out from 1990 until the beginning of 1994. Approximately one quarter of all jobs in manufacturing disappeared (250,000), and substantial job losses were noted in the public sector (100,000) as well as in the service sector (150,000)[1]. A recovery started in 1995 and continued in 1996, followed by a downturn during the subsequent two years. Since then, the economic cycle has turned upwards. In principle, the economic cycle can affect self-employment in two different ways. Because people are more likely to become unemployed, and the possibility of finding alternative jobs is restricted during recessions, the attractiveness of self-employment relative to employment increases. Individuals will be more likely to transit to self-employment when regular job opportunities are scarce. Therefore, there should be a positive association between economic downturn and self-employment. This is often referred to as people being pushed into self-employment. On the other hand, during recessions, business opportunities are less abundant, which reduces the value of pursuing self-employment. Thus, for people having jobs, the pursuit of self-employment appears less attractive during recessions, meaning that the pull into self-employment is weak. The science and technology labor force is likely valuable to employers who probably are reluctant to rid themselves of such employees during downturns. Therefore, among this category, few are likely to become pushed into self-employment during recessions, while few also are pulled into self-employment. Thus, we would expect the level of self-employment of the science and technology labor-force to follow the economic cycle rather than being counter-cyclical. This means that we expect self-employment to decrease during the first years of the decade, and to increase during the latter years.

[1] *Data obtained from Statistics Sweden home page, www.scb.se.*

4 Method

4.1 Design of the study

This study has three main advantages to its design. First, we study educational groups with high expected pay-off to education that probably also have access to the information valuable to the discovery of entrepreneurial opportunities based on science. Technological change and scientific development represent the sets of entrepreneurial opportunities that developed economies depend upon. Second, we study the whole complete population and not a sample. Therefore, any differences we discover represent actual differences in the population examined. Third, we follow the development of the population over an eleven-year period giving us the possibility to assess the dynamics and trends of this population when it comes to their engagement in self-employment.

We decided that controlling for both the level and the direction of education provided us with the most optimal population to study self-employment because indirectly, it also controls for several other factors. People having the same degree tend to come from the same social background and take their degree at approximately the same age. This gives us a well defined population that is more homogenous than those used in most previous studies of transition to self-employment (Bates, 1995; Carroll & Mosakowski, 1987; de Wit & van Winden, 1989; Delmar & Davidsson, 2000; Dunn & Holtz-Eakin, 1995; Dunn & Holtz-Eakin, 2000; Taylor, 2001). The fact that they have approximately the same background and the same education allows us to better understand what kind of opportunities they discover and how successful they are in exploiting them. This is important, because people with a degree in for-example computer science have a higher probability to identify a potential high-growth opportunity, than a person with no education (Freeman, 1982; Kirzner, 1997; Shane, 2000).

Another unique feature, and hence advantage of this study is the examination of the total population and that we follow that population for eleven years from 1990 until 2000. There we can follow everyone who is already in the population (those graduating prior to 1990), those entering the population (graduating 1990 or after, or emigrating to Sweden during this period), and those leaving the population (mortality or emigration). We can therefore examine both changes in the population (all active members) and also the progression of cohorts (people examined after 1990) when entering the population. We therefore control for age and cohort effects. Hence these data give us a unique opportunity to understand how and when this group of academics transit to self-employment.

This study relies on register data from Statistics Sweden. While it is based on register data we have not accepted data as it is, but have worked closely with register experts in order to combine data from various registers with the purpose of developing a unique data set to analyze the transition of academics in engineering, natural sciences and medicine into self-employment.

4.2 Data sources

Data were taken from Statistics Sweden. Statistics Sweden has developed a number of longitudinal databases that give us a unique opportunity to follow both the individual and the firm between the period of 1990 and 2000. This is made possible as tracking is based on the individual person number (the Swedish equivalent to the social security number), which is unchanged during the life of an individual. As a consequence we obtain stable units of analysis to follow over time.

The database LOUISE is an example of such a register and is the primary database for this specific set. It is a longitudinal database, where different official data registers have been combined to one to focus on issues related to the roles of education, income and labor. The primary entity of the registers is the individual, but we also have the possibility to attach other entities as, e.g., the family, the work place, and the firm (from other official register). Yearly data exists for the period 1990 to 2000 (eleven years). As a result, we can follow individuals, groups of individuals and firms over time.

4.3 Unit of analysis

The primary unit of analysis of this study is the individual as it represents the most stable entity in the data registers. It is also our purpose to follow how individuals transit into and out of self-employment. The majority of firms are started by a team of founders, and not by a single founder (Delmar & Shane, Forthcoming), and individuals can start and operate more than one firm in parallel. Therefore, the number of transitions into self-employment does not equal the number of firms created during the period of observation, because several entries into self-employment could represent one firm.

The data set thus comprises all individuals living in Sweden between 1990 and 2000 that have received a university degree (at least three years) in engineering, natural sciences, or medicine (nursing school excluded). With respect to these categories of people, it is therefore a census study. There are 221,708 such individuals of which 49,122 (22 procent) have been self-employed one year or more. Out of this population 44,182 (20 procent) graduated between 1990 and 2000 and thus entered the population. 4,790 (11 procent) of those individuals have been self-employed one year or more. Those graduating 1990 or after have a lower participation in self-employment because they are younger and are present a shorter time on the job market (between one and eleven years) than the rest of the population (at least eleven years if they do not die or emigrate during the period of observation). Therefore, they have been less exposed to self-employment opportunities, and therefore have a lower participation rate.

4.4 Definition of self-employment

The central variable of this study is self-employment. We set out to study the science and technology labor force's transition into and from self-employment. We define as self-employed any individual who operates a sole proprietorship or a partnership irrespectively of whether the individual receives an income from the company or whether the individual is also concurrently employed by another com-

pany. In addition, an individual owning (part of) a close held limited liability company, reporting it as the major workplaces is also considered self-employed.

This definition has several advantages compared to previous studies of self-employment. With this definition we are able to track individuals entering self-employment before they receive a positive income, but also when no positive income is received but the firm is still active. This leads to better estimates of how many actually enter into self-employment and not only those that are able to show a positive income. The inability to do so would otherwise lead to two important problems:

1. We would underestimate how soon people enter self-employment because depending on the type of opportunity exploited it will take more or less time (if ever) to positive income.
2. We would also overestimate the number of exits and entries as only individuals with a positive income from self-employment are coded as self-employed. Therefore, not correcting the data would lead a person to be coded as an exit from self-employment when the income was zero or negative and to be coded as a new entry into self-employment when the income became positive again.

However, only using this definition could lead us to misinterpret data as we might overestimate self-employment when the registered firm is actually inactive or has been terminated, or the legal status of the firm has changed. We have therefore other criteria to control for the firm's stability over time. Instead of solely relying on the organization number of the firm (which changes as owners change, with legal status, and geographic relocation) we have created a second identity taking into consideration the work place, people working there (if any), and ownership to better track the "real" life of the firms created by our population.

It is important to note that self-employment does not necessarily equal the creation of an independent firm. People can enter into self-employment in a number of ways. They can choose to start a new independent firm alone or together with others. They can buy shares of an existing business and become part-owners or full owners. They can also inherit a firm. In the present study we do not differentiate among the types of entry.

There are also some important limitations to the data. Full data was not available for all years in the sample. The major restriction is that it was only possible to discriminate between self-employment as primary or secondary activity from 1997 and onwards. Consequently, analyses of this variable only contain this time-period. Further, location and industry data at the work place level were only available for the primary activity of the individuals. Therefore, we do not know the industry or location of those businesses that are operated as a secondary activity. Therefore, because we can not discriminate between self-employment as primary or secondary activity before 1997 and we do not know location and industry for businesses operated as secondary activities, we can only conduct analyses on location and industry for those businesses that are operated as primary activity, and only from 1997 and onwards.

In sum, the design of the study enables us to follow the individual over time. Compared to earlier studies we are able to employ a more rigorous definition of self-employment, which allows us to more precisely determine self-employment entries and exits.

4.5 Education and educational length

We discriminate among three types of education and between two educational lengths. In order to be included in the population an individual has to have received at least a three year university degree in the following fields: engineering, medicine and the natural sciences. The categorization of types of educations is based on SUN and SUN2000 codes which are the Swedish official system to categorize educations.[2] Thus we do not include categories such as nurses. Nursing in Sweden is defined as a tertiary education, but does not fulfill our definition of a university degree. Nor are individuals who have taken shorter engineering training or has not taken a degree for one reason or another. Additionally, we differentiate between those having taken a university degree based on a minimum of three years of university, and those that have receive a postgraduate degree. That is, those having a research degree versus those not having taken such a degree.

4.6 Region

We use two different measures to measure regional variation. We use the Swedish county system, which is based on 21 different counties. A county represents a regional administrative unit. Our second measure is based on socio-economic structure and has been developed by Nutek. This classification divides Sweden into six different types of regions. The six types are:

1. Metropolitan regions
2. University regions
3. Regional centers
4. Secondary regional centers
5. Small regions dominated by private enterprising
6. Small regions dominated by public sector

The second measure enables us to better assess the reasons behind the regional variations in self-employment.

4.7 Industry

Following previous work in this area (Davidsson & Delmar, 2003; Davidsson, Lindmark, & Olofsson, 1994a, 1996) we base our industry classification on three categories: manufacturing, knowledge intensive services, and other. These categories are based on the Swedish industry standard (SNI92).

[2] *The exact categorization is available from the authors.*

4.8 Description of the population

In Table 1 the development of the population from 1990 to 2000 is presented. For each year we report the number of people that are included in the population, i.e. the total stock of individuals that have the type of education we are focusing on in this report. The figures for the total number of individuals included during a specific year represent previous year's value plus (or minus) the net change. The net change is the number of entries in the population (graduation plus people moving to Sweden) minus the number of exits (people dying or moving out of Sweden). First of all we can conclude that we are dealing with a growing population (140,769 in 1990 and 186,496 equaling an increase of 45,727) in 2000. The increase in population size between 1990 and 2000 is approximately 39 procent for engineering, 17 procent for medicine and 44 procent for science, which adds up to a total increase of 33 procent for the whole population.[3] Second, the relative share of the three types of education is almost constant over the studied period. On average the population is comprised of approximately 50 procent having a degree in engineering, 30 procent having a degree in medicine, and 20 procent having a degree within the natural sciences.

[3] *1990 represents a difficult year in all calculations where flows are examined (entry and exits) instead of stocks. The entry rates (e.g. number of new graduates, and number of new firms) are not necessarily correct. The reason is that we cannot control for the status prior to 1990. The values for new entrants in 1990 include both those genuinely new as well as those that may have entered the population prior to 1990. As a consequence, we might overestimate the value for variables related to entry in the population in 1990.*

Table 1 Development of the population 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000
Engineers total:	68783	70638	71136	72947	74945	77380	80405	84114	88140	92917	95456	26673
Percent of total	48.9%	49.3%	49.5%	50.0%	47.9%	48.3%	49.1%	49.6%	50.3%	50.1%	51.2%	38.8%
Medicine total:	47532	48081	47930	48272	49829	50165	50651	51360	52029	52952	55752	8220
Percent of total	33.8%	33.5%	33.4%	33.1%	31.8%	31.3%	30.9%	30.3%	29.7%	28.5%	29.9%	17.3%
Science total:	24454	24637	24643	24780	31737	32643	32760	33962	34899	39693	35288	10834
Percent of total	17.4%	17.2%	17.1%	17.0%	20.3%	20.4%	20.0%	20.0%	19.9%	21.4%	18.9%	44.3%
Total:	140769	143356	143709	145999	156511	160188	163816	169436	175068	185562	186496	45727
												32.5%

Table 2 below depicts how the population has developed in relation to the three educational groups in regards to length of education. The three main groups of engineering, medicine and natural sciences each have been divided into two categories describing the length of education. The first category is comprised of individuals that have conducted undergraduate and/or graduate studies, whereas the latter category contains individuals with postgraduate studies. Thereby we are able to distinguish between individuals with a, for our population, basic education and those that have research training. In other words we have made distinctions between individuals with undergraduate and graduate studies and those with postgraduate studies.

Based on Table 2 we can observe that both the group of graduates and the group of postgraduates have grown in absolute numbers between 1990 and 2000. The first group has grown with 30 % during the period whereas the latter group has increased by 48 %. On average for the whole population the relative share of undergraduates and graduates is 86 % and consequently for postgraduates the share is 14 % on average. Another overall statement that can be made is that the relative share of postgraduates has slightly increased during the period from 13 % in 1990 to 15 % in 2000.

In absolute numbers there has been an increase in number of postgraduates within all three educational groups, i.e., engineering, medicine and science. Since all three groups have grown in absolute numbers it is interesting to consider the relative share of postgraduates within each group and its development over time. Looking at each main education group individually enables us to compare the relative share of postgraduates within each group. In other words we can compare the relative proportion of postgraduates within engineering with the relative share of postgraduates within medicine. Such a comparison can indicate in which group there is a heavier focus on research. By doing so we can see that natural sciences has the highest relative share of postgraduates. Closely behind we find medicine. The engineering group has the lowest share of postgraduates. Looking at the development over time we find that the relative share of postgraduates within natural sciences has decreased, from 27 % to 24 %. At the same time the relative share of postgraduates within engineering has been quite stable over time, between 7 % and 9 %. Medicine on the other hand is characterized by an increased proportion of postgraduates. Here the proportion has grown from 15 % to 21 % during the studied period, which is quite impressive.

Table 2 Development of population by length of education (Graduate and post-graduate)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000
Engineers total:	68 783	70 638	71 136	72 947	74 945	77 380	80 405	84 114	88 140	92 917	95 456	
Undergraduate and graduate	63 728	65 271	65 627	67 138	68 803	70 813	73 451	76 660	80 213	84 476	88 168	24 440
	92.7%	92.4%	92.3%	92.0%	91.8%	91.5%	91.4%	91.1%	91.0%	90.9%	92.4%	38.4%
Postgraduate	5 055	5 367	5 509	5 809	6 142	6 567	6 954	7 454	7 927	8 441	7 288	2 233
	7.3%	7.6%	7.7%	8.0%	8.2%	8.5%	8.6%	8.9%	9.0%	9.1%	7.6%	44.2%
Medicine total:	47 532	48 081	47 930	48 272	49 829	50 165	50 651	51 360	52 029	52 952	52 952	
Undergraduate and graduate	40 450	40 651	40 333	40 429	41 181	41 213	41 360	41 691	42 019	42 424	44 856	4 406
	85.1%	84.5%	84.1%	83.8%	82.6%	82.2%	81.7%	81.2%	80.8%	80.1%	84.7%	10.9%
Postgraduate	7 082	7 430	7 597	7 843	8 648	8 952	9 291	9 669	10 010	10 528	10 896	3 814
	14.9%	15.5%	15.9%	16.2%	17.4%	17.8%	18.3%	18.8%	19.2%	19.9%	20.6%	53.9%
Science total:	24 454	24 637	24 643	24 780	31 737	32 643	32 760	33 962	34 899	39 693	39 693	
Undergraduate and graduate	17 829	17 832	17 711	17 738	23 404	23 995	24 114	25 136	25 767	29 526	25 651	7 822
	72.9%	72.4%	71.9%	71.6%	73.7%	73.5%	73.6%	74.0%	73.8%	74.4%	64.6%	43.9%
Postgraduate	6 625	6 805	6 932	7 042	8 333	8 468	8 646	8 826	9 132	10 167	9 637	3 012
	27.1%	27.6%	28.1%	28.4%	26.3%	25.9%	26.4%	26.0%	26.2%	25.6%	24.3%	45.5%
Total:	140 769	143 356	143 709	145 999	156 511	160 188	163 816	169 436	175 068	185 562	186 496	
Undergraduate and graduate	122 007	123 754	123 671	125 305	133 388	136 021	138 925	143 487	147 999	156 426	158 675	36 668
	86.7%	86.3%	86.1%	85.8%	85.2%	84.9%	84.8%	84.7%	84.5%	84.3%	85.1%	30.1%
Postgraduate	18 762	19 602	20 038	20 694	23 123	23 987	24 891	25 949	27 069	29 136	27 821	9 059
	13.3%	13.7%	13.9%	14.2%	14.8%	15.0%	15.2%	15.3%	15.5%	15.7%	14.9%	48.3%

Table 3 describes the development of the population when the sex distribution is taken into account. The basic sex distribution across education is important for several reasons. First, we know that gender stereotypes make women avoid the natural sciences and technological sciences in favor for other educational choices as humanities and social sciences. In general women and especially younger women are better educated than their male counterparts in terms of years in schooling and university degrees, but important differences remain between what kind of education is chosen. This has been recognized as an important problem in Europe (Eurostat, 2001). Second, the basic gender distribution determines the base rate for the opportunities to engage in self-employment. As we have concluded, women and men do not have equal opportunities in their choice of education, and we therefore have biased distribution in the favor of a male majority.

Table 3 Development of the population by gender 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000
Engineers total:	68 783	70 638	71 136	72 947	74 945	77 380	80 405	84 114	88 140	92 917	95 456	
Men	60 734	62 060	62 305	63 558	65 040	66 923	69 185	71 942	74 954	78 439	79 669	18 935
	88.3%	87.9%	87.6%	87.1%	86.8%	86.5%	86.0%	85.5%	85.0%	84.4%	83.5%	31.2%
Women	8 049	8 578	8 831	9 389	9 905	10 457	11 220	12 172	13 186	14 478	15 787	7 738
	11.7%	12.1%	12.4%	12.9%	13.2%	13.5%	14.0%	14.5%	15.0%	15.6%	16.5%	96.1%
Medicine total:	47 532	48 081	47 930	48 272	49 829	50 165	50 651	51 360	52 029	52 952	55 752	
Men	29 261	29 423	29 338	29 324	29 975	29 931	29 989	30 081	30 120	30 331	31 339	2 078
	61.6%	61.2%	61.2%	60.7%	60.2%	59.7%	59.2%	58.6%	57.9%	57.3%	56.2%	7.1%
Women	18 271	18 658	18 592	18 948	19 854	20 234	20 662	21 279	21 909	22 621	24 413	6 142
	38.4%	38.8%	38.8%	39.3%	39.8%	40.3%	40.8%	41.4%	42.1%	42.7%	43.8%	33.6%
Science total:	24 454	24 637	24 643	24 780	31 737	32 643	32 760	33 962	34 899	39 693	35 288	
Men	16 940	17 006	16 935	17 013	21 789	22 128	22 143	22 798	23 253	26 141	23 214	6 274
	69.3%	69.0%	68.7%	68.7%	68.7%	67.8%	67.6%	67.1%	66.6%	65.9%	65.8%	37.0%
Women	7 514	7 631	7 708	7 767	9 948	10 335	10 617	11 164	11 646	13 552	12 074	4 560
	30.7%	31.0%	31.3%	31.3%	31.3%	31.7%	32.4%	32.9%	33.4%	34.1%	34.2%	60.7%
Total:	140 769	143 356	143 709	145 999	156 511	160 188	163 816	169 436	175 068	185 562	186 496	
Men	106 935	108 489	108 578	109 895	116 804	118 982	121 317	124 821	128 327	134 911	134 222	27 287
	76.0%	75.7%	75.6%	75.3%	74.6%	74.3%	74.1%	73.7%	73.3%	72.7%	72.0%	25.5%
Women	33 834	34 867	35 131	36 104	39 707	41 026	42 499	44 615	46 741	50 651	52 274	18 440
	24.0%	24.3%	24.4%	24.7%	25.4%	25.6%	25.9%	26.3%	26.7%	27.3%	28.0%	54.5%

In all three educational groups women represent the minority, even if there are large differences between the three groups. The group with the highest share of women is medicine and the group with the lowest share of women is engineering. The participation rate of women in medicine is on average 27 % units higher than for women within engineering. In medicine we can observe that on average about 41 % of the population are women and in engineering the corresponding share is about 14 % for the observed period. Even if these results are undesirable we can from a perspective of equal opportunities, however, observe a positive trend in all three educational groups: the participation rate of women is rising steadily. The total stock of women has increased with 96 % within engineering, 34 % within medicine and 61 % for the natural sciences. Looking at the relative share represented by women within the three educational groups we can conclude that a positive trend is visible also here. From representing 12 % of engineers, 38 % of medicine and 31 % of natural sciences in 1990 the relative share has increased for all three groups during the studied period. In year 2000 women represented 17 % of the engineers, 44 % of the medics and 34 % of the natural scientists. For the overall population the relative share represented by women has increased from 24 % to 28 %.

To sum up the description of the population, we can conclude that it is a growing population. It is a population where we can observe that women remain in minority, although their participation is growing and there are large differences between the three types of education. Other differences between the three education groups concern the length of education where we find that the natural sciences is the most research intensive education group. However, the medicine group is closing in and also has high research intensity. Out of the three education groups engineering has the lowest relative share of postgraduates.

4.9 Analyzing the population and its involvement in self-employment

The purpose of this study is to describe how involved these three educational groups are in self-employment. This involvement can be described in numerous ways. We have decided to use four different variables to describe not only the involvement but also the dynamics of self-employment. We use the following variables:

1. Rates of self-employment
2. Entry into and exit from self-employment
3. Duration in time of self-employment
4. Self-employment as primary vs. secondary source of income

Before we go into the specific details of the different descriptor variables, it is worthwhile spending some time to understand the structure of data and how self-employment can be understood in the specific setting of longitudinal data. This enables us to better motivate the variables utilized to describe self-employment and for the reader to understand what is and what is not covered by the data.

Understanding longitudinal data. In this study we are covering one specific time period, more precisely 1990-2000. We are not only working with a longitudinal design, but we also work with different cohorts, since new people enter the population each year. In total we have eleven different cohorts plus those that have taken a degree prior to 1990. The eleven cohorts are all those that graduate every year between 1990 and 2000. As we follow the population under eleven years, we also include those newly graduated each year, which make up our eleven cohorts. So the data are comprised of two main categories of individuals: those that have a degree prior to 1990, and those taking a degree 1990 or after. All individuals are at "risk" of becoming self-employed. However our possibility to describe why and how they become self-employed differ between the two groups. For the former group, we have no information of what happened prior to 1990, when they may or may not have been self-employed. These cases are left-censored, as their work careers are unknown before we start to measure it in 1990. For the latter group we follow them from the time they enter the job market (defined as the year they graduate) and forward. However, in this group we can only follow them from a minimum of one year (those graduating in 2000) to a maximum of eleven years (those graduating in 1990). Thus we measure their early years on the labor market. This time period might be too short for them to gain the needed idiosyncratic experience and the resources to become self-employed.

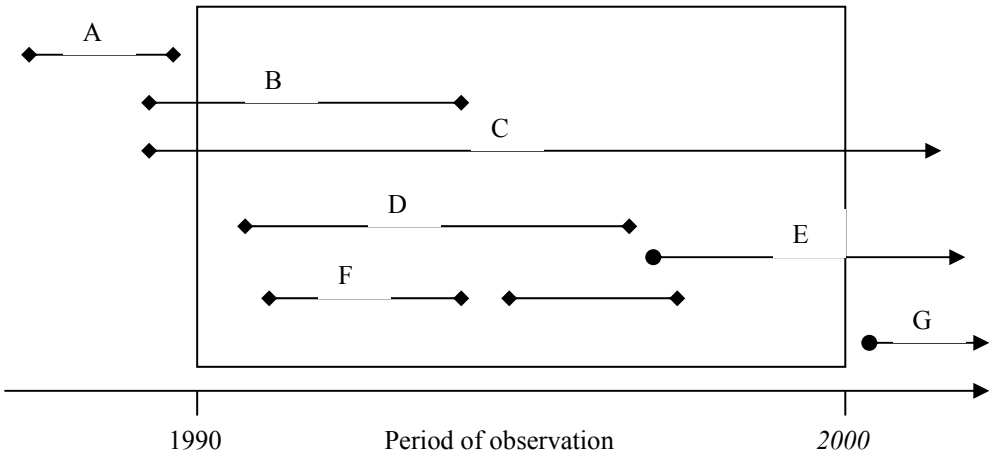
Figure 1 illustrates the structure of the data and a number of different possible spells (i.e. periods of self-employment) that we can encounter. As mentioned above, the observation period is limited and there are cases that have censored information. Spell (A) is an example that is not grasped by our data since we do not have any information covering the period before 1990. This could concern a case where the person has been self-employed and has stopped being self-employed previous to our measurement period. In our data, we cannot see this. Regarding (B), we do not have information about the spell before 1990, e.g. when the individual entered into self-employment, but from 1990 and onwards we have complete information. This is a case where a person is self-employed when we start the period of observation. However, we do not know how long this person has been self-employed. It could vary from one year and upwards. For (C) we only have access to information during the observed period and have no information about what happens before or after. This is the same case as the previous example with the difference that person is self-employed during the whole period of observation. All these examples are in some sense left-censored and are all present in our data.

The following examples are all right-censored. Examples (D) and (F) are fully covered by our data. In the case of (D), it is an individual with one spell of self-employment and (F) has entered into and exited from self-employment twice. Regarding (E) we do not have any information after 2000 and we have no information whatsoever about (G). This is a case where the person is not self-employed during the period of observation, but becomes so after it ends. The lack of information covering the period before 1990, is referred to as left censoring and the lack of information after the studied period is called right censoring.

As depicted in Figure 1 below, we are dealing with both left and right censoring. Left censoring is most difficult to deal with and especially when it is a case of full censoring, i.e. example (A). This is why it is problematic for us to deal with individuals that graduated prior to 1990, since we do not have access to their past track record, instead they are all included from 1990 and onwards, regardless of when they actually graduated. Left-censoring is especially problematic when trying to explain how and why processes develop as they do. The only way to deal with left-censoring is to either gather more data or to eliminate such cases. However, our prime purpose is not to explain what is happening, but to describe the development of this population over time.

Furthermore, understanding the structure of the data is important for understanding how to present the results. For example, we will have a number of cases that do not have an entry into self-employment, but only one exit (persons entering self-employment prior to 1990). We also have a number of cases that do not have an exit from self-employment, because they exit self-employment after 2000. Obviously, the structure of data leads us to adopt a number of different measures to be able to describe what is happening in this particular population.

Figure 1 Possible spells of self-employment in data



Rates. The rate of self-employed is defined as the absolute or relative number of self-employed in relation to population at a particular point of time. We measure the rates of self-employment on a yearly base as the number of people reported that year to be self-employed.

Rates change from one year to another as a number of people become self-employed (entry) or choose to terminate their spell of self-employment (exit). Rates, therefore, represent the present stock of self-employed and do not give us any information about the dynamics underlying the present status. For example, while unlikely, it could be possible that from one year to another, the whole population of self-employed is changed. That is, all those self-employed during the previous year could be replaced by a whole new group each year. We therefore need additional measures in addition to rates in order to capture the dynamics of self-employment.

Entry and exit. A complementary measure to self-employment is the number of entries and exits that we observe on a yearly base. For each year, we are able to measure the number of people who choose to enter self-employment and the number of people that exit self-employment. This gives us a possibility to understand both the net and gross changes in rates of self-employment over time. We measure entry as the change in labor status from one labor force status to self-employment. We calculate exit as the change in labor force status from self-employment to another labor force status.

However, neither rates nor the number of entries and exits give any information about how long people stay in self-employment. As with firm survival (Audretsch & Mahmood, 1995; Carroll & Hannan, 2000), the duration of self-employment varies.

Duration. We measure duration as the number of years a person stays self-employed. The value of the measure varies between one year and ten years. We calculate duration for every cohort (or year) as it is possible that depending on when self-employment was entered, the person is more or less prone to exit. For example, the economic cycle might lead people to stay for a longer or a shorter period depending on the opportunity cost associated with other options on the labor market. Self-employment is episodic in the sense that people over their job careers move in and out of self-employment (Carroll et al., 1987). Duration is calculated as the time between entry and exit for one single person.

Duration is not to be interpreted as an indicator of financial performance. That is, the shorter the duration of the spell, the poorer the value of the entrepreneurial opportunity exploited. People choose to exit from self-employment for a number of other reasons besides purely financial ones. People may leave self-employment because they have lost interest or are not able to combine self-employment with other goals in life. Furthermore, as people have personal thresholds for what they perceive to be a financially poor alternative (Gimeno, Folta, Cooper, & Woo, 1997) it is difficult to say anything conclusive of why people have left self-employment. Some people might leave self-employment because they have better options elsewhere, despite that the exploited opportunity is financially sound. Vice versa people might continue as self-employed with a financially unsound opportunity because they do not believe they have other alternatives.

Self-employment as primary or secondary source of income. Not all that enter self-employment do so full time. On the contrary, there is reason to believe that most people that become self-employed do so part-time beside their regular employment. This is not necessarily negative as we might consider this to be a strategy to either gain more entrepreneurial experience or to test the potential value of an opportunity before committing full time to it.

In this study we are able to measure those who are self-employed part or full time from 1997 and onwards. For this particular study we define someone as being part time self-employed when he or she reports to have an income from employment that exceeds the income received from the firm. A person is full time self-employed when his or her income is higher (or the only one) than for any other type of income.

5 Results

We here describe the results of our analyses concerning the involvement in self-employment of individuals with a university degree in engineering, in the natural sciences or in medicine. We first start describing the population in general, and then we take a closer look at the sex structure of the population. Third, we present the results concerning the geographical dispersion of self-employment. Fourth and finally we present the results concerning the industry affiliation of the self-employed.

5.1 The dynamics of self-employment

5.1.1 Rates of self-employment

We now move on to describe the development of individuals involved in self-employment. Table 4 displays how the number of self-employed has developed over the period. We have already mentioned that there are 221,708 individuals who remain in the population at least one year. Out of those, 49,122 (22 %) have been self-employed one year or more. However, the yearly average is much lower with about 23,000 individuals being self-employed each year. This represents about 14 % of the active population a particular year. We can only observe one important shift in the development of self-employed and it occurs in 1994. This shift is observed in all statistics of Swedish self-employment, and is due to the introduction of the enterprise allowance scheme[4] "Starta eget-bidraget" in combination with a general upturn in the economy.

Two other observations are worthwhile mentioning. First, as shown in table 4 we can see that the absolute number of self-employed has increased within all three categories during the studied period (see also appendix A1 for a better visualization). However, there is a general down turn in the relative number of individuals engaged in self-employment. In 1990 15 % of the population was self-employed, and in 2000 the corresponding share was 13 %, which represents a relative downturn of 15 %. A closer examination reveals that engineers account for that decrease, whereas the relative share of self-employed within medicine and natural science has remained quite stable (see also appendix A2). Actually, the ICT boom during 1996-1999 does not seem to have an important effect on the rate of self-employment. The second observation is that important differences exist between the three educational groups. People in medicine have a much higher rate of self-employed compared to natural sciences and engineering. The average during the period for people in engineering is about 13 % and in natural sciences close to 10 %, whereas it is close to 19 % for people within medicine! It seems as if people in medicine have significantly higher probability to become self-employed than do people from the other two educational groups. This finding was anticipated. Medical doctors

[4] *This subsidy was introduced to support unemployed individuals' attempt to start their own business. The subsidy is designed to provide the unemployed/self-employed with a small salary during the first year of operation.*

have a tradition of working for the public sector and few alternatives for employment exist outside this sector. On the other hand, there is a long-standing tradition among medical doctors to run their own practice on the side while at the same time being employed. Thus, it is plausible that medical doctors by tradition are more likely to start their own business. Further, the opportunity cost for doing so is likely to be lower than for the other categories, because there are fewer other career alternatives apart from the few public sector employers.

Table 4 Rates of self-employment 1990-2000

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**Change 1990-2000**
Engineers total:	68 783	70 638	71 136	72 947	74 945	77 380	80 405	84 114	88 140	92 917	95 456	
Self-employed	9 724	9 452	9 346	9 373	10 916	11 038	10 526	10 456	10 365	10 481	10 457	733
% of engineering	14.1%	13.4%	13.1%	12.8%	14.6%	14.3%	13.1%	12.4%	11.8%	11.3%	11.0%	7.5%
Medicine total:	47 532	48 081	47 930	48 272	49 829	50 165	50 651	51 360	52 029	52 952	55 752	
Self-employed	8 890	8 885	8 775	8 802	10 081	10 360	10 052	10 068	9 979	10 153	10 908	2 018
% of medicine	18.7%	18.5%	18.3%	18.2%	20.2%	20.7%	19.8%	19.6%	19.2%	19.2%	19.6%	22.7%
Science total:	24 454	24 637	24 643	24 780	31 737	32 643	32 760	33 962	34 899	39 693	35 288	
Self-employed	2 511	2 420	2 373	2 381	3 115	3 261	3 286	3 447	3 585	3 699	3 654	1 143
% of science	10.3%	9.8%	9.6%	9.6%	9.8%	10.0%	10.0%	10.1%	10.3%	9.3%	10.4%	45.5%
Total:	140769	143356	143709	145999	156511	160188	163816	169436	175068	185562	186496	
Self-employed	21 125	20 757	20 494	20 556	24 112	24 659	23 864	23 971	23 929	24 333	25 019	3 894
% of total	15.0%	14.5%	14.3%	14.1%	15.4%	15.4%	14.6%	14.1%	13.7%	13.1%	13.4%	18.4%

Since there are differences between the three educational groups, it is also likely that differences in self-employment in relation to the educational groups and length of education exist. In appendix 3 we have compared the level of self-employment not only between the three educational categories, but also with regards to length of education. In other words, undergraduates and graduates are compared with post-graduates. The most striking finding here is that postgraduates are much more prone to engage in self-employment than are graduates, and this holds true for all three educational categories. Many individuals with post-graduate education work at universities, and universities allow – and to an increasing extent even encourage – their employees to start businesses while remaining employed at the university. Therefore, we would expect those with post-graduate education to be more prone to become self-employed.

Furthermore, there are large differences between postgraduates within engineering, medicine and the natural sciences, where postgraduates within medicine are the individuals most likely to enter into self-employment. The share of self-employed postgraduates within medicine is above 20% during the whole period. The absolute number of self-employed postgraduates has increased for all groups during the studied period. However, the relative share of self-employment for postgraduates within medicine and engineering has decreased, while the corresponding share within natural science has been quite stable during the whole period. The development of the relative share within each group is depicted in appendix 4. As shown in appendix 4 the groups of postgraduates within each category has a higher share of self-employed than do their counterparts, i.e. undergraduates and graduates. Furthermore, self-employment is highest within medicine and lowest for the natural sciences category.

5.1.2 Entry and exit

In Table 5 we find the dynamics of entry and exit from self-employment. For each year we present the number of people that either enter into or exit from self-employment. The number of self-employed in a particular year (year 1) equals the number of self-employed in existence the previous year (year 0) minus the number of exits that year (year 0) plus the entries during this particular year (year 1). For example, the number of self-employed in 1991 can be obtained by: 21,127 (number of self-employed 1990) – 4,514 (number of exits in 1990) + 4,148 (number of entries in 1991) = 20,761 (number of self-employed in 1991). This share of entry and exit reflects dynamics and is also known as the "churning" of the group. By doing this, we can describe both the net and the gross flows within the group of self-employed and determine the structural stability of the group. The more stable the group is (the less entries and exits), the longer people stay self-employed on average, and the less dynamics can be observed.

However, stability might indicate that there are barriers to entries and exists which also means that there probably is less exposure to competition and therefore, the economic development is hampered. This is positive on the micro level, since those that actually engage in self-employment have higher probability of survival. It is negative on a macro level, as competition does not drive development effectively

enough, and that the labour market may be too rigid. More entries and exits can therefore indicate that more people during their work life are self-employed at one time or the other, and that they can easily flow back and forth between employment and self-employment. Obviously, the churning can be interpreted in a variety of ways and we need to supplement this with information of how long on average an individual stays self-employed.

The period between the entry into and the exit from self-employment is referred to as a spell. The length of a spell can both be an indication of how rewarding (financially and socially) self-employment is, but also an indicator of how difficult it may be to shift back to get another job. How many spells a single individual engages in during the period of observation can be seen as an indicator of how attractive and easy it is to go back and forth between self-employment and other labor market status. The easier the transition can be made, the higher the number of spells people will engage in. The combination of these four types of information (entry, exit, average length of spells and number of spells) allows us to determine the nature of the dynamics of self-employment.

The total number of entries and exits during the period of observation are presented in Table 5. As can be seen in the table, there are important shifts in the entry and exit rates over time. Entry and exit rates are highly related to each other. When the entry rate is high so is then the exit rate. We can observe two years where the changes in rates were the most dramatic. In 1990-91 more than 20% of the population of self-employed were replaced which also led to a reduction in the total number of self-employed. This can be seen as a reaction to the severe recession Sweden experienced in the beginning of the 1990's. The second important year is 1993-94, where the number of entries is the most important for the whole period, with a net addition of self-employed of 24%. Here we can observe the effect of an expanding economy in combination with state supported subsidiaries. Hence, while the total number of self-employed seems to be relatively constant over the years, they tend to mask important flows of entries and exits from self-employment.

Table 5 Entry into and exit from self-employment 1990-2000

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Entries		4148	2931	2778	5771	4304	3530	3732	3475	3704	4235
Exits	4514	3194	2704	2168	3737	4309	3588	3503	3255	3630	
Total self-employed	21127	20761	20498	20572	24175	24742	23963	24107	24079	24528	25133
Entries as % of total		20.0%	14.3%	13.5%	23.9%	17.4%	14.7%	15.5%	14.4%	15.1%	16.9%
Exits as % of total	21.4%	15.4%	13.2%	10.5%	15.5%	17.4%	15.0%	14.5%	13.5%	14.8%	

What we observe are probably important shifts in pull and push factors affecting self-employment. Push factors are factors that drive people into self-employment such as unemployment or dissatisfaction with current employment. Pull factors are factors that attract people to become self-employed because of valuable opportuni-

ties to become self-employed. Theory argues that during a recession people are pushed into self-employment, because it is the only alternative to generate an income. During an economic boom, people are pulled into self-employment because the general economic situation allows for a higher risk-taking (and a higher return on investment). If we assume that pull and push factors have the same effect on people and that they replace each other as the nature of the economy changes, we would observe no relationship between the economic cycle and self-employment rates because the factors affecting entry and exit cancel each other out.

It is possible that there will be differences in exit and entry rates if the data is broken down into more fine-grained categories (see appendix 5). In order to investigate whether such differences actually exist we have compared entry and exit rates in regards to education. Only examining rates of entry and exit, we can observe small differences between the three education groups in general. However, there are some differences worth mentioning. First, the share of self-employment accounted for by entries and exits lies at a relatively low level for the medicine group in comparison to the other two groups. This might be an indication that we are dealing with a rather stable group of self-employment. As mentioned earlier, it could also be a sign of barriers to entry and exit. However, since the group accounts for a high number of self-employment the observation is most likely attributable to the stability of the group. We have already pointed out that 1994 was an extraordinary year in regards to the high level of entries. The group that distinguishes itself the most is the natural sciences group, which demonstrates a very high entry rate of 32 % and an exit rate of 17 %. The difference between the rate of entry and the rate of exit is consequently the highest for this group. Furthermore, the science group shows the highest degree of entries each year and for some of the years also presents the highest rate of exits. This is probably an indication of the group being the least stable, but perhaps also very dynamic. In order to make such a statement, however, the data needs to be complemented with figures on average length of spells and number of spells, which is done in one of the following sections.

5.1.3 Duration

A second way to measure involvement in self-employment is to measure for how long people stay in self-employment once they choose to enter. This is the length or duration of the spell of self-employment. Stated differently, we measure how long people keep their businesses and then abandon them (independent of reason). This is not the same as saying that we measure the duration of the life of the firms they start. The measures differ from each other. An individual can chose to leave self-employment and abandon the firm, but the firm might continue to live. For example, consider the case where three people decide to start a new firm together. Two of the founders might decide to abandon the firm after five years, while the third founder decides to continue. In this case, we would code the spells as five years long for two of the founders, and longer for the third founder. None of the cases represent the survival of the firm. Another example, a consultant working as an employee in a small firm for a number of years is offered to become partner and

share ownership. In this case, the consultant becomes self-employed, but no new firm is created.

Table 6 presents the distribution of duration across nine cohorts. There are nine cohorts because we need to know exactly when entry was made and the entry must have the possibility to exit at least once. We therefore exclude year 1990, as we do not have reliable information about the status of the population prior to 1990. Our first cohort is therefore 1991. We exclude year 2000, because entry is made during the last year and we cannot measure if there are any exits as they are recorded the following year. This means that we are dealing with nine different cohorts or years, where those started in 1991 are tracked for ten consecutive years, and those started in 1999 for two years.

The table should be interpreted the following way: each year represents the frequency of individuals still self-employed. In year one all are self-employed and in year two 69 % (the 1991 cohort) are still self-employed. This means that between year 1 and 2, 31 % exited from self-employment. Depending on when individuals become self-employed they might vary in their ability to stay self-employed. For example, becoming self-employed in 1991 when Sweden was in a recession might differ altogether from becoming self-employed in 1998 during the economic boom. We could therefore expect the duration of self-employment to vary due to differences in the economic cycle at the time of their respective entry. These differences are known as cohort effects. Cohort effects differ from age effects. Age effects are changes associated with the duration of existence itself, for example, the gradual loss of the self-employee's initial enthusiasm for their situation. By comparing the cohorts with each other, we can determine if the distribution of spells is due to difference related to when they entered self-employment (cohort effect), or to difference in age effects. In the former case, we would expect an important variation across the years, and in the later case, we would expect a similar distribution independent of when self-employment was done.

Table 6 Duration of spells for self-employed for cohorts 1991-1999

	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
1	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2	68.6%	72.4%	78.9%	76.1%	76.6%	73.5%	74.0%	73.6%	70.8%	73.8%
3	54.1%	62.9%	66.1%	62.9%	63.8%	60.0%	61.4%	58.0%		61.2%
4	47.2%	53.8%	55.8%	53.6%	55.3%	51.6%	50.5%			52.5%
5	41.7%	45.2%	49.5%	46.9%	48.7%	44.8%				46.1%
6	35.4%	39.0%	44.4%	40.8%	43.4%					40.6%
7	31.2%	34.7%	40.0%	35.7%						35.4%
8	27.4%	31.8%	35.6%							31.6%
9	24.6%	28.7%								26.7%
10	22.2%									22.2%

We can conclude that some important variations exist in duration that are related to when the individual entered self-employment. The lowest durations in self-employment are observed in 1990 and in 1999. The first year is during the recession, and the latest year is during the end of the economic boom. It is possible, that in 1990 people had a difficult time to stay in business, and had to find other options. In this case, they are pushed from self-employment. In 1999, the economy was still at its strongest, and it is possible that the strong demand for people with the kind of educational background of the people in this population had other more profitable and less risky alternatives on the labor market. They were pulled out of self-employment.

Between 1993 and 1995, we can observe that the share of self-employed being in self-employment three years or less is significantly higher then for the other years. This indicates that the recovery in the economy that occurred during that period had an effect on duration. Otherwise we would have observed a similar pattern over the years. The relatively largest drop occurs after the first year where 25 to 30 % of the self-employed leave. Half of them are still self-employed after four years. The rest have chosen to exit. For obvious reasons there is a diminishing trend to exit as time goes by. The longer people have been self-employed, the higher is the probability that they will remain so the following year. That is, the relative drop from one year to another decreases over time.

In order to account for differences between different groups, we have compared the duration rates in relation to education. When comparing the three educational groups (see appendix A6 for details) the most evident difference is that the duration rates for medicine is much higher than for engineering and natural science. For every year and cohort, people in medicine tend to stay longer self-employed than the two other educational groups. There is no indication that the three groups converge as time goes by. People in medicine remain self-employed at a higher level over the years.

We also examine the effect of educational length (see appendix 7). The difference is small but it is stable over time: Postgraduates have shorter spells of self-employment than undergraduate and graduate. This can probably be explained by the fact they have higher opportunity costs than undergraduate and graduate.

Level of individual activity. Another way to measure self-employment in this population is to examine how often a single individual enters and exits during the period of observation. This is an indication about the level of activity of people, and if people find it easy to become self-employed or not. There are 32,777 entries during the period of observation. This does not mean that 33,777 people actually become self-employed, since a person can go back and forth between self-employment and employment several times. However, 84 % of the entries are made by people who only make one transition during the period, 14 % of the entries are made by individuals that make two entries. People who make three or more entries represent less than two percent of the entries.

There are 29,964 exits during the period of observation. Of the exits, 86 % are made by people that make only one transition, people doing two exits make up for 13 % of the exits. People who make three or more exits represent somewhat more than 1 % of the exits. So for most people self-employment seems to be a unique experience that they do not necessarily want or have the possibility to repeat, at least not during the eleven years that we observe. The probability of entering and exiting from self-employment is obviously correlated with the length of the spell of self-employment. A high number of entries and exits per person can lead to the conclusion that the spells are relatively short, that the individual is prepared to repeat the transition, or both. That a majority of people only experience one entry or one exit, can be both an indicator that once they have become self-employed, they tend to stay so, or that if they exit from self-employment they do not become self-employed again. We do not observe any important differences between groups of education and gender when it comes to entry and exit.

5.1.4 Self-employment as primary vs secondary income

Table 7 presents the results concerning the distribution between those being self-employed and having it as their primary source of income, and those being self-employed and having it as their secondary source of income. The ability to separate self-employment as a primary source of income from self-employment as a secondary source of income is another unique feature of this study.

Table 7 Self-employment as primary vs secondary income 1997-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Secondary income	11267	12200	11945	11954	14696	14941	14380	13900	13779	13797	14278
Primary income	9858	8557	8549	8602	9416	9718	9484	10071	10150	10536	10741
Total self-employed	21125	20757	20494	20556	24112	24659	23864	23971	23929	24333	25019
% secondary/total	53.3%	58.8%	58.3%	58.2%	60.9%	60.6%	60.3%	58.0%	57.6%	56.7%	57.1%

As indicated in Table 7, the absolute majority of those being self-employed a particular year have their firm as a secondary income after employment representing their main income. On average 58 % of those self-employed have a firm as a secondary source of income.

If we take a closer examination at how the educational background affects whether self-employment is used as a primary or a secondary source of income we find important differences. On average over the four years measured, individuals with a background in medicine have a significantly higher propensity to have a firm as a secondary source of income relative to engineers and individuals with a degree from the natural sciences. Medicine has 62 % of their firms as secondary income, in comparison with the natural sciences with 55 % and engineering with 53 %. The differences are stable across all years. This is probably a result of the labor market

structure encountered by the different educational groups. People trained in medicine still work in a labor market, which is strongly dominated by a state monopoly. There is also a long tradition of supplementing this kind of employment with a secondary source of income working with a private medical practice.

Thus, it is plausible that medical doctors by tradition are more likely to start their own business. Further, the opportunity cost for doing so is likely to be lower than for the other categories, because there are fewer other career alternatives apart from the few public sector employers. Therefore, we would expect that those educated in medicine are more likely to be self-employed. The specific human capital applicable to running an independent business, which is obtained from education, training, and experience, might also differ between the categories. However, it is difficult to predict which of the three categories has more specific human capital.

Taking educational length into account the differences are even larger. On average, people with a postgraduate degree are much more prone to have a firm as a secondary source of income in comparison to undergraduates and graduates. In the former group 76 % have a firm as a secondary income compared to 53 % for the latter group. Thus, the longer the length of education the higher is the probability of choosing self-employment as a secondary source of income.

5.1.5 Summary

When examining the involvement of the science and technology labor market into self-employment we find several important results. On average somewhat more than 14 % of these three educational groups are in any year in self-employment. The rates of self-employment tend to vary somewhat with the economic cycle, with an important rise in self-employment in 1994 when the Swedish economy went from a recession to an economic boom. We find significant differences among medicine, engineers, and natural sciences when it comes to their relative involvement in self-employment. Medically trained individuals have a considerably higher probability to engage in self-employment compared to those in engineering and natural sciences. They were almost twice as likely to be self-employed compared to the two other groups. We also find an important effect of educational length. Individuals with postgraduate education are more likely to be self-employed.

Examining the entries into and exits from self-employment we observe small differences between the three educational groups. To start, we find that on a yearly base about 17 % of the population of self-employed are new entrants, and that 15 % of the same population will exit from self-employment that year. However, the share of self-employment accounted for by entries and exits lies at a relatively low level for the medicine group in comparison to the other two groups. Our interpretation is that we are dealing with a rather stable group of self-employment. As mentioned earlier, it could also be a sign of barriers to entry and exit. However, since the group accounts for a high number of self-employment the observation is most likely attributable to the stability of the group.

The same pattern is reproduced when analyzing the length of spells in self-employment (duration). Medicine stands out as having appreciably longer spells of self-

employment than the two other groups. This result gives support to our previous conclusion that medicine represents a much more stable group of self-employed relative to the two other groups. For educational length we find that the spells of self-employment decrease with the educational length. That is, postgraduates have on average shorter spells of self-employment than undergraduates and graduates.

Finally, we have examined whether self-employment is the primary or secondary source of income. Self-employment is a secondary source of income when the self-employed is reported to have another income that is higher than the one obtained from self-employment. We find that in general about 57 % of the self-employed have the firm as their secondary source of income. Once more, medicine stands out. This educational group has 62 % with self-employment as secondary source of income compared to engineering and natural sciences, with 55 % and 53 % respectively.

5.2 Sex and self-employment

5.2.1 Rates of self-employment among men and women

As mentioned previously women are under-represented within the population (i.e. individuals with an education in engineering, medicine or natural sciences). Therefore, the base rate for women is lower than the base rate for men. The question, then, is if self-employment alters that distribution in any way? If the opportunities were equal we would expect the distribution between self-employed men and women to be the same as the distribution between men and women in the population. However, if gender stereotypes also affect the choice to become self-employed we would then expect a distribution among self-employed to be different from that of the population. When analyzing the differences between the gender groups, we will look at the likelihood of engaging in self-employment as well as the distribution of self-employed compared to the base rate.

Table 8 displays the rates of self-employed for the two sexes over the period of observation. It is clear that there are important differences between men and women. On average over the period, 15 % of the men are self-employed in a specific year compared to 12 % for women. The relative difference is almost the same during the whole time. Both groups have increased both in terms of absolute number of people with this education and the absolute numbers of people becoming self-employed, but the relative shares are constant. However, as the share of women relative to men has increased in the technology and science labor force, we can now observe a much higher number of women self-employed in 2000 compared to 1990. We had 4,133 self-employed women in 1990 and 6,002 self-employed women in 2000. This represents an absolute increase of 1,869 self-employed women or a relative increase of 45%. In short, women are still less prone than men to become self-employed, but the difference diminishes over time. Taking the base rate in consideration we have 26 % more men being self-employed than women. That is, if there were the exact same amount of women and men in a specific educational group, we would still see 25 % more men starting a business than women.

Table 8 Self-employment and sex

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000
Total men self-employed	16992	16513	16340	16213	18996	19328	18641	18643	18519	18795	19017	2025
	15.9%	15.2%	15.0%	14.8%	16.3%	16.2%	15.4%	14.9%	14.4%	13.9%	14.2%	11.9%
Total men	106935	108489	108578	109895	116804	118982	121317	124821	128327	134911	134222	
Total women self-employed	4133	4244	4154	4343	5116	5331	5223	5328	5410	5538	6002	1869
	12.2%	12.2%	11.8%	12.0%	12.9%	13.0%	12.3%	11.9%	11.6%	10.9%	11.5%	45.2%
Total women	33834	34867	35131	36104	39707	41026	42499	44615	46741	50651	52274	

Table 9 presents the rates of self-employment by educational groups and sex. As expected we can observe large difference between the educational groups in terms of women self-employed. Women in medicine are much more probable to being self-employed than women in engineering or in natural sciences (on average for the eleven years, 16 %, 9 %, and 7 % respectively). These differences largely reflect the general tendency of different educational groups to engage in self-employment. As we have seen previously medicine has a much higher rate of self-employment than the two other groups.

As we argued in the theory section, there exists an interaction between educational group and sex, but it is small. We suggested that because there are important sex differences among the three educational groups, this would have an effect on the rates of self-employment. The results are in the expected directions. That is, in educational groups where the sex structure is less skewed we can see that a relatively higher share of women engaging in self-employment than in educational groups with a more skewed sex structure. However, the differences are small. For medicine, the ratio between men and women is 1.37, in engineering it is 1.46, and for natural science it is 1.50. The ratio is calculated as the relative share of self-employed men divided by the relative share of self-employed women.[5] This gives us a measure of the probability of being self-employed when controlling for base rates. The lower the ratio, the lower the difference between the probability of the sexes being self-employed. We see that in medicine the difference is smaller than in educational groups where the sex structure is more skewed (engineering and natural sciences).

Thus, we can conclude that there exists some kind of sex discrimination mechanism in these educational groups. The discrimination does not only occur at the level of the sex structure at the educational level, where women are less likely to choose an education within science and technology, and are more likely to choose one in medicine. The discrimination also occurs at the level of who is and who is not self-employed. We can quite clearly observe that in educational groups where the sex structure is more skewed, women are less likely to become self-employed. However, these differences are likely to diminish as more women choose an education within science and technology.

[5] *These estimates cannot be compared directly with the 26% difference between men and women in general for this population. The estimates differ from each other because the base rate for the different educational groups shift and hence the relative share shift over time and between the groups.*

Table 9 Self-employment, sex and education

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000
Engineers men self-employed	8915	8643	8505	8487	9879	9964	9476	9371	9238	9320	9256	341
	14.7%	13.9%	13.7%	13.4%	15.2%	14.9%	13.7%	13.0%	12.3%	11.9%	11.6%	3.8%
Engineers men	60734	62060	62305	63558	65040	66923	69185	71942	74954	78439	79669	
Engineers women self-employed	809	809	841	886	1037	1074	1050	1085	1127	1161	1201	392
	10.1%	9.4%	9.5%	9.4%	10.5%	10.3%	9.4%	8.9%	8.5%	8.0%	7.6%	48.5%
Engineers women	8049	8578	8831	9389	9905	10457	11220	12172	13186	14478	15787	
Medicine men self-employed	6148	6037	6020	5924	6764	6897	6692	6649	6554	6672	6967	819
	21.0%	20.5%	20.5%	20.2%	22.6%	23.0%	22.3%	22.1%	21.8%	22.0%	22.2%	13.3%
Medicine men	29261	29423	29338	29324	29975	29931	29989	30081	30120	30331	31339	
Medicine women self-employed	2742	2848	2755	2878	3317	3463	3360	3419	3425	3481	3941	1199
	15.0%	15.3%	14.8%	15.2%	16.7%	17.1%	16.3%	16.1%	15.6%	15.4%	16.1%	43.7%
Medicine woman	18271	18658	18592	18948	19854	20234	20662	21279	21909	22621	24413	
Science men self-employed	1929	1833	1815	1802	2353	2467	2473	2623	2727	2803	2794	865
	11.4%	10.8%	10.7%	10.6%	10.8%	11.1%	11.2%	11.5%	11.7%	10.7%	12.0%	44.8%
Science men	16940	17006	16935	17013	21789	22128	22143	22798	23253	26141	23214	
Science women self-employed	582	587	558	579	762	794	813	824	858	896	860	278
	7.7%	7.7%	7.2%	7.5%	7.7%	7.7%	7.7%	7.4%	7.4%	6.6%	7.1%	47.8%
Science women	7514	7631	7708	7767	9948	10335	10617	11164	11646	13552	12074	

5.2.2 Entry and exit among men and women

Table 10 presents the number of entries and exits made by men and women in the present population. A closer examination of the table supports the results from the previous section that the absolute number of women self-employed increases with an increase in the number of women in the educational group. On average, the rate of entry for women is 18 % per year whereas it is 16 % for men. The average rate of exit is 15 % per year for both sexes. So when men only experience a slight increase in the number of self-employed the increase is considerably higher for women.

As we reported above, a higher and increasing share of women relative to men can explain this change. However, the dynamic change is less pronounced for men than for women. Examining the relationship between entries and exit (relative share of entries divided by the relative share of exits), we find that it is higher for women than for men (1.2 and 1.1 respectively). A ratio above one indicates that more entries are recorded than exits. A ratio below one indicates that more exits than entries are recorded. In this case, we can see that the ratio is higher among women than among men.

Table 10 Entry and exit into self-employment by sex 1990-2000

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Men											
Entries		3209	2275	2074	4531	3315	2688	2903	2671	2819	2974
Exits	3688	2449	2195	1730	2971	3370	2886	2786	2522	2769	
Entries % of tot. men		19.4%	13.9%	12.8%	23.8%	17.1%	14.4%	15.5%	14.4%	14.9%	15.6%
Exits % of tot. men	21.7%	14.8%	13.4%	10.7%	15.6%	17.4%	15.4%	14.9%	13.6%	14.7%	
Women											
Entry		939	656	704	1240	989	842	829	804	885	1261
Exit	826	745	509	438	766	939	702	717	733	861	
Entries % of tot wom.		22.1%	15.8%	16.2%	24.1%	18.4%	15.9%	15.3%	14.6%	15.7%	20.9%
Exits % of tot. wom.	20.0%	17.5%	12.2%	10.1%	14.9%	17.5%	13.3%	13.3%	13.3%	15.2%	

5.2.3 Duration in self-employment among men and women

The analysis of the number of entries and exits in combination with the analysis of the rates of self-employment suggests that the absolute number of self-employed women is increasing, but not their relative share as more women also enter the educational groups. Furthermore, women experience relatively lower shares of exits than men. This suggests that women are likely to stay self-employed longer than men.

Table 11 shows the duration rates for self-employment by sex. We can conclude that women are less likely to rapidly exit from self-employment than men. With the exception of only two cells in the table, women have longer spells of self-employment than men. The difference is not large. It is about two percentage units of differences per year. When we later turn to the examination of self-employment as primary versus secondary source of income, we see that this is a likely explanation for the longer duration among women.

Table 11 Duration of spells by sex for cohorts 1991-1999

	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
Men										
1	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
2	68.00%	71.70%	78.40%	76.10%	76.40%	72.50%	72.80%	73.00%	71.10%	73.3%
3	53.10%	61.70%	65.30%	62.80%	63.00%	58.40%	60.40%	57.80%		60.3%
4	46.00%	53.00%	55.40%	53.00%	54.60%	50.50%	49.90%			51.8%
5	40.40%	44.90%	48.70%	46.10%	48.30%	43.80%				45.4%
6	34.30%	38.60%	43.50%	40.10%	43.20%					39.9%
7	30.20%	34.60%	39.00%	35.20%						34.8%
8	26.20%	31.90%	34.50%							30.9%
9	23.80%	28.70%								26.3%
10	21.10%									21.10%
Women										
1	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
2	70.60%	74.80%	80.30%	75.80%	77.10%	76.80%	78.00%	75.50%	69.60%	75.4%
3	57.60%	66.90%	68.50%	63.30%	66.20%	65.00%	64.90%	58.80%		63.9%
4	51.20%	56.70%	57.10%	55.90%	57.40%	55.00%	52.50%			55.1%
5	46.10%	46.30%	51.60%	49.60%	50.10%	48.00%				48.6%
6	39.00%	40.40%	47.00%	43.70%	43.80%					42.8%
7	34.70%	35.10%	43.00%	37.30%						37.5%
8	31.50%	31.70%	38.90%							34.0%
9	27.50%	28.70%								28.1%
10	25.90%									25.90%

5.2.4 Primary vs. secondary source of income for men and women

Our final analysis in this section concerns differences in self-employment as the primary or secondary source of income by sex. Table 12 presents the distribution of self-employed women and men when it comes to having self-employment as a primary or a secondary source of income. The frequencies are based on yearly rates. The results are clear: self-employed women are more likely to have self-employment as a secondary source of income. On average for the ten years, 65 % of the self-employed women use their firms as a secondary source of income compared to 54 % for men. These are quite large differences indicating difference between men and women when it comes to their respective ability to engage in self-employment. For year 2000, we can observe a change where women and men are almost equally probable to have self-employment as a primary source of in-

come. The change in rates from 1999 to 2000 can be attributed specifically to an increase of women in medicine choosing self-employment as a primary source of income. If this change represent a break in the general trend is consequently difficult to say.

The higher proportion of women self-employed with a firm as a secondary source of income can also explain why they have longer spells of self-employment. As they are not to the same extent dependent on the own firm to generate the primary source of income, they are also more prone of letting a firm survive even if it does not necessarily generate an income. If the firm is the primary source of income, the self-employed is then much more dependent on exploiting an opportunity that is able to fully support him or her financially.

Table 12 Self-employment as primary vs secondary income by sex 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Man											
Secondary income	8731	9304	9127	9034	11219	11319	10910	10521	10365	10411	10934
Primary income	8261	7209	7213	7179	7777	8009	7731	8122	8154	8384	8083
	16992	16513	16340	16213	18996	19328	18641	18643	18519	18795	19017
%secondary of total	51.4%	56.3%	55.9%	55.7%	59.1%	58.6%	58.5%	56.4%	56.0%	55.4%	57.5%
Woman											
Secondary income	2536	2896	2818	2920	3477	3622	3470	3379	3414	3377	3344
Primary income	1597	1348	1336	1423	1639	1709	1753	1949	1996	2161	2658
	4133	4244	4154	4343	5116	5331	5223	5328	5410	5538	6002
%secondary of total	61.4%	68.2%	67.8%	67.2%	68.0%	67.9%	66.4%	63.4%	63.1%	61.0%	55.7%

5.2.5 Summary

The analyses of the sex structure and self-employment for these three groups leave us with both positive and negative results from a perspective of equal opportunities. We can conclude that, as for other countries, women are under-represented in the natural sciences and in engineering, but they have a stronger position in medicine. However, the share and the total number of women are increasing for the two former groups, and it is stable in the latter group.

This increase in the absolute number of women also has an effect on the number of women in self-employment. Even if we do not note a relative increase in women self-employment, we note a major increase in the absolute number of self-employed women. This is a positive result. We also find a significant interaction between education and sex. The less biased the educational group is, the higher the probability of women becoming self-employed. Thus equal opportunities in terms of educational choice also reflect on equal opportunities in terms of self-employment. This is somewhat a more negative result, because it once more demonstrates how difficult and time consuming it is to change the sex structure.

Women also display on average a relative higher number of entries in relation to exits compared to men. This indicates that women are to a higher degree moving into self-employment, and that once they are in they tend to stay longer. This conclusion is supported by our analysis of duration where we find that women have longer spells of self-employment than men. Why this is so is not obvious. However, one possible explanation is given when we study the self-employment as a primary or secondary source of income. Women have a higher tendency to have their firm as their secondary source of income. Therefore, we argue that, as they are less dependent on the financial well being of their firms (because it is their secondary income), they are also less prone to abandon it for better options. Obviously other explanations are possible, as for example many women self-employed are also in medicine and we know that this educational group has a special structure of opportunity cost (see the previous section). Future analyses will give us a better opportunity to tease out the unique effect of sex versus for example education.

5.3 Regional differences in self-employment

5.3.1 Rates of self-employment and geographical dispersion

Table 14 shows the size of the science and technology labor force (STLF) and self-employment rates by county, reported yearly from 1990 to 2000. The STLF has grown in all counties. Similarly, the number of self-employed has grown in all counties. As self-employment has not increased among the general population, this suggests that self-employment among the STFL is becoming increasingly important to all geographical parts of Sweden. The development of the Stockholm county warrants a comment. Close to 40 % of the growth among the STLF took place in the Stockholm county. However, self-employment did not grow at all as quickly there. In relative terms, the share of self-employed among the STLF decreased in the county of Stockholm. Our interpretation of this result is that there were abundant employment opportunities in this part of Sweden. The STLF has many

employment options in addition to self-employment and largely chose those alternatives in Stockholm. Therefore, the fact that the relative rate of self-employment decreases in Stockholm more than in any other region is not a sign of poor opportunities for self-employment but rather a sign of abundant employment opportunities. It could be noted that the relative rate of self-employment does not change dramatically over time in any county.

While the rate of self-employment does not vary greatly over time, there is notable variation in self-employment rates across counties. Whereas self-employment in Jämtland and Gotland reach more than 20 % of the science and technology labor force during some years, Uppsala has less than 10 % during other years. The general pattern, however, is that the differences in self-employment tend to become smaller over time. It appears that regional differences, in this respect, become less pronounced. Most counties show a downward trend in the beginning of the decade, followed by an increase in the middle, with a slight drop towards the end. The notable exceptions from this general pattern are Jämtland and Gotland. The fluctuations in self-employment in Jämtland are very large, with a big "hump" in the mid-nineties where self-employment reaches a high of 21 %. Whereas self-employment decreased in most counties during the latter part of the nineties, in Gotland it kept increasing. The Gotland figures should however be interpreted with great care because of the small labor force in this county.

Table 13 Self-employment rates by county 1990-2000

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000	Change %
Stockholm	In county	46264	47070	47162	47949	51654	52955	54445	56648	58955	63222	63661	17397	37.6%
	# of S-E	7790	7698	7486	7537	8460	8374	8173	8189	8078	8152	8271	481	6.2%
	% S-E	16.8%	16.4%	15.9%	15.7%	16.4%	15.8%	15.0%	14.5%	13.7%	12.9%	13.0%		-3.8%
Uppsala	In county	7831	7972	8013	8123	8719	8799	8963	9090	9315	9892	9866	2035	26.0%
	# of S-E	809	780	750	809	1018	1148	1185	1244	1273	1288	1326	517	63.9%
	% S-E	10.3%	9.8%	9.4%	10.0%	11.7%	13.0%	13.2%	13.7%	13.7%	13.0%	13.4%		3.1%
Södermanland	In county	2576	2449	2430	2465	2618	2652	2811	2920	3010	3115	3102	526	20.4%
	# of S-E	392	331	336	334	383	415	451	482	488	503	510	118	30.1%
	% S-E	15.2%	13.5%	13.8%	13.5%	14.6%	15.6%	16.0%	16.5%	16.2%	16.1%	16.4%		1.2%
Östergötland	In county	6998	7283	7337	7499	7955	8122	8296	8562	8785	9229	9305	2307	33.0%
	# of S-E	896	904	863	836	975	1008	971	1045	1023	1011	1046	150	16.7%
	% S-E	12.8%	12.4%	11.8%	11.1%	12.3%	12.4%	11.7%	12.2%	11.6%	11.0%	11.2%		-1.6%
Jönköping	In county	2404	2428	2429	2443	2661	2701	2796	3004	3155	3294	3449	1045	43.5%
	# of S-E	444	424	435	425	513	533	539	562	578	585	604	160	36.0%
	% S-E	18.5%	17.5%	17.9%	17.4%	19.3%	19.7%	19.3%	18.7%	18.3%	17.8%	17.5%		-1.0%

Table 14 Self-employment rates by county 1990-2000

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000	Change %
Kronobergs	In county	1659	1674	1649	1670	1803	1807	1818	1846	1899	2010	2027	368	22.2%
	# of S-E	266	272	268	262	332	330	327	325	321	328	332	66	24.8%
	% S-E	16.0%	16.2%	16.3%	15.7%	18.4%	18.3%	18.0%	17.6%	16.9%	16.3%	16.4%		0.3%
Kalmar	In county	1880	1942	1935	2001	2164	2215	2259	2323	2357	2477	2434	554	29.5%
	# of S-E	269	269	279	268	349	382	397	400	401	425	442	173	64.3%
	% S-E	14.3%	13.9%	14.4%	13.4%	16.1%	17.2%	17.6%	17.2%	17.0%	17.2%	18.2%		3.9%
Gotland	In county	378	396	393	397	411	434	436	449	467	475	493	115	30.4%
	# of S-E	60	50	63	68	77	82	95	103	104	104	110	50	83.3%
	% S-E	15.9%	12.6%	16.0%	17.1%	18.7%	18.9%	21.8%	22.9%	22.3%	21.9%	22.3%		6.4%
Blekinge	In county	1290	1317	1365	1411	1556	1668	1699	1761	1796	1890	1934	644	49.9%
	# of S-E	153	139	149	136	187	212	212	210	205	211	215	62	40.5%
	% S-E	11.9%	10.6%	10.9%	9.6%	12.0%	12.7%	12.5%	11.9%	11.4%	11.2%	11.1%		-0.7%
Skåne	In county	18424	18828	18820	19076	20450	20792	21241	21945	22707	24128	24328	5904	32.0%
	# of S-E	3032	2860	2876	2818	3326	3353	3248	3277	3316	3425	3553	521	17.2%
	% S-E	16.5%	15.2%	15.3%	14.8%	16.3%	16.1%	15.3%	14.9%	14.6%	14.2%	14.6%		-1.9%
Halland	In county	3049	3171	3213	3294	3508	3622	3729	3874	4004	4242	4364	1315	43.1%
	# of S-E	500	458	474	485	572	617	628	671	707	752	754	254	50.8%
	% S-E	16.4%	14.4%	14.8%	14.7%	16.3%	17.0%	16.8%	17.3%	17.7%	17.7%	17.3%		0.9%

Table 15 Self-employment rates by county 1990-2000

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000	Change %
Västra Götaland	In county	23734	24066	24083	24451	26109	26920	27717	28731	29699	31584	32058	8324	35.1%
	# of S-E	3503	3545	3487	3460	4106	4240	3762	3556	3590	3698	3793	290	8.3%
	% S-E	14.8%	14.7%	14.5%	14.2%	15.7%	15.8%	13.6%	12.4%	12.1%	11.7%	11.8%		-2.9%
Värmland	In county	2599	2671	2685	2720	2928	2982	2990	3050	3150	3263	3218	619	23.8%
	# of S-E	319	337	325	316	444	446	452	453	453	452	487	168	52.7%
	% S-E	12.3%	12.6%	12.1%	11.6%	15.2%	15.0%	15.1%	14.9%	14.4%	13.9%	15.1%		2.9%
Örebro	In county	2655	2672	2670	2707	2833	2856	2914	2975	3104	3194	3191	536	20.2%
	# of S-E	351	342	348	389	446	471	471	480	486	487	506	155	44.2%
	% S-E	13.2%	12.8%	13.0%	14.4%	15.7%	16.5%	16.2%	16.1%	15.7%	15.2%	15.9%		2.6%
Västmanland	In county	4078	4209	4098	4069	4246	4373	4468	4597	4695	4916	4843	765	18.8%
	# of S-E	407	409	426	428	529	564	541	547	547	550	575	168	41.3%
	% S-E	10.0%	9.7%	10.4%	10.5%	12.5%	12.9%	12.1%	11.9%	11.7%	11.2%	11.9%		1.9%
Kopparberg	In county	2929	2925	2932	2949	3148	3223	3280	3305	3379	3468	3403	474	16.2%
	# of S-E	369	324	314	341	402	447	444	451	448	443	452	83	22.5%
	% S-E	12.6%	11.1%	10.7%	11.6%	12.8%	13.9%	13.5%	13.6%	13.3%	12.8%	13.3%		0.7%
Gävleborg	In county	2387	2410	2408	2444	2640	2696	2745	2843	2885	3007	2867	480	20.1%
	# of S-E	295	300	277	269	366	401	396	404	396	399	420	125	42.4%
	% S-E	12.4%	12.4%	11.5%	11.0%	13.9%	14.9%	14.4%	14.2%	13.7%	13.3%	14.6%		2.3%

Table 16 Self-employment rates by county 1990-2000

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000	Change %
Västernorrl	In county	2469	2531	2540	2577	2722	2776	2831	2868	2880	2989	2981	512	20.7%
	# of S-E	338	327	321	338	414	421	427	437	425	430	445	107	31.7%
	% S-E	13.7%	12.9%	12.6%	13.1%	15.2%	15.2%	15.1%	15.2%	14.8%	14.4%	14.9%		1.2%
Jämtland	In county	1030	1060	1068	1068	1130	1106	1126	1145	1162	1195	1236	206	20.0%
	# of S-E	169	179	186	189	237	234	220	187	183	200	206	37	21.9%
	% S-E	16.4%	16.9%	17.4%	17.7%	21.0%	21.2%	19.5%	16.3%	15.7%	16.7%	16.7%		0.3%
Västerbotten	In county	3438	3529	3550	3650	3933	3975	4066	4228	4362	4610	4487	1049	30.5%
	# of S-E	454	451	443	468	558	574	581	591	609	610	644	190	41.9%
	% S-E	13.2%	12.8%	12.5%	12.8%	14.2%	14.4%	14.3%	14.0%	14.0%	13.2%	14.4%		1.1%
Norrbotten	In county	2697	2718	2793	2898	3118	3133	3186	3272	3302	3371	3249	552	20.5%
	# of S-E	311	328	353	362	437	445	443	493	448	475	442	131	42.1%
	% S-E	11.5%	12.1%	12.6%	12.5%	14.0%	14.2%	13.9%	15.1%	13.6%	14.1%	13.6%		2.1%
Total	In county	140769	143321	143573	145861	156306	159807	163816	169436	175068	185571	186496	45727	32.5%
	# of S-E	21127	20727	20459	20538	24131	24697	23963	24107	24079	24528	25133	4006	19.0%
	% S-E	15.0%	14.5%	14.2%	14.1%	15.4%	15.5%	14.6%	14.2%	13.8%	13.2%	13.5%		-1.5%

NOTE: S-E = self-employed

We also use the regional classification based on socio-economic structure developed by Nutek (see Table 17). This classification divides Sweden into six region types: metropolitan region, university area, regional center, secondary regional center, small region dominated by private enterprising or small region dominated by public sector. Here a relatively clear pattern emerges. The growth of the STLF is substantially larger in region types dominated by larger cities (i.e., metropolitan region, university area, and regional center), than in less populated region types (i.e., small region – private enterprising, and small region – public sector). The pattern for self-employment is different. Large relative increases in the number of self-employed can be noted in all regions except the metropolitan region, spanning from 28 % to 37 %. Turning to the share of self-employed, we note the largest growth in the small region – public sector type and shrinkage in the metropolitan region type. Our interpretation of this finding is that because of greater employment opportunities in some areas, most notable metropolitan areas, self-employment is relatively less attractive. The opposite applies to less densely populated regions, where the relative attractiveness of self-employment is higher. All in all, the greater the structural differences between regions, the larger the differences in the development of the size of the STLF and in rates of self-employment.

Table 17 Self-employment rates by type of socio-economic region 1990-2000

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change	Change %
Metropolitan	In region	79780	81249	81378	82694	88794	91066	93310	97086	100925	108031	109273	29493	37.0%
	# S-E	12977	12783	12534	12474	14213	14295	13410	13307	13226	13490	13718	741	5.7%
	% S-E	16.3%	15.7%	15.4%	15.1%	16.0%	15.7%	14.4%	13.7%	13.1%	12.5%	12.6%		-3.7%
University area	In region	26110	26953	27077	27477	29274	29760	30526	31459	32531	34285	34349	8239	31.6%
	# S-E	3314	3262	3239	3320	4019	4233	4276	4372	4474	4547	4753	1439	43.4%
	% S-E	12.7%	12.1%	12.0%	12.1%	13.7%	14.2%	14.0%	13.9%	13.8%	13.3%	13.8%		1.1%
Regional centre	In region	23215	23592	23712	24141	25886	26491	26944	27697	28258	29532	29379	6164	26.6%
	# S-E	3210	3170	3175	3218	3924	4094	4114	4225	4203	4282	4391	1181	36.8%
	% S-E	13.8%	13.4%	13.4%	13.3%	15.2%	15.5%	15.3%	15.3%	14.9%	14.5%	14.9%		1.1%
Secondary centre	In region	6482	6335	6324	6432	6941	7074	7358	7633	7773	8008	7912	1430	22.1%
	# S-E	939	860	900	906	1122	1187	1248	1312	1291	1305	1349	410	43.7%
	% S-E	14.5%	13.6%	14.2%	14.1%	16.2%	16.8%	17.0%	17.2%	16.6%	16.3%	17.1%		2.6%
Small region	In region	2343	2361	2317	2334	2466	2449	2508	2465	2503	2614	2538	195	8.3%
privat enterprise	# S-E	274	278	265	282	354	366	361	341	335	351	362	88	32.1%
	% S-E	11.7%	11.8%	11.4%	12.1%	14.4%	14.9%	14.4%	13.8%	13.4%	13.4%	14.3%		2.6%
Small region	In region	2839	2866	2901	2921	3150	3168	3170	3096	3078	3092	3045	206	7.3%
public sector	# S-E	413	408	385	372	543	567	554	550	550	553	560	147	35.6%
	% S-E	14.5%	14.2%	13.3%	12.7%	17.2%	17.9%	17.5%	17.8%	17.9%	17.9%	18.4%		3.8%
Total	In region	140769	143356	143709	145999	156511	160008	163816	169436	175068	185562	186496	45727	32.5%
	# S-E	21127	20761	20498	20572	24175	24742	23963	24107	24079	24528	25133	4006	19.0%
	% S-E	15.0%	14.5%	14.3%	14.1%	15.4%	15.5%	14.6%	14.2%	13.8%	13.2%	13.5%		-1.5%

NOTE: S-E = self-employed

5.3.2 Self-employment by location of education

This analysis probes into the locations of educations that are more likely to educate those individuals who become self-employed. Six counties totally dominate the education of the STLF. The results from this analysis are shown in table 15. In this table we show only three years for reason of clarity. The counties that dominate education are: Stockholm, Uppsala, Östergötland, Skåne, Västra Götaland, Västerbotten and Norrbotten. For example, in the year 2000 more than 95 % of all individuals in the STLF were educated in one of these counties. In all six locations the number of educated people increases over time. So does the number of self-employed, but at a slower rate. This means that the share of self-employed decreases in all of these counties (with the exception of Uppsala). A possible reason for this decrease in the share of self-employed is the time lag between education and moving into self-employment. If people on average spend several years in the labor force before becoming self-employed, this is the pattern we would expect to find because newly educated enter the population at greater numbers than people exit the population. An additional reason could be that, on average, people now start their tertiary education at a younger age and with less work experience than they did some years ago. Therefore, those educated later might spend longer time as employed before they become self-employed. The economic cycle might also play a role. In 2000 Sweden entered an economic downturn, which might hamper the opportunities for becoming self-employed.

Comparing the six dominating regions, we find some substantial and interesting differences. The county of Stockholm appears to be particularly successful at educating those who become self-employed, while the opposite applies to Norrbotten. The share of individuals being self-employed is twice as high in the county of Stockholm as in Norrbotten and ranges between 14 % and 17 %, while the corresponding figures in Norrbotten are 7 % to 8 %.

It is difficult to say if these differences should be attributed to differences in education, or to differences in business opportunities in the respective counties. We know that many people with university education prefer to pursue their professional careers in close vicinity to the locations where they earned their degrees. Generally speaking it appears as if those counties with larger populations (e.g., Stockholm, Skåne and Västra Götaland) perform better in terms of self-employment than counties with smaller population (e.g., Östergötland and Norrbotten). If people pursue self-employment where they receive their education, such a finding would be consistent with what we find for the Swedish population at large. People in heavily populated areas are more prone to enter self-employment (cf. Davidsson et al., 1994).

Table 18 Self-employment by location of education for 1990, 1995, and 2000

	1990			1995			2000		
	Educated	**S-E**	**Share**	**Educated**	**S-E**	**Share**	**Educated**	**S-E**	**Share**
Unclassified	48679	7105		45721	7056		38774	5945	
Stockholm	**29651**	**5111**	**17%**	**35897**	**6133**	**17%**	**44652**	**6472**	**14%**
Uppsala	**10157**	**1182**	**12%**	**12380**	**1806**	**15%**	**15881**	**2175**	**14%**
Södermanland			-	58		0%	16		0%
Östergötland	**6078**	**672**	**11%**	**8541**	**936**	**11%**	**11679**	**1079**	**9%**
Jönköping	8	1	13%	95	9	9%	542	31	6%
Kronoberg	50	4	8%	97	7	7%	349	12	3%
Kalmar	117	3	3%	362	10	3%	515	18	3%
Gotland			-			-			0%
Blekinge			-	84		-	437	22	5%
Skåne	**16210**	**2655**	**16%**	**19355**	**3082**	**16%**	**24260**	**3336**	**14%**
Halland	60	1	2%	335	47	14%	738	65	9%
Västra Götaland	**21264**	**3146**	**15%**	**25929**	**4011**	**15%**	**32088**	**4022**	**13%**
Värmland	109	6	6%	322	17	5%	671	30	4%
Örebro	1909	470	25%	1782	462	26%	1932	450	23%
Västmanland			-			-	585	26	4%
Kopparberg			-	169	2	1%	634	22	3%
Gävleborg			-	67	4	6%	272	15	6%
Västernorrland	55	1	2%	124	2	2%	78	4	5%
Jämtland			-	86		0%	619	21	3%
Västerbotten	**4676**	**623**	**13%**	**5818**	**859**	**15%**	**7712**	**1003**	**13%**
Norrbotten	**1746**	**145**	**8%**	**2786**	**216**	**8%**	**4042**	**268**	**7%**
Total	**140769**	**21125**	**15%**	**160008**	**24659**	**15%**	**186496**	**25019**	**13%**

NOTE: S-E = self-employed

5.3.3 Regional flow of the STLF

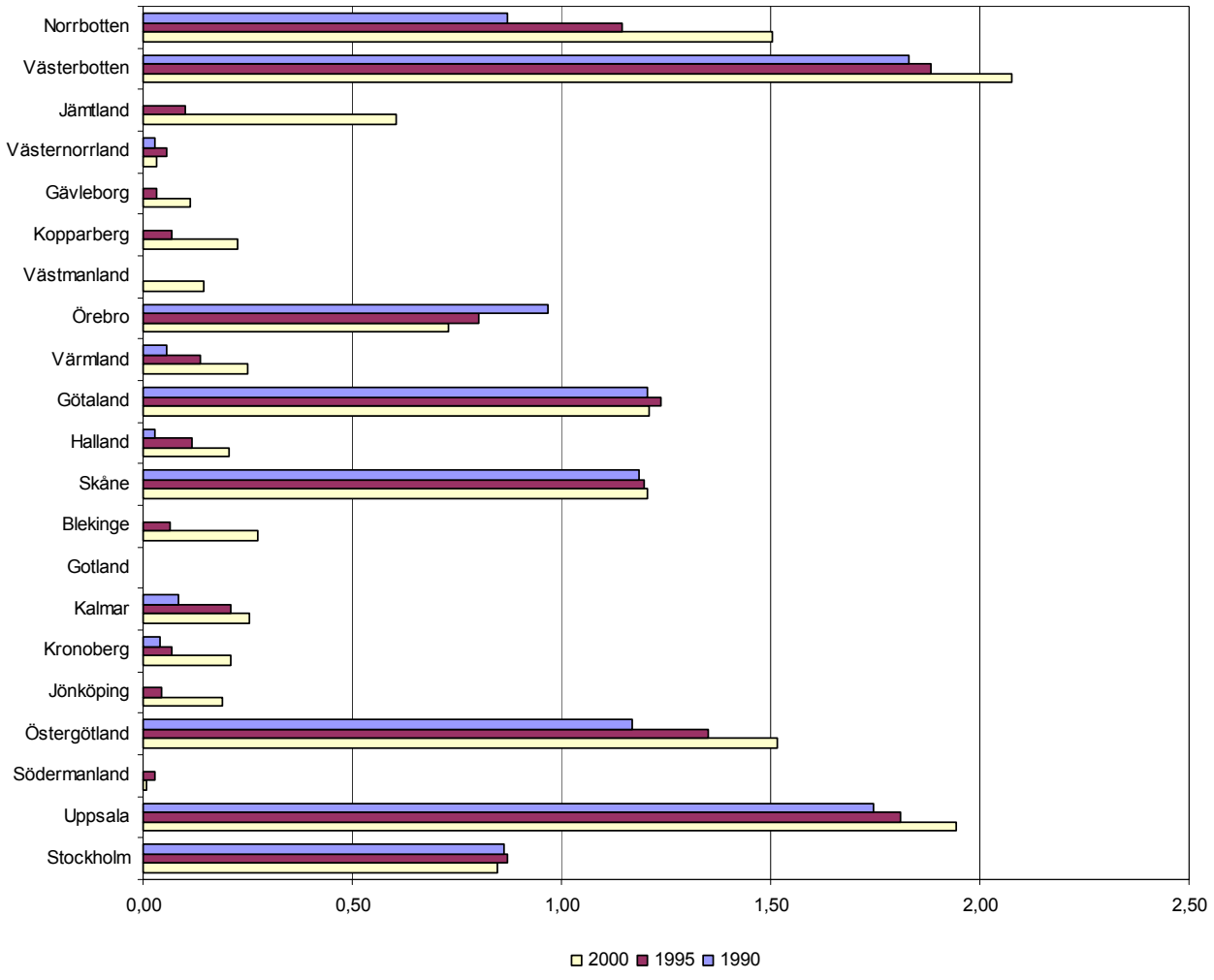
In this section we assess the regional flow of the STLF. Figure 2 below illustrates relative gain or loss in the number of individuals among the STLF educated vs. residing in the Swedish counties. We have included the years 1990, 1995, and 2000 in the figure. If a bar in the diagram reaches 1, this means that the share of individuals educated in the county is equal to the number of individuals living in the county. A bar that reaches 0.5 is indicative of half the population living in the county also being educated there, suggesting large migration to the county. If the bar reaches 2, then twice as many have been educated in the county as the number of individuals living there, suggesting large immigration from the county.

As can be seen, several counties had no education in science and technology prior to 1990. In 2000 all counties except Gotland have such educations. The general trend for counties that only educate few individuals in science and technology (excluding the "big seven", see above) is that they increasingly become self-supplying, as can be seen from the fact that the bars in 2000 are longer than in 1990 or 1995. The only exceptions are Örebro and Södermanland. Still in 2000, 12 out of 21 counties still educate less than half of the STLF employed there. Among the

seven counties that educate large numbers, Norrbotten made net gains in the flow of people in 1990 but change dramatically to make large net losses in 2000. While the number of educated in the county has more than doubled since 1990, the size of the labor force has only increased by a meager 20 %. This suggests that several of the individuals who receive their education in Norrbotten move elsewhere to pursue their professional career.

In 2000 Stockholm is the only county with a sizeable education in science and technology that gains people from the STLF. Despite Stockholm educating more than 30 % of the labor force more people reside there than are educated in the county. Västerbotten and Uppsala are the counties that lose the largest share of the people they educate. In 2000, close to twice as many are educated in the county than those living there.

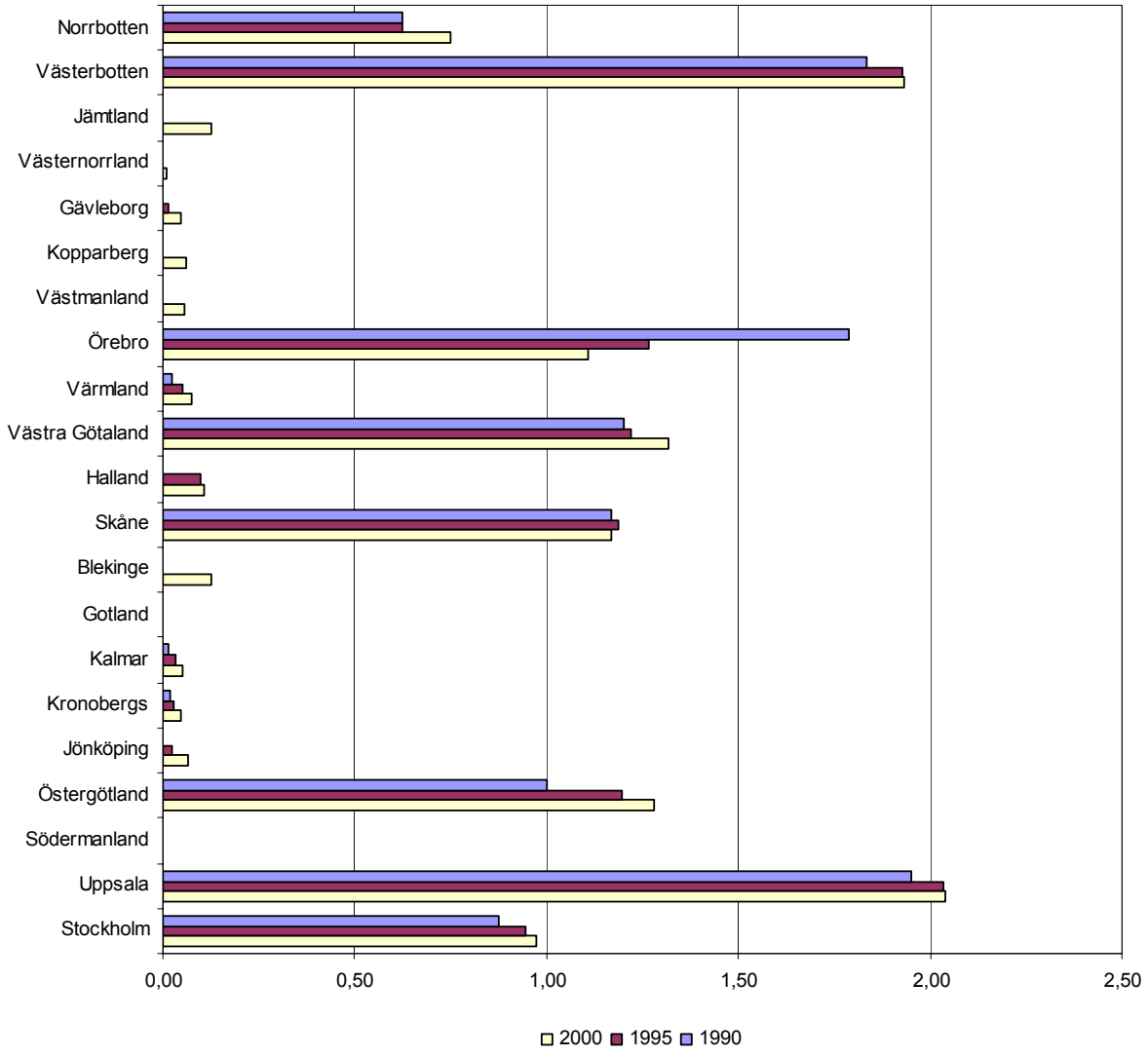
Figure 2 County of residence related to county of education 1990, 1995, and 2000



5.3.4 Regional flow of self-employed

If we also consider where self-employed individuals have been educated and where they live, we are able to discern differences between counties in relation to net flows. In other words, we are able to observe where self-employed individuals are educated in relation to where they live. If a region has a number below 1 it means that the number of self-employed people that have been educated within the county is lower than the amount of self-employed individuals living in the county. Thus the county is characterized by a positive net flow. If the county is represented by a number higher than 1, it indicates that more self-employed people were educated within the county than the actual number of self-employed living in the county. Consequently, this would be an example of a negative net flow. The findings concerning education and county of residence for self-employed are presented in figure 3. Also here the years 1990, 1995 and 2000 are included in the diagram.

Figure 3 County of residence related to county of education for self-employed 1990, 1995, and 2000



Some interesting findings emerge from the diagram above. We can observe that Uppsala and Västerbotten have educated a high number of self-employed while not as many self-employed tend to live within these regions. Therefore, these counties are characterized by having a negative net flow of self-employed, i.e. they educate more self-employed than the amount of self-employed that are actually living in the county. Stockholm is close to one, but the county is residence for a slightly larger group than the group of people that have been educated within Stockholm. Thus, Stockholm has a net flow close to zero. Norrbotten on the other hand is characterized by having a positive net flow. Here the group of self-employed that are educated within the region is smaller than the group of self-employed actually living in Norrbotten. If this result is combined with the findings presented in Figure 2, we can see that a lot of people move from Norrbotten, but they are not likely to be self-employed. Uppsala on the contrary seems to show a different pattern, i.e. a lot of people move from the county and they are also more likely to be self-employed. We can se that the net flows of self-employed are similar to the net flows of the total STLF, with the exception of Norrbotten.

5.3.5 Summary

The size of the STLF has increased substantially in all Swedish counties during the 1990 to 2000 period. Among this labor force, the number of self-employed has also increased, which suggests that in all parts of Sweden, self-employment among the STLF is becoming increasingly important. Differences between counties can be noted concerning self-employment rates, but these differences tend to become somewhat smaller over time. Utilizing Nutek's region types a different picture emerges. We find that the STLF has expanded the most in regions dominated by larger cities, whereas the share of self-employed grew the most in more rural areas. The larger the structural differences between regions, the larger the differences in the development of the size of the STLF and self-employment rates. This likely reflects differences in employment opportunities across region types.

Examining the flow of the STLF between regions, we find that in particular Västerbotten and Uppsala educate many more than are employed in the county and therefore "export" people to the rest of Sweden. Stockholm educates over 30 % of the total STLF but still this is not sufficient, and Stockholm has a large influx of STLF from other parts of the country. The regional flow of those being self-employed seems to suggest that Uppsala educates many that move from the county and become self-employed, whereas Norrbotten also educates several individuals that move from the county, but these individuals are not likely to become self-employed.

5.4 Industry differences in self-employment

5.4.1 Self-employment rates and industry affiliation

Barriers to entry are likely to vary across industries, so that it requires less investment in equipment, knowledge and technology and so forth in order to enter some industries (Geroski 1995). Examples of industries that generally have low barriers to entry are retail and hospitality, while the pulp and paper industry is associated with high barriers to entry. Generally speaking, barriers to entry are likely to be higher in manufacturing than in retail and services. The reason is that the cost of investments is much higher in manufacturing (e.g. cost for machines and developing production routines) than in the service industries. There are also higher barriers to exit, because more capital is tied up in machinery and other assets than in the service industries.

However, because low barriers of entry are associated with high levels of entries of new firms, these sectors are also expected to generally provide lower profit opportunities. That is, the industries that are easier to enter are typically also less attractive for entry. Given that we deal with a category of individuals that possess extraordinarily much human capital, we expect to find a somewhat different pattern than among the population at large. For example, thanks to substantial knowledge and better access to financial capital, the STLF likely has overcome several of the barriers that other individuals may encounter. Further, because of abundant job opportunities, the STLF is less likely to enter industries where profit opportunities are restricted. Taken together, we therefore expect fewer entries into low barrier sectors of the economy.

The results from the analysis are shown in Table 16. Based on ISIC codes, we have aggregated the firms into three broad categories: Manufacturing, knowledge intensive services and other. Within the first two categories, we have also created more detailed categories. The classification follows Davidsson et al. (1994). In the table we first present the share of employment in each industry, i.e., the number of individuals working in the particular industry divided by the total number of working individuals. On the following line we present the share of self-employment, i.e., the number of self-employed individuals in the particular industry divided by the total number of self-employed individuals.

As can be seen in the table, more than half the labor force works in knowledge intensive services (on average 54 % for the time period). This is far above the share of the general population. About 20 % work in manufacturing, and the remaining 26 % can be found in the other sectors. Given the large share of medical doctors in the sample, it is hardly surprising that we find 24 % in health care. During the eleven-year time-span of the study, we cannot observe any clear trends, but levels have remained quite stable.

Turning now to self-employment, only an average 4 % of the self-employed can be found in manufacturing, whereas over 63 % work within knowledge intensive services. The technology service sector, in particular, attracts many self-employed, which alone accounts on average over time for 24 % of all the self-employed. On average 40 % of the self-employed works in other industries. These are industries which a priori do not necessarily require the educational qualities of displayed by this group.

Comparing the relative share of self-employed to the relative share of employed in the different industries, we are able to discern where self-employed are over- and under-represented. The relative share of self-employed is low in manufacturing, in particular within steel and mining and pulp, paper and wood. This is indicative of high barriers to entry in these sectors. The financial investments needed and the minimal efficient size of operations is generally substantial in these sectors. Therefore, this result is hardly surprising. The proportion of self-employed is high in knowledge intensive services, especially in technology services and health care. The technology service sector includes services such as technology consultants. For a person with substantial knowledge, starting such an operation involves few investments in addition to those already made in human capital through education and work experience. Therefore, while such companies may be associated with high barriers to entry for most individuals in the general population, barriers are likely to be low for people in the STLF.

The industry affiliation of self-employment is not only dependent on the barriers to entries and exits. Perhaps more important is the age, and growth of the industries. Previous research has found that entries tend to concentrate to younger industries and to growing industries. This can be seen as an indication for the individual that there exist more attractive opportunities than in other industries with different patterns of development. The over-representation of self-employed in health and in other knowledge intensive industries is therefore not surprising as they represent the industries that during the decade examined also had the largest growth.

More problematic from a perspective of academic entrepreneurship is that the lowest relative share of self-employed can be found within research. Research requires substantial financial investments, and is typically primarily carried out by large companies. However, there is also a trend among large companies to out-source research to new and small ventures. Given our findings, this does not seem to be the case in Sweden. Alternatively, because research intensive new ventures typically take a relatively long time before they break even, it may be that people who operate these companies to a large extent remain employed and operate their own firms as a secondary activity in order to ensure a steady income.

Also problematic from the perspective of academic entrepreneurship is the over-representation of self-employed in the "other" industries (40 % self-employed compared to 26 % employed). These industries (retail, hotel and restaurants, communication and transport) have in general lo barriers to entry, and require little of the specific human capital accumulated by this group. It is therefore possible to argue that a non-negligible amount of self-employment is directed to sectors in the economy where the STLF have chosen not rely on their competence, basically they doing something altogether different. This can be problematic, because it can be seen as a waste of investment in human capital. However, more detailed analyses must be done in order to more exactly estimate the impact of this tendency, and determine if we can argue for a waste in human capital or not.

Table 19 Self-employment rates by industry 1997-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
High-technology	8.9%	9.1%	9.3%	9.2%	9.2%	10.0%	10.5%	10.5%	10.6%	9.6%	10.6%
S-E (Primary income)	2.0%	2.1%	1.8%	1.6%	1.5%	1.5%	1.5%	1.3%	1.2%	1.1%	2.5%
Mechanical industry	5.9%	5.8%	5.5%	5.3%	5.3%	5.6%	5.8%	5.9%	6.0%	5.5%	5.7%
S-E (Primary income)	1.2%	1.1%	1.1%	1.1%	1.0%	0.9%	0.9%	0.9%	0.9%	0.8%	1.3%
Wood, pulp and paper	1.0%	1.1%	1.0%	1.0%	0.9%	1.0%	1.0%	0.9%	0.9%	0.9%	1.0%
S-E (Primary income)	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.5%
Mine and steel	1.1%	1.0%	1.0%	1.0%	0.9%	1.0%	1.0%	1.0%	0.9%	1.0%	0.8%
S-E (Primary income)	0.2%	0.2%	0.1%	0.1%	0.1%	0.2%	0.1%	0.2%	0.2%	0.2%	0.3%
Other manufacturing	2.7%	2.8%	2.7%	2.6%	2.7%	2.5%	2.5%	2.5%	2.6%	2.5%	2.3%
S-E (Primary income)	1.2%	1.3%	1.1%	1.2%	1.1%	1.1%	1.0%	1.0%	0.9%	0.9%	1.1%
Manufacturing total	**19.5%**	**19.8%**	**19.4%**	**19.1%**	**19.0%**	**20.1%**	**20.8%**	**20.8%**	**21.0%**	**19.5%**	**20.3%**
Manufaturing S-E total	**4.9%**	**5.0%**	**4.5%**	**4.4%**	**4.1%**	**4.0%**	**3.9%**	**3.6%**	**3.5%**	**3.2%**	**5.7%**
Knowledge intensive services											
Technology services	9.8%	9.8%	9.7%	9.6%	9.5%	10.2%	11.1%	11.7%	12.6%	13.6%	14.6%
S-E (Primary income)	24.8%	27.6%	26.9%	25.6%	24.0%	23.6%	22.8%	22.9%	23.5%	23.5%	21.3%

Table 20 Self-employment rates by industry 1997-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Financial services	2.2%	2.0%	2.2%	2.2%	2.2%	2.2%	2.2%	2.3%	2.3%	2.5%	2.2%
S-E (Primary income)	1.4%	1.5%	1.2%	1.3%	1.3%	1.3%	1.1%	1.1%	1.2%	1.3%	1.6%
Education etc.	9.9%	10.4%	10.4%	10.0%	9.5%	9.3%	9.1%	9.1%	9.0%	8.9%	8.1%
S-E (Primary income)	0.6%	0.7%	0.8%	1.0%	0.8%	1.0%	1.1%	1.2%	1.4%	1.8%	4.1%
Research within eng. med. & sci.	5.2%	4.9%	5.2%	5.9%	6.0%	5.8%	5.8%	5.6%	5.6%	6.9%	5.3%
S-E (Primary income)	0.4%	0.5%	0.6%	0.5%	0.8%	0.7%	0.9%	0.9%	0.9%	0.9%	1.7%
Health-care	26.7%	26.8%	26.4%	26.2%	25.0%	23.6%	22.9%	21.9%	21.5%	20.6%	21.0%
S-E (Primary income)	19.0%	21.3%	21.5%	21.4%	21.6%	21.9%	22.5%	21.8%	21.8%	21.9%	27.4%
Other knowl.-int. firms	1.1%	1.1%	1.1%	1.0%	1.2%	1.3%	1.3%	1.4%	1.5%	1.9%	2.5%
S-E (Primary income)	4.4%	5.5%	5.5%	5.7%	5.5%	5.8%	6.2%	6.5%	6.7%	6.8%	6.5%
Knowledge intensive services total	**54.9%**	**55.1%**	**55.1%**	**55.0%**	**53.4%**	**52.3%**	**52.6%**	**52.0%**	**52.4%**	**54.4%**	**53.7%**
Knowledge intensive services S-E total	**50.6%**	**57.1%**	**56.5%**	**55.5%**	**54.0%**	**54.3%**	**54.6%**	**54.3%**	**55.6%**	**56.1%**	**62.6%**
Other total	**25.6%**	**25.2%**	**25.4%**	**25.9%**	**27.6%**	**27.6%**	**26.6%**	**27.2%**	**26.6%**	**26.2%**	**26.0%**
Other S-E total	**44.5%**	**37.9%**	**39.0%**	**40.2%**	**42.0%**	**41.7%**	**41.6%**	**42.2%**	**40.9%**	**40.7%**	**31.7%**

NOTE: S-E = self-employed

6 Conclusions

6.1 Major Findings

In this report we set out to examine the science and technology labor force (STLF) and its involvement in self-employment. More specifically, we examine the following aspects of the labor force:

- A description of the extent of self-employment in the science and technology labor-force over time.
- Entries into and exits from self-employment over time.
- Differences depending on type and length of education, and sex.
- Distribution of self-employed across industries.
- Distribution of self-employed across county of education and county of residence.
- The relationship between full-time and part-time self-employment.
- The duration in time of self-employment.

6.1.1 Self-employment rates

If we examine the number of self-employed over time, the eleven-year period that we study can be broken down into three relatively distinct periods. From 1990 to 1993 there is a slight annual drop in the number of self-employed. Then there is a large upwards jump in 1994 followed by a slow annual increase. In this, the rate of self-employed does not closely follow the economic cycle, neither in a cyclical, nor in a counter-cyclical manner. The big leap in 1994 is somewhat surprising and is worthy of a specific comment. In part, it may be attributed to the introduction of the enterprise allowance scheme. Interestingly, the effect of this scheme is not temporary in 1994 but appears to have a lasting effect on the number of self-employed up until 2000. In addition to the enterprise allowance scheme, the tax terms for sole proprietorships and partnerships changed in 1994, so that losses from the business could be fully set off against income from other work. This could affect the relative attractiveness of self-employment. Finally, Statistics Sweden changed its labor market statistics this year, which also may have an effect. Therefore, it may be premature to attribute the whole increase in self-employment in 1994 to the enterprise allowance scheme.

Over time, the STLF expands with more than 30 %. The number of self-employed also increases, but at a slower rate (18 %). This means that over time, the relative share of self-employed decreases. This should not be attributed to decreases in entrepreneurial spirit in this specific population, or decreases in the supply of entrepreneurial opportunities. One reason for the decrease is instead that, in general, people become self-employed several years after they graduate. The growth of the population is mainly due to expansion of education during the 1990s. Therefore, the number of young, recently graduated individuals increases in the

population. These individuals have less human capital and are less likely to become self-employed. Another, and more important, explanation is that the share of women has increased in the population. The probability of becoming self-employed is about 25 % higher among men than among women. Further, the share of women has increased particularly much in engineering and in science where their likelihood of becoming self-employed is particularly low. These are probably the main explanations for the decrease in the share of self-employed over time.

Previous research has found that in general women are less prone than men to become self-employed. In this study, focusing solely on the STLF, this pattern is also evident. There are fewer women then men in the study, but taking this into account, we still find that the propensity among women to become self-employed is much lower than the propensity among men. Given that over time, the share of women increases in all three types of education we have examined, this is likely to further depress the share of self-employed in the future, unless measures are taken that ensure that women are provided better opportunities and incentives for becoming self-employed.

The rates of self-employment vary across types of education. It is almost twice as high among those educated in medicine as compared to those educated in the natural sciences. While we in part attribute this to the tradition of medical doctors to run private practices as a sideline, it may also be reflective of different education providing different opportunity structures for self-employment. Differences in type of education lead to differences in human capital. From the viewpoint of evolutionary theory, this means that individuals have access to different types of information based on idiosyncratic work experience and education and therefore pursue different entrepreneurial opportunities. This, in turn, affects the types of businesses started and the subsequent development of those businesses. The type of education that people pursue seems to be related to several aspects of self-employment. It affects the probability of becoming self-employed and whether the business becomes the primary or secondary source of income as well as the duration of remaining self-employed.

We also examined self-employment as primary versus secondary source of income. Slightly more than half of those being self-employed have a regular job as their primary source of income. Here we note differences depending on type and length of education. Those educated in medicine are self-employed as a sideline to a regular job to a larger extent than the other groups. This can be explained by the long-standing tradition among medical doctors to run their own practice on the side while at the same time being employed by the public health care system. Also among individuals with post-graduate training, the type of employers they have is likely to explain their high share of operating businesses as a secondary source of income. Many individuals with post-graduate education work at universities, and universities allow – and to an increasing extent even encourage – their employees to start businesses while remaining employed at the university.

6.1.2 Entry into, exit from and duration of self-employment

Turning now to the entry into and exit from self-employment, we find that on a yearly basis these two follow each other relatively closely. That is, while entry and exit changes substantially over time, for any given year, entry and exit are of similar magnitude. This explains why the rate of self-employment does not closely follow the economic cycle, as mentioned above. Entries increase during good times, but so do exits. Therefore, the net effect on self-employment rates is relatively small.

In fact, entries and exits are closely related to the economic cycle so that many entries and exits are observed during economic expansions and few during economic downturns. This suggests that the entry into self-employment of the STLF is opportunity driven rather than necessity driven. That is, for this particular part of the labor force, people are pulled rather than pushed into self-employment. Among the labor force in general, there is substantial push into self-employment during recessions. Because people become unemployed, the relative attractiveness of self-employment increases and people are more likely to transit to self-employment when regular job opportunities are scarce. On the other hand, during recessions, business opportunities are less abundant, which reduces the value of pursuing self-employment. Thus, for people having jobs, the pursuit of self-employment appears less attractive during recessions, meaning that the pull into self-employment is weak.

The STLF appears to be valuable to employers who probably are reluctant to dismiss such employees during downturns. Therefore, among this category, few become unemployment during recessions, while few also are pulled into self-employment. As argued in our theory section above, there are opportunity costs associated with becoming and remaining self-employed. The STLF likely has several different employment options, self-employment being one. Therefore, during economic booms, many individuals previously employed find self-employment attractive, while many self-employed find other attractive jobs. Most likely, the ones becoming self-employed during good times are the individuals with the most viable business ideas, and those leaving self-employment are the individuals who operate businesses that provide less benefits to them. Therefore, while economic growth may not be associated with large net gains in the number of self-employed, the dynamics probably lead to more viable businesses.

During the eleven-year period studied here, the vast majority (84 %) of individuals only pursue self-employment once. While the time period of eleven years is too short to draw any definite conclusions, it appears that serial entrepreneurship in the sense of repeatedly becoming self-employed is not a widespread phenomenon in the STLF. At the same time, more than half of those entering self-employment exit within four years. This suggests that counter to common belief, being self-employed is not a lifelong career choice for most people. Instead, many pursue self-employment when it is suitable given present life situation, but leave when the situation changes.

We find that the duration of self-employment varies greatly across types of education, with the duration among those educated in medicine being longer. While we can not penetrate the reasons in detail, we suspect that to a large extent this can be explained by the high share of individuals with this education being self-employed as a secondary activity, see above. Operating a business while at the same time earning the main share of the income from a regular job means that people are less dependent upon their own businesses. For example, it is possible to lay the business dormant, or keep operations at a very low level without really closing the business. We believe this to be the main explanation for the variation of duration across types of education. The same probably applies to differences is sex. Women have longer duration than men do. At the same time, women are over-represented in medical education, and people with medical education are more prone to operate their businesses as a secondary activity.

6.1.3 Regional differences in self-employment

Our analysis of regional variation in self-employment further emphasizes the importance of taking the opportunity cost of self-employment into account. Close to 40 % of the growth among the STLF between 1990 and 2000 took place in the county of Stockholm, but the number of self-employed did not increase substantially. In relative terms, it actually decreased. This suggests that the Stockholm region supplied substantial work opportunities, which made self-employment a relatively less attractive option for many individuals. For example, Ericsson hired large numbers of engineers in Stockholm during the period, and many ICT companies formed during the period were located in Stockholm. Thus, many individuals reside in Stockholm in order to get a job, but fewer reside there to start a business. Other counties, such as Örebro and Västmanland, had the opposite development. The STLF did not expand as much here, but the relative share of self-employed did. This suggests that opportunities for employment were not great, and self-employment became a relatively more attractive option.

When constructing six different region types, the pattern is even clearer. The growth of the STLF is substantially larger in region types dominated by larger cities, while the share of self-employed grows the most in less populated region types. Our interpretation of this finding is that because of greater employment opportunities in some areas, most notable metropolitan areas, self-employment is relatively less attractive. The opposite applies to less densely populated regions, where the relative attractiveness of self-employment is higher. All in all, the greater the structural differences between regions, the larger the differences in the development of the size of the STLF and in rates of self-employment.

When we instead compare level of self-employment across the regions where people receive their education, focusing on the seven counties that educate 95 % of the STLF (Stockholm, Uppsala, Östergötland, Skåne, Västra Götaland, Västerbotten, Norrbotten), we find that the county of Stockholm appears to be particularly successful, while the opposite applies to Norrbotten. The share of self-employed is almost twice as high for those educated in Stockholm compared to Norrbotten. To some extent these differences should be attributed to differences in education, but

also to differences in business opportunities in the respective counties. We know that many people with university education prefer to pursue their professional careers in close vicinity to the locations where they earned their degrees. If people in the STLF pursue self-employment where they receive their education, such a finding would be consistent with what we find for the Swedish population at large. People in heavily populated areas are more prone to enter self-employment (cf. Davidsson et al., 1994).

An interesting picture emerges when we compare the county where people receive their education with the county where they live. Among the seven counties where the majority of the STLF is educated, all but Stockholm are net exporters to the rest of Sweden. Stockholm is the largest educator, but also has the largest demand, leading to a net import of labor. In particular Uppsala, and Västerbotten, and in 2000 also Norrbotten, appear to supply the rest of Sweden with this type of labor. The relatively large net flows from these counties suggest that there is geographical mobility among the STLF. For example, by 2000, Västerbotten had educated close to twice as many in the STLF as lived in the county. When we specifically examine those individuals being self-employed, the picture is similar with one exception. It appears that Norrbotten exports many in the STLF, but few of those become self-employed. In most other counties, the flows of self-employed are similar to the flows of the STLF in general.

6.1.4 Industry differences in self-employment

Comparing knowledge intensive services, manufacturing, and other industries, we find that self-employment is greatly over-represented in knowledge intensive services. For a person with substantial knowledge, starting a company it this sector likely involves few investments in addition to those already made in human capital through education and work experience. Therefore, while such companies may be associated with high barriers to entry for most individuals in the general population, barriers are likely to be low for people in the STLF. Further, this sector has grown during the 1990s and is concentrated to larger cities and their vicinities. This suggests that business opportunities are likely to be extensive and located to attractive living locations in the knowledge intensive service sector.

6.2 Policy implications

This study offers new knowledge relevant for policy makers. We provide unique population parameters for the rates of self-employment; entry into and exit from self-employment; duration of self-employment; the sex structure of self-employment and so forth. All this is done for one of the most interesting and economically relevant groups in the labor force: The science and technology labor force. By providing such data, this study represents an important step in understanding the extent and importance of academic entrepreneurship. It also provides policy makers with the high quality data and results that are needed in order to develop appropriate policy measures. At the same time, the text is by no means exhaustive. In order to develop policy instruments additional, and more detailed, information is needed.

However, this report represents an important first step in building knowledge on the science and technology labor force and their involvement is self-employment.

We find that the self-employment rates among the STLF is higher than among the general labor force, as reported in official Swedish labor market statistics (12 vs. 10 %, but because of different operationalizations, this figure should be interpreted with care). While this over-representation may seem small, two percentage points of the STLF is close to 4.000 individuals, and suggests that the STLF is more prone to start their own business than people in general.

An important question is to what extent the STLF contributes to economic development through their engagement in self-employment. There is sometimes an implicit assumption that highly educated individuals start high-tech businesses that achieve massive growth. What we find is that the majority of the highly educated entrepreneurs studied here engages in self-employment for a shorter time period (and rarely come back despite acquiring experience) and most often operate their businesses as a sideline to a regular job. While this result is concurrent with other Swedish observations (e.g., (Eliasson, 2000; Jacobsson & Lindholm Dahlstrand, 2001), it may run counter to what many policy makers hope for and expect. On the other hand, it is likely that among the 40.000 plus individuals who some time engage in self-employment during the eleven years we study, some start the high growth knowledge intensive firms that policy makers look for. However, it only applies for a minority of self-employed. One way to increase the number of such high growth firms is to increase the stock of new firms being started. It is very difficult to know at start-up which firm will be successful. Therefore, a substantial stock of new firms is needed, out of which a small number of highly successful firms can sprout.

The fact that many people start their businesses as a sideline to a regular job is in many ways positive. It provides them with the possibility of gaining entrepreneurial experience (i.e., knowledge that is needed to organize, manage, and market science-based entrepreneurial opportunities) and understanding the value of the opportunity being exploited, without taking the risk associated with leaving a job. However, it appears that few make the transition into full time entrepreneurship and build a fledging business. This can be understood in terms of the relative attractiveness of self-employment versus the relative attractiveness of remaining employed. It appears that even to those who become self-employed, it is not all that much more attractive than employment. We do not know if it is the psychic or the economic benefits to self-employment that are insufficient, but dare to speculate that increased financial pay-offs to self-employment among the science and technology labor force would be associated with larger numbers moving into self-employment, and larger shares doing it full-time.

The relative unattractiveness of self-employment is also associated with labor market rigidities. Someone who decides to leave a job in order to become self-employed becomes “last in line” when attempting to return into employment, because Swedish labor market laws promote constantly remaining with the same employer. Further, becoming self-employed full time is also associated with giving

up social benefits. If such rigidities could be removed, the relative attractiveness of self-employment would increase.

A final reason for the relative unattractiveness is associated with tradition and attitudes. Sweden has a long tradition of successful large multinational industrial firms. To a large extent, educations have been designed in order to supply these firms with competent employees. Therefore, self-employment is generally not a career option that is emphasized by educators. If more individuals in the STLF were exposed to the idea of self-employment during their education, this could lead to more people seeing this as an attractive and viable option to regular employment. There appears to be differences in the propensity for universities to educate individuals who become self-employed. For example, those educated in Uppsala appear much more likely to become self-employed than those educated in Norrbotten. While we do not have detailed information on why this is the case, a likely explanation is that some universities have designed educations that are better suited for becoming self-employed. A greater supply of such educations would probably be beneficial.

From a geographical viewpoint we know that academic entrepreneurship tends to be geographically concentrated (Acs, Audretsch, & Feldman, 1994; Feldman, 2001), and located to regions where markets are sizeable and where there is a tradition of entrepreneurship (Baumol, 2002; Eliasson, 1991, 2000). We also know that the access to large pools of educated individuals is important (Acs, 2002). Based on our findings of how the STLF tends to cluster in densely populated regions, it appears that making self-employment relatively more attractive here would have the largest effects because of clustering, large market size, and access to educated potential employees.

We find that women have a lower propensity of entering self-employment while at the same time the share of women is increasing in the STLF. Therefore, if the differences in self-employment rates between the sexes remain, this will further depress the share of self-employed in the future. This points to the importance of taking measures that ensure that women are provided better opportunities and incentives for becoming self-employed. On the basis of the research conducted here, it is difficult to say exactly what these measures might be. However, from other research we know that role models are important for individuals becoming self-employed.

Finally, individuals who pursue long educations make large investments, but so does society, because higher education is free in Sweden. The science and technology educations are among the most expensive for society. It is therefore important that these educations pay off to society. Academic entrepreneurship is believed to be an important vehicle for turning education into economic development. Therefore, it makes sense for society to seriously consider the policy measures that most efficiently make self-employment possible and attractive for the science and technology labor force.

6.2.1 Policy recommendations

Based on the above, it is possible to make some tentative recommendations. The first relates to the need for more research. In particular, more knowledge is needed on how self-employment within the STLF compares to self-employment among the Swedish labor force in general, as well as with other countries. Additional knowledge is also needed on the development of the firms that the STLF starts. A second recommendation relates to the supply of entrepreneurship among the STLF. In order to increase the number of high growth firms, a larger stock of new firms is needed. Therefore, the economic incentives for highly educated individuals to start their own businesses should be strengthened. Third, the demand for entrepreneurship among the STLF could also be strengthened. One way to do so would be increased privatization in the health care system. Also, a clear national policy aiming at developing more knowledge intensive firms involving universities and other key players would be beneficial. Fourth, society can influence the values of young people. Therefore, a stronger focus at the universities on educating the STLF for self-employment rather than employment would likely make these individuals more prone to start their own businesses.

6.3 Implications for theory and research

The theoretical foundation of this study is human capital theory (Becker, 1964). This theory is highly relevant for understanding individuals' decisions regarding work careers in relation to work experience and education. In line with previous research we find that human capital has an important impact on people's willingness to engage in self-employment. Human capital was in this study operationalized as the kind of education people have and the length of that education. We found important differences among the educational groups and for educational length when it comes to all aspects of self-employment measured here. Education and educational length affect the probability of becoming self-employed, rates of entry and exit, duration, and whether self-employment becomes a primary or secondary source of income.

This study also informs the evolutionary stand of entrepreneurship (Aldrich, 1979, 1999; Nelson, 1995; Nelson & Winter, 1982). We have seen that depending on what kind of job experience and education people have, they develop different levels of information and idiosyncratic experiences. Therefore, they tend to become self-employed in the industries for which they have been trained. From an evolutionary point of view, people with the same background and information have the same probability to discover the same entrepreneurial opportunity. However, even when controlling for educational background we find substantial variation in both the numbers of self-employed and what kind of opportunities they exploit. For example, an engineer is probably more likely to discover an opportunity based on their experience in construction and product development than is for example a mathematician. As science and technology based expertise is highly valuable, it often can only be exploited in specific industries. Therefore this group of people is more probable than other educational groups to start firms in the same industries as they have worked in previously (Klepper, 2001). When it comes to regional

aspects, we also see that people move into regions with high business dynamics. It is also there they tend to become self-employed. Hence, regional factors related to high concentrations of existing firms and large and growing labor force with the same background is attractive for those becoming self-employed. Thus, self-employment is socially embedded. This is also in line with evolutionary theory.

We make several important contributions to the entrepreneurship literature. For example, we are not aware of a single study that is able to separate between self-employment as the primary source of income and the secondary source of income. Our ability to do so opens new venues for studying entrepreneurship. We have concluded that more than 50 % of all self-employed receive their secondary income from the firm, and have another job as the primary source. That result is by itself interesting, but moreover we have observed important difference in this propensity depending on the industry, education and educational length. This possibility to separate between the two forms of income source gives us better possibilities to understand the entrepreneurial process and its economic impact.

Another important aspect of this study is that we have developed a better methodology than previous research to capture entries into self-employment from register data. Together with the help of experts on register data from Statistics Sweden, we have been able to capture activities in the domain of self-employment independently of whether the firms have shown a positive income or not. This is an important achievement because many spells of self-employed would not normally be observed. Possible reasons are when a firm has not been able to generate an income or that the self-employed deliberately avoids showing a taxable income.

This study joins the increasing number of studies that empirically study entrepreneurship as a process using longitudinal data. This study is unique because it follows a complete population over a long period of time using relatively fine data on self-employment. Therefore, we also have a distinctive advantage in assessing the dynamics of entrepreneurship.

Our results indicate quite strongly that the real life of self-employed departs quite a lot from the regular textbook version. The textbook version often talks about someone working for a long time building up experience and resources making a life long commitment to a firm. Our picture is much more complex. We see that people tend to quite frequently move into self-employment and then back to employment. We also see that the time they spend as self-employed is quite short (relative to a whole working career). The median time spent is less than four years for the studied population. Often this self-employment only represents a secondary source of income. Thus, we present a totally different picture than is normally presented when talking about self-employment and entrepreneurship.

6.4 Future research

After having read this report is should be clear to the reader that we have just started our quest to better understand and explain academic entrepreneurship in general, and in Sweden specifically. More research needs to be done using more sophisticated tools of analysis than the ones used here. Especially different kinds of multivariate statistics that can handle panel data come to mind (Balgati, 2001; Wooldridge, 2002; Yamaguchi, 1991). We need to jointly examine the influence of a large number of variables on self-employment.

We also need to complement the data with more variables as well as more information on existing variables. For example, a unique feature is the ability to separate between primary and secondary source of income. The present analyses suggest that this is an important key to unlock substantial new knowledge about the entrepreneurial process. It is therefore necessary to have this data for the period 1990 - 1996 as well.

Furthermore, we need to more closely examine the firms of the self-employed. Even if we already know that most of them are part-time efforts managed under a shorter time period, it is important to understand the nature of the other firms. What is their organizational structure and how do they perform? Finally, the cohorts of entrants into the STLF population during the 1990 to 2000 period need to be separated from the rest of the data to better understand the timing of different events. This would give a better understanding of what is actually happening.

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8 APPENDIX

FIGURE A1

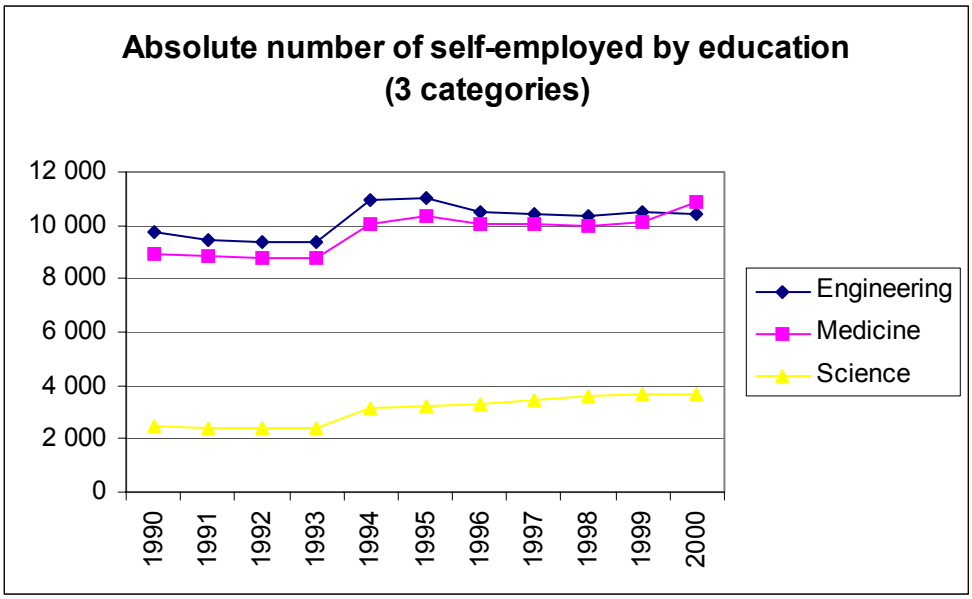

FIGURE A2

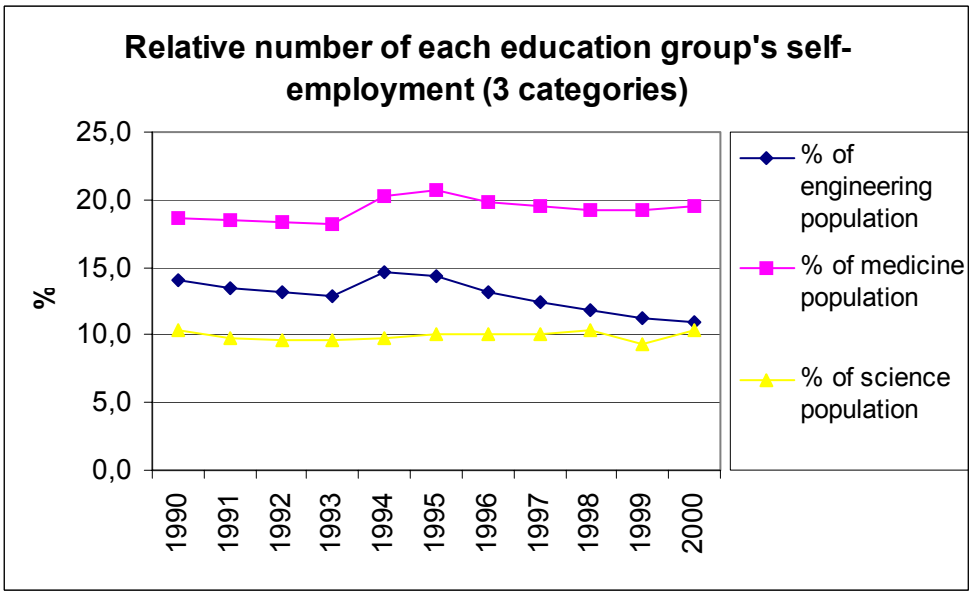

TABLE A3 Rates of self-employment by length of education

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Change 1990-2000
Engineering												
Undergr. & grad.	63 728	65 271	65 627	67 138	68 803	70 813	73 451	76 660	80 213	84 476	88 168	
Self-employed	8 693	8 487	8 373	8 405	9 732	9 833	9 361	9 252	9 150	9 213	9 298	605
	13.6%	13.0%	12.8%	12.5%	14.1%	13.9%	12.7%	12.1%	11.4%	10.9%	10.5%	7.0%
Postgraduate	5 055	5 367	5 509	5 809	6 142	6 567	6 954	7 454	7 927	8 441	7 288	
Self-employed	1 031	965	973	968	1 184	1 205	1 165	1 204	1 215	1 268	1 159	128
	20.4%	18.0%	17.7%	16.7%	19.3%	18.3%	16.8%	16.2%	15.3%	15.0%	15.9%	12.4%
Medicine												
Undergr. & grad.	40 450	40 651	40 333	40 429	41 181	41 213	41 360	41 691	42 019	42 424	44 856	
Self-employed	7 219	7 219	7 070	7 091	8 059	8 257	7 989	7 982	7 852	7 944	8 626	1 407
	17.8%	17.8%	17.5%	17.5%	19.6%	20.0%	19.3%	19.1%	18.7%	18.7%	19.2%	19.5%
Postgraduate:	7 082	7 430	7 597	7 843	8 648	8 952	9 291	9 669	10 010	10 528	10 896	
Self-employed	1 671	1 666	1 705	1 663	2 022	2 103	2 063	2 086	2 127	2 209	2 282	611
	23.6%	22.4%	22.4%	21.2%	23.4%	23.5%	22.2%	21.6%	21.2%	21.0%	20.9%	36.6%

TABLE A3 Rates of self-employment by length of education

Science												
Undergr. & grad.	17 829	17 832	17 711	17 738	23 404	23 995	24 114	25 136	25 767	29 526	25 651	
Self-employed	1 730	1 675	1 638	1 663	2 182	2 308	2 340	2 497	2 600	2 681	2 591	861
	9.7%	9.4%	9.2%	9.4%	9.3%	9.6%	9.7%	9.9%	10.1%	9.1%	10.1%	49.8%
Postgraduate	6 625	6 805	6 932	7 042	8 333	8 468	8 646	8 826	9 132	10 167	9 637	
Self-employed	781	745	735	718	933	953	946	950	985	1 018	1 063	282
	11.8%	10.9%	10.6%	10.2%	11.2%	11.3%	10.9%	10.8%	10.8%	10.0%	11.0%	36.1%
Total:	140 769	143 356	143 709	145 999	156 511	160 188	163 816	169 436	175 068	185 562	186 496	
Undergr. & grad.	122 007	123 754	123 671	125 305	133 388	136 021	138 925	143 487	147 999	156 426	158 675	
Self-employed	17 642	17 381	17 081	17 159	19 973	20 398	19 690	19 731	19 602	19 838	20 515	2 873
	14.5%	14.0%	13.8%	13.7%	15.0%	15.0%	14.2%	13.8%	13.2%	12.7%	12.9%	16.3%
Postgraduate	18 762	19 602	20 038	20 694	23 123	23 987	24 891	25 949	27 069	29 136	27 821	
Self-employed	3 483	3 376	3 413	3 349	4 139	4 261	4 174	4 240	4 327	4 495	4 504	1 021
	18.6%	17.2%	17.0%	16.2%	17.9%	17.8%	16.8%	16.3%	16.0%	15.4%	16.2%	29.3%

TABLE A4 Entry and exit into self-employment by education 1990-2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Engineering											
Entries		1795	1275	1262	2576	2006	1603	1668	1557	1574	1723
Exits	2066	1375	1234	1028	1865	2111	1736	1645	1454	1703	
Total self-empl. eng.	9724	9452	9346	9373	10916	11038	10526	10456	10365	10481	10501
Entries % of tot. eng.		19,0%	13,6%	13,5%	23,6%	18,2%	15,2%	16,0%	15,0%	15,0%	16,4%
Exits % of tot. eng.	21,2%	14,5%	13,2%	11,0%	17,1%	19,1%	16,5%	15,7%	14,0%	16,2%	
Medicine											
Entries		1842	1287	1167	2156	1611	1311	1324	1222	1359	1814
Exits	1848	1412	1135	881	1338	1626	1312	1316	1185	1092	
Total self-empl. med.	8890	8885	8775	8802	10081	10360	10052	10068	9979	10153	10875
Entries % of tot. med.		20,7%	14,7%	13,3%	21,4%	15,6%	13,0%	13,2%	12,2%	13,4%	16,7%
Exits % of tot. med.	20,8%	15,9%	12,9%	10,0%	13,3%	15,7%	13,1%	13,1%	11,9%	10,8%	
Science											
Entry		509	368	341	991	657	582	681	657	700	667
Exit	600	407	334	258	524	554	519	518	591	666	
Total self-empl. sci.	2511	2420	2373	2381	3115	3261	3286	3447	3585	3699	3700
Entries % of tot. sci.		21,0%	15,5%	14,3%	31,8%	20,1%	17,7%	19,8%	18,3%	18,9%	18,0%
Exits % of tot. sci.	23,9%	16,8%	14,1%	10,8%	16,8%	17,0%	15,8%	15,0%	16,5%	18,0%	

TABLE A5 Duration of spells by education for cohorts 1991-1999

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Engineering									
1	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
2	69,2%	71,8%	78,4%	74,6%	74,5%	70,4%	70,8%	72,8%	70,1%
3	54,0%	61,1%	64,8%	61,2%	61,0%	55,5%	58,0%	56,1%	
4	47,5%	50,8%	54,1%	51,8%	52,8%	47,4%	47,0%		
5	41,5%	41,9%	47,9%	44,8%	46,6%	40,5%			
6	33,9%	35,5%	42,2%	39,4%	40,7%				
7	29,5%	31,8%	37,8%	34,2%					
8	25,5%	29,6%	32,7%						
9	22,8%	25,5%							
10	20,0%								
Medicine									
1	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
2	69,2%	73,7%	79,6%	78,0%	79,4%	77,2%	77,0%	76,2%	78,6%
3	55,2%	65,5%	67,9%	64,0%	67,8%	65,2%	64,6%	63,8%	
4	47,6%	57,5%	58,0%	55,3%	59,7%	57,9%	56,0%		
5	42,3%	48,7%	52,0%	48,6%	53,6%	52,5%			
6	37,1%	42,5%	47,2%	42,7%	49,5%				
7	33,0%	38,1%	42,7%	38,3%					
8	29,1%	34,5%	39,3%						
9	26,1%	31,9%							
10	24,2%								
Science									
1	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
2	64,4%	70,1%	77,7%	75,5%	76,1%	74,2%	75,5%	70,6%	62,4%
3	50,5%	59,8%	63,9%	64,5%	63,2%	60,7%	62,6%	54,6%	
4	44,6%	51,4%	54,3%	54,1%	52,8%	49,1%	52,0%		
5	40,5%	44,3%	46,3%	47,9%	44,3%	41,4%			
6	34,4%	38,9%	42,5%	40,3%	38,1%				
7	31,0%	33,2%	38,7%	35,6%					
8	28,1%	30,4%	34,3%						
9	25,7%	28,3%							
10	22,8%								

TABLE A6. Duration by length of education

	1991	1992	1993	1994	1995	1996	1997	1998	1999	
Under-graduate and graduate										
1	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
2	68,7%	73,8%	78,8%	76,1%	76,4%	73,9%	74,1%	73,8%	71,9%	74,2%
3	54,1%	63,8%	65,8%	63,1%	63,7%	60,5%	61,3%	59,0%		61,4%
4	47,2%	54,7%	55,6%	54,2%	55,4%	52,4%	51,4%			53,0%
5	41,5%	45,7%	49,0%	47,6%	49,0%	45,9%				46,5%
6	35,2%	39,3%	44,0%	41,4%	44,0%					40,8%
7	31,2%	34,9%	39,8%	36,6%						35,6%
8	27,4%	31,9%	35,8%							31,7%
9	24,8%	28,8%								26,8%
10	22,7%									22,7%
Post-graduate										
1	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
2	68,2%	65,8%	79,0%	75,5%	77,6%	71,8%	73,0%	72,9%	71,6%	72,8%
3	54,3%	58,1%	66,9%	61,4%	64,6%	57,5%	60,8%	56,9%		60,1%
4	47,1%	49,7%	56,5%	50,4%	55,4%	47,7%	49,9%			51,0%
5	42,9%	42,7%	51,5%	42,8%	48,2%	41,6%				45,0%
6	36,1%	37,8%	46,6%	38,0%	41,3%					40,0%
7	31,3%	33,6%	40,7%	33,2%						34,7%
8	27,5%	31,6%	35,2%							31,4%
9	23,9%	28,2%								26,0%
10	19,8%									19,8%

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