A DYNAMIC ANALYSIS OF THE FLOWS OF CANADIAN SCIENCE AND TECHNOLOGY GRADUATES INTO THE LABOUR MARKET

Marie Lavoie

Independent Researcher

Ross Finnie

School of Public Administration (Carleton University) and Business, Labour and Market Analysis,
Statistics Canada

September 1997

This research has been funded by the Science and Technology Redesign Project (Fred Gault, Director), Statistics Canada. It has also been supported through previously funded research using the NGS data by the Human Capital and Education Studies Division (Doug Giddings, Director, Human Resources Development Canada) and by the Social Sciences and Humanities Research Council in the form of a Strategic Themes research grant awarded to Ross Finnie for related work on the school-to-work transition. Excellent research assistance was provided by Michel Villeneuve. The views expressed in this paper are those of the authors and do not necessarily reflect those of Statistics Canada.

Science and Technology Redesign Project
Statistics Canada
February 1998

ST-98-04
Price: $75.00

THE INFORMATION SYSTEM FOR SCIENCE AND TECHNOLOGY PROJECT

The purpose of this project is to develop useful indicators of activity and a framework to tie them together into a coherent picture of science and technology in Canada.

To achieve the purpose, statistical measurements are being developed in five key areas: innovation systems; innovation; government S&T activities; industry; and human resources, including employment and higher education. The work is being done at Statistics Canada, in collaboration with Industry Canada and with a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited and potentially misleading picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and more work has to be done to understand the characteristics of innovative, and non-innovative firms, especially in the service sector which dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say how much the federal government spends and where it spends it. The current report, Federal Scientific Activities (Catalogue 88-204), released early in 1997, begins to show what the S&T money is spent on with the new Socio-Economic Objectives indicators. As well as offering a basis for a public debate on the priorities of government spending, all of this information will provide a context for reports of individual departments and agencies on performance measures which focus on outcomes at the level of individual projects.

By the final year of the Project in 1998-99, there will be enough information in place to report on the Canadian system on innovation and show the role of the federal government in that system. As well, there will be new measures in place that will provide a more complete and realistic picture of science and technology activity in Canada.

CONTACTS FOR MORE INFORMATION

S & T Redesign Project

Director Dr. F.D. Gault (613-951-2198)

An Information System for Science and Technology

Chief, Indicators Development
Dr. Frances Anderson (613-951-6307)

Chief, Human Resources Indicators
Michael Bordt (613-951-8585)

Chief, Data Integration Projects
Daood Hamdani (613-951-3490)

Project Development Officer
Antoine Rose (613-951-9919)

Science and Technology Section

Project Leader, Private Sector
Michel Boucher (613-951-7683)

Senior Project Officer
Don O'Grady (613-951-9923)

Project Leader, Public Sector
Bert Plaus (613-951-6347)

Senior Project Officer
Janet Thompson (613-951-2580)

FAX: (613-951-9920)

Working Papers

The Working Papers publish research related to science and technology issues. All papers are subject to internal review. The views expressed in the articles are those of the authors and do not necessarily reflect the views of Statistics Canada.

Table of Contents

Preface

> The revolution in the knowledge and information economy is transforming all sectors of the economy from primary resources to service industries. Canada is well-positioned to be a world leader in the global knowledge-based economy of the 21st century. We have the talent, we have the resources, we have the technology, and we have the institutions.
>
> By rising to the opportunity of mobilizing our resources well, we can enable our citizens to succeed in the global knowledge-based economy. This is how we will spur continuing job creation and sustained growth in our standard of living in the 21st century. The Government is determined to do more to support innovation and risk-taking in Canada and to attract more foreign investment in knowledge-based industries in Canada. We will build creative partnerships between the private and public sectors to accelerate the adoption of innovative technologies in all sectors of the economy.
>
> The Governor General of Canada, Speech from the Throne to Open the First Session of the Thirty-Sixth Parliament of Canada, September, 1997

Growth in Canada's service-dominated economy is largely dependent on scientific and technological innovation in knowledge-based industries. Research and development and advanced technologies such as aerospace, environmental technologies, information technology, biotechnology and telecommunications require a supply of highly qualified and appropriately qualified labour force.

The successful deployment of recent graduates on the labour market is an essential input to the production of new ideas and new knowledge in an economy. Simply having a stock of science and technology graduates is not enough to ensure economic growth. How this skill base is used will determine if these ideas and knowledge are applied. The study of the careers of recent graduates is essential to understanding the processes that transform investments in scientific and technological activities into economic growth.

Ideally, the skills available match the skills required. On the supply side, universities and colleges, as well as their students, make their decisions based on the current perception of the skills required. Governments, educational institutions and the private sector have often collaborated to promote the acquisition of appropriate skills through programmes such as SchoolNet, the Network Centres of Excellence and the new Canada Foundation for Innovation.

The demand for skills is influenced by many factors including relative growth rates between industries and government investment in research and development. Again, the current programmes to stimulate growth in the knowledge-based sectors are often collaborations. These programs focus on technology development (Technology Partnerships Canada) and communications between businesses and experts (Canadian Technology Network, Industry Canada's Web site, Strategis). Facilities such as the National Graduate Register promote the exchange of information between students seeking employment and employers with job openings.

To provide some insight into the recent record of matching skills with demand, this paper looks into the dynamics of school-to-work transition and the early careers of science and technology graduates in Canada. The analysis is based on three rounds of Statistics Canada's National Graduate Survey. This survey represents a large, representative sample of graduates from Canadian universities and colleges. Over 30,000 Bachelor's, Master's and Doctorate graduates completing their programmes in 1982, 1986 and 1990 were interviewed two and five years after graduation.

As well as the industrial distribution, the paper looks at the characteristics of science and technology graduates. The paper is a first look at the NGS data from the perspective of science and technology graduates. Its principal purpose is to raise questions for future analysis of the NGS data and data from other Statistics Canada databases.

This paper is one of four related studies for the Information System for Science and Technology Project at Statistics Canada. The objective of the Project is to develop useful indicators of activity and a framework to tie them together into a coherent picture of science and technology in Canada. The indicators to be tied together include employment, exports, and economic growth, linked to research and development, invention, innovation, technology diffusion and the characteristics of the human resources related to these activities. To do this, there are surveys, in 1997, of innovation in selected service industries and of the use and planned use of biotechnologies in selected manufacturing and primary industries, as well as various analytical projects. Each of the surveys examine sources, barriers and outcomes of the activity measured, including the characteristics of the human resources involved.

Four studies provide a context for this activity. Each draws upon databases that are unique to Statistics Canada. This paper uses the National Graduate Survey (NGS) data base to examine the flow of graduates from Canadian universities to industries and their industrial distribution two and five years after graduation. Two papers, Business Demographics as Indicators of Innovation Activity, and Job Creation, Job Destruction and Job Reallocation, use the Longitudinal Employment Analysis Programme (LEAP) data base to analyse the net creation of firms, and of jobs, by industry. A fourth paper, Exports and Related Employment in Canadian Industries, takes data from the Input-Output tables of Statistics Canada and looks at the trends in exports, value added production, and export related employment for the period 1980 to 1992.

The objective of all of these papers is to look at characteristics of employment and of the firm across the economy.

It is evident from this study that the graduates from some disciplines have indeed been rewarded with stable employment, higher earning levels and rates of job satisfaction. The more "successful" disciplines include computer scientists and health care professionals at the Bachelor's level and Doctorate graduates in pure and applied sciences. Bachelor's graduates in pure and applied sciences and Master's graduates in all disciplines have been met with higher unemployment rates, lower salaries, lower job satisfaction and less appropriate jobs than the other disciplines. The large contingent of graduates in the social sciences and humanities fared somewhere between the two extremes in most instances.

Graduates with their Master's degrees, except for those with degrees in health care, have the highest levels of "over-qualification" for their jobs. This raises questions about the benefits of obtaining a Master's degree.

In terms of industry of employment, the business services sector has been a major growth area for employment of graduates with Bachelor's degrees. This reflects not only the high rate of growth economic growth in this sector but also its overall transformation towards knowledge based work such as consulting engineering. Although the jobs are lower-paid than in the goods producing sector, it does provide the highest salary increase two to five years after graduation.

Future work will include an update of the current work based on the 1995 survey of 1990 graduates and the 1997 survey of 1995 graduates. This will provide the basis for a more detailed analysis of science and technology graduates in and out of the business services sector.

A DYNAMIC ANALYSIS OF THE FLOWS OF CANADIAN SCIENCE AND TECHNOLOGY GRADUATES INTO THE LABOUR MARKET

1 Introduction

It is increasingly recognized that scientific and technological activities are at the core of economic growth and that human resources are the central element in what has come to be called the *knowledge-based model* of advanced economies (OECD: 1996a). The growing pace of scientific and technological advance has, therefore, encouraged governments to increase the supply of science and technology graduates, although relatively little is known about careers in these areas. Furthermore, since the beginning of the 1990s, there have been numerous studies reporting that science and engineering graduates in this country and elsewhere have been facing quite a difficult labour market (AAAS: 1991, ACFAS: 1997, Finnie: 1995, Tobias *et al*.: 1995). The goal of this paper is, therefore, to shed some light on the early careers of science and engineering graduates over the last decade in Canada.

Virtually all studies of innovation and economic growth look at either the inputs or the outputs of innovation processes and are framed in a static perspective. Hence, they fail to open up the "black box" of going from inputs to outputs and to address the accumulation of knowledge within the dynamic framework which characterizes these processes. Some informed observers have pondered the difficulty of measuring knowledge and, especially, the accumulation of knowledge (Carter: 1996, OECD: 1996a, David, Foray: 1995, Smith: 1995) and have generally identified data limitations as being largely responsible for constraining analyses to a static perspective.

In this paper, we propose to leave aside the measurement of R&D investment, patenting activity or the stock of certain types of machines and equipment. Instead, we look at the evolution of the employment patterns and other indicators of recent graduates' ability to find work where their skills are used and continue to be developed. The basic objective of this research is, therefore, to study the attractiveness of science and technology as a career for three cohorts of recent university graduates at all levels – Bachelor's, Master's, and Doctorate. As well, it will identify the implications of the findings for the accumulation of knowledge on the basis of labour market outcomes.

The work employs three cohorts of the National Graduates Surveys, which comprise large and representative samples of Canadian college and university graduates interviewed two and five years after graduation.

Our major findings indicate there is considerable variation in careers in science and technology. At one extreme, the fact that computer scientists perform quite well reflects the 'skill bias' of information and communication technologies. At the other extreme, pure scientists and, especially, applied scientists are lagging behind on the labour market, which is rather disconcerting in a context where there is supposedly an increasing importance of science generally and a growing interaction between science and technology in particular (Metcalfe: 1995, Rosenberg: 1994). Moreover, we also confirm the employment shift of these highly skilled workers towards the service industries, although one should not presume that this employment increase is directly related to growth in the service sector *per se*. The more complex and intricate relationships between the goods and service sectors are not captured by these data, and need to be better understood before ascribing a leading role to the service sector in this respect.

The paper begins by discussing the importance of science and technology graduates to the accumulation of knowledge using an evolutionary approach. We then move to a description of the National Graduates Surveys and the treatment of the data for the purposes of this project. This is followed by the empirical section that evolves around two major themes,

- the attractiveness of a science and technology career in Canada, and
- the location of scientific and technological opportunities in the Canadian industrial system and, hence, the industrial location of job opportunities for graduates in science and technology.

The paper provides new evidence on the early experiences of science and technology graduates and their relation to the accumulation of knowledge in a knowledge-based economy. At the same time, many important issues remain to be addressed, and future avenues of research, both short- and long-term, are suggested in the concluding section.

2 The Accumulation of Knowledge and the Role of Scientists and Engineers

This section provides the broad framework of the analysis by introducing some concepts which are key to understanding the importance of careers in science and technology to the economy. The dynamics between the accumulation of knowledge, economic growth and varied nature of the knowledge of different disciplines are underlined.

It has been well documented that scientific and technological activities are bread-and-butter for achieving economic growth. We still do not understand the complexity of the mechanisms which transform investments in these activities into wealth, but it is believed that the way the economy uses its science and technology graduates has an important role to play in these dynamics (OECD/TEP: 1992, OECD: 1996a). The successful deployment of recent university graduates on the labour market is especially important, for these constitute an essential input in the production of new ideas and new knowledge in an economy (Dosi *et al*: 1994). That is, simply having a stock of science and technology graduates is not enough; the precise manner in which the economy actually uses its science and technology skill base is equally important, and the study of recent graduates' careers is central to understanding these processes (Lavoie, Finnie: 1997, 1996).

While much emphasis has been put on the knowledge-based economy, we still have difficulties with operationalizing this dynamic reality and related concepts such as competence, skill, knowledge, learning, and so on. As argued by Freeman, "(w)e have measures of 'capital-intensity' and of 'energy-intensity' but not of 'knowledge-intensity'. There will always be problems in defining and measuring 'knowledge-intensity' but a more serious attempt will be needed in the 1990s and the twenty-first century." (Freeman: 1994, 488).

The staggering lack of understanding of the relationships between science, technology and economic growth is still more pronounced in what concerns the relationships between a career in science and technology and the pursuit of economic growth. This involves a complex set of relationships which has, unfortunately, not been fully addressed. Some aspects, such as the flows of disembodied knowledge, have been measured through citation analysis, but very little has been really done on the basis of science and technology personnel mobility.

Moreover, we do not know much about the factors that underlie job gains and losses in particular sectors for skilled workers. Are they related to the particular nature of knowledge of these different groups? Obviously, knowledge is not a homogeneous asset; there are different bodies of knowledge that maintain different relationships with economic growth and there are significant inter-industrial differences of innovation sources (Lavoie, Roy: 1997). Besides, some disciplines play a more natural role than others within and between private firms, public laboratories and universities and have different mechanisms of accumulation.

For example, knowledge in pure science is epistemologically rooted in established laws and requires replicable, experimental methods to be verified. Knowledge in applied science is distinguished from the preceding in that it stems from scientific knowledge but does not necessarily require scientific verification to solve specific and practical problems. Finally, the body of knowledge required to solve engineering problems relies essentially on a trial after trial pattern of problem-solving activities for practicable results (Metcalfe: 1995, Lavoie, Roy: 1997).

On the basis of these considerations, the early employment patterns and the continuity of use, renewal and upgrading of the skills of these different categories of graduates developed during school and in previous jobs are likely to be important to the accumulation of knowledge in an individual, a firm and the economy as a whole. By looking at these employment patterns, we just begin, in this paper, to lift a corner of the veil on the accumulation of knowledge.

3 The Data

The National Graduates Surveys (and Follow-Up) databases that underlie the research reported here comprise large, representative, longitudinal surveys of those who successfully completed their degrees at Canadian universities and colleges in 1982, 1986, and 1990 which focus on the educational experiences and early labour market experience of recent graduates. In this section, we describe the general characteristics of the NGS databases and outline the construction of the samples and the reporting rules used in the report. Furthermore, we explain the academic discipline and industrial sector classifications, and the key variables employed in the analysis – some of the latter being of a rather novel nature.

3.1 The National Graduates Surveys

The NGS databases are derived from interviews conducted with representative samples of post-secondary graduates two and five years after graduation. The information from the second interview for the latest cohort is not yet ready for analysis and, therefore, is not used in this study. Stratified random sample design methods were employed (by province, level of education, and field of study) to provide for the analysis of smaller groups, with the results reported below reflecting the appropriate sample weights. Response rates were around 80 percent for each of the first interviews and about 90 percent of these individuals were successfully interviewed a second time for the first two cohorts. This resulted in 30,000-35,000 observations across the various years of data (1984/87, 1988/91, and 1992).[1]

[1] Such coverage is quite good for a survey of this type, although the samples inevitably over-represent "successful" graduates who are more likely to be located and willing to co-operate with the interviewer.

The NGS data are very well suited to the present study for a number of reasons. First, the longitudinal aspect represented in the two interviews conducted for each cohort provides a dynamic perspective of the school-to-work transition, with this view precisely situated as of two well-defined points in time relative to graduation. The repeated surveys also allow for the analysis of dynamics at the individual level (e.g., inter-sectoral mobility).

Secondly, the availability of data for three cohorts of graduates facilitates comparisons of outcomes from the early/mid-1980s into the beginning of the 1990s. This traverses a period generally thought to be one of significant change in labour market structures and outcomes.

Third, the large size of the NGS files along with their stratified sample scheme provide for sufficient numbers of observations to study not only overall outcomes by the targeted disciplines at each level of study, but also to push the analysis to a quite detailed level within these groups (e.g., employment patterns and earnings levels by industrial sector for a given discipline). The stratification by level of education is especially critical in providing sufficient numbers of observations at the Master's and Doctorate levels, with the NGS databases coming close to representing censuses in the case of the latter.

Finally, the NGS files contain an interesting range of variables related to the educational experiences and early labour market outcomes of recent graduates. These include not only more conventional measures, such as employment status and earnings levels, but also more original ones related to the particular experiences of recent post-secondary graduates, such as the degree to which the skills learned at school are used in the work place, and evaluations of both the current job and the education programme from which the individual graduated. The variables used in the analysis are discussed further below.

3.1.1 The Working Samples and Reporting Rules

As a very first step, the relevant level and field of study were taken to be those pertaining to the programme from which the individual graduated in the year in question (i.e., those upon which the NGS samples are based) – as opposed to any other degrees (in particular, higher ones) which might have been previously obtained. For example, those who graduated with a Bachelor's degree who had already obtained a Master's degree were considered in terms of the former rather than the latter. This approach was based on the assumption that the latest degree is the most relevant one. In addition, earlier analysis with the NGS data that indicated that previously obtained higher degrees seem to have no significant influence on subsequent labour market outcomes.[2]

Second, except for an initial set of results, graduates who obtained an additional degree after the relevant graduation date were deleted from the samples on the grounds that they no longer belonged to the original education group. For example., a Bachelor's graduate might have become a Master's graduate. This would have mixed school and work in a way likely to affect the labour market outcomes upon which we focus in this study. Furthermore, after an initial set of results regarding labour force status, the samples were limited to full-time workers, thus further focusing the analysis on those with the greatest labour market attachment. Finally, observations were dropped where the

---

[2] See (Finnie:1995). The patterns of returning to school to complete "lower" degrees are pursued somewhat further in (Finnie: 1997). This would be an interesting avenue of research to pursue in greater depth with the NGS data.

required information was missing, took extreme values (in the case of earnings), or was otherwise deemed unusable, generally resulting in a small number of deletions.

The general rule used in this report is that reported statistics are based on a minimum of 30 observations. This rule takes two forms. First, there are the straightforward cases of outcomes such as mean earnings levels, the job-education skill match index, etc. For these, results are reported where there are at least 30 observations in the relevant cell and smaller cells are indicated by a dash (zeros are shown as such). The second case is the reporting of distributions, such as employment rates and employment by sector. In these cases, the authors have developed the convention of reporting results for cells where there is either:

- at least 30 observations per parameter for the relevant group, with the number of parameters taken to be the number of cells minus 1, or
- at least 30 observations in a given cell.[3] The reporting rules are somewhat different for the analysis of mean earnings by sector of employment (starting in Table 10).

An asterisk indicates a single observation, while "nil" indicates cells with no observations.

3.1.2 The Field of Study Classification

The grouping of graduates by discipline generally follows the standard classifications – such as used by the NGS – with a couple of small adjustments appropriate to this study's emphasis on technology. Pure Science includes all disciplines in the Mathematics and Physical Sciences category (the 80000 group by the standard USIS classification, including geology, metallurgy, meteorology, and oceanography) except computer science. Applied Science includes all those in the Agricultural and Biological Sciences category (the 50000 group, including various agricultural sciences, biochemistry, biophysics, botany, fisheries and wildlife management, household science, and veterinary related). Engineering includes all those in the Engineering and Applied Sciences group (60000), including architecture. Computer Science stands alone (code 80600).

Health is the most diverse group and includes all those in the Health Professions and Occupations group (70000), including dentistry, optometry, pharmacy, medicine and nursing, as well as the basic medical sciences (anatomy, biochemistry, etc.), paraclinical sciences (microbiology, etc.), epidemiology and public health, rehabilitation medicine, medical technology, and other health professions and occupations. It is worth noting that basic degrees in medicine, dentistry, and pharmacy are classed at the Bachelor's level (consistent with their treatment in the NGS), while related specialisation are treated as Master's degrees.

---

3 The logic behind this second class of applications as discussed with various experts at Statistics Canada and elsewhere is best shown by a series of examples. In the simplest case where there are just two possible outcomes, the proportions in the two cells comprise just one independent parameter. Applying the rule means that (2-1) $\times$ 30=30 observations are required to report the result for that one independent parameter– consistent with the general rule of 30 (even as two numbers are reported, these summing to 1.00). Extending the case by one additional possible outcome implies two independent parameters, while there must be at least (3-1) $\times$ 30=60 observations to report the three proportions (which again sum to 1.00). In short, the general rule of 30 is simply applied to the number of independent parameters to be estimated across any set of proportions. Finally, where there are at least 30 observations in a given cell, that proportion is reported even if the entire set of proportions do not meet the more general reporting rule on the grounds that that statistic singly conforms to the rule of 30. The choice of 30 as the cut-off conforms to common practice based on the behaviour of parameter estimates across different sample sizes.

Finally, the Social Science and the Humanities comparison group includes all other disciplines, including not only the named areas, but also education, fine and applied arts, law, and commerce. (The few graduates whose discipline was not given or who had no field of specialisation were dropped from the analysis.)

As for the degree levels, in this research we again adopt the classification scheme embodied in the NGS databases, thus grouping degrees, diplomas, certificates, and other forms of awards together under the broad categories of Bachelor's, Master's, and Doctorate. This approach is adopted not only due to the limitations in the data, with the file for the 1982 cohort providing only the three broad classifications, but further due to a wish to keep the analysis simple and the samples inclusive. This precludes the breakdown of outcomes by specific type of programme or the deletion of any significant number of questionable cases.[4]

3.2 The Industrial Sector Classifications

In terms of analysing technology, there are currently no standard classifications of industrial sectors for Canada. Thus, while different divisions could be – and have been – developed according to various indicators relating to the current level of technological capacity or the likely sources of further technological advances (e.g., the classification developed in Lavoie, Finnie: 1995), the industrial sector groupings used in this study were chosen to conform to other research commissioned by Statistics Canada on science and technology.

The first, and broadest, classification used in this study is a comprehensive six-sector set of divisions which covers all industrial sectors. The first sector, Primary Industries, includes all SIC major groups 01 through 09, including agriculture and related services, fishing and trapping, logging, mining, petroleum, quarrying, and services related to mineral extraction. Goods Industries includes major groups 10 through 44 plus group 49, including food, beverages and tobacco; rubber, leather, textiles and clothing; wood, furniture, paper, and printing; primary metal, fabricated metal, machinery, transportation equipment, electrical products, mineral products, refined petroleum products, chemicals, and other manufacturing; all construction industries; and other utility industries. Services Related to Goods Industries includes major groups 45-47 and 50-69, including transportation, pipelines, and storage; all wholesale trade industries; and various retail trade industries: food, beverage and drug retail industries; shoe, apparel, fabric, and yarn retail industries; household furniture retail industries; autos and auto parts, including sales and service; and general retail merchandising industries, other retail store industries, and non-store retail industries.

There are then three service divisions. Public Service Industries consists of SIC major groups 81-84, including federal, provincial/territorial, local and international/other government service industries. Semi-Public Service Industries consists of SIC groups 85 and 86, including educational service industries (education at all levels and related industries) and health and social services industries.

[4] Fully sorting out and separately taking account of degrees, diplomas, certificates, etc. would be a nigh impossible task in any event due to the different meanings these awards can have. For example, while some institutions will award a second Bachelor's degree, others do not, giving a certificate instead, which is also given for shorter programmes. Thus, the same award can mean different things in different cases, while essentially the same programme of studies can lead to different awards in two different institutions. One could use the information on previously held degrees and length of programme included in the NGS databases to try to resolve these ambiguities, but such a task is beyond the scope of this project and would, in any event, still be constrained by the differences in detail provided in the 1982 versus 1986 and 1990 cohorts.

Private Service Industries consists of all other service industries, comprising SIC codes 48 (communication industries) and 70-99 except for those just noted, thus including finance, insurance, and real estate industries; business services industries; accommodation, food, and beverage industries; and other service industries.

A second set of industrial divisions focuses on a given set of two-digit industries: Electrical and Electronic Products Industries (SIC major group 33), Communication and Other Utility Industries (48), Business Services Industries (77), Educational Service Industries (85), and a residual of all other industries.

A final grouping focuses on the following three-digit industries: Communication and Other Electronic Equipment Industries (335), Business Machine Industries (336), Computer and Related Services Industries (772), University Education (853), and all other industries.

3.3 The Variables Used in the Analysis

The variables used in the analysis include a mix of conventional measures and some more original ones of particular relevance to recent graduates which merit some explanation.

First, the employment and unemployment rates are standard measures, essentially following the usual Statistics Canada conventions.[5] Second, the earnings variable reflects what individuals would earn on an annual basis were the job to last the full year, regardless of the actual job status. It thus represents a rate of pay, rather than the amount necessarily earned, with this approach having the advantage of automatically adjusting for irregular work patterns over the course of the year.[6] Earnings are expressed in 1986 constant dollars. The precise wording of the earnings question is given in the Annex.

Third, the job-education skill match measure, the two job satisfaction measures (salary, overall), and the overall evaluation of the education programme measure are all based on underlying categorical responses ("Linkert" scales) which were converted, by the authors, onto scales running from 0 to 100. Each of these constructed variables may, therefore, be thought of as reflecting an underlying index which represents the job-education skill match, job satisfaction, etc., which was first reduced to a series of discrete choices (the original responses), then transformed into a summary quasi-continuous measure. The tables show the mean values of these scores, with higher numbers indicating a closer job-education skill match, greater satisfaction, etc., with the standard errors also reported.[7]

---

5 There is the possibility of some small departures from the standard labour force definitions related to on-going students in certain years due to imprecision in the NGS databases regarding respondents' student status, but these are very unlikely to be of much consequence in terms of the results reported below.

6 Whether actual earnings or this imputed annual-equivalent would be the preferred measure – were one to have the choice – would presumably depend on one's view of the underlying sources of differences in work patterns over the year and the objectives of the analysis. If, for example, irregular work patterns were largely voluntary, the annualised measure would more accurately reflect labour market opportunities.

7 An analogy in the econometrics literature is the general approach underlying the well-known dichotomous response models such as the probit, the logit, and the tobit. In these cases, there is assumed to be an underlying index variable that triggers different categorical responses once certain thresholds are passed (e.g., individuals enter the labour market when the market wage they face is greater than their reservation wage). In the present case, we may, for example, think of a certain underlying job-education skill match index

For example, the job satisfaction question allowed for responses of “very satisfied”, “satisfied”, dissatisfied”, and “very dissatisfied”. These were then ordered on a scale running from 0 to 100, with “very satisfied” taking the value of 100; “quite satisfied”, 66.7; “not very satisfied”, 33.3; and “not at all satisfied”, 0. The means (and accompanying standard errors) of this score are reported, with higher scores indicating greater job satisfaction.

In short, each set of multiple responses (the original Linkert variables) is reduced to a much more convenient scalar measure which contains approximately the same information, while greatly simplifying the presentation of the findings and facilitating easy and direct comparisons across groups and over time.[8] The precise construction of each of these indexes is explained in the Annex. (It is worth noting here the slight difference in the overall evaluation of the education programme measure between the 1990 cohort and the two earlier cohorts.)

Finally, being over- or under-qualified for the current job is a variable that has been derived by Statistics Canada based on a straightforward application of the information collected in the surveys, as explained in the Annex. It is worth noting, however, that the definition differs slightly from the first interview to the second for the first two cohorts. In the 1984, 1988, and 1992 surveys, the measure is based on a comparison of the educational prerequisites of the current job with the highest level of education, while in the 1987 and 1991 surveys, the prerequisites are compared with the programme from which the individual graduated in the given year (i.e., 1982 or 1986). Thus, responses could differ for individuals who previously held a higher degree than the one with which they more recently graduated. This small difference is, however, likely to affect only a small proportion of individuals (mostly at the Bachelor’s level), will generally not influence comparisons across fields or cohorts, and will probably touch comparisons across degree levels to only a minor degree.

4 The Empirical Analysis

The first part of this section consists of a series of cross-tabulations that describe the school-to-work transition of science and technology graduates for all levels of education in terms of employment rates, earnings, the job-education skill match, job satisfaction and overall satisfaction with the education programme. For purposes of comparison, results are also presented for social science graduates. The second part shows employment and earnings patterns by industrial sector. In the third section, we focus on the employment trends for a group of selected industries. In the last

---

that triggers different responses as different thresholds are passed – thus generating the categorical response variables found in the original data. Our conversion of these responses into the 0-100 scales, therefore, may be seen as approximately replicating the underlying index in a discrete manner. The standard errors of the mean index scores that we report are not exactly correct, since they assume normality, but should give a good approximation of the underlying precision.

[8] In previous work, one of the authors used complex sets of chi-squared tests based on the underlying statistical properties of the discrete distributions represented by the original categorical variables to test for differences across groups, but only with a single cohort of data and for a smaller number of educational groups (Finnie: 1995). The present approach has since been developed and applied in other work by the authors (see references) as a means of better summarizing the relevant information. In particular, the various categorical responses are reduced to a single scalar measure, and the resulting test indicates the direction of any shift in the distribution of responses.

section, we look at the rate of employment stability by industrial sector from two years to five years on the labour market.

4.1 The Early Career of Scientists and Engineers

The school-to-work transition process of recent graduates in science and technology will be reviewed in this section by looking at diverse indices of satisfaction and labour market outcomes. This should give us a general picture of the early career of these graduates. Is it worth doing a science and technology career in Canada?

4.1.1 The Number and Distribution of Graduates by Discipline

The weighted number and distribution of graduates by discipline at each level of education are reported in Table 1 (with the distributions shown in Graph 1 as well), along with the absolute (unweighted) numbers. The latter figures reveal the benefits of the size and focus on recent graduates of the NGS databases in terms of the resulting sample sizes. At the Bachelor's level, these range from just under 300 (computer science graduates in the 1982 cohort) to over 1,200 (health graduates in 1986). There are generally fewer observations at the graduate level, but still sufficient to generate reliable estimates for most of the outcomes we wish to study here.

The weighted distributions of graduates by discipline, which should represent national totals, are generally similar across the three cohorts, with the exceptions to this rule being a small drop in the proportion of engineering graduates at the Bachelor's level but a significant increase at the Doctorate level, a general increase in the proportion of pure science graduates at the graduate level (both Master's and Doctorate).

Altogether, science and technology graduates made up 28-30 percent of all graduates at the Bachelor's level across the three cohorts, around 25 percent at the Master's level, and 46-55 at the Doctorate level (considering just the 1986 and 1990 cohorts due to the questionable classification of doctors in the earlier cohort as described in the footnote above) – thus indicating relative stability in the proportion of science and technology graduates over time.

4.1.2 Activity Rates

Table 2 and Graph 2 (only for the first interview for the latter) show that the rate of unemployment of Bachelor's graduates in pure science and especially applied science is relatively high after two years on the labour market. Their rate does not improve much after five years and is even worse than that of SSH graduates, which is similar to that of Bachelor's graduates in engineering. In addition to their high levels of unemployment, applied science graduates show also significantly higher rates of part-time jobs. At the other extreme, the health disciplines have a consistently low rate of unemployment across cohorts and over time. Then follows computer science, which has consistently, at all five points in time, a 6 percent or less rate of unemployment and a consistently low rate of part-timers as well.

Another observation worth noting is the predictably high rate of part timers in health disciplines which relates quite probably to a high rate of female graduates, patterns which are similar on this point to that of SSH (Finnie: 1997).

Looking at the Master's level, we also find a surprisingly high rate of unemployment for pure and applied science graduates. Master's graduates in pure science consistently exceed, over time and across cohorts, the rate of unemployment of SSH. As at the Bachelor's level, those holding a Master's degree in the health fields are also frequently part-timers but manifest a very low rate of unemployment. Master's graduates in engineering improve their rate of employment compared to those with a Bachelor's degree. Only at the doctorate level do we find a lower rate of unemployment for pure science and applied science graduates than for others.

4.1.3 Skill Matches and Mismatches

Though much has been said about the skill mismatch of low skilled workers, there is not much information about the situation for the highly skilled, especially for graduates in science and technology. We often take for granted that their educational background provides them with a broad range of skills allowing them to be more flexible on the labour market, but is this true?

In addition to these considerations, the question about the optimal match between the skills used on the job and what has been learned in school must be addressed. Should we assume that a tighter match is necessarily better than a looser one? There is always a trade-off between developing and using skills, and this depends on the nature of the discipline as well as on the sector in which the graduates of this discipline find themselves. This leads us to the measurement issue, which is typically a matter of expectations, perceptions and reality. Nevertheless, the NGS data provide evidence on graduates' evaluations of the job-education skill match, which is at least a useful starting point.

A comparison between disciplines shows that health, computer science and engineering have the highest scores on the transformed Lickert scale. Pure science and applied science have the lowest, reaching scores even worse than that of SSH for the second cohort (Table 3 and Graph 3). Obviously, the particular nature of their knowledge bodies – specific versus general nature of knowledge – is a determining factor in this match, and the results probably reflect these specificities as much as the inadequacies of the curriculum for a specific discipline.

Including graduate studies – Master's and Ph.D. – in the analysis, it is particularly interesting to look at the third cohort, which shows a closer match than do earlier cohorts for all disciplines except health. The reasons for this could range from a wholesale change in the universities' curriculum (rather doubtful) to an increasing number of more "relevant" job opportunities or to something as banal as a shift in the manner graduates answer the question. Finally, it is certainly worth noting that Master's graduates in pure science, applied science and SSH have generally a closer match than those in the same discipline with a Bachelor's. In comparison, this match is practically the same for graduates in health, computer science and engineering – a Master's degree makes the difference for the first group of disciplines. Having a doctorate closes the match between job and education except for the health group of disciplines, which is quite high for all levels of education.

As shown in Table 3, the match is closer in the second interview than in the first and this could be for a number of different reasons. Perhaps the learning capacity acquired at school is more generic than understood two years after graduation, and after five years a graduate has had more opportunities to use the whole range of knowledge acquired at school. Alternatively, it might be that having acquired more experience, the graduate is no longer able to separate the skills acquired at school from those acquired through experience. Or, perhaps graduates wish to justify their education choices ex post, and thus ascribe more relevance of their schooling to their work at later dates.[9]

Another form of skill mismatch is the more subtle issue of underemployment, which also implies the under-utilisation of graduates. Being overqualified implies that there is less challenge and consequently less motivation to do the job. This can induce a vicious circle, since the attraction of a career in science and technology may considerably fade in the eyes of the next generation of young talented people, who would simply avoid it. This fading could lead to serious shortages in the longer term or to a reduction of the quality of the candidates attracted by a career in science and technology, and consequently be detrimental to the economy (Gibbons: 1995). Finally, having a high proportion of overqualified graduates should make us wonder about the structure of labour markets and the education system at a broader level.

The figures in Table 4 and Graph 4 show that Master's graduates are those suffering most from being overqualified for the type of job they are doing. This is particularly true for the first cohort, except for the health group of disciplines, which seems relatively appropriately qualified. As a whole, these rates seem significantly high and force us to question the relevance of doing a Master's degree. Fortunately, the rates seem to decrease across cohorts. Moreover, the substantial decrease in the rate of over-qualification after five years on the labour market might mean that there has been rapid promotion for many graduates. At other levels, graduates holding a Bachelor's degree in applied science compare as badly as SSH in terms of over-qualification. Doing a Ph.D. seems advantageous for applied science in terms of having the right qualification.

One of the most interesting findings is probably the seeming adequacy of the market for engineering graduates, the only case where graduates do not express an excessive rate either of over-qualification or under-qualification. This probably reflects the fact that the education curricula are quite in line with the labour market requirements.

4.1.4 Earnings and Earnings Satisfaction

Earnings are a good indicator of the social status a society gives to a group of workers and are certainly an important element in the attractiveness of a career. Mean earnings are shown in Table 5 and Graph 5. Except for health disciplines, in which physicians are included, among full-time workers with a Bachelor's degree, engineering graduates and computer scientists have the highest earnings in all years for all cohorts. Although their advantage seems to dip somewhat for the second cohort, they regain their advantage in the third cohort. Across cohorts, these earnings differences diverge further, with applied and pure science falling further behind the others. In contrast to engineering and computer science, pure science and applied science of the third cohort still lose some points on the mean earnings.

It is; conversely, quite surprising to observe that, two years after graduation, SSH disciplines have higher mean earnings than applied science, and are quite competitive with pure science. However,

---

9 It is worth quoting Florman on this point about the specific case of engineers: "When older engineers get together they invariably agree that immediately after graduating from college they wished they had taken more technical courses. Ten years later, advancing along career paths, they wished they had learned more about business and economics. Ten years again, in their forties, thinking about the nature of leadership and musing about the meaning of life, they regretted not having studied literature, history, and philosophy. This pattern has become something of a cliche, confirmed by studies and polls". (Florman: 1987,16-17)

the rate of earnings change from two years to five years is higher for applied and pure science than for SSH, but although this allows pure science to catch up to SSH, applied science continues to lag behind.

Furthermore, looking at the three levels of education, it appears quite clearly that the SSH have a relative advantage in terms of increasing their earnings the more they acquire a higher level of education. Thus, the return on investment for doing a Master's or a Ph.D. in SSH seems sensibly higher than for doing a Master's or Ph.D. in other disciplines, except for the health disciplines which, in including physicians, are difficult to compare. Doing a Ph.D. in engineering gives mean earnings as high as a Ph.D. in SSH, but the earnings trend is slightly increasing across cohorts for SSH and decreasing for engineering.

Finally, the earnings figures for the first and second interviews reveal a substantial increase in earnings over the early years in the labour market, especially at the Bachelor's level.

To summarize, as for the patterns by specific group of disciplines, there appears to be an enduring earnings advantage for engineering and computer science graduates – leaving aside the health disciplines in which physicians are included – over the others for the Bachelor's level, with applied science particularly lagging behind all others. The picture changes for the Master's degree and the Ph.D., where SSH have a moderate lead, especially for the third cohort, while computer science has a small advantage over others for the first and second cohorts. Once again, however, applied and pure science fields of study are left behind.

Earnings satisfaction (Table 6) is the lowest level of satisfaction expressed by all groups of disciplines and at all levels of education. This probably reflects the expectations of students, which are perhaps great and somewhat unrealistic. It is possible that they do indeed hope for higher earnings levels, attach greater importance to this aspect of their jobs, and are, therefore, disappointed when they move into their first jobs and learn what it costs to adapt to a post-student lifestyle. It would be very interesting to compare earnings levels and earnings satisfaction indices with those of community college graduates.

4.1.5 Job Satisfaction

Table 7 and Graph 7 present results regarding the overall level of satisfaction with the job. Although there is not a great degree of variation by discipline, level or across time, the results are worth considering briefly. At the Bachelor's level, while applied scientists are the least satisfied after two years in the labour market, their satisfaction increases after five years, and their relative ranking improves. The most satisfied people are computer scientists and health scientists, consistently over time and across cohorts for the Bachelor's level.

It is also interesting to note the generally higher job satisfaction rates for all disciplines at the Master's level. Doctorate graduates, particularly the applied scientists, are still more satisfied.

4.1.6 Overall Evaluation of the Education Programme

Table 8 and Graph 8 present results regarding the satisfaction with the education programme on a scale which runs from 0 to 100 derived from the ordered responses provided in the original data. The answer to "Would you do it again?" is probably a very good measure of the overall satisfaction with the education programme. The group the most satisfied with their education programme is computer scientists, followed by health specialists and then engineering graduates. Interestingly, in relation to the nature of their expertise, these people are fundamentally problem-solvers.

Much more disconcerting is that Social Science and Humanities graduates are consistently more satisfied with their programmes than are pure and applied science graduates; this is particularly true for the second cohort. Finally, it is worth mentioning that the highest levels of satisfaction for applied scientists come with the acquisition of higher levels of education. This is also true for all other categories of disciplines, except perhaps in engineering, where Master's graduates express sensibly the same or only marginally higher levels of satisfaction than Bachelor's graduates.

4.1.7 Is It Worth Doing a Science or Technology Degree in Canada? – Some Concluding Comments

To sum up the overall picture drawn from the NGS is quite uneven amongst the science and technology disciplines. It shows some rather alarming facts for graduates holding a pure or applied science degree. It asserts that health disciplines follow a conventional career path. This will be confirmed in the next chapter on the basis of employment patterns by industrial sector; and displays generally positive outcomes for computer scientists and engineering graduates. These patterns deserve more discussion.

Obviously, the perceptions of graduates are always founded on expectations they had before entering university, which are based on the signal given by previous generations of graduates. In other words, the level of satisfaction depends on the level of expectations. The NGS data do not tell us what those expectations are, and so we are left to interpret the results in the context of this ambiguity.

In general, however, the picture drawn above suggests that the market is giving a negative signal to future potential candidates of pure and applied science. Conversely, the picture sets forth a rather positive signal for careers in computer science and health and, to a lesser extent, engineering. In more detail, the signals given by the picture drawn from the NGS data are as follows:

- Taking a decision to pursue an interesting career in applied science is perhaps to be prepared to go beyond the Bachelor's degree, since outcomes and satisfaction levels increase considerably with the level of education. In relation to the proportion of SSH, the share of graduates pursuing a Ph.D. is much higher in pure science and applied science, the two disciplines in which careers are generally less attractive as documented in most measures reported (figures not shown). This is probably due to the general lack of job opportunities for these graduates in Canada.
- Doing a degree in some health disciplines leads the certainty of finding a job and that job being one in which the skill match is high, the earnings are high and the overall satisfaction relatively high.
- Computer science career offers a well-defined job with high returns in terms of earnings and satisfaction.
- Despite the relatively high rate of unemployment across cohorts two years after graduation, engineering graduates manifest quite high levels of satisfaction and enjoy moderately high earnings levels. Regarding skills, they seem particularly well adapted to the requirements of the labour market.

Thus, one of the most astonishing findings in an era when there is much talk about the knowledge-based economy, about the "growing 'scientification' of technology" and about the importance of the interaction between science and technology is that there is such a high rate of unemployment, dissatisfaction and relatively low earnings among many science graduates, even after a Master's degree. Significant questions must follow. Is there an excess production of these graduates? Is it a widespread situation across industrial sectors or is it specific to some sectors? Is there a problem with the education system?

The next section further builds our analysis of careers in science and technology by showing the inter-sectoral employment patterns of recent graduates, thus attempting to lead us towards some answers to these suggestions.

4.2 The Employment Patterns of Scientists and Engineers Across Industrial Sectors

The overall picture of careers of recent graduates in science and technology drawn above provides, in some areas, cause for concern. In this section, we extend the view to the perspective of the industrial sector. One reason to look at the industrial pattern of employment is related to the cumulative, routinistic and idiosyncratic nature of technology and, to a lesser extent, of science (Metcalfe: 1995: David, Foray: 1995), and also to the fact that learning is path-dependent (Dosi: 1996). Therefore, the industrial sector in which these graduates get their first job determines the future development of their career. What an engineer or scientist (the same for a firm or a country) has done in the past is an important determinant to what s/he will be able to do in the future (Lavoie, Finnie: 1996).

Second, given that industrial sectors have different sources of innovation and patterns of knowledge accumulation, the associated employment patterns should be revealing with respect to science and technology graduates' role in the accumulation of knowledge.

4.2.1 Evolution of Total Employment by Industrial Sector

Before looking in more detail at the employment patterns of science and technology graduates by industrial sector, let us glance at the trends in total employment by industrial sector in order to compare these overall patterns with those of recent science and technology graduates. Graph 9 shows the proportion and the evolution of total employment according to each group of the classification used for the study.

Over the period 1980-1995, total employment in the private section of the service sector grew very rapidly, reflecting seemingly the general employment shift from the manufacturing sector to the service sector. In fact, it is worth looking at both curves – the private section of service industries and goods industries – in parallel. It is particularly worth noting that since 1983, total employment in the private section of the service industries has been greater than that in the goods industries. From 1983 through 1989, growth in the private service industries moderately outpaced the goods sector. From 1989-93, however, the growth patterns diverged sharply, with declines in the goods sector contrasted by stability and growth in the service sector. Although the goods sector recovered in 1993, continued growth in the service sector took it even further ahead. This says something about the complementarity of these two large industrial sectors, and the patterns might, to at least some degree, represent the "contracting-out" strategy of the goods industries, as will be discussed further later in this section.

We also observe the particularly low and rather stable employment pattern in the public section of the service industries and of the primary industries. Meanwhile, the semi-public section of the service industries had a steady rate of increase of employment over this period. Finally, the pattern of employment of the service related to goods industries is quite similar to that of goods industries, especially between 1991 to 1995.

4.2.2 Sector of Employment by Field of Study: Where Graduates Go

The patterns of employment by sector are shown in Table 9. Amongst Bachelor's graduates, the greatest concentration of employment over all fields and all years is of health science graduates in the semi-public section of the service industries, with a stable concentration over time and across cohorts of around 80 percent. Then, follows computer science, with a large and increasing contingent of graduates in the private section of the service industries; that is, 40 percent after two years for the 1982 cohort, 48 percent for the second cohort and 54 percent for the last cohort. This is an especially interesting result when we consider that the nature of their respective expertise has something in common – that the related curricula are quite specialized, rather than general. Thus there it is no surprise to find a large proportion of health specialists in the semi-public section of the service industries and equally unsurprising to find computer scientists largely concentrated in the private section of the service industries. We will come back to this later.

In fact, the former industrial sector – the private section of the service industries – is also an increasingly attractive niche for pure scientists and engineers and, to a lesser degree, for applied scientists. Although it is more typical for an engineer to start a career in this sector given that this is where the consulting engineering firms are classified, it is more remarkable to find significant numbers of pure science and applied science graduates there, although this sector also includes consulting firms in scientific and technical services. A large percentage of pure science graduates are also found in the goods industries over time and across cohorts. These findings deserve more discussion and will be developed later in the discussion section.

Applied science graduates are more evenly distributed across industrial sectors although the largest concentration is found in the service sector (especially semi-public). This is expected, since their expertise is complementary to the health industry and also because the education sector would be a natural niche for the specific nature of that expertise.

For those in engineering disciplines, the largest share of employment is located in the goods industries, and this concentration slightly increased over time, while their presence in the primary industries has declined. In the following sections, it will be seen, on a more disaggregated basis, that they are quite present in electrical and electronic products industries that belong to the goods industries group. A glance at the utility industries belonging to the goods sector would have probably shown the presence of significant numbers of engineers as well. This pattern is particularly interesting if we consider that, at the same time, they are increasingly present in the private section of service industries.

The service related to goods industries, which are essentially composed of transportation, wholesale trade and retail trade industries, seems to have been attracting the largest number of young recruits in health, computer science and SSH and, to a lesser extent, applied science for the first cohort. However, these patterns of employment have slightly declined for the second cohort, leaving a small but increasing number of pure science and engineering graduates entering this sector. One suspects that many of these graduates are in sales occupations, but only an analysis of data on occupational patterns would tell us more about this. Finally, the only discipline increasingly hired in the public sector is computer science.

The overall picture remains quite similar for the Master's degree, although the concentrations are sensibly higher. The Ph.D. graduates, when the numbers allow an analysis, find a job, for the most part, in the semi-public section of the service industries, probably mostly in universities. This will be looked at more carefully in the following section. However, contrary to other levels of education, the public sector remains a relatively important sector of employment for the 1990 cohort for the disciplines for which numbers are available. The health workers holding a Ph.D. are still located in the semi-public category of the service industries.

In conclusion, it is worth emphasizing that there is a large number of recent graduates in science and technology who find their first job in the private service industries. This finding has been conclusively documented in the literature. We will come back to this point later in the discussion section of this chapter.

4.2.3 Earnings

The profile of salary levels by industrial sector will reflect the social and economic status associated with specific career paths for a given discipline and will, therefore, serve as a summary measure of the level of attractiveness of various career options. Table 10 reports some interesting observations in this respect (see footnote in Table 10 for the reporting rules). First, except for health and SSH disciplines, primary industries generally offer the highest earnings. The second observation of interest is that, while not offering the highest salaries early in the career, the private service industries is the sector which embodies one of the largest increases over the two interviews periods and does this consistently amongst disciplines. The manufacturing sector, the goods industries of the classification, is also quite competitive in terms of salaries, two and five years after having been on the labour market.

Earnings levels in the public sector tend to be in the middle ranges except, perhaps, for SSH graduates for whom this is an increasingly interesting rate, particularly for the second and third cohorts, relative to other sectors in which they are present. In fact, the pattern of earnings offered to SSH differs slightly from other disciplines in that they get one of the lowest earnings rate which is quite similar to that of applied science earnings pattern.

If earnings reflect the potential of attractiveness of different groups of disciplines for different sectors, it appears quite clear that, for instance, the private service sector is not much inclined to hire applied scientists and that the primary industries have attractive earnings for pure science, applied science, engineering and computer science graduates, although after five years other sectors become as competitive.

4.2.4 Where are the Technological and Scientific Employment Opportunities in Canada and Is There an Increasing Trend Toward the ‘Scientification’ of Technology? – A Discussion

On the basis of the findings of the preceding section and the profile of careers in science and technology presented in the third section, we now pose the following questions: In which sectors are technological and scientific opportunities located in Canada? And, furthermore, is there a “growing ‘scientification’ of technology”?

According to the literature, there is a widespread trend towards employment growth in service industries across countries (OECD:1996b, Soete: 1995, O’Farrell: 1995). While this trend is reflected in our data, it is, however, more delicate to disentangle the reasons underlying this shift.

In general, it would be essential to know more about the science and technology interdependencies between industrial sectors to better understand this so-called shift. Can we, for example, conclude that, henceforth, the great technological and scientific opportunities are in the service sector and that the primary and manufacturing sectors are relics of the past? A simple reading of employment trends could give a misleading impression which misses the fact that much of the employment growth in the service sector that is, might be essentially explained by the "contracting-out" strategy of other sectors. Specific activities currently carried out in the service industries might have been performed previously in the manufacturing sector, this shift being motivated by "...potential cost savings; the ability to obtain an improved quality of service; and the increasing technical complexity and specialisation of service functions" (O'Farrell: 1995, 527). Or, as expressed by others:

> To some extent, this growth reflected the practice of contracting out service-type activity from firms in the manufacturing sector to firms in business services, which saw a particularly rapid expansion over the period (OECD/TEP: 1992, 151). [10]

In summary, answering the first question would require a deeper understanding of the scientific and technological interdependencies across sectors. According to our findings, there are a large number of science and technology graduates in the service sector, but these employment patterns probably reflect only the tip of an iceberg, under which a larger and more obscure reality looms. Further research is required before drawing implications regarding future employment patterns and the significance of these for knowledge accumulation.

The second question in this section stems from the finding that there is an increasing number of young scientists – from both applied and pure science – entering the private sector, such as shown in Table 9. Evolutionary theory tells us that the public sector has a role to play in basic research (OECD/TEP: 1992, Metcalfe: 1995, Pavitt: 1993). We should, therefore, expect a large concentration of pure scientists entering the public sector and universities. Instead, we found a large proportion of pure science graduates entering the private section of the service sector, and the trend is increasing over time. Goods industries are also attracting around 20 percent of these graduates with Bachelor's degrees over time.

One therefore wonders if the private sector is effectively offering new opportunities for science graduates, or if there are diminishing opportunities in the public sectors, especially universities, where they had, in the past, a more natural niche. In short, does the lack of job opportunities in their natural niche pressure them into the private sector? Furthermore, does the picture that emerges from the NGS data reflect the so-called higher intensity of the interaction between science and technology?

We cannot present any final answers to these questions on the basis of this short paper. However, our findings deserve some development in order to provide a useful empirical background upon which further investigations could build.

On the one hand, let us start the reasoning by noting that numerous studies have confirmed that scientific expertise is a main determinant in the success of many innovations.

---

10 See also, for example, (Osberg: 1989) and (Howe: 1986). On the other hand, O'Farrell also offers evidence which challenges the flexible firm model, reporting that the primary cause of increasing business service output and employment is the expansion of demand for these services. In any event, we need to better understand patterns of contracting out by type of service and related phenomena before arriving at any final conclusions regarding the source and implications of these sectoral employment shifts in Canada.

> (...) although less frequent and directly affecting a much smaller number of firms and innovations, inputs of new scientific knowledge are nevertheless extremely important. The results of the studies on radical innovations commissioned by the US National Science Foundation demonstrated not only that the major twentieth century innovations would have been impossible without the prior accumulation of scientific knowledge, but also that some very recent scientific advances played a critical part during the development stage (Freeman: 1994, 469).

On the other hand, it has been well documented that very few firms undertake fundamental research that can eventually lead to major scientific advances (OECD/TEP: 1992, 35). This is mainly due to proprietary issues and the high thresholds of R&D investment. As argued by the OECD, which quotes Dasgupta and David, science has a social role:

> By contrast the public-good-producing attributes of science and its social role have come to be dangerously overlooked by some governments. In the words of Dasgupta and David, "The argument is given that if there is some useful research to be done it will be performed as R&D, by organisations working in technology, and that it will be done there by cheaper means and without recourse to the public purse. This, quite simply, betrays a staggering lack of understanding of the socio-economics of science and technology" (OECD/TEP: 1992, 44).

Also, the following:

> Universities not only create new knowledge, they also act as repositories of the stock of established knowledge which may have important generic implications for a whole range of technologies including traditional ones (Metcalfe: 1996, 39).

Thus, placing our observation that large proportions of science graduates are finding their first jobs in the business enterprise sector in the context of what has been discussed just above provides the basis for concern about an incremental weakening of the basic research system in Canada.

However, this might also be good news, in the sense that the interface between science and technology may have become more and more blurred – otherwise put, science and technology might becoming more integrated at a time when the problems facing private enterprises may increasingly require a scientific expertise to be solved (Rosenberg: 1994)[11]. This could be the reasons that the business sector has been attracting a larger contingent of science graduates. According to Pavitt, firms learn from basic research through the recruitment of young graduates with new and valuable skills and knowledge (Pavitt: 1993). Conversely, this can be bad news in the sense that we should wonder about the financial capacity of small firms to afford the high investment in science. Moreover, the risk is that fundamental research in private enterprise tends to be oriented to problem-solving, and leaves not enough freedom for producing major scientific advances.

---

[11] In a paper one of the authors has undertaken elsewhere using a decomposition model of different effects on employment growth, we found that during the last decade, a large proportion of the employment growth was due to the production recipes and conditions having changed towards favoring pure and applied science expertise, meaning essentially that advances have more frequently been coming from the interaction between science and technology (Lavoie, Roy: 1997).

Should we conclude that there is, effectively, a "growing 'scientification' of technology" (Metcalfe: 1996, 41)? We need to know more about the occupations these graduates are holding and their precise activities in those positions, as well as more about the labour market outcomes by industrial sector, before concluding anything more regarding the meaning of the increasing pattern of science graduates in the private enterprise. This more fundamental question deserves further exploration.

4.3 The Employment Patterns of Scientists and Engineers in Selected Industries

In this section, we probe more deeply some of the findings regarding the sectoral patterns of employment reported above. Table 11 reports employment patterns in selected 2-digit industries. We observe first of all, that the greatest, and fastest growing concentration of Bachelor's graduates in these selected industries is in the business service sector, as also shown in Graph 10. This is particularly true for computer science graduates, while the concentration of engineering graduates in this sector is also high and increasing across cohorts. This is perhaps not surprising when we consider that this broad sector includes the computer and related services industry and the consulting engineering sector, whose respective core activities require the expertise of the computer scientist for the former, and engineering expertise for the latter. Moreover, the business services sector also includes management consulting services, which might constitute another natural home for engineers and computer scientists. We also find a moderately large concentration of pure science graduates in this sector, probably those who find employment with scientific and technical services consulting firms.

We also consider the educational service industries, which constitute a significant niche for pure science, applied science and computer science graduates. However, the largest share of graduates is from the SSH disciplines. Moreover, it is worth noting that Bachelor's and Master's pure science and applied science graduates appear to enter jobs in the educational service industries two years after graduation as an entry position and, then, in some numbers, leave. This pattern of employment probably means that they remain in universities after graduation to work on a research team for some time and then, gradually move into positions in other sectors by the second interview.

Going further in the disaggregation of sectors, Table 12 presents employment patterns by selected 3-digit sectors. We can now observe that a large proportion of the graduates located in the educational service industries sector, previously shown in Table 11, are mainly holding a job in a university rather than in a community college, or elsewhere. It is somewhat encouraging to find pure and applied science graduates in this sector because, as already discussed, the nature of their knowledge is generally closer to the type of fundamental research conducted in universities than to the research conducted in the private sector.

Pure science and applied science graduates are, at this level, found most in universities. SSH graduates at the PhD level have the highest concentration amongst disciplines in this sector, but they are not, for the most part, holding jobs in universities, which probably means they are holding jobs in colleges[12]. Finally, the attraction of computer and related service industry to a large concentration of computer science graduates is hardly surprising.

---

[12] To compare better these different groups of graduates, it would be imperative to look at the occupations held. This information is provided in the NGS data and should be exploited further. (For an example of a study based on the inter-professional mobility, see Lavoie, Finnie: 1996).

4.4 The Industrial Stability of Science and Technology Graduates

One of the areas where data are generally scarce is regarding the dynamics of employment, including the mobility of workers from one job to another, from one industrial sector to another, and from one occupation to another (David, Foray: 1995, Smith: 1995).

In this section, we provide a view of science and technology graduates' employment stability by industrial sector. An analysis of these stocks (as opposed to flows, given the small number of movers across the sectors used in this study) allows us to view at least one side of these dynamics which can help us to understand better the dynamics of an economy based on knowledge. Of course, there is no established consensus on what constitutes the optimal stability of individuals within one industry. Any empirical work at this point must, therefore, be seen as descriptive and exploratory rather than rigorous and definitive.

Although it would be very interesting to exploit more fully the longitudinal nature of the NGS data to investigate inter-sectoral stability/mobility patterns in greater depth, such as analysing the detailed sector-by-sector movements and studying various outcomes for those who stay in their original sector versus those who move from one to another (see the conclusion to the paper for suggested avenues of research in this regard), there are good reasons to leave this endeavour to a later stage of research.

First, as previously noted, the numbers of observations associated with the inter-sectoral flows are in most cases quite small and typically do not meet the general reporting rules adopted in this study (as described above). Thus, while various aggregating schemes and alternative reporting conventions could be usefully developed for this particular element of the research, these would need to be done with careful consideration of the reliability of the estimates in light of the precise objectives of the analysis.

Second, one would want to be certain that the inter-sectoral flows were measured with respect to the most appropriate industrial classification, and if the work reported in this first stage of the research (or elsewhere) indicated that a different division might be preferred, the inter-sectoral analysis could incorporate this adjustment. Third, the topic of inter-sectoral mobility is potentially quite involved, and any serious undertaking in this regard would be beyond the scope of the present report. For example, simply reporting various outcomes for movers and stayers by discipline and level of education for the first two cohorts for which we have the two years of data would involve a great deal of output and associated analysis.

Finally, it seems worth waiting to include the 1995 data in any analysis focused on inter-sectoral mobility patterns, given that the dynamics over the period from 1992 to 1995 would be much more relevant to policy analysts than those from 1984 to 1987 and 1988 to 1991, the periods covered by the presently available NGS files. In this context, we note that the 1995 data have recently been received and are currently being edited and manipulated into a form suitable for analysis.

Table 13 reports the percentage of graduates who were employed in a given sector at the first interview who are still there at the second interview. In the private section of the service industries, where we found an important and increasing proportion of graduates, particularly for pure science, engineering, computer science, and SSH, the rate of stability is relatively high for all fields of study and across all cohorts. This is not only an industrial sector with significant employment growth for all disciplines, it is also a sector which offers a significantly high stability of employment patterns. Given its large size, however, much mobility can also occur internally to the sector.

In the primary sector, where we found a relatively high concentration of applied science graduates for both cohorts and for pure science graduates in the first cohort, the rate of stability is especially high. The pattern is similar for Master's graduates in both fields of study, though the small number of observations does not allow us to go further in the analysis for now.

Let us go a little further with Bachelor's and Master's in applied science, a group which, according to our analysis, has been having some difficulties in the labour market. Here we find a high rate of stability in the semi-public section of the service sector where the graduates are found in large number for both cohorts.

Bachelor's and Master's engineering graduates were previously shown to be found in large proportion in the goods industries. Table 13 reports that 94 percent of those employed in this sector in 1984 were still there in 1987, that the stability of these graduates for the second cohort was slightly lower at 83 percent for those with a Bachelor's degree, and that the same pattern holds for the Master's degree.

Another interesting observation, though quite foreseeable given the large concentration of the health disciplines in the health sector which is part of the semi-public category, is the exceptional stability of these disciplines, reaching a level of 96 percent for both cohorts. The level of stability is still higher for the Master's graduates, reaching 98 percent for both cohorts.

While Bachelor's SSH disciplines (our group of comparison) are found with approximately the same level of concentration in the private and semi-public sections of the service sector, we found higher employment stability in the semi-public section, with 92 and 93 percent respectively for the first and second cohorts. The private section retains a smaller number of employees in both cohorts, with a level of stability reaching 84 percent for the first cohort and 77 percent for the second cohort. The stability is still higher for those with a Master's degree in the semi-public section of the service sector. In the case of the private section, Master's graduates who are, however, found in a lower concentration than Bachelor's, remain for the most part in this sector after five years, reaching 81 and 84 percent of stability for the first and second cohorts.

We might, therefore, conclude by restating the general finding that there is a fairly high degree of stability in the sector of employment over the first years in the labour market for each cohort.

5 Conclusion

That human resources and science and technology graduates, in particular, have a crucial role to play in the knowledge-based economy is generally recognised. Yet despite the fact that much effort has been invested in trying to convince governmental authorities around the world about the significant role of the related knowledge bases to economic growth, we still do not know much about the careers of these graduates.

This paper has provided new evidence on a variety of issues related to the early career in science and technology in Canada. Perhaps the major finding is that such a career may be generally a good choice for graduates of some disciplines, such as computer science, health science and engineering, but a rather less rewarding choice for those in pure science and, especially, applied science.

Regarding sectoral employment patterns, a second general finding is that there has indeed been a shift of high-skilled workers into the service sector, but these trends raise numerous questions regarding the complementarity between manufacturing and service sectors and the true significance of these shifts and the implications for the accumulation of knowledge.

All these questions should be answered if we want to fully develop the productive potential of science and technology graduates and to prevent science and technology from fading irremediably as a career for future cohorts of talented young people, something which could lead to significant long-term harm to the country's economic performance. However, much additional information is still needed, and we now take the opportunity to profile some future avenues of research which would represent relatively straightforward extensions of the work based on the NGS data reported here.

6 Further Avenues of Research

First, a preliminary version of the 1995 NGS file – containing the information from the second interview of the 1990 cohort – has recently been received and is currently being assessed and prepared for analysis. A first natural extension would, therefore, be to update the analysis to include the more recent data, including the extension of the individual-level dynamic elements of the study to the cohort of 1990 graduates (the 1992-95 period).

Second, the analysis could be extended to college graduates. Are science and technology graduates doing better or worse at that level? Should we be encouraging the expansion of these areas at the college level?

Third, any of the outcomes looked at here could be analysed in significantly greater depth, including the use of more formal econometric models. For example, the measures of the job-education skill match or the satisfaction with the job and the education programme from which the individual graduated could be correlated with various other outcomes (e.g., are those with higher earnings or a tighter job-education skill match more satisfied with their choices?), and analysed using multivariate probit regression models. The econometric models could, in particular, incorporate variables not considered in the present analysis, including various specific aspects of the educational experience (e.g., part-time versus full-time studies, enrolment in a co-op programme, time to completion) other elements of the early labour market experiences (a proxy for total job experience, temporary versus permanent job status, etc.), and various other individual attributes (age, province of origin/study/current residence). For the outcome variables with various categorical responses, ordered probits would be the model of choice.

Fourth, and really just a specific example stemming from the previous point, we could undertake a rigorous regression analysis of the earnings patterns of science and technology graduates as a summary measure of the relevant career opportunities. Such an approach would be based on standard earnings models techniques, including the use of established methods of breaking the cross-discipline wage patterns into various components, such as the portion due to post-graduation labour market experiences versus the "pure" effects of field of study per se. This line of research could build directly from that undertaken for the 1982 cohort of science and engineering graduates contained in (Finnie: 1995), as well as the more general analysis contained in (Finnie: 1997).

Fifth, occupational patterns could be studied in a variety of ways. In which occupations are science and technology graduates finding employment? How do the patterns vary by level of education and how have they changed over time? In particular, pursuing better an issue raised above, do we see an emerging ‘scientification’ of technology – scientists working in technology occupations and vice versa, a trend the recent literature suggests is key to a country’s technological development? How do outcomes (earnings, job satisfaction, etc.) vary by occupation?

Sixth, the elements of the analysis relating to industrial sector were no more than just opened up in this report, and could be extended in many ways. In particular, the analysis of inter-sectoral mobility patterns could be deepened in various directions, some of which have already been outlined above, with the ultimate goals of such an undertaking being to exploit the longitudinal elements of the NGS data to identify the patterns of inter-sectoral mobility, to measure various outcomes (earnings, skill match, satisfaction, etc.) in a dynamic framework for movers and stayers, and to analyse these findings in terms of their implications for careers in science and technology and the uses to which the skills of science and technology graduates are being put in Canada. This research could build directly on the work contained in (Lavoie, Finnie: 1995).

Before going in this direction, however, the classification of industries should perhaps be revisited and consideration given to using one which is more directly related to the analysis of technology, based on measures such as R&D expenditures, the number of workers involved in research and development, and other indicators of technological intensity. In particular, the sectors employed here are so large that most of the mobility is of an intra-sectoral nature which we do not observe, clearly leaving room to improve the framework of the analysis.

Seventh, while there is much scope for broadening and extending the analysis in the various ways just described, it would also be worthwhile to go in the other direction and focus more tightly on certain specific groups, outcomes, or dynamics. For example, it might be interesting to investigate the transfer of scientific and technological knowledge at its highest level by studying the flows of Doctoral science and technology graduates between the private sector and universities. As another example, it might be interesting to focus on the service sector and the mobility flows back and forth between services and the manufacturing sectors. Any number of such specific topics could be easily conceived.

In summary, the depth of the topic and the rich potential of the NGS data have only been scratched with the present report, and it only remains to choose which of the many possible further avenues of research upon which we should embark.

Table 1: The Number and Distribution of Graduates by Discipline

Level of Education and Discipline	1982 Cohort Weighted %	1982 Cohort Weighted #	1982 Cohort Unweighted #	1986 Cohort Weighted %	1986 Cohort Weighted #	1986 Cohort Unweighted #	1990 Cohort Weighted %	1990 Cohort Weighted #	1990 Cohort Unweighted #
BACHELOR'S									
Pure Science	4	3,124	542	4	4,118	511	4	3,988	566
Applied Science	6	5,112	891	6	5,737	1,040	7	6,860	979
Engineering	9	7,004	893	8	8,307	1,169	7	7,443	973
Computer Science	2	1,725	295	3	3,294	445	2	2,195	320
Health	7	6,119	874	9	9,021	1,211	7	7,656	1,030
SSH	72	58,993	6,131	70	72,461	6,860	73	75,730	6,684
	100%	82,076	9,626	100%	102,938	11,236	100%	103,872	10,552
MASTER'S									
Pure Science	3	428	264	4	604	318	5	800	421
Applied Science	5	691	306	4	626	373	5	807	499
Engineering	8	1,055	516	9	1,219	575	8	1,235	604
Computer Science	1	157	93	2	241	122	2	291	157
Health	7	871	383	7	965	484	5	830	534
SSH	76	9,927	3,607	74	10,479	3,634	75	11,986	4,146
	100%	13,129	5,169	100%	14,134	5,506	100%	15,949	6,361
DOCTORATE									
Pure Science	13	127	86	14	178	155	15	308	248
Applied Science	13	134	83	11	142	114	13	271	207
Engineering	10	95	72	10	124	110	14	285	235
Computer Science	1	12	8	1	17	14	2	36	29
Health	11	105	73	10	134	117	11	228	190
SSH	52	523	409	54	703	541	45	942	724
	100%	996	731	100%	1,298	1,050	100%	2,070	1,633

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 2: Employment Rates[1, 2]

Level of education and Discipline	1982 Cohort						1986 Cohort						1990 Cohort		
	1984			1987			1988			1991			1992		
	Employed			Employed			Employed			Employed			Employed		
	Full	Part	Unemp.	Full	Part	Unemp.	Full	Part	Unemp.	Full	Part	Unemp.	Full	Part	Unemp.
	%			%			%			%			%		
BACHELOR'S															
Pure Science	82	9	9	90	3	7	85	6	9	83	6	11	82	6	12
Applied Science	74	13	13	83	9	8	74	11	15	80	9	11	77	9	14
Engineering	90	2	8	95	2	3	90	2	8	93	3	5	89	1	10
Computer Science	92	1	6	96	3	1	93	3	4	93	2	5	93	2	6
Health	91	5	4	84	14	1	84	13	3	83	15	2	88	9	4
SSH	79	11	10	85	11	4	80	10	9	83	9	7	78	12	10
Total	81	10	9	86	10	4	82	10	9	84	9	7	80	10	10
MASTER'S															
Pure Science	79	10	11	84	10	7	72	15	14	82	8	9	75	11	13
Applied Science	82	6	12	84	11	5	77	13	10	81	11	8	87	6	8
Engineering	90	4	6	95	3	2	92	4	4	91	3	6	87	4	9
Computer Science	87	12	1	97	1	2	93	4	3	96	4	0	89	7	4
Health	90	5	5	84	14	2	87	10	4	87	11	2	87	10	4
SSH	85	8	7	88	10	2	84	9	7	85	11	4	82	10	7
Total	86	8	7	88	10	2	84	9	7	86	10	4	83	9	8
DOCTORATE															
Pure Science	87	5	8	97	2	2	95	2	3	93	3	4	92	3	6
Applied Science	91	1	9	91	3	5	95	1	4	95	2	2	95	1	4
Engineering	98	0	2	-	-	-	92	3	5	97	2	1	96	1	3
Computer Science	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Health	-	-	-	-	-	-	95	4	1	91	7	2	95	4	1
SSH	88	7	5	88	9	2	84	9	8	92	6	2	85	7	8
Total	89	5	6	91	6	3	89	6	6	93	5	2	90	4	6

[1] In this and all subsequent tables, the samples exclude graduates who had completed another degree by the relevant interview.

[2] Dashes indicate cells with too few observations to report; see the text for further explanation.

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 3: Job-Education Skill Match Index[1, 2]

Level of Education and Discipline	1982 Cohort 1984	1982 Cohort 1987	1982 Cohort % Δ	1986 Cohort 1988	1986 Cohort 1991	1986 Cohort % Δ	1990 Cohort 1992
BACHELOR'S							
Pure Science	69	77	10	61	70	13	63
Applied Science	58	69	16	54	67	19	63
Engineering	75	85	12	75	84	11	83
Computer Science	81	89	9	76	85	11	88
Health	91	94	3	84	84	0	90
SSH	62	72	14	63	71	11	68
Total	66	76	13	67	74	9	71
MASTER'S							
Pure Science	60[b]	82[b]	27	70[a]	76[a]	8	80[a]
Applied Science	67[a]	75[a]	11	71[a]	76[a]	7	83[a]
Engineering	74[a]	81[a]	9	70[a]	78	10	83
Computer Science	78[c]	88[b]	11	67[b]	75[a]	11	84[a]
Health	91[a]	90[a]	-1	84[a]	89	6	87[a]
SSH	73	82	11	71	79	10	81
Total	74	82	10	72	80	10	82
DOCTORATE							
Pure Science	78[b]	87[b]	10	79[b]	86[a]	8	92[a]
Applied Science	83[b]	90[b]	8	87[b]	93[a]	6	92[a]
Engineering	83[b]	92[b]	10	78[b]	85[b]	8	91[a]
Computer Science	-	-	-	-	-	-	-
Health	80[c]	90[c]	11	89[b]	92[a]	3	81[a]
SSH	76[a]	86[a]	12	79[a]	86[a]	8	89
Total	78[a]	88	11	81	87	7	89

[1] In this and all subsequent tables, the samples are restricted to full-time workers.

[2] The means with no letter superscript have standard errors below 1, those with an *a* superscript have standard errors between 1 and 2, those with a *b* have standard errors between 2 and 3, and those with a *c* have standard errors greater than 3. These conventions also apply to the tables which follow.

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 4: Percentage of Those "Under-Qualified" and "Over-Qualified" for Their Jobs (According to the Educational Prerequisites)

Level of education	1982 Cohort				1986 Cohort				1990 Cohort	
and Discipline	1984		1987		1988		1991		1992	
	Under qualified	Over qualified	Under qualified	Over qualified	Under qualified	Over qualified	Under qualified	Over qualified	Under qualified	Over qualified
	%		%		%		%		%	
BACHELOR'S										
Pure Science	2	29	6	19	5	29	11	22	6	22
Applied Science	5	40	9	33	3	38	16	23	4	36
Engineering	0	16	4	10	2	18	10	14	3	11
Computer Science	0	28	1	17	3	26	14	23	2	14
Health	9	21	12	12	6	37	18	30	4	27
SSH	1	48	5	30	4	44	15	28	4	30
Total	2	40	5	26	4	39	15	26	4	28
MASTER'S										
Pure Science	0	70	2	59	2	51	23	37	0	46
Applied Science	0	59	6	47	0	51	30	38	1	50
Engineering	0	63	3	60	0	65	7	58	0	57
Computer Science	-	-	-	-	2	61	15	54	4	61
Health	7	36	13	35	5	41	17	31	1	35
SSH	1	65	5	54	0	64	4	55	0	58
Total	2	63	5	53	1	62	7	52	0	56
DOCTORATE										
Pure Science	0	31	-	-	0	26	0	26	0	24
Applied Science	0	15	-	-	0	16	0	15	0	17
Engineering	0	43	-	-	0	26	0	38	0	32
Computer Science	-	-	-	-	-	-	-	-	-	-
Health	-	-	-	-	0	20	-	-	0	21
SSH	0	48	0	44	0	41	0	34	0	34
Total	1	38	0	36	0	32	0	30	0	28

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 5: Mean Earnings ($1986)[1]

Level of Education and Discipline	1982 Cohort 1984	1982 Cohort 1987	1982 Cohort % Δ	1986 Cohort 1988	1986 Cohort 1991	1986 Cohort % Δ	1990 Cohort 1992
BACHELOR'S							
Pure Science	26 800	33 000	19	25 500	31 900	20	24 800
	(204)	(272)		(159)	(202)		(214)
Applied Science	22 200	29 000	23	21 700	28 400	24	21 200
	(190)	(521)		(253)	(239)		(200)
Engineering	29 100	34 600	16	27 600	33 500	18	28 700
	(109)	(141)		(87)	(111)		(180)
Computer Science	29 400	36 000	18	27 700	32 900	16	28 900
	(189)	(333)		(156)	(158)		(170)
Health	34 000	45 700	26	35 000	41 600	16	32 900
	(261)	(561)		(291)	(385)		(214)
SSH	24 800	30 300	18	25 400	29 700	14	24 900
	(56)	(77)		(53)	(62)		(63)
Total	26 100	32 300	19	26 500	31 300	15	25 800
	(50)	(82)		(51)	(60)		(54)
MASTER'S							
Pure Science	32 900	36 200	9	30 400	32 400	6	29 300
	(668)	(913)		(621)	(525)		(870)
Applied Science	26 600	32 300	18	28 500	31 000	8	26 700
	(573)	(722)		(474)	(477)		(412)
Engineering	34 800	41 100	15	34 900	39 100	11	34 300
	(413)	(587)		(343)	(395)		(344)
Computer Science	35 900	41 800	14	36 600	38 400	5	32 700
	(964)	(1582)		(823)	(564)		(612)
Health	40 600	54 100	25	43 100	46 000	6	38 500
	(889)	(1829)		(1128)	(1123)		(1054)
SSH	35 300	39 000	9	36 300	40 000	9	37 200
	(150)	(172)		(170)	(195)		(167)
Total	35 200	39 800	12	36 200	39 700	9	36 200
	(141)	(189)		(158)	(173)		(149)
DOCTORATE							
Pure Science	35 700	39 700	10	32 100	38 100	16	31 800
	(819)	(1025)		(754)	(721)		(627)
Applied Science	30 100	39 700	24	30 400	36 200	16	30 900
	(766)	(3599)		(942)	(719)		(1468)
Engineering	43 400	49 100	12	39 200	43 800	11	38 300
	(1224)	(1950)		(1093)	(1207)		(567)
Computer Science	-	-		-	-		-
Health	33 300	54 200	39	38 500	46 600	17	43 400
	(1462)	(4885)		(1744)	(2580)		(2210)
SSH	37 400	41 500	10	38 000	40 300	6	38 900
	(557)	(774)		(499)	(540)		(465)
Total	36 500	42 900	15	36 400	40 600	10	37 000
	(401)	(820)		(387)	(435)		(404)

[1] Standard errors shown in parentheses.

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 6: Job Satisfaction (Salary) Index

Level of Education and Discipline	1982 Cohort 1984	1982 Cohort 1987	1982 Cohort % Δ	1986 Cohort 1988	1986 Cohort 1991	1986 Cohort % Δ	1990 Cohort 1992
BACHELOR'S							
Pure Science	67	71	6	66	67	1	68
Applied Science	64	64	0	61	62	2	66
Engineering	67	67	0	66	66	0	68
Computer Science	72	71	-1	68	71	4	73
Health	67	66	-2	61	63	3	70
SSH	66	66	0	63	66	5	66
Total	66	66	0	63	66	5	67
MASTER'S							
Pure Science	73[a]	73[a]	0	70[a]	67[a]	-4	67[a]
Applied Science	67[a]	62[a]	-8	63[a]	65[a]	3	65[a]
Engineering	67	65	-3	66	66	0	68
Computer Science	77[b]	77[b]	0	72[a]	72[a]	0	68[a]
Health	65[a]	65[a]	0	67	65	-3	71
SSH	71	68	-4	69	69	0	71
Total	70	67	-4	69	69	0	70
DOCTORATE							
Pure Science	68[b]	68[b]	0	65[b]	67[a]	3	66[a]
Applied Science	61[b]	65[b]	6	68[b]	67[a]	-1	59[a]
Engineering	65[b]	63[b]	-3	64[b]	67[a]	4	65[a]
Computer Science	-	-	-	-	-	-	-
Health	59[c]	59[c]	0	64[b]	62[b]	-3	67[a]
SSH	68[a]	64[a]	-6	65[a]	64[a]	-2	69
Total	66	64	-3	65	65	0	67

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 7: Job Satisfaction (Overall) Index

Level of Education and Discipline	1982 Cohort 1984	1982 Cohort 1987	% Δ	1986 Cohort 1988	1986 Cohort 1991	% Δ	1990 Cohort 1992
BACHELOR'S							
Pure Science	81	81	0	77	80	4	78
Applied Science	77	80	4	76	82	7	76
Engineering	79	78	-1	80	80	0	80
Computer Science	83	84	1	81	80	-1	82
Health	82	84	2	80	82	2	86
SSH	77	80	4	78	80	3	79
Total	78	80	3	78	81	4	80
MASTER'S							
Pure Science	83[a]	81[a]	-2	86[a]	83[a]	-4	83[a]
Applied Science	83[a]	84	1	80[a]	83[a]	4	83
Engineering	81	82	1	81	82	1	83
Computer Science	89[a]	86[b]	-3	78[a]	79[a]	1	84[a]
Health	82	87	6	85	86	1	88
SSH	82	83	1	82	84	2	84
Total	82	83	1	82	84	2	84
DOCTORATE							
Pure Science	80[b]	84[a]	5	86[a]	85[a]	-1	83[a]
Applied Science	87[b]	87[b]	0	86[a]	88[a]	2	84[a]
Engineering	83[b]	80[b]	-4	84[a]	83[a]	-1	86[a]
Computer Science	-	-	-	-	-		-
Health	81[b]	86[c]	6	89[a]	83[b]	-7	91[a]
SSH	84[a]	85[a]	1	84	85	1	88
Total	83	85	2	85	85	0	86

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 8: Overall Satisfaction with the Education Programme Index

Level of Education and Discipline	1982 Cohort 1984	1982 Cohort 1987	1982 Cohort % Δ	1986 Cohort 1988	1986 Cohort 1991	1986 Cohort % Δ	1990 Cohort 1992
BACHELOR'S							
Pure Science	69[a]	67[a]	-3	60	58[a]	-3	70
Applied Science	65	64[a]	-2	54	55	2	65
Engineering	79	70	-13	74	76	3	85
Computer Science	83	82[a]	-1	85	85	0	89
Health	81	82	1	78	83	6	87
SSH	69	68	-1	72	72	0	75
Total	71	70	-1	72	72	0	76
MASTER'S							
Pure Science	78[b]	83[b]	6	69[b]	81[b]	15	81[b]
Applied Science	79[b]	77[b]	-3	71[b]	80[b]	11	74[b]
Engineering	71[a]	75[a]	5	78[a]	77[a]	-1	84[a]
Computer Science	88[c]	95[b]	7	84[b]	88[b]	5	95[a]
Health	86[a]	90[a]	4	84[a]	85[a]	1	89[a]
SSH	84	83	-1	83	83	0	89
Total	83	83	0	82	82	0	88
DOCTORATE							
Pure Science	76[c]	77[c]	1	81[c]	79[c]	-3	76[b]
Applied Science	88[c]	94[b]	6	83[c]	79[c]	-5	80[b]
Engineering	89[c]	88[c]	-1	76[c]	80[c]	5	86[b]
Computer Science	-	-	-	-	-	-	-
Health	79[c]	86[c]	8	88[b]	83[c]	-6	92[a]
SSH	79[a]	84[a]	6	81[a]	85[a]	5	88[a]
Total	81[a]	85[a]	5	82[a]	83[a]	1	86

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 9: The Industrial Sector of Employment - Classification I

Bachelor's

Sector of Employment and Discipline	1982 Cohort 1984	1982 Cohort 1987	1986 Cohort 1988	1986 Cohort 1991	1990 Cohort 1992
	%		%		%
Pure Science					
Primary Industries	15	14	7	6	4
Goods Industries	17	19	24	18	21
Service Related to Goods Industries	9	8	10	11	7
Service Industries - Private	35	32	38	40	39
Service Industries - Semi-Public	15	14	17	15	18
Service Industries - Public	10	13	5	9	10
Applied Science					
Primary Industries	16	13	16	14	12
Goods Industries	14	17	16	13	17
Service Related to Goods Industries	11	11	10	8	9
Service Industries - Private	14	18	17	17	21
Service Industries - Semi-Public	30	27	27	32	30
Service Industries - Public	16	14	13	17	12
Engineering					
Primary Industries	12	9	5	4	6
Goods Industries	39	45	46	45	46
Service Related to Goods Industries	6	3	7	6	5
Service Industries - Private	27	28	32	33	33
Service Industries - Semi-Public	4	3	3	5	4
Service Industries - Public	11	12	7	8	6
Computer Science					
Primary Industries	4	3	2	3	2
Goods Industries	14	17	12	13	12
Service Related to Goods Industries	15	15	8	9	8
Service Industries - Private	41	41	48	44	54
Service Industries - Semi-Public	11	13	18	15	7
Service Industries - Public	15	11	12	16	17
Health					
Primary Industries	0	0	0	0	0
Goods Industries	1	1	2	2	1
Service Related to Goods Industries	11	13	6	7	10
Service Industries - Private	1	3	3	3	1
Service Industries - Semi-Public	84	80	81	83	83
Service Industries - Public	3	3	8	6	4
SSH					
Primary Industries	1	1	1	1	1
Goods Industries	10	11	9	9	9
Service Related to Goods Industries	10	11	9	8	9
Service Industries - Private	32	30	33	31	33
Service Industries - Semi-Public	36	37	36	37	38
Service Industries - Public	11	10	12	13	10
Total					
Primary Industries	4	3	2	2	2
Goods Industries	13	14	13	13	12
Service Related to Goods Industries	10	10	9	8	9
Service Industries - Private	28	28	30	29	30
Service Industries - Semi-Public	35	35	35	36	37
Service Industries - Public	11	10	11	12	10

Continued...

Tables 9: continued

Master's

Sector of Employment and Discipline	1982 Cohort		1986 Cohort		1990 Cohort
	1984	1987	1988	1991	1992
	%		%		%
Pure Science					
Primary Industries	-	-	-	10	9
Goods Industries	-	-	-	14	12
Service Related to Goods Industries	-	-	-	1	2
Service Industries - Private	-	-	-	18	27
Service Industries - Semi-Public	-	-	-	32	29
Service Industries - Public	-	-	-	26	21
Applied Science					
Primary Industries	20	-	7	7	4
Goods Industries	14	-	7	8	7
Service Related to Goods Industries	6	-	3	5	1
Service Industries - Private	10	-	13	13	14
Service Industries - Semi-Public	29	-	48	42	43
Service Industries - Public	21	-	22	25	30
Engineering					
Primary Industries	4	3	5	4	5
Goods Industries	35	38	29	27	29
Service Related to Goods Industries	5	4	3	2	3
Service Industries - Private	31	33	41	41	44
Service Industries - Semi-Public	8	7	9	11	10
Service Industries - Public	16	16	14	15	10
Computer Science					
Primary Industries	-	-	-	-	-
Goods Industries	-	-	-	-	-
Service Related to Goods Industries	-	-	-	-	-
Service Industries - Private	-	-	-	-	-
Service Industries - Semi-Public	-	-	-	-	-
Service Industries - Public	-	-	-	-	-
Health					
Primary Industries	0	0	0	1	1
Goods Industries	1	2	3	4	6
Service Related to Goods Industries	2	1	1	1	1
Service Industries - Private	2	2	4	2	6
Service Industries - Semi-Public	90	90	78	81	78
Service Industries - Public	6	5	14	12	8
SSH					
Primary Industries	1	1	1	0	1
Goods Industries	7	6	9	9	8
Service Related to Goods Industries	4	5	5	4	4
Service Industries - Private	21	19	25	24	24
Service Industries - Semi-Public	53	54	46	47	49
Service Industries - Public	14	16	15	16	14
Total					
Primary Industries	2	2	2	1	2
Goods Industries	9	9	10	10	10
Service Related to Goods Industries	4	4	4	3	4
Service Industries - Private	20	19	24	24	25
Service Industries - Semi-Public	50	51	44	45	46
Service Industries - Public	14	16	15	16	14

Continued...

Tables 9: continued

Doctorate

Sector of Employment and Discipline	1982 Cohort 1984	1982 Cohort 1987	1986 Cohort 1988	1986 Cohort 1991	1990 Cohort 1992
	%		%		%
Pure Science					
Primary Industries	-	-	-	-	4
Goods Industries	-	-	-	-	14
Service Related to Goods Industries	-	-	-	-	0
Service Industries - Private	-	-	-	-	16
Service Industries - Semi-Public	-	-	-	-	46
Service Industries - Public	-	-	-	-	20
Applied Science					
Primary Industries	-	-	-	-	9
Goods Industries	-	-	-	-	4
Service Related to Goods Industries	-	-	-	-	2
Service Industries - Private	-	-	-	-	9
Service Industries - Semi-Public	-	-	-	-	60
Service Industries - Public	-	-	-	-	17
Engineering					
Primary Industries	-	-	-	-	1
Goods Industries	-	-	-	-	16
Service Related to Goods Industries	-	-	-	-	0
Service Industries - Private	-	-	-	-	28
Service Industries - Semi-Public	-	-	-	-	38
Service Industries - Public	-	-	-	-	17
Computer Science					
Primary Industries	-	-	-	-	-
Goods Industries	-	-	-	-	-
Service Related to Goods Industries	-	-	-	-	-
Service Industries - Private	-	-	-	-	-
Service Industries - Semi-Public	-	-	-	-	-
Service Industries - Public	-	-	-	-	-
Health					
Primary Industries	-	-	-	-	0
Goods Industries	-	-	-	-	4
Service Related to Goods Industries	-	-	-	-	0
Service Industries - Private	-	-	-	-	3
Service Industries - Semi-Public	-	-	-	-	89
Service Industries - Public	-	-	-	-	4
SSH					
Primary Industries	0	0	0	0	0
Goods Industries	1	1	2	2	1
Service Related to Goods Industries	1	0	0	0	0
Service Industries - Private	10	11	9	10	10
Service Industries - Semi-Public	77	77	79	79	79
Service Industries - Public	11	10	10	9	10
Total					
Primary Industries	2	2	1	1	2
Goods Industries	4	5	5	6	6
Service Related to Goods Industries	1	1	1	1	0
Service Industries - Private	12	12	10	12	13
Service Industries - Semi-Public	67	66	70	69	66
Service Industries - Public	14	14	13	12	13

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 10: Mean Earnings by Sector of Employment ($1986)[1]

Bachelor's

Discipline and Sector of Employment	1982 Cohort 1984	1982 Cohort 1987	1982 Cohort %Δ	1986 Cohort 1988	1986 Cohort 1991	1986 Cohort %Δ	1990 Cohort 1992
Pure Science							
Primary Industries	33 400	35 400	6	27 500	32 300	15	26 500
	(521)	(562)		(477)	(880)		(743)
Goods Industries	28 100	33 400	16	26 300	33 800	22	24 200
	(321)	(457)		(378)	(362)		(366)
Service Related to Goods Industries	21 600	31 500	31	24 000	29 600	19	21 000
	(732)	(1390)		(466)	(504)		(1167)
Service Industries - Private	26 300	34 900	25	27 500	34 700	21	26 800
	(320)	(567)		(225)	(326)		(314)
Service Industries - Semi-Public	22 700	26 200	13	21 000	25 700	18	20 900
	(586)	(588)		(391)	(491)		(498)
Service Industries - Public	27 600	33 600	18	23 000	28 600	20	27 000
	(446)	(382)		(355)	(492)		(698)
Applied Science							
Primary Industries	27 000	39 400	31	27 900	36 300	23	27 200
	(827)	(2303)		(1149)	(1207)		(873)
Goods Industries	24 900	35 700	30	23 800	27 900	15	23 800
	(354)	(2184)		(807)	(349)		(452)
Service Related to Goods Industries	20 000	27 400	27	20 200	26 200	23	20 500
	(440)	(1106)		(536)	(808)		(965)
Service Industries - Private	19 500	23 400	17	19 400	25 400	24	18 500
	(366)	(598)		(368)	(397)		(272)
Service Industries - Semi-Public	20 100	25 400	21	19 600	27 000	27	19 000
	(255)	(280)		(243)	(362)		(305)
Service Industries - Public	22 000	28 200	22	20 800	28 600	27	22 300
	(369)	(366)		(304)	(278)		(368)
Engineering							
Primary Industries	32 700	35 600	8	31 400	34 900	10	30 900
	(430)	(455)		(328)	(422)		(313)
Goods Industries	30 300	36 000	16	28 100	33 900	17	29 900
	(148)	(164)		(124)	(132)		(270)
Service Related to Goods Industries	29 300	34 700	16	27 700	31 500	12	27 700
	(493)	(933)		(442)	(733)		(625)
Service Industries - Private	26 700	33 500	20	27 100	33 700	20	27 700
	(202)	(351)		(146)	(235)		(365)
Service Industries - Semi-Public	25 400	27 800	9	23 100	30 000	23	22 300
	(528)	(599)		(520)	(403)		(447)
Service Industries - Public	28 300	33 400	15	26 800	32 600	18	27 000
	(252)	(318)		(272)	(244)		(367)
Computer Science							
Primary Industries	32 600	39 500	17	30 700	36 200	15	32 700
	(280)	(347)		(527)	(766)		(1442)
Goods Industries	31 500	37 300	16	29 500	34 200	14	30 500
	(331)	(324)		(685)	(386)		(371)
Service Related to Goods Industries	27 900	35 000	20	24 000	33 500	28	25 500
	(536)	(561)		(387)	(664)		(452)
Service Industries - Private	30 500	38 200	20	26 400	31 500	16	28 700
	(315)	(713)		(188)	(244)		(252)
Service Industries - Semi-Public	25 300	28 500	11	30 800	35 300	13	26 600
	(419)	(470)		(336)	(329)		(490)
Service Industries - Public	28 600	33 900	16	28 900	32 600	11	30 900
	(507)	(611)		(396)	(370)		(353)

Continued...

Table 10: continued

Discipline and Sector of Employment	1982 Cohort 1984	1982 Cohort 1987	1982 Cohort %Δ	1986 Cohort 1988	1986 Cohort 1991	1986 Cohort %Δ	1990 Cohort 1992
Health							
Primary Industries	nil	*	*	*	nil	*	nil
Goods Industries	26 800	33 900	21	30 600	36 300	16	30 300
	(1721)	(979)		(955)	(764)		(835)
Service Related to Goods Industries	31 600	36 000	12	34 000	39 400	14	37 800
	(365)	(543)		(526)	(551)		(377)
Service Industries - Private	*	24 200	*	28 900	35 000	17	22 800
		(638)		(1389)	(1649)		(1042)
Service Industries - Semi-Public	34 700	48 700	29	35 600	43 000	17	32 700
	(300)	(683)		(341)	(456)		(246)
Service Industries - Public	32 000	31 400	-2	30 200	30 900	2	29 900
	(1054)	(651)		(399)	(454)		(688)
SSH							
Primary Industries	24 600	29 000	15	24 900	28 300	12	23 600
	(407)	(763)		(601)	(450)		(465)
Goods Industries	25 800	32 100	20	26 900	32 700	18	24 400
	(188)	(220)		(183)	(252)		(208)
Service Related to Goods Industries	22 600	30 000	25	23 200	28 900	20	21 300
	(170)	(274)		(188)	(222)		(180)
Service Industries - Private	22 400	31 500	29	23 900	30 000	20	24 100
	(107)	(195)		(110)	(149)		(138)
Service Industries - Semi-Public	27 200	29 200	7	26 300	28 500	8	26 000
	(83)	(81)		(71)	(68)		(89)
Service Industries - Public	25 300	30 000	13	26 500	30 700	14	26 300
	(160)	(164)		(130)	(125)		(137)
Total							
Primary Industries	29 400	35 000	16	28 800	33 000	13	27 000
	(282)	(544)		(524)	(444)		(343)
Goods Industries	27 500	33 800	19	27 300	33 000	17	26 300
	(120)	(184)		(116)	(138)		(147)
Service Related to Goods Industries	24 100	31 000	22	24 200	30 100	20	23 500
	(144)	(226)		(155)	(185)		(173)
Service Industries - Private	23 300	31 900	27	24 500	30 700	20	24 600
	(91)	(162)		(87)	(116)		(114)
Service Industries - Semi-Public	28 500	32 800	13	28 200	31 600	11	26 900
	(94)	(160)		(98)	(116)		(86)
Service Industries - Public	25 800	30 700	16	26 500	30 700	14	26 500
	(130)	(130)		(109)	(101)		(118)

Continued...

Table 10: continued

Master's

Discipline and Sector of Employment	1982 Cohort 1984	1982 Cohort 1987	1982 Cohort %Δ	1986 Cohort 1988	1986 Cohort 1991	1986 Cohort %Δ	1990 Cohort 1992
Pure Science							
Primary Industries	-	-	-	-	39 400	-	33 400
					(946)		(1387)
Goods Industries	-	-	-	-	37 000	-	32 500
					(1440)		(891)
Service Related to Goods Industries	-	-	-	-	*	-	19 600
							(2912)
Service Industries - Private	-	-	-	-	33 000	-	31 800
					(1299)		(775)
Service Industries - Semi-Public	-	-	-	-	27 300	-	25 100
					(882)		(2539)
Service Industries - Public	-	-	-	-	34 500	-	30 100
					(659)		(1078)
Applied Science							
Primary Industries	-	-	-	28 600	31 700	10	21 900
				(3022)	(2108)		(2551)
Goods Industries	-	-	-	26 400	28 500	7	31 100
				(1582)	(1328)		(1187)
Service Related to Goods Industries	-	-	-	32 900	30 400	-8	20 500
				(2726)	(3081)		(5898)
Service Industries - Private	-	-	-	26 900	30 500	12	25 400
				(911)	(1400)		(773)
Service Industries - Semi-Public	-	-	-	26 900	29 200	8	23 300
				(624)	(670)		(534)
Service Industries - Public	-	-	-	32 900	35 100	6	32 000
				(871)	(875)		(712)
Engineering							
Primary Industries	38 600	50 200	23	40 100	47 000	15	38 000
	(2974)	(2926)		(1792)	(2970)		(1180)
Goods Industries	37 000	43 600	15	36 200	41 400	13	36 000
	(707)	(670)		(601)	(722)		(546)
Service Related to Goods Industries	27 700	33 300	17	35 500	34 900	-2	40 500
	(1661)	(2120)		(1459)	(1818)		(2424)
Service Industries - Private	34 700	40 800	15	33 500	38 300	13	33 400
	(629)	(1373)		(519)	(634)		(543)
Service Industries - Semi-Public	27 000	30 600	12	27 500	33 800	19	27 500
	(1102)	(1831)		(1016)	(1165)		(1225)
Service Industries - Public	35 300	40 300	12	38 500	39 500	3	36 200
	(925)	(955)		(847)	(760)		(783)
Computer Science							
Primary Industries	-	-	-	-	-	-	-
Goods Industries	-	-	-	-	-	-	-
Service Related to Goods Industries	-	-	-	-	-	-	-
Service Industries - Private	-	-	-	-	-	-	-
Service Industries - Semi-Public	-	-	-	-	-	-	-
Service Industries - Public	-	-	-	-	-	-	-

Continued...

Table 10: continued

Discipline and Sector of Employment	1982 Cohort 1984	1987	% Δ	1986 Cohort 1988	1991	% Δ	1990 Cohort 1992
Health							
Primary Industries	nil	nil	nil	*	*	*	22 300
							(6383)
Goods Industries	31 000	51 900	40	41 400	40 200	-3	39 800
	(1585)	(7133)		(4485)	(3678)		(1596)
Service Related to Goods Industries	34 700	*	*	34 000	38 600	12	27 900
	(4696)			(3676)	(2533)		(4488)
Service Industries - Private	36 900	44 800	18	33 500	38 200	12	33 000
	(6040)	(5454)		(3943)	(6396)		(1839)
Service Industries - Semi-Public	41 100	55 000	25	45 000	47 600	5	39 200
	(986)	(2004)		(1388)	(1354)		(1306)
Service Industries - Public	37 700	44 700	16	35 700	40 000	11	38 200
	(1565)	(2747)		(1297)	(1446)		(2260)
SSH							
Primary Industries	44 700	58 700	24	40 000	50 300	20	40 500
	(2002)	(2397)		(2125)	(2103)		(1435)
Goods Industries	38 500	46 300	17	39 200	46 700	16	41 300
	(661)	(910)		(634)	(829)		(666)
Service Related to Goods Industries	29 400	39 900	26	37 100	46 200	20	38 700
	(671)	(1183)		(799)	(1376)		(963)
Service Industries - Private	31 800	39 500	9	35 400	42 000	16	36 400
	(437)	(594)		(472)	(573)		(455)
Service Industries - Semi-Public	36 100	37 800	4	36 700	37 600	2	37 100
	(170)	(174)		(212)	(191)		(201)
Service Industries - Public	37 000	39 500	6	34 100	38 800	12	36 000
	(354)	(333)		(306)	(344)		(322)
Total							
Primary Industries	37 700	47 400	20	37 400	42 900	13	36 000
	(1295)	(1819)		(1084)	(1282)		(939)
Goods Industries	37 100	44 700	17	37 900	44 000	14	39 200
	(463)	(587)		(464)	(573)		(455)
Service Related to Goods Industries	29 100	38 900	25	37 000	44 200	16	38 000
	(591)	(1043)		(726)	(1220)		(891)
Service Industries - Private	32 200	39 500	18	34 900	40 800	14	35 300
	(369)	(511)		(377)	(449)		(352)
Service Industries - Semi-Public	36 100	39 100	8	37 000	38 100	3	36 200
	(189)	(273)		(246)	(233)		(216)
Service Industries - Public	36 500	39 300	7	34 300	38 500	11	35 400
	(303)	(291)		(266)	(281)		(275)

Continued...

Table 10: continued

Doctorate

Discipline and	1982 Cohort			1986 Cohort			1990 Cohort
Sector of Employment	1984	1987	% Δ	1988	1991	% Δ	1992
Pure Science							
Primary Industries	-	-	-	-	-	-	40 500 (2010)
Goods Industries	-	-	-	-	-	-	41 100 (2150)
Service Related to Goods Industries	-	-	-	-	-	-	*
Service Industries - Private	-	-	-	-	-	-	34 400 (1104)
Service Industries - Semi-Public	-	-	-	-	-	-	27 400 (755)
Service Industries - Public	-	-	-	-	-	-	31 700 (1037)
Applied Science							
Primary Industries	-	-	-	-	-	-	38 800 (6382)
Goods Industries	-	-	-	-	-	-	35 700 (1907)
Service Related to Goods Industries	-	-	-	-	-	-	22 100 (5867)
Service Industries - Private	-	-	-	-	-	-	38 600 (6814)
Service Industries - Semi-Public	-	-	-	-	-	-	28 900 (1897)
Service Industries - Public	-	-	-	-	-	-	29 500 (1775)
Engineering							
Primary Industries	-	-	-	-	-	-	50 800 (2964)
Goods Industries	-	-	-	-	-	-	42 000 (1515)
Service Related to Goods Industries	-	-	-	-	-	-	*
Service Industries - Private	-	-	-	-	-	-	38 900 (901)
Service Industries - Semi-Public	-	-	-	-	-	-	34 700 (923)
Service Industries - Public	-	-	-	-	-	-	41 000 (1083)
Computer Science							
Primary Industries	-	-	-	-	-	-	-
Goods Industries	-	-	-	-	-	-	-
Service Related to Goods Industries	-	-	-	-	-	-	-
Service Industries - Private	-	-	-	-	-	-	-
Service Industries - Semi-Public	-	-	-	-	-	-	-
Service Industries - Public	-	-	-	-	-	-	-

Continued...

Table 10: continued

Discipline and Sector of Employment	1982 Cohort 1984	1987	% Δ	1986 Cohort 1988	1991	% Δ	1990 Cohort 1992
Health							
Primary Industries	-	-	-	-	-	-	nil
Goods Industries	-	-	-	-	-	-	42 900 (1743)
Service Related to Goods Industries	-	-	-	-	-	-	nil
Service Industries - Private	-	-	-	-	-	-	37 400 (4276)
Service Industries - Semi-Public	-	-	-	-	-	-	44 100 (2474)
Service Industries - Public	-	-	-	-	-	-	32 900 (4539)
SSH							
Primary Industries	nil	nil	nil	nil	nil	nil	nil
Goods Industries	26 400 (3249)	91 200 (29 838)	71	36 500 (4458)	42 700 (3806)	15	37 800 (7267)
Service Related to Goods Industries	11 800 (672)	*	*	*	*	*	nil
Service Industries - Private	30 700 (1912)	42 500 (3890)	28	36 200 (2638)	39 900 (2848)	9	40 100 (2019)
Service Industries - Semi-Public	37 300 (584)	40 000 (678)	7	38 120 (534)	40 200 (575)	5	38 500 (502)
Service Industries - Public	44 700 (1671)	47 500 (1980)	6	38 700 (1321)	41 900 (1220)	8	40 800 (1115)
Total							
Primary Industries	46 400 (1576)	58 300 (2759)	20	33 500 (2348)	40 600 (1710)	17	40 500 (4057)
Goods Industries	40 500 (1923)	50 300 (4300)	19	38 300 (1328)	40 100 (1193)	4	41 000 (1142)
Service Related to Goods Industries	28 000 (6228)	114 800 (74366)	76	33 700 (4723)	33 800 (5605)	0	26 400 (4101)
Service Industries - Private	36 700 (1414)	44 800 (2415)	18	39 600 (1534)	42 200 (1389)	6	38 200 (1076)
Service Industries - Semi-Public	39 800 (467)	40 700 (835)	2	36 000 (476)	40 400 (558)	11	36 500 (535)
Service Industries - Public	40 400 (931)	43 500 (929)	7	36 200 (749)	41 200 (809)	12	36 300 (704)

[1] In this and the following two tables, standard errors are shown in parentheses. Also, unlike previous tables, mean earnings are given here for all cells for which the distributions are reported in the preceding table, even when there are less than 30 observations in a cell. The exception to this rule is where there is only a single observation, indicated by an asterisk, while "nil" indicates cells with no observations (for which mean earnings are obviously not defined).

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 11: The Industrial Sector of Employment - Selected 2-Digit Industries

Bachelor's

Sector of Employment and Discipline	1982 Cohort 1984	1982 Cohort 1987	1986 Cohort 1988	1986 Cohort 1991	1990 Cohort 1992
	%		%		%
Pure Science					
Elec. & Elec. Prods. Indus	3	3	3	5	4
Communication Indus	1	1	2	3	2
Business Service Indus	22	20	16	19	20
Educational Service Indus	12	10	13	12	14
All Other Industries	62	67	65	61	60
Applied Science					
Elec. & Elec. Prods. Indus	0	0	0	0	1
Communication Indus	0	1	0	0	1
Business Service Indus	3	8	7	9	6
Educational Service Indus	15	14	14	11	14
All Other Industries	81	78	79	80	78
Engineering					
Elec. & Elec. Prods. Indus	10	11	7	9	10
Communication Indus	3	3	5	6	5
Business Service Indus	23	23	26	26	28
Educational Service Indus	3	3	3	4	4
All Other Industries	61	60	59	55	53
Computer Science					
Elec. & Elec. Prods. Indus	3	6	4	3	8
Communication Indus	4	4	6	6	6
Business Service Indus	27	25	31	26	33
Educational Service Indus	11	13	16	13	6
All Other Industries	55	51	44	52	47
Health					
Elec. & Elec. Prods. Indus	0	0	0	0	0
Communication Indus	0	0	0	1	0
Business Service Indus	0	1	0	0	1
Educational Service Indus	5	6	7	7	5
All Other Industries	94	93	92	92	94
SSH					
Elec. & Elec. Prods. Indus	1	1	1	1	1
Communication Indus	2	2	2	3	2
Business Service Indus	14	13	14	14	14
Educational Service Indus	29	30	27	29	29
All Other Industries	54	53	55	53	54
Total					
Elec. & Elec. Prods. Indus	2	2	2	2	2
Communication Indus	2	2	2	3	2
Business Service Indus	14	13	14	14	14
Educational Service Indus	22	23	22	23	23
All Other Industries	60	59	60	58	59

Continued...

Tables 11: continued

Master's

Sector of Employment and Discipline	1982 Cohort 1984	1982 Cohort 1987	1986 Cohort 1988	1986 Cohort 1991	1990 Cohort 1992
	%		%		%
Pure Science					
Elec. & Elec. Prods. Indus	1	-	4	5	4
Communication Indus	1	-	3	1	1
Business Service Indus	18	-	19	16	24
Educational Service Indus	28	-	24	29	25
All Other Industries	52	-	51	49	46
Applied Science					
Elec. & Elec. Prods. Indus	0	0	0	0	0
Communication Indus	0	0	0	0	0
Business Service Indus	8	6	9	10	10
Educational Service Indus	24	22	36	31	31
All Other Industries	68	72	54	58	59
Engineering					
Elec. & Elec. Prods. Indus	16	16	7	7	9
Communication Indus	3	3	7	6	4
Business Service Indus	30	31	34	36	40
Educational Service Indus	8	7	8	10	9
All Other Industries	44	43	43	41	38
Computer Science					
Elec. & Elec. Prods. Indus	-	-	-	-	-
Communication Indus	-	-	-	-	-
Business Service Indus	-	-	-	-	-
Educational Service Indus	-	-	-	-	-
All Other Industries	-	-	-	-	-
Health					
Elec. & Elec. Prods. Indus	0	0	0	0	0
Communication Indus	0	0	0	0	0
Business Service Indus	0	1	1	0	3
Educational Service Indus	20	14	20	21	19
All Other Industries	80	85	79	78	78
SSH					
Elec. & Elec. Prods. Indus	1	1	1	1	1
Communication Indus	1	1	2	2	2
Business Service Indus	9	8	10	11	10
Educational Service Indus	44	44	35	37	37
All Other Industries	45	46	51	49	50
Total					
Elec. & Elec. Prods. Indus	2	2	2	2	2
Communication Indus	1	1	2	2	2
Business Service Indus	10	9	12	13	13
Educational Service Indus	38	38	32	33	33
All Other Industries	48	49	52	50	50

Continued...

Tables 11: continued

Doctorate

Sector of Employment and Discipline	1982 Cohort 1984	1982 Cohort 1987	1986 Cohort 1988	1986 Cohort 1991	1990 Cohort 1992
	%		%		%
Pure Science					
Elec. & Elec. Prods. Indus	-	-	4	-	2
Communication Indus	-	-	0	-	0
Business Service Indus	-	-	12	-	15
Educational Service Indus	-	-	46	-	43
All Other Industries	-	-	39	-	41
Applied Science					
Elec. & Elec. Prods. Indus	-	-	-	-	0
Communication Indus	-	-	-	-	0
Business Service Indus	-	-	-	-	8
Educational Service Indus	-	-	-	-	50
All Other Industries	-	-	-	-	42
Engineering					
Elec. & Elec. Prods. Indus	-	-	-	-	6
Communication Indus	-	-	-	-	2
Business Service Indus	-	-	-	-	26
Educational Service Indus	-	-	-	-	39
All Other Industries	-	-	-	-	27
Computer Science					
Elec. & Elec. Prods. Indus	-	-	-	-	-
Communication Indus	-	-	-	-	-
Business Service Indus	-	-	-	-	-
Educational Service Indus	-	-	-	-	-
All Other Industries	-	-	-	-	-
Health					
Elec. & Elec. Prods. Indus	-	-	-	-	0
Communication Indus	-	-	-	-	0
Business Service Indus	-	-	-	-	3
Educational Service Indus	-	-	-	-	41
All Other Industries	-	-	-	-	56
SSH					
Elec. & Elec. Prods. Indus	0	0	0	0	0
Communication Indus	1	1	0	0	0
Business Service Indus	5	5	5	5	4
Educational Service Indus	64	66	63	66	66
All Other Industries	31	28	31	29	29
Total					
Elec. & Elec. Prods. Indus	0	1	1	1	1
Communication Indus	0	0	1	1	0
Business Service Indus	9	9	8	8	10
Educational Service Indus	54	56	55	56	53
All Other Industries	36	35	36	34	35

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Table 12: The Industrial Sector of Employment - Selected 3-Digit Industries

Bachelor's

Sector of Employment and Discipline	1982 Cohort 1984	1982 Cohort 1987	1986 Cohort 1988	1986 Cohort 1991	1990 Cohort 1992
	%		%		%
Pure Science					
Comm. & Other Elec. Equip.	1	2	1	1	2
Business Machine Indus	2	0	1	2	2
Computer & Related Service	5	8	7	7	6
University Education	7	5	7	6	6
All Other Industries	85	86	84	84	84
Applied Science					
Comm. & Other Elec. Equip.	0	0	0	0	0
Business Machine Indus	0	0	0	0	0
Computer & Related Service	0	1	0	0	1
University Education	12	6	9	6	11
All Other Industries	88	93	91	94	87
Engineering					
Comm. & Other Elec. Equip.	5	6	4	5	5
Business Machine Indus	2	2	1	2	3
Computer & Related Service	1	2	3	3	3
University Education	1	1	2	2	2
All Other Industries	90	89	90	88	87
Computer Science					
Comm. & Other Elec. Equip.	1	2	1	1	5
Business Machine Indus	2	5	2	2	2
Computer & Related Service	19	19	23	18	23
University Education	8	6	5	4	4
All Other Industries	70	68	70	75	66
Health					
Comm. & Other Elec. Equip.	0	0	0	0	0
Business Machine Indus	0	0	0	0	0
Computer & Related Service	0	0	0	0	0
University Education	1	4	5	4	3
All Other Industries	99	96	95	96	97
SSH					
Comm. & Other Elec. Equip.	0	1	0	0	0
Business Machine Indus	0	1	0	0	0
Computer & Related Service	1	1	1	1	1
University Education	2	1	2	2	2
All Other Industries	97	97	97	96	97
Total					
Comm. & Other Elec. Equip.	1	1	1	1	1
Business Machine Indus	1	1	0	1	1
Computer & Related Service	1	2	2	2	2
University Education	3	2	3	3	3
All Other Industries	95	94	94	94	94

Continued...

Tables 12: continued

Master's

Sector of Employment and Discipline	1982 Cohort 1984	1982 Cohort 1987	1986 Cohort 1988	1986 Cohort 1991	1990 Cohort 1992
	%		%		%
Pure Science					
Comm. & Other Elec. Equip.	1	-	0	2	2
Business Machine Indus	1	-	3	2	1
Computer & Related Service	3	-	3	2	3
University Education	12	-	18	23	18
All Other Industries	84	-	77	69	77
Applied Science					
Comm. & Other Elec. Equip.	0	0	0	0	0
Business Machine Indus	0	0	0	0	0
Computer & Related Service	0	0	0	0	1
University Education	17	13	23	16	24
All Other Industries	83	87	77	84	75
Engineering					
Comm. & Other Elec. Equip.	10	10	4	4	6
Business Machine Indus	3	3	1	2	3
Computer & Related Service	2	2	4	4	4
University Education	6	4	6	8	7
All Other Industries	78	80	85	82	81
Computer Science					
Comm. & Other Elec. Equip.	-	-	-	-	-
Business Machine Indus	-	-	-	-	-
Computer & Related Service	-	-	-	-	-
University Education	-	-	-	-	-
All Other Industries	-	-	-	-	-
Health					
Comm. & Other Elec. Equip.	0	0	0	0	0
Business Machine Indus	0	0	0	0	0
Computer & Related Service	0	0	1	0	0
University Education	12	8	11	12	12
All Other Industries	88	92	87	88	88
SSH					
Comm. & Other Elec. Equip.	0	0	1	1	0
Business Machine Indus	0	0	1	0	1
Computer & Related Service	1	1	1	1	1
University Education	5	5	5	6	6
All Other Industries	93	93	92	91	92
Total					
Comm. & Other Elec. Equip.	1	1	1	1	1
Business Machine Indus	1	1	1	1	1
Computer & Related Service	1	1	2	2	2
University Education	7	6	7	8	8
All Other Industries	90	91	90	88	88

Continued...

Tables 12: continued

Doctorate

Sector of Employment and Discipline	1982 Cohort 1984	1982 Cohort 1987	1986 Cohort 1988	1986 Cohort 1991	1990 Cohort 1992
	%		%		%
Pure Science					
Comm. & Other Elec. Equip.	-	-	1	-	1
Business Machine Indus	-	-	2	-	0
Computer & Related Service	-	-	1	-	2
University Education	-	-	40	-	39
All Other Industries	-	-	55	-	58
Applied Science					
Comm. & Other Elec. Equip.	-	-	-	-	0
Business Machine Indus	-	-	-	-	0
Computer & Related Service	-	-	-	-	1
University Education	-	-	-	-	46
All Other Industries	-	-	-	-	53
Engineering					
Comm. & Other Elec. Equip.	-	-	-	-	3
Business Machine Indus	-	-	-	-	2
Computer & Related Service	-	-	-	-	1
University Education	-	-	-	-	36
All Other Industries	-	-	-	-	58
Computer Science					
Comm. & Other Elec. Equip.	-	-	-	-	-
Business Machine Indus	-	-	-	-	-
Computer & Related Service	-	-	-	-	-
University Education	-	-	-	-	-
All Other Industries	-	-	-	-	-
Health					
Comm. & Other Elec. Equip.	-	-	-	-	0
Business Machine Indus	-	-	-	-	0
Computer & Related Service	-	-	-	-	0
University Education	-	-	-	-	40
All Other Industries	-	-	-	-	60
SSH					
Comm. & Other Elec. Equip.	0	0	0	0	0
Business Machine Indus	0	0	0	0	0
Computer & Related Service	1	2	0	0	0
University Education	48	50	46	51	51
All Other Industries	51	48	54	49	48
Total					
Comm. & Other Elec. Equip.	0	0	0	0	1
Business Machine Indus	0	0	0	0	0
Computer & Related Service	1	1	1	1	1
University Education	44	46	44	46	45
All Other Industries	55	53	54	53	53

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

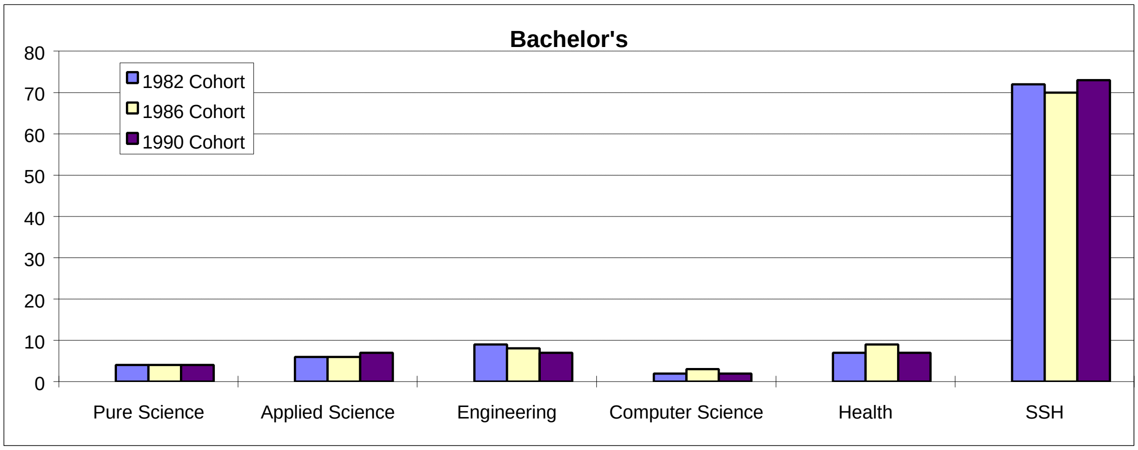
Table 13: Sectoral Stability - Classification I[1]

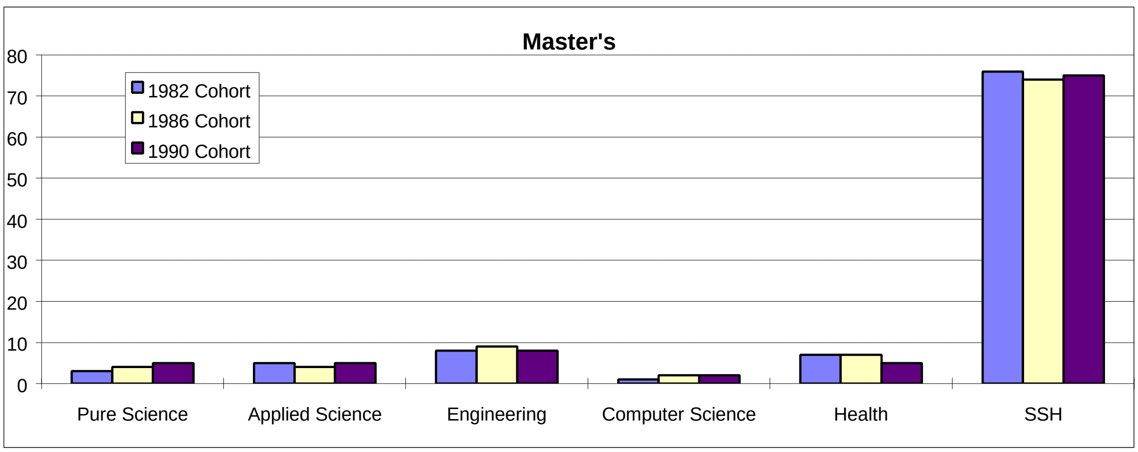
Level of Education	1984 - 1987 Status						1988 - 1991 Status					
and Discipline	Primary	Goods	Servgood	Servpriv	Servsemi	Servpub	Primary	Goods	Servgood	Servpriv	Servsemi	Servpub
BACHELOR'S												
Pure Sc.	96	70	62	76	67	85	65	63	73	80	73	100
Applied Sc.	84	86	73	74	82	76	85	63	50	81	78	64
Engineering	84	94	42	80	57	78	58	83	49	78	53	68
Computer Sc.	100	85	79	82	70	69	83	80	56	78	77	89
Health	nil	73	96	100	96	51	100	58	92	44	96	60
SSH	62	75	68	84	92	73	61	66	67	77	93	79
Total	81	82	70	83	92	73	70	72	67	77	92	77
MASTER'S												
Pure Sc.	95	74	nil	64	96	100	87	92	nil	70	75	82
Applied Sc.	89	83	100	82	86	87	87	82	69	72	83	88
Engineering	51	95	89	90	67	87	70	84	70	82	80	87
Computer Sc.	100	86	16	82	95	82	0	83	35	88	90	81
Health	nil	70	50	100	98	75	100	57	100	46	98	85
SSH	79	76	71	81	94	87	70	79	71	84	95	82
Total	82	83	73	82	94	87	75	80	70	83	94	83
DOCTORATE												
Pure Sc.	73	100	0	89	89	72	54	76	100	92	83	54
Applied Sc.	nil	nil	nil	59	87	95	55	34	100	45	91	94
Engineering	77	88	0	84	83	77	33	91	0	64	82	59
Computer Sc.	nil	nil	nil	0	81	nil	nil	nil	nil	100	100	nil
Health	100	100	nil	0	93	50	nil	100	nil	50	95	55
SSH	nil	100	0	83	96	83	100	86	0	87	96	69
Total	76	94	0	79	93	81	53	80	62	78	93	67

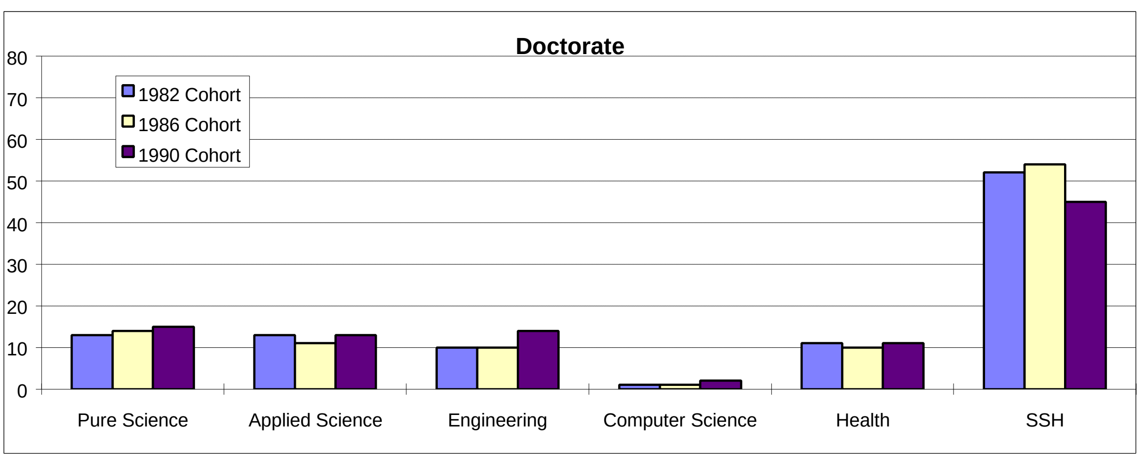
[1] Shaded figures indicate a percentage representing a single observation.

Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Graph 1: The Distribution of Graduates by Discipline

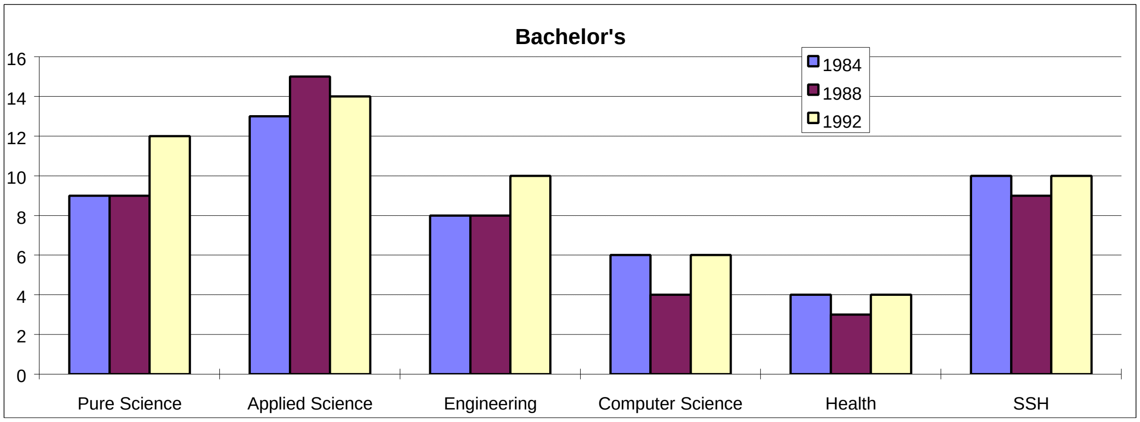


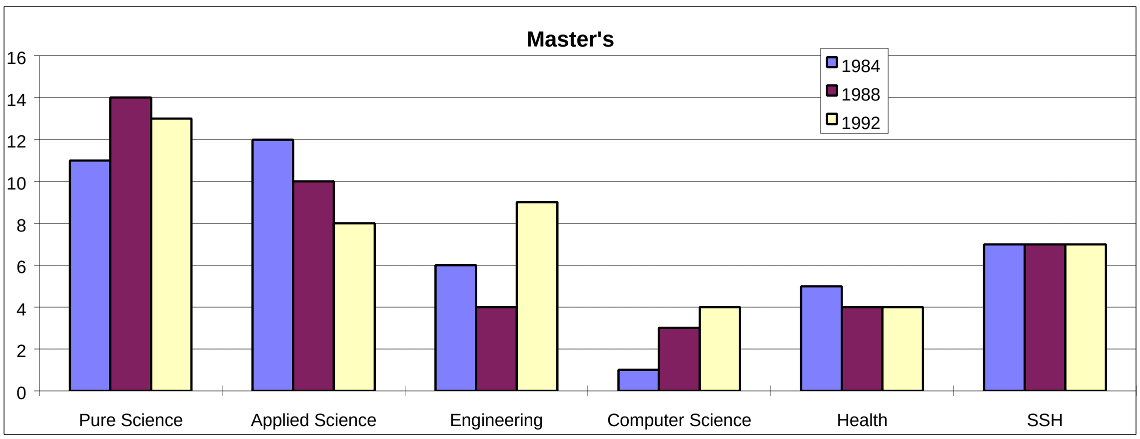


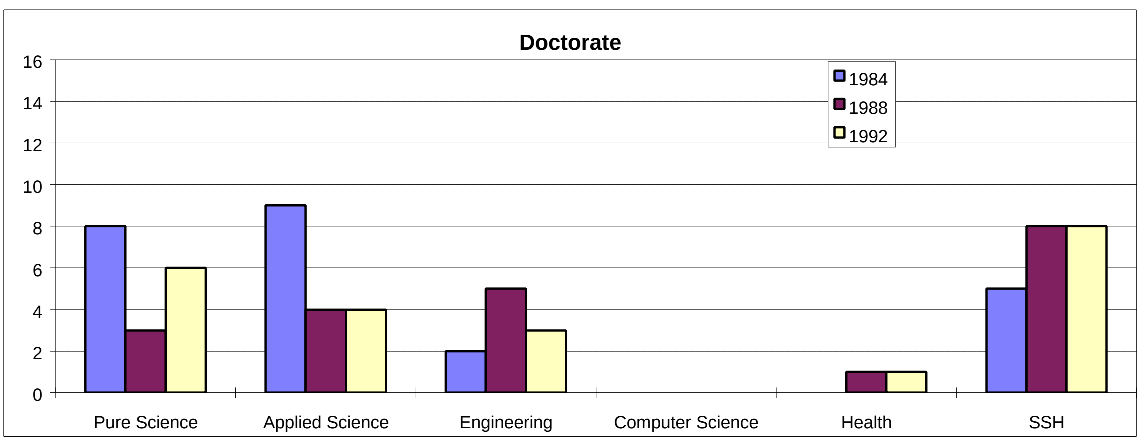


Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Graph 2: Unemployment Rates

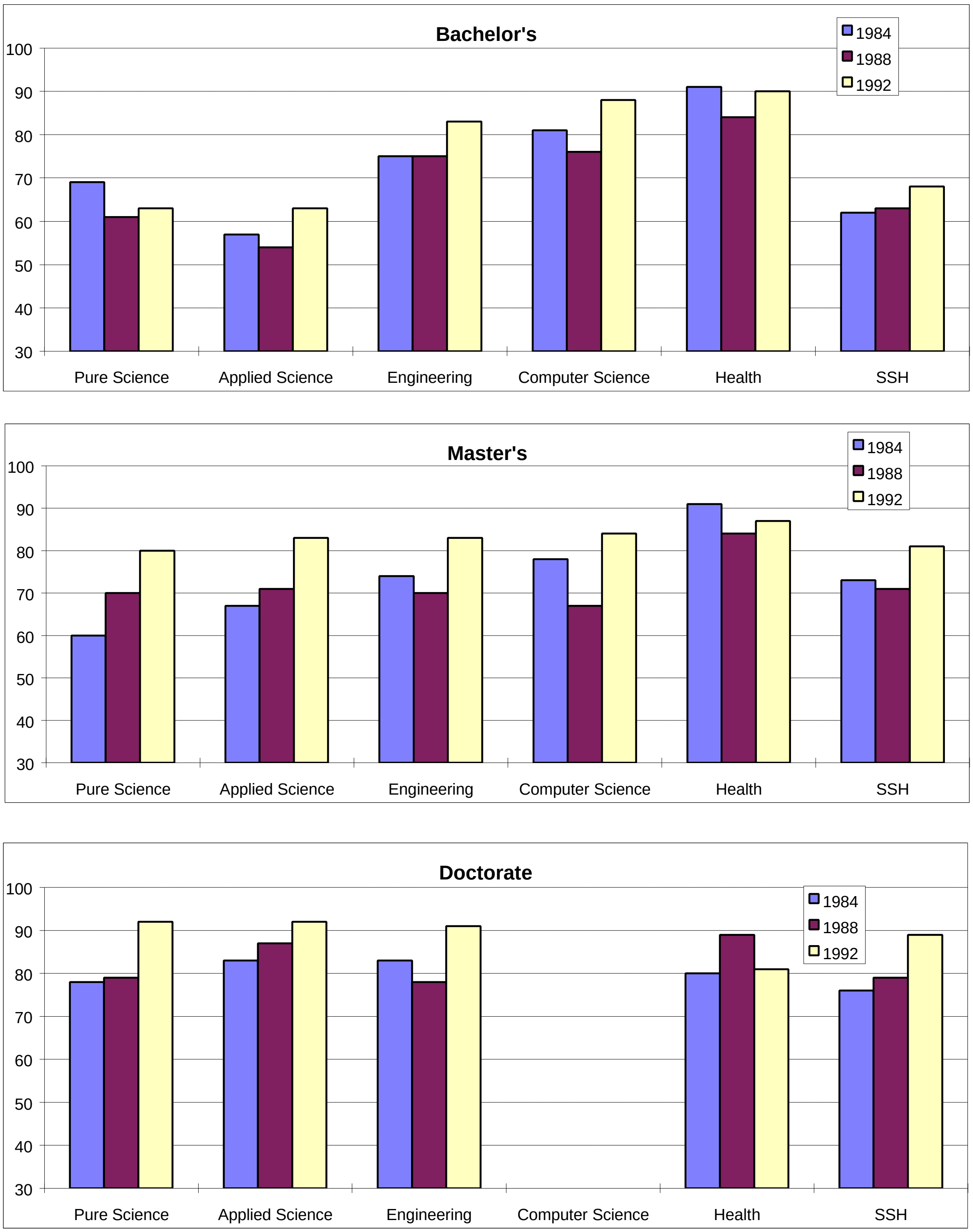






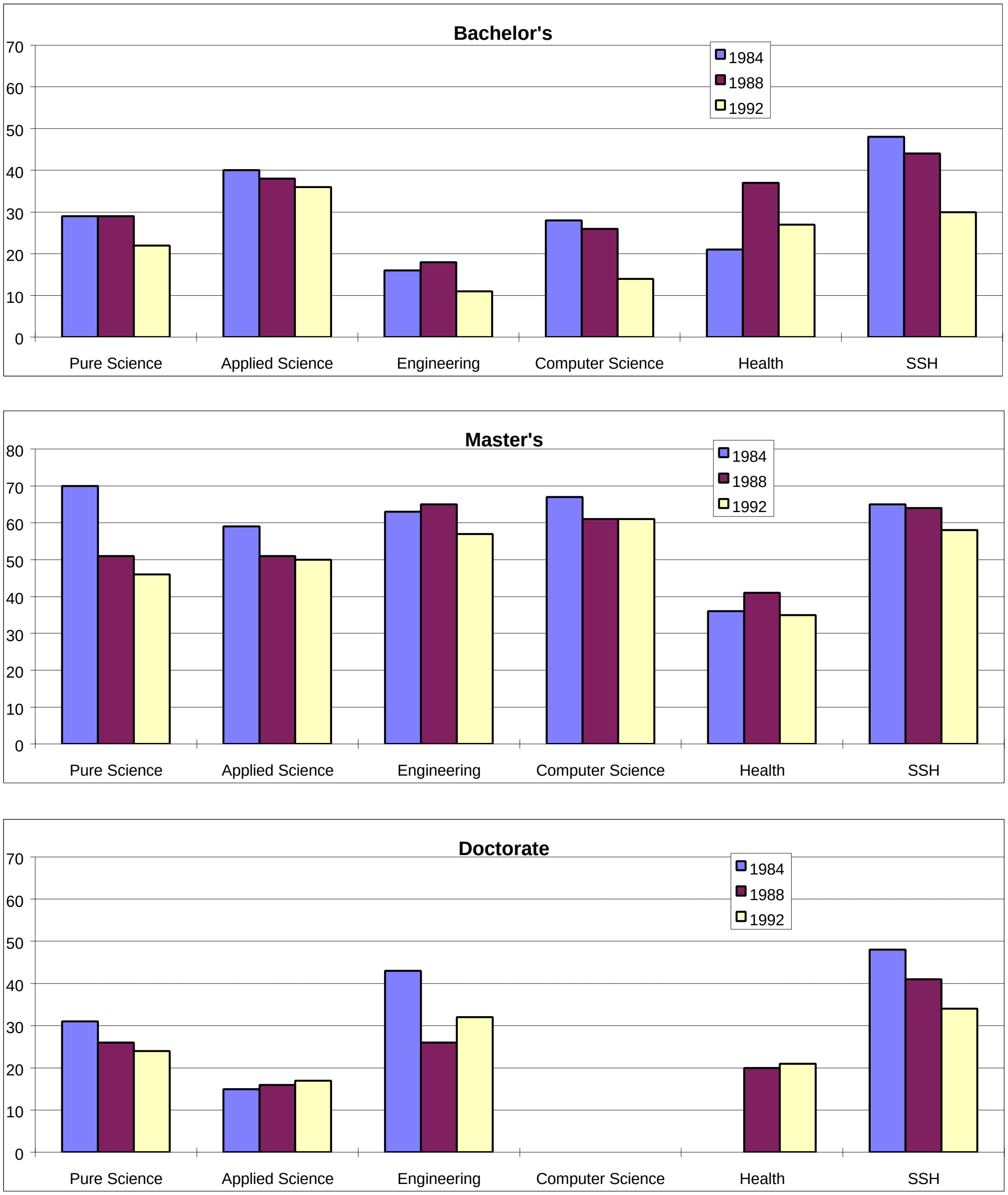
Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Graph 3: Job-Education Skill Match Index



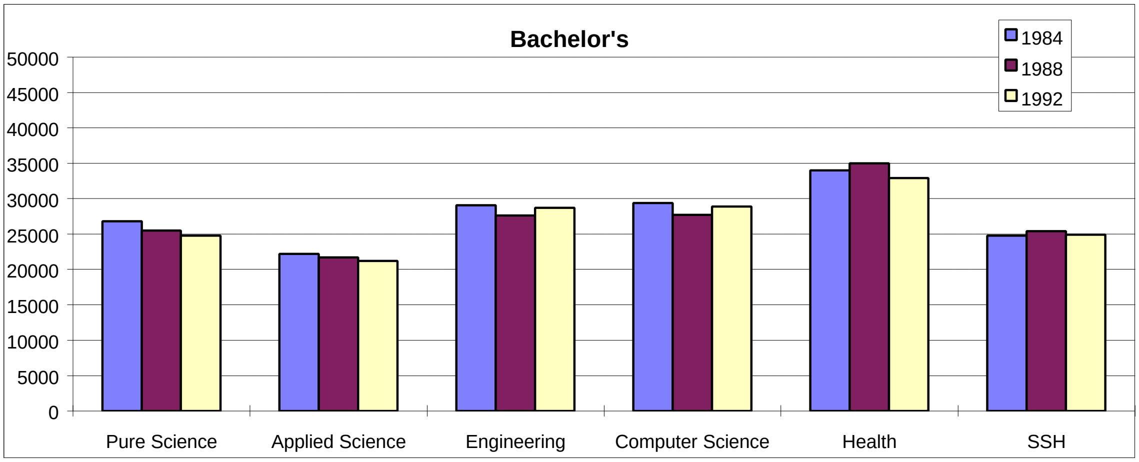
Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

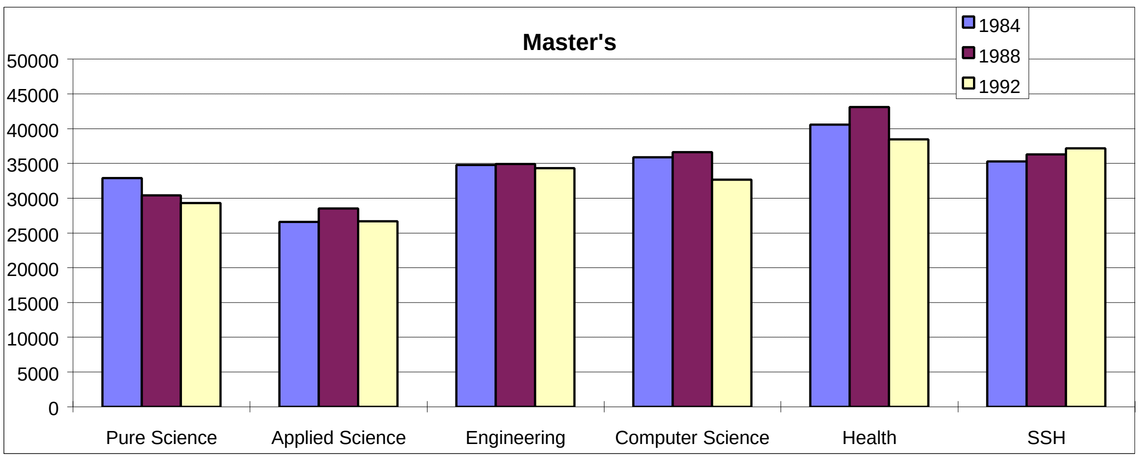
Graph 4: Percentage of Those "Over-Qualified" for Their Jobs (According to the Educational Prerequisites)

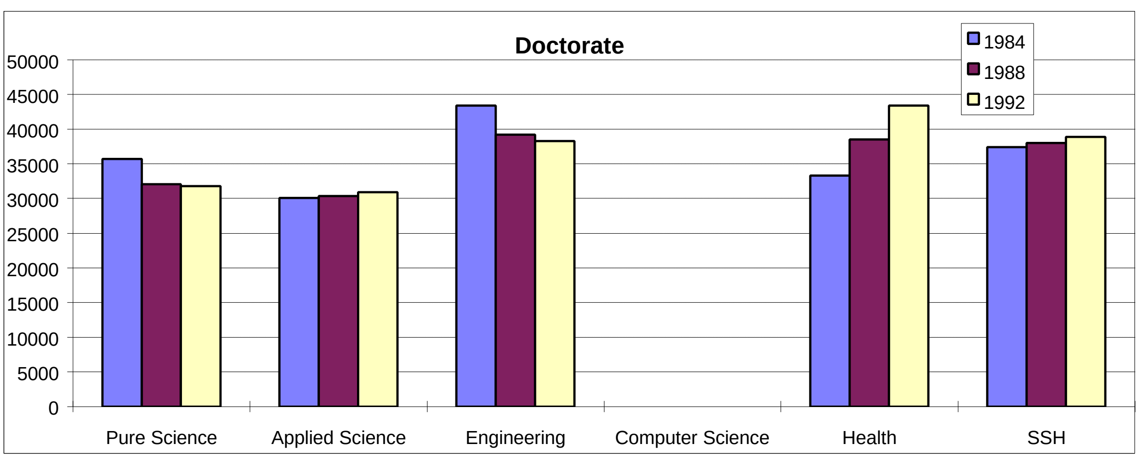


Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Graph 5: Mean Earnings ($1986)

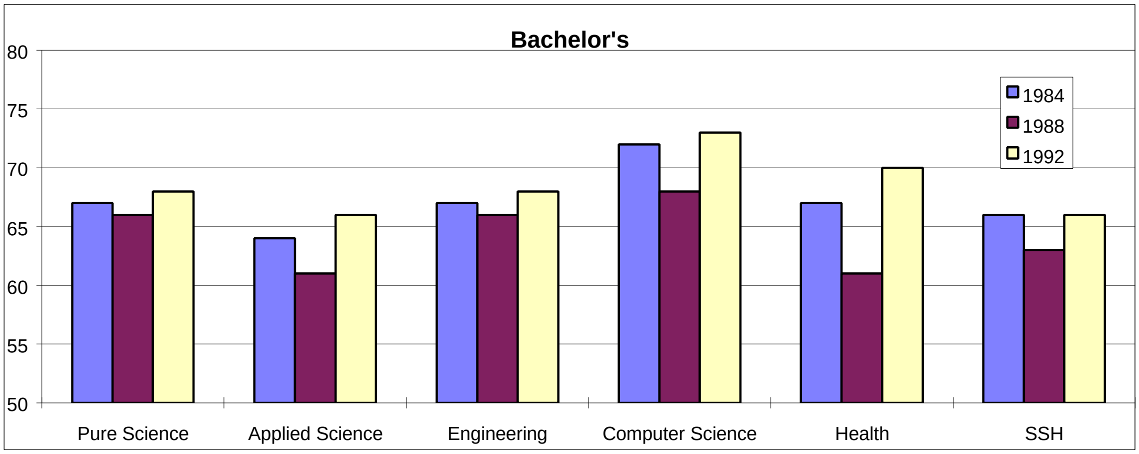


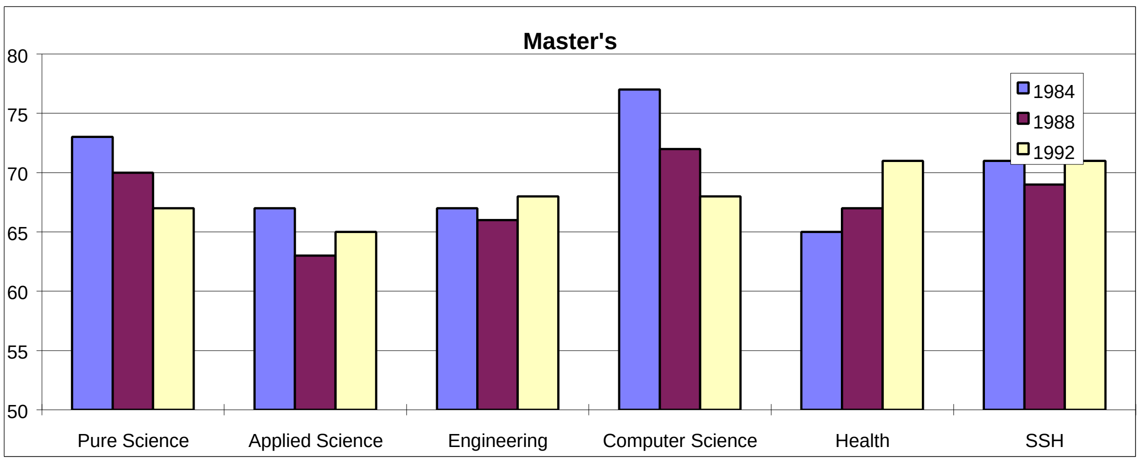


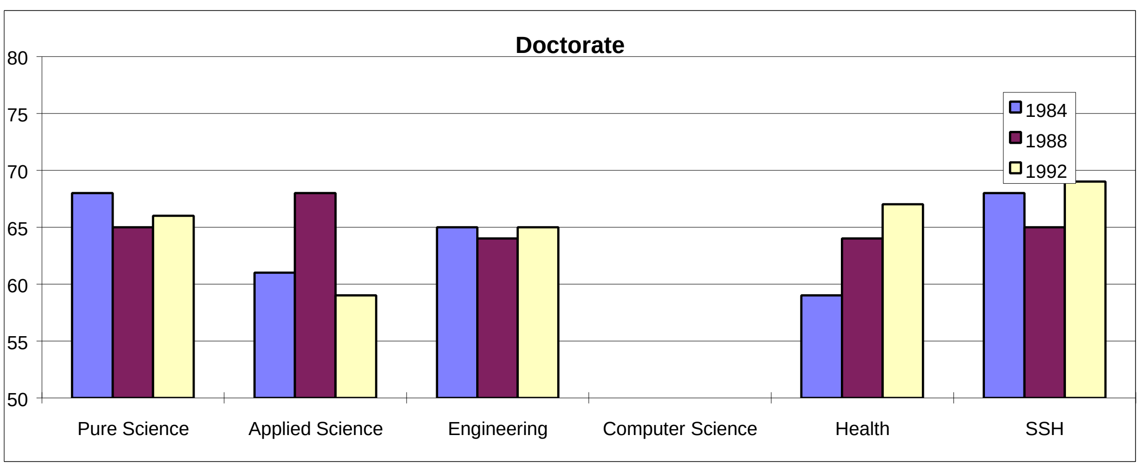


Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Graph 6: Job Satisfaction (Salary) Index

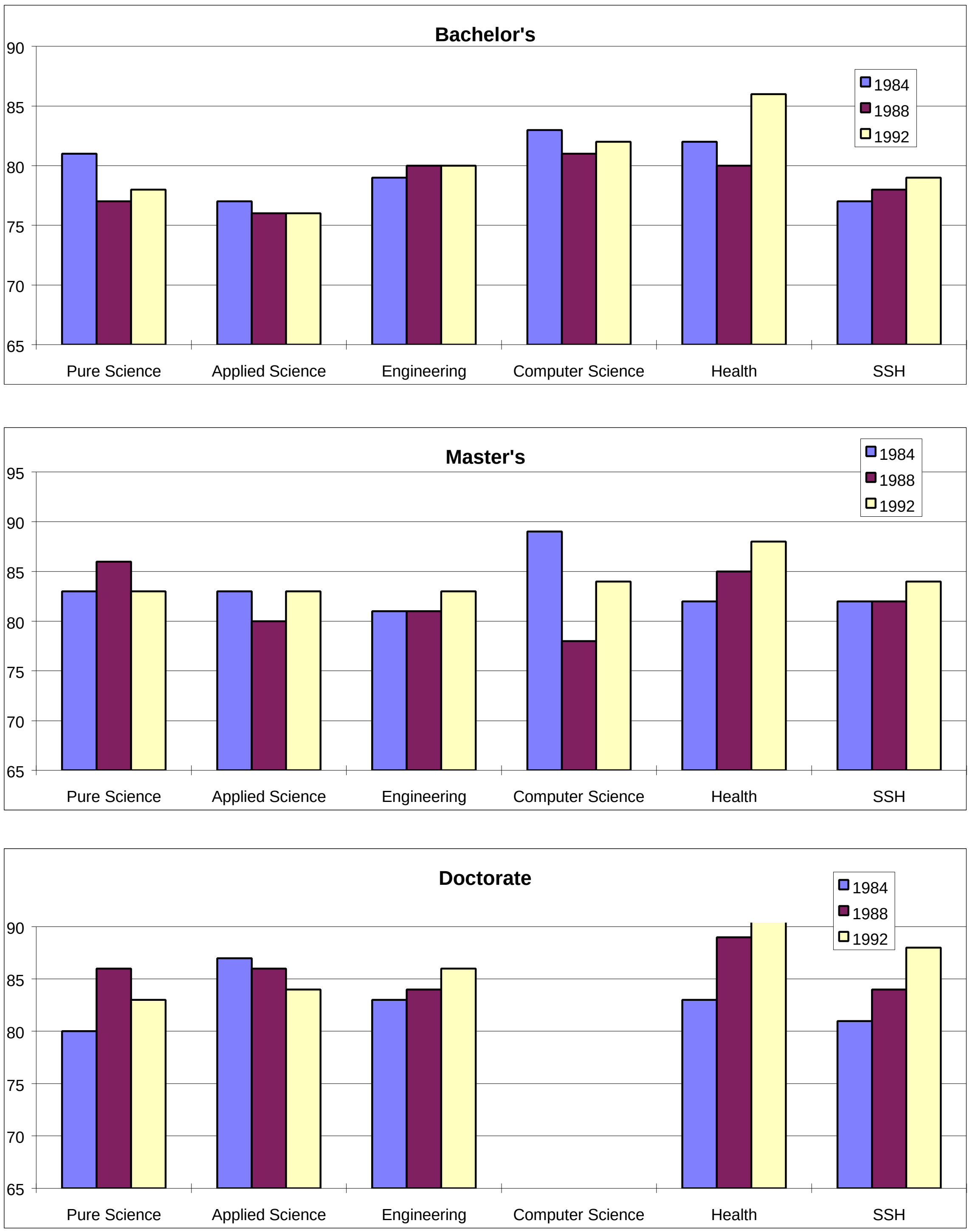






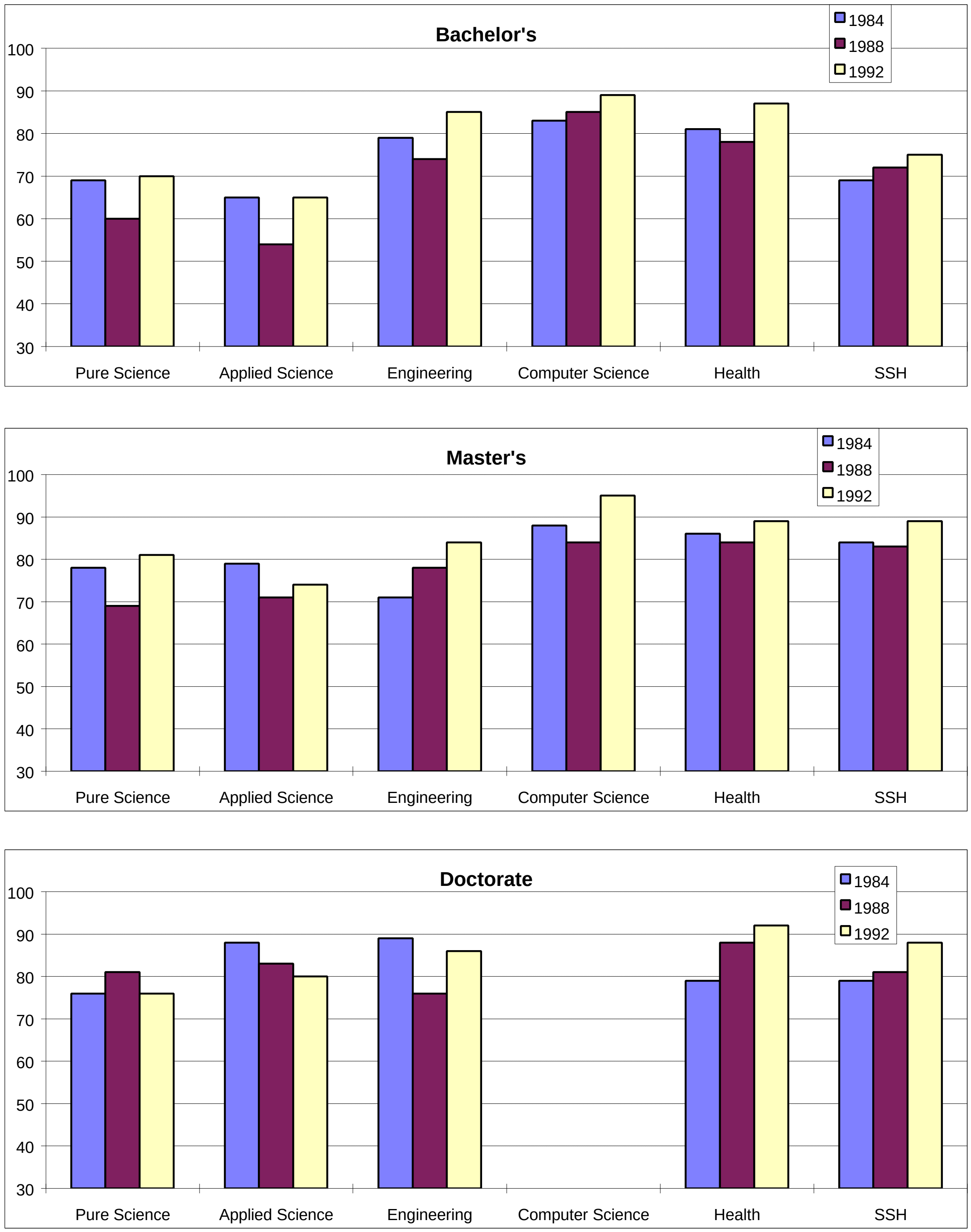
Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Graph 7: Job Satisfaction (Overall) Index



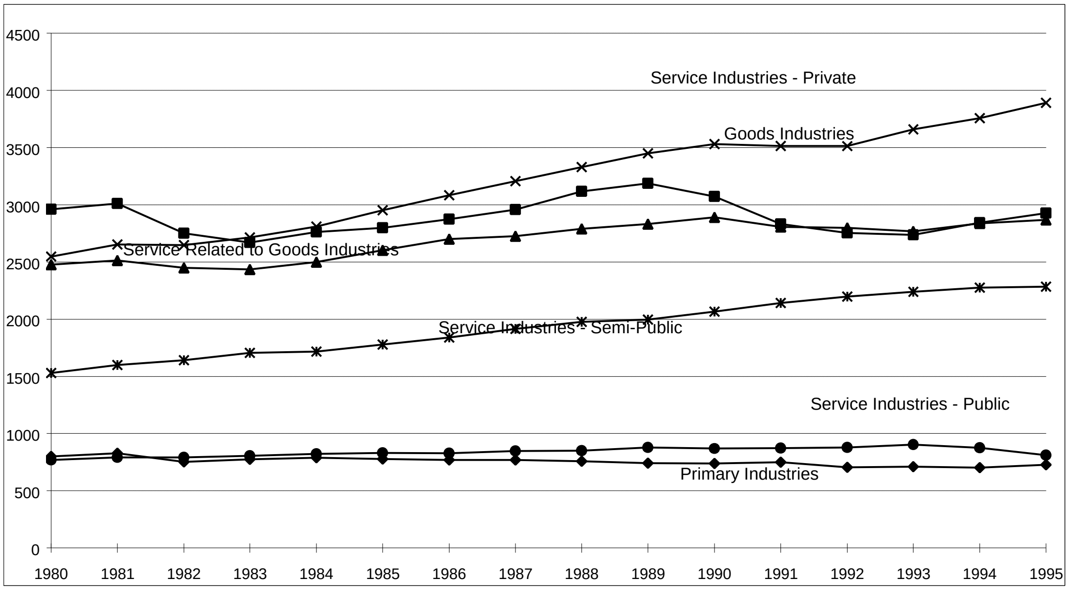
Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Graph 8: Overall Satisfaction with the Education Programme Index



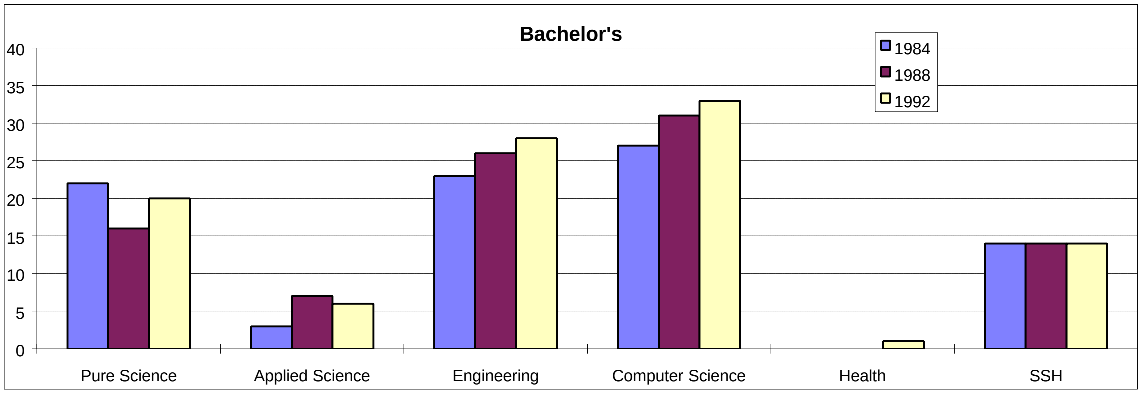
Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

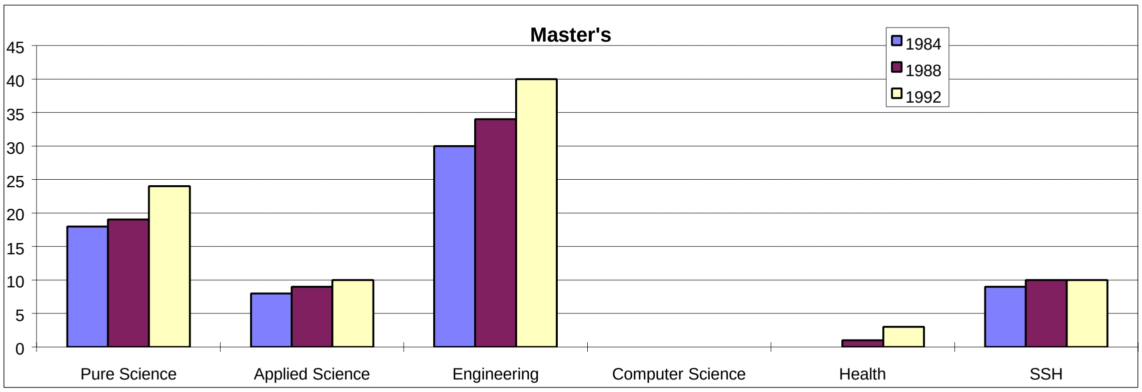
Graph 9: Total Employment by Industrial Sector - Classification I

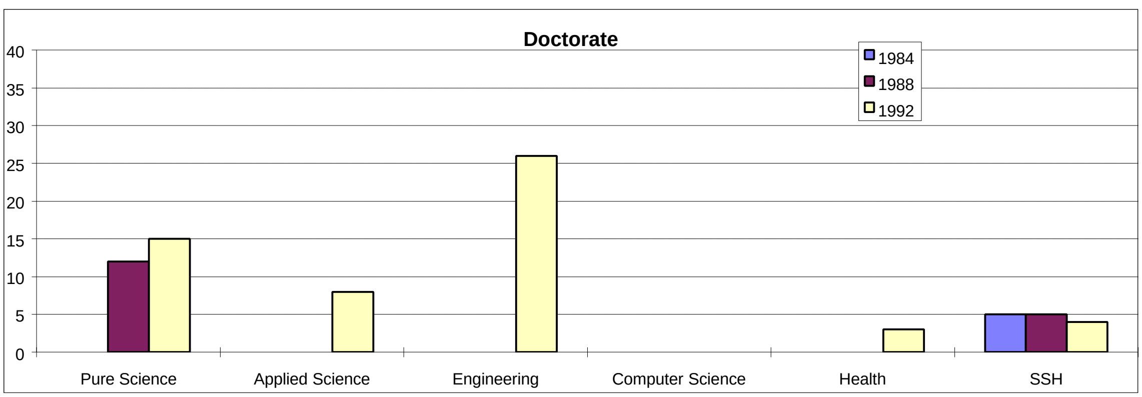


Source: Derived from Table ANN09E, Labor Force Historical Review, Statistics Canada, 71F0004XCB. Employment figures in thousands.

Graph 10: Percentage Employed in Business Service Industries - Selected 2-Digit Industries







Source: calculations performed by the authors using the National Graduates Surveys and Follow-ups.

Bibliography

Association canadienne-française pour l'avancement des sciences (ACFAS) (1997) *Interface*, March-April, vol.18, no.2.

American Association for the Advancement of Science (AAAS) (1991) *Science*, May, vol. 252.

Carter, A. P., (1996) Measuring the Performance of a Knowledge-Based Economy in OECD (ed.) *Employment and Growth in the Knowledge-Based Economy*, Paris, pp. 61-68.

David, P. and D. Foray (1995) Accessing and Expanding the Science and Technology Knowledge Base, Science, *Technology, Industry Review*, no. 16, pp. 13-68.

Dosi, G., (1996) The Contribution of Economic Theory to the Understanding of a Knowledge-Based Economy in OECD (ed*.) Employment and Growth in the Knowledge-Based Economy*, Paris, pp. 81-92.

Dosi, G., Freeman, C. and S. Fabiani (1994) The Process of Economic Development: Introducing Some Stylized Facts and Theories on Technologies, Firms and Institutions, *Industrial and Corporate Change*, vol. 3, no. 1, pp. 1-45.

Finnie, R., (1997) How Have Post-Secondary Graduates Been Faring? A Cross-Cohort, Longitudinal Analysis Using the National Graduates Surveys (working title), forthcoming report for *Human Resources Development Canada* and *Statistics Canada*.

Finnie, R., (1995) Steppin' Out: An Analysis of Recent University Graduates Into the Labour Market, *Industry Canada*, Working Paper, Number 5, 129 p.

Florman, S. C., (1987) *The Civilized Engineer*, St. Martin's Press, 258 p.

Freeman, C., (1994) The Economics of Technical Change, *Cambridge Journal of Economics*, vol. 18, pp. 463-514.

Gibbons, M., (1995) Technology and the Economy: A Review of Some Critical Relationships, *Industry Canada*, Occasional Paper, Number 12, 220 p.

Howe, W.J., (1986) The Business Services Industry Sets Pace in Employment Growth, *Monthly Labour Review*, April, pp. 29-36.

Lavoie, M. and R. Roy (1997) Employment in the Information Economy: A Growth Accounting Exercise for Canada, *Quarterly Macroeconomic & Labour Market Review: Special Report*, Spring, pp. 22-36.

Lavoie, M. and R. Finnie (1997) The Early Careers of Engineers and the Accumulation of Skills in the Canadian Economy, *Economics of Innovation and New Technology*, (forthcoming).

Lavoie, M. and R. Finnie (1996) The Occupational Dynamics of Recent Canadian Engineering Graduates Inside and Outside the Bounds of Technology, submitted to *Futures*, 27 p.

Lavoie, M. and R. Finnie (1995) *The Accumulation of Technology: A Cross-Cohort Longitudinal Analysis of Recent Engineering Graduates*, prepared for Human Resources Development Canada, May, 90 p. + tables.

Metcalfe, J.S., (1995) Technology Systems and Technology Policy in an Evolutionary Framework, *Cambridge Journal of Economics*, vol. 19, pp. 25-46.

OECD, (1996a) *Employment and Growth in the Knowledge-Based Economy*, Paris, 389 p.

OECD, (1996b) *The OECD Jobs Strategy. Technology, Productivity and Job Creation*, Vol. 2 Analytical Report.

OECD: The Technology/Economy Programme, (1992) *Technology and the Economy: The Key Relationships*, Paris, 328 p.

O'Farrell, P., (1995) Manufacturing Demand for Business Services, *Cambridge Journal of Economics*, vol. 19, no. 4, August, pp. 523-543.

Osberg, L., (1989) Introduction in Osberg, L., Wolff, E.N. and W.J. Baumol (eds.) *The Information Economy: The Implications of Unbalanced Growth*, Institute for Research on Public Policy, pp. 1-16.

Pavitt, K., (1993) What Do Firms Learn from Basic Research? in Foray, D. and C. Freeman (eds.) *Technology and the Wealth of Nations*, London: Pinter.

Rosenberg, N., (1994) *Exploring the Black Box: Technology, Economics, and History*, Cambridge: Cambridge University Press, 274 p.

Smith, K., (1995) Interactions in Knowledge Systems: Foundations, Policy Implications and Empirical Methods, *Science, Technology, Industry Review*, OECD, no. 16, pp. 69-102.

Soete, L., (1996) Globalisation, Employment and the Knowledge-Based Economy in OECD (ed.), *Employment and Growth in the Knowledge-Based Economy*, Paris, pp. 383-389.

Soete, L., (1995) Structural Change and Employment Growth: The Challenges Ahead, *Science, Technology, Industry Review*, no. 15, pp.237-271.

Tobias, S., Chubin, D., and K. Aylesworth (1995) *Rethinking Science as a Career. Perceptions and Realities in the Physical Sciences*, Research Corporation, 158 p.

Annex: The Construction and Precise Definitions of the Variables Used in the Analysis

This annex describes in greater detail the variables used in the analysis – as summarized in the text.

Earnings:

The earnings variable is based on the question: "Working your usual number of hours, approximately what would be your annual earnings before taxes and deductions at that job?"

The Job-Education Skill Match:

The job-education skill match measure is based on the questions: "Was the education programme you completed in [year] intended to prepare you for this job?" and "Do you use any of the skills acquired through the education programme completed in [year] [in your job]?" A single "job-education relationship" variable was then created by Statistics Canada: if the individual responded yes to both questions, the variable was coded "Directly Related"; if the person answered yes to just one of the questions, the variable was coded "Partly Related"; if the answer was no to both questions, the variable was coded "Unrelated". We then ordered the responses on a scale running from 0 to 100, with the directly related, partly related, and unrelated categories taking the values 100, 50, and 0 respectively.

Job Satisfaction:

The job satisfaction measures are based on the questions: "Considering the duties and responsibilities of your job, how satisfied are you with the money you make?" (earnings satisfaction) and "Considering all aspects of your job, how satisfied are you with it?" (overall job satisfaction). We then ordered the responses of "very satisfied, "quite satisfied", "not very satisfied" and "not at all satisfied" on a scale of 0 to 100, with "very satisfied" taking the value of 100; "quite satisfied", 66.7; "not very satisfied", 33.3; and "not at all satisfied", 0.

The Overall Evaluation of the Education Programme:

The overall evaluation of the education programme measure for the 1990 cohort is based on the questions: "Given your experience…would you have selected the same field of study or specialization?" and "Would you have taken the same level of program [that is, university or college or trade-vocational]?" In each case, the respondent could answer yes or no. For the two earlier cohorts, there was only a single question: "Given your experience, which educational programme would you have selected?" with the permitted responses being: "Would choose the same programme," "Would choose a different programme," and "Would choose no programme." We then ordered these responses on a scale running from 0 to 100, giving a value of 100 to those who indicated they would choose the same field and level (1990 respondents) or simply "the same programme" (1982 and 1986 respondents), and a value of 0 where another field or level would have been chosen.

The Educational Prerequisites of the Current Job:

The measure of the educational prerequisites of the job versus the level held are based on the question: "What was the level of education needed to get the job?" The over- and under-qualified measures were then created by Statistics Canada by comparing this level with either, in the case of the two-year surveys (1984, 1988, and 1992), the highest level of education or, in the case of the five-year follow-ups (1987, 1991), the level of education of the programme from which the individual graduated in the given year (see the text for further discussion).

How to Order Catalogued Publications

These and other Statistics Canada publications may be purchased from local authorized agents and other community bookstores, through the local Statistics Canada offices, or by mail order to:

Statistics Canada
Operations and Integration Division
Circulation Management
120 Parkdale Avenue
Ottawa, Ontario
K1A 0T6
1(613)951-7277

National toll free order line: 1-800-267-6677
Fax number: 1-(613)951-1584
Toronto Credit Card only (416)973-8018

CATALOGUED PUBLICATIONS

Statistical Publications

88-202-XPB	Industrial Research and Development, 1997 Intentions (with 1996 preliminary estimates and 1995 actual expenditures)
88-204-XPB	Federal Scientific Activities, 1997-98 (annual)
88-001-XPB	Science Statistics (monthly)

Volume 20

No. 1	The Provincial Research Organizations, 1994
No. 2	Software Research and Development (R&D) in Canadian Industry, 1993
No. 3	Research and Development Personnel in Canada, 1983 to 1993
No. 4	Federal Government Expenditures on Scientific Activities, 1996-97
No. 5	Industrial Research and Development, 1991 to 1996
No. 6	Total Spending on Research and Development in Canada, 1971 to 1996
No. 7	Estimation of Research and Development Expenditures in the Higher Education Sector, 1994-95
No. 8	Distribution of Federal Expenditures on Science and Technology, by Province and Territories, 1994-95
No. 9	The Provincial Distribution of R&D in Canada, 1979 to 1994
No. 10	Federal Government Personnel Engaged in Scientific and Technological (S&T) Activities, 1987-88 to 1996-97[e]
No. 11	Research and Development (R&D) for Pollution Abatement and Control in Canadian Industry, 1990, 1991 and 1993
No. 12	Biotechnology Research and Development (R&D) in Canadian Industry, 1989 and 1993
No. 13	Research and Development (R&D) Expenditures of Private Non-Profit (PNP) Organizations, 1995

Volume 21

No. 1	Scientific and Technological (S&T) Activities of Provincial Governments, 1987-88 to 1995-96
No. 2	The Effect of Country of Control on Industrial Research and Development (R&D) Performance in Canada, 1993
No. 3	The Provincial Research Organizations, 1995

No. 4 Federal Government Expenditures on Scientific Activities, 1997-98
No. 5 Industrial Research and Development, 1993 to 1997
No. 6 Software Research and Development (R&D) in Canadian Industry, 1995
No. 7 Distribution of Federal Expenditures on Science and Technology, by Province and Territories, 1995-96
No. 8 Total Spending on Research and Development in Canada, 1986 to 1997[e], and Provinces, 1986 to 1995
No. 9 Estimation of Research and Development Expenditures in the Higher Education Sector, 1995-1996
No. 10 Research and Development (R&D) Personnel in Canada, 1986 to 1995
No. 11 Biotechnology Research and Development (R&D) in Canadian Industry, 1995
No. 12 Research and Development (R&D) Expenditures for Environmental Protection in Canadian Industry, 1995
No. 13 Research and Development (R&D) Expenditures of Private Non-Profit (PNP) Organizations, 1996

WORKING PAPERS - 1996 AND 1997

These working papers are available from the Science and Technology Section of Statistics Canada, please contact:

Science and Technology Section
Science and Technology Redesign Project
Statistics Canada
Ottawa, Ontario
K1A 0T6
Tel: (613) 951-6347

ST-96-01 Estimation of Research and Development Expenditures in the Higher Education Sector, 1993-94, December 1995
Price: $75.00

ST-96-02E Federal Science Expenditures and Personnel, 1993-94 to 1995-96, January 1996
Price: $75.00

ST-96-03 Federal Government Expenditures and Personnel on Activities in the Natural and Social Sciences, 1986-87 to 1995-96, March 1996
Price: $75.00

ST-96-04 Scientific and Technological Activities of Provincial Governments, 1988-89 to 1994-95, March 1996
Price: $75.00

ST-96-05 Methodology for Estimation of Higher Education Personnel, June 1996
Price: $75.00

ST-96-06 Estimates of Research and Development Personnel in Canada, 1979 to 1993, June 1996
Price: $75.00

ST-96-07 Estimation of Research and Development Expenditures in the Higher Education Sector, 1994-95, October 1996
Price: $75.00

ST-96-08 Estimates of Canadian Research and Development Expenditures (GERD), National 1963 to 1996, and by province 1979 to 1994, November 1996
Price: $100.00

ST-96-08 Appendix #1
National Series of GERD, 1963 to 1996, November 1996
Price: $100.00

ST-96-08 Appendix #2
Estimates of Canadian Research and Development Expenditures in the Natural Sciences, Canada 1985 to 1996 and by Province, 1985 to 1994, November 1996
Price: $100.00

ST-97-01 A Compendium of Science and Technology Statistics, February 1997
Price: $75.00

ST-97-02 Provincial Distribution of Federal Expenditures and Personnel on Science and Technology, 1994-95, February 1997
Price: $75.00

ST-97-03 Scientific and Technological Activities of Provincial Governments, 1989-90 to 1995-96, March 1997
Price: $75.00

ST-97-04 Federal Government Expenditures and Personnel on Activities in the Natural and Social Sciences, 1987-88 to 1996-97^{e}, March 1997
Price: $75.00

ST-97-05 Transfers of Funds for Research and Development in Canadian Industry, 1993 March 1997
Price: $75.00

ST-97-06 Estimation of Research and Development Expenditures in the Higher Education Sector, 1995-96, August 1997
Price: $75.00

ST-97-07 Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1986 to 1997, and by Province, 1986 to 1995, August 1997
Price: $75.00

ST-97-08 Federal Government Expenditures and Personnel on Activities in the Natural and Social Sciences, 1988-89 to 1997-98^{e}, July 1997
Price: $75.00

ST-97-09 R&D Tax Treatment in Canada: A Provincial Comparison, September 1997
Price: $75.00

ST-97-10 Provincial Distribution of Federal Expenditures and Personnel on Science and Technology, 1987-88 to 1995-96, October 1997
Price: $75.00

ST-97-11 Commercialization of Intellectual Property in the Higher Education Sector: A Feasibility Study, October 1997
Price: $75.00

ST-97-12 Business Demographics as Indicators of Innovation Activity, October 1997
Price: $75.00

ST-97-13 Methodology for Estimation of Higher Education R&D Personnel, November 1997
Price: $75.00

ST-97-14 Estimates of Research and Development Personnel in Canada, 1979-1995, December 1997
Price: $75.00

ST-98-01 A Compendium of Science and Technology Statistics, February 1998
Price: $75.00

LIST OF RESEARCH DOCUMENTS ALREADY RELEASED

No. 1 The State of Science and Technology Indicators in the OECD Countries, by Benoît Godin, August 1996

No. 2 Knowledge as a Capacity for Action, by Nico Stehr, June 1996

No. 3 Linking Outcomes for Workers to Changes in Workplace Practices: An Experimental Canadian Workplace and Employee Survey, by Garnett Picot and Ted Wannell, June 1996

No. 4 Are the Costs and Benefits of Health Research Measurable? by M.B. Wilk, February 1997