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Jobs and Skills in a Knowledge-Based Economy

The development of a knowledge-based economy necessarily involves major changes in the nature and organization of labour markets. In an economic environment where competition is getting stronger, companies look for strategies and ways of organizing that will enable them to be more flexible and innovative. Their challenge is to adjust to technological change, globalization, and varying economic value. Thus, businesses reorganize and increase their competitiveness by improving the quality of their products and services, including their productivity, and by becoming more flexible.

The introduction of such practices necessarily results in a variety of organizational changes. With respect to structure, for instance, there is a general trend towards reducing the average size of businesses and their operational units. This is evidenced by the growing share of employment in small businesses (less than a hundred salaried workers) compared with overall employment. In most OECD countries, while the share of jobs represented by small businesses continues to rise, that of large corporations (over five hundred salaried workers) has been declining by about 1 percent per year over the last few years.¹⁷

■ **The Impact of the Knowledge Economy on Employment Structure and Skills Demand**

These organizational changes have the biggest impact on employment structure and skills demand. At least five major trends can be identified: (1) a shift in the economic activity of goods-producing industries towards the service industry, (2) an increase in the skills required for the performance of tasks that favour skilled work, (3) the need for ongoing training, (4) a polarization of wages around skill levels, and (5) a more frequent use of atypical, or nonstandard, work contracts.

17. OECD, *Jobs Strategy: Technology, Productivity and Job Creation*, vol. 2: *Analytical Report* (Paris, OECD, 1996), 163.

(1) From Goods to Services: A Shift in the Industrial Structure

One of the fundamental changes accompanying the move from the industrial to the information and knowledge era is the continual shifting of economic activity towards service industries. If we take Canada as an example, in 1976 about 65 percent of the jobs were in the service sector; today, the proportion is close to 75 percent (see table 1). During this same period, the average annual growth rate of employment in the service sector was 2.3 percent, compared with only 0.2 percent in the goods-producing sector.

Table 1
Employment Distribution in Canada by Sector 1976–99

	Share of Employment (%)			Average Annual Growth Rate (%)		
	1976	1987	1999	1976–87	1987–99	1976–99
Goods sector	35.5	28.7	25.3	0.2	0.3	0.2
Service sector	64.5	71.3	74.7	2.8	1.6	2.3

Source: Statistics Canada, *Labour Force Survey*, cat. 71-001.

Several factors underlie this shift of employment towards the service sector. Among the most frequently mentioned is that businesses, in order to have greater flexibility, turn increasingly to subcontracting for services which used to be available internally. Some economists also report a strong growth in the intermediate demand for services to meet production requirements (reflecting the increased value of knowledge as input, e.g., in the case of computer programming). Finally, along with these two factors, the consumer demand for services has increased more rapidly than it has for goods.

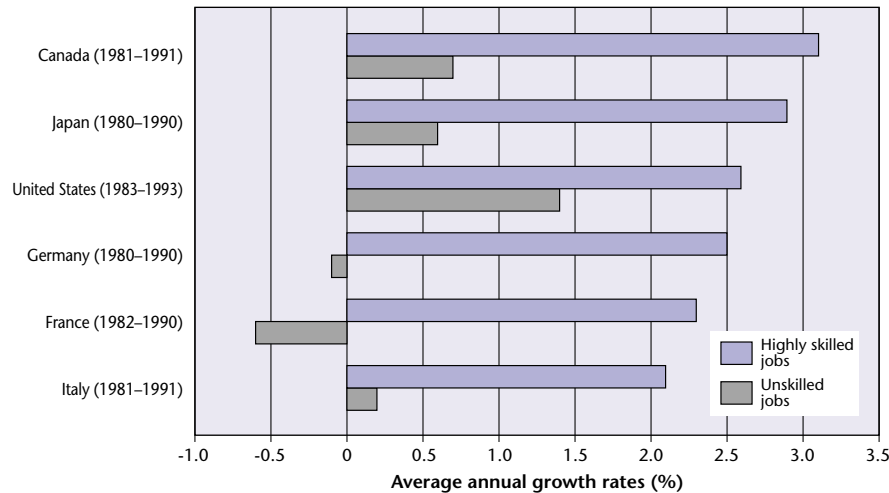
A study by the Economic Council of Canada on employment in the service sector reminds us that it is still difficult to isolate with precision the influence of each one of these factors. A review of these explanations for the shift of the goods sector towards the service sector leads to rather ambiguous conclusions.¹⁸

(2) Employment Growth among Skilled Workers

In addition to the industrial shift of the goods-producing sector towards the service sector, the advent of a knowledge-based economy

18. Economic Council of Canada, *Employment in the Service Economy* (Ottawa: Economic Council of Canada, 1991).

Figure 2
Employment Growth Based on Skill Level
for Selected Industrialized Countries, 1980s



Source: OECD, *A New Economy? The Changing Role of Innovation and Information Technology in Growth* (Paris: OECD, 2000), 20; graph 4.

results in a more rapid increase in the number of highly skilled jobs than in the number of unskilled jobs (see figure 2).¹⁹ In fact, it is agreed that globally, “There is substantial evidence that the situation of unskilled workers has deteriorated in absolute terms” throughout the 1980s and 1990s.²⁰

There is no doubt that the speed at which technology progresses and knowledge circulates has a lot to do with the increased demand for highly skilled workers. A recent study on technology and skill demand in the Canadian economy confirmed that the minimum skill level required by employers keeps rising. It is reported that from 1981 to 1994 the skill intensity (defined as the proportion of salary mass or share of employment held by skilled workers) has increased in almost all sectors of the Canadian industry.²¹ The rise in skills has been particularly noticeable in the manufacturing sectors, where economies

19. As a general rule, the term *skills* refers to the skills required by the labour market for the performance of certain tasks. When speaking of highly skilled workers, we mean those in intellectual and scientific occupations, managers, and other business and public administration officers.

20. OECD, *Jobs Strategy*, vol. 1, 18.

21. S. Gera, W. Gu, and Z. Lin, *Technology and the Demand for Skills: An Industry-Level Analysis*, Working Paper no. 28 (Ottawa: Industry Canada, 1999).

of scale are important (such as in the machinery and printing industries), and in the vast majority of service industries.

While the demand for highly skilled workers continues to increase, the supply is also on the rise. Skills upgrading in the different OECD countries is also evident from the improvement in workers' education levels. Data on education and the labour force reveal that the number of individuals with a high education level (e.g., a university degree) has increased much more rapidly than the number with a low education level (e.g., primary school).

(3) *Continual Learning*

Given the employment evolution from unskilled to skilled jobs and the general increase in the skill level sought by employers, education and training are taking on greater importance. A knowledge-based economy is characterized by the need to be constantly acquiring both information and the skills essential for using this information. Today, the notion of a "learning society" is tacitly accepted by everyone.²²

In the 1950s, when three in five American workers had no training or particular professional expertise, education was considered superfluous; today, the one worker in five who does not have an education is at a serious disadvantage compared with those who do. Because we can no longer count on knowledge acquired or rely on experience, which becomes rapidly obsolete owing to technological change, there is a need to constantly "retrain," which extends even to the advanced stages of one's working life.²³

New technologies are progressing and circulating so fast that it is necessary for workers to constantly update their skills. The reason for this is that career jobs with a single employer are becoming a rare commodity, and job characteristics are changing and diversifying with the market's evolution. Workers in the knowledge economy have to be more flexible than ever before, and they need skills that are easily transferable.

22. Beyond the economic imperatives, there is a whole range of socio-cultural benefits that can stem from continual learning. In a report on the state of adult education and training in Canada, it is stated that "learning through life goes further than updating one's knowledge to improve productivity and individual earning power — it is also an important component of individual inclusion and active citizenship." See Statistics Canada and Human Resources Development Canada, *A Report on Adult Education and Training in Canada: Learning a Living* (Statistics Canada and Human Resources Development Canada, 2001).

23. "The Future of Work: Career Evolution," *Economist* 354, no. 8155 (29 January 2000): 89–92.

This trend towards the widening of tasks and responsibilities is observed in almost all sectors. In the world of finance, for instance, computerization has turned bank personnel, whose jobs used to be essentially administrative, into financial consultants. In the automotive sector, workers are now grouped in work teams and must be capable of undertaking and performing a variety of tasks. In short, a capacity for flexibility and adjustment is essential for all workers in the new economy and can only be ensured by constant investments in human capital; this applies not only to employees but to businesses and governments as well.

(4) Wage Polarization

It is not surprising given the rapid increase in the number of skilled jobs and the advanced skills sought by employers that the range of salaries reflects a polarization of incomes. This is confirmed by numerous studies that show that the wage gap is widening between skilled and unskilled workers. Nickell and Bell, for example, have looked at the changes in wage distribution in terms of the education level of workers in different OECD countries in the 1980s.²⁴ According to them, the earnings differentials between the higher and lower education-level categories have widened in the majority of G7 countries, and especially in the United States and the United Kingdom. The only exceptions are France and Japan, where wage gaps have remained much the same.

(5) Transformation of the Employment Contract

While businesses have to be more flexible in response to the new requirements of a knowledge-based economy, workers have to adopt increasingly atypical, or nonstandard, work formats. In many cases, for instance, the number of salaried workers in a given firm may vary considerably with production flows. To respond to such fluctuations, more firms are resorting to temporary personnel (whose contracts can be terminated under flexible hiring-and-firing conditions) or simply to subcontractors. Even the working hours of full-time staff vary, and part-time work is often encouraged.²⁵

24. S. Nickell and B. Bell, "Changes in the Distribution of Wages and Unemployment in OECD Countries," *American Economic Review* 86, no. 2 (May 1996): 302.

25. OECD, "Flexible Firms, Skills, and Employment," *Observer*, no. 202 (October-November 1996): 17–21.

Part-time work is the most important form of nonstandard employment. Throughout the 1980s and 1990s, the proportion of part-time work relative to total employment has increased considerably in the G7 countries as a whole. In Canada, part-time work in 1999 represented over 18 percent of all jobs, i.e., about 2.7 million jobs, compared with only about 12 percent in 1976. In fact, with an average annual growth rate of 3.3 percent from 1976 to 1999, part-time work has increased twice as fast as total employment.

The number of self-employed workers has also risen significantly. From 1976 to 1999, the percentage of self-employed workers based on total employment rose from 12 percent to almost 17 percent. Even more significant is the fact that between 1990 and 1999, close to 43 percent of the new jobs created came from self-employment. Several factors have contributed to the expansion of this sector. According to a study by Betcherman, McMullen, and Davidman, it can be attributed to the rather limited opportunities for paid work which characterized a good portion of the decade, to the development of the service sector (where there is a strong concentration of self-employed people), and to a growing trend towards the use of subcontractors.²⁶

■ Problems Measuring the Impact of Knowledge on the Economy

Although general trends can be observed (at the macroeconomic level) in the structural evolution of employment, it is difficult to measure statistically the scope of the microeconomic impact of knowledge: “In general, our understanding of what is happening in the knowledge-based economy is constrained by the extent and quality of the available knowledge-related indicators. Traditional national accounts frameworks are not offering convincing explanations of trends in economic growth, productivity and employment. Development of indicators of the knowledge-based economy must start with improvements to more traditional input indicators of R & D expenditures and research personnel. Better indicators are also needed of knowledge stocks and flows, particularly relating to the diffusion of information technologies, in both manufacturing and service sectors; social and private rates of return to knowledge investments to better gauge the impact of technology on productivity and growth;

26. G. Betcherman, K. McMullen, and K. Davidman, *Training for the New Economy: A Synthesis Report* (Ottawa: Canadian Policy Research Networks Inc., 1998), 24.

the functioning of knowledge networks and national innovation systems; and the development and skilling of human capital."²⁷ It is such statements that have persuaded the Expert Panel on Skills (EPS) to recommend that our labour market monitoring and analysis system, although among the most elaborate in the world, be more oriented towards the collection of data on the skills required for certain occupations.²⁸

A few examples will illustrate the problems faced when trying to assess the degree of integration or concentration of knowledge in each job. It is true, for instance, that one of the main characteristics of the transition to a knowledge-based economy is a rapid increase in production in the sectors which are developing and using ICTs intensively, sectors requiring highly advanced skills. One thinks in particular of aerospace, telecommunications, industrial biotechnology, and biopharmaceutics — in short, industries said to be *knowledge generators*. At the same time, the spread of knowledge into more traditional sectors is also a source of economic growth. The use of new technologies increases the productivity of more traditional sectors while satisfying the demand for products made by high-tech industries, thus stimulating the innovation process. It also leads to changes in the skills that these industries require.

Today, numerous traditional industries are *knowledge users*. Fishers, for instance, are using satellite-positioning systems and various types of computerized detectors to find fish stocks and follow their movements at sea. In the oil sector, geologists are now discovering new oil reserves with highly specialized computer equipment, and drillers are able to extract the resource more efficiently.²⁹ As well, several traditional manufacturing sectors are resorting to computer-assisted design and production methods. Such is the case with pulp and paper mills, where ultramodern machinery and equipment are used to automate the production process. Even suppliers of traditional services are making use of developments in the new economy. For example, transportation companies and courier services are using the Internet to track their cargoes or followup on their shipments.

27. OECD, *The Knowledge-Based Economy*, 8.

28. Expert Panel on Skills, *Stepping Up: Skills and Opportunities in the Knowledge Economy*, report submitted to the Prime Minister's Advisory Council on Science and Technology (Ottawa: Expert Panel on Skills, 2000), 41.

29. Jonathan Rauch, "The New Old Economy: Oil, Computers and the Reinvention of Earth," *Atlantic Monthly* 287, no. 1 (January 2001): 35–49.

It is indeed difficult to observe, understand, and predict labour market developments because of the rapid evolution of skills in a knowledge economy and the present structure of our national accounting systems. But while waiting as our data collection systems become more efficient, we can still use existing indicators to evaluate the impact of knowledge on the economy. We can, for instance, use data relating to R & D investments, machinery and equipment investments, the number of scientific jobs (e.g., in engineering), and education and training expenditures. Research is also carried out by analyzing the data on physical capital investments or even on patents, which enables us to estimate, to a certain degree, the outcome of the knowledge-generating process.

Two approaches are generally used to report on the medium- and long-term evolution of employment from a statistical perspective in the context of the transition to a knowledge-based economy. The first rests on a quantitative evaluation of industries, and the second on an aggregate analysis of occupations.

The study by Lee and Has³⁰ is one of the rare attempts at a quantitative evaluation of Canadian industries according to their knowledge concentration level. By using a mix of indicators, these researchers measured the knowledge content of over fifty industries in Canada. Depending on their degree of “technicity,” industries were classified as being high-, medium-, or low-knowledge-intensive. To build such a “knowledge barometer,” three R & D activity indicators and three human-capital-content indicators were used. The R & D indicators included R & D intensity (i.e., R & D expenditures relative to gross production), the proportion of R & D staff relative to the total number of employees, and the proportion of professional R & D staff relative to the total number of employees. The evaluation of human-capital content was based on the number of employees with a postsecondary education relative to the total number of employees, the number of employees with some expertise (high-knowledge content, e.g., teaching, law, medicine, etc.) relative to the total number of employees, and the number of scientists and engineers employed relative to the total number of employees.

30. Frank Lee and Handan Has, “Quantitative Assessment of High-Knowledge Industries versus Low-Knowledge Industries,” in *The Implications of Knowledge-Based Growth for Micro-Economic Policies*, ed. Peter Howitt (Calgary: University of Calgary Press and Procurement and Services Canada, 1996).

For an industry to be considered as high-knowledge-intensive, at least two of the three R & D indicators and at least two of the three human-capital-content indicators must be in the upper third of their respective categories. Appendix A provides a list of these industries according to their knowledge intensiveness or concentration. From this classification system, Lee and Has briefly outlined the evolution of Canadian economic conditions.

With respect to the GDP, the high-knowledge-intensive sector recorded the highest growth among the three sectors from 1981 to 1990, with an average annual growth rate of 3.6 percent. Furthermore, its market share rose from 16.0 to 17.1 percent in the same period, an increase of 1.1 percentage point, compared with a market-share variation of 0.7 percent in the medium-knowledge-intensive sector and -1.8 percent in the low-knowledge-intensive sector.

As for employment, the data are even more revealing. There was a greater increase in employment in the high-knowledge-intensive industries than in the other two. The labour market share rose by 2.9 percent in the high-technicity industries, while it remained practically unchanged in the medium-intensive industries and dropped by about 3.0 percent in the low-intensive industries during the same period. With regard to wages, the high-knowledge-intensive sector recorded the highest average annual growth rate at 6.3 percent.

In short, for the first time in Canada, this approach has brought to light some long-suspected results which could not be proven because of a lack of empirical evidence. There is also another quantitative approach for evaluating the evolution of the knowledge economy. That one is mostly used to classify occupations for the purpose of analysing the level of skills and the evolution of the workforce skill structure.

Given that the Canadian economy is increasingly becoming knowledge-based and that globalization and technological progress are determining factors in this structural change, it is only natural to look at the labour market evolution from an occupational point of view. Using an approach based on industrial activities, such as that of Lee and Has, it is possible, by referring to occupations as analysis units, to establish a classification of economic activities based on the tasks performed by workers and the qualifications/skills sought. That is the approach favoured by Lavoie and Roy, who stated that “a classification scheme based on workers’ activities allows a better

understanding of the interdependencies among industrial sectors and their implications for aggregate employment trends.”³¹

As will be seen later, by dividing the workforce into various categories of workers (e.g., pure science, management, and goods manufacturing), the changes occurring within various professional groups can be observed. It is through a similar method that the OECD noticed the emergence of the job-bipolarization phenomenon, whereby highly skilled jobs grow at a faster rate than unskilled jobs.

In Canada, among the trends observed by Lavoie and Roy, who developed and applied an occupational classification framework for the accounting of employment progression in the knowledge economy, there are many differences between the growth rates of occupational categories. For example, in the 1990s jobs related to the knowledge economy grew at a higher rate than other types of occupations. On the other hand, the proportion of occupations in the knowledge category remained rather modest in relation to total employment in Canada.

■ The State of Research in Atlantic Canada

As we have just seen, the existing literature on new skill requirements in a knowledge-based economy mostly speaks of recent developments at the international or even national level. After considering the nature of these developments, however, several studies have endeavoured to present an analytical framework for measuring the economic impact of knowledge. Studies such as those by Lee and Has and by Lavoie and Roy, among others, reflect the research efforts made on the evolution of the economy and employment from a quantitative standpoint.

Others, however, have used analyses of a qualitative nature to present a more general outline of the dynamics of labour markets, and of the skill requirements in an economy that is more knowledge-based. Such an approach was used in the recent study by the EPS, whose report combines both empirical analyses and a whole range of surveys, workshops, and interviews with business managers to examine the issues, trends, and challenges relating to skills in industries often associated with the new economy. Five key industries were considered, namely, information and communication technologies, biotechnology, the aerospace industry, the automotive industry, and

31. M. Lavoie and R. Roy, *Employment in the Knowledge-Based Economy: A Growth Accounting Exercise for Canada* (Ottawa: Applied Research Branch [Strategic Policy], Human Resources Development Canada, 1998), 16.

environmental technologies. As emphasized in this report, these sectors “share much in common with other industry sectors trying to survive and thrive in the knowledge-based economy.”³²

Based on its study the EPS has reached certain conclusions about the evolution of labour markets. Although there is no lack of technical skills at the moment, some sectors have difficulty recruiting and retaining specialized technical staff in various niches. Shortages are also reported in the area of nontechnical skills, such as essential (communication, etc.) and management skills.

The study by Betcherman, McCullen, and Davidman also provides an interesting perspective on skills development in Canada, as well as stressing the importance of training and education. Three critical issues are examined: (1) employment trends and skill requirements in the “new” labour market, (2) the effects of these trends on human capital investments, and (3) the role and responsibilities of individuals, employers, and governments in the labour market changes that are occurring in the new economy.

For the most part, these studies provide some instructive insight into the general trends that are emerging in labour markets at the national level. Very few of them, however, deal with the differences specific to provincial and regional economic conditions. To fill this gap and bring to light the current state of labour markets in Atlantic Canada, and elsewhere, a conference was held in 1999 in Moncton, NB, on the theme skills development in a knowledge-based economy.³³ Although most of the presentations addressed this theme from a perspective other than regional, a few dealt with issues which are specific to labour markets in the Atlantic region.

The Atlantic Provinces Economic Council has conducted a major study on the development of the information technology sector and the knowledge economy in Atlantic Canada.³⁴ Its report gives a summary evaluation of the knowledge economy in the region and of the labour market evolution. The study is of particular interest because it is based on the analytical framework introduced by Lee and Has (1996) and enables us to evaluate quantitatively the development of high-knowledge-intensive industries in relation to low-knowledge-intensive industries.

32. Expert Panel on Skills, *Stepping Up*, 12.

33. This conference was sponsored by the Atlantic Canada Opportunities Agency (ACOA), the Secretariat for Policy Research, the Atlantic Provinces Economic Council, Human Resources Development Canada, and Industry Canada.

34. Atlantic Provinces Economic Council (APEC), *IT and the Knowledge Economy in Atlantic Canada* (Halifax: APEC, 1999).

However, the scope of this study is limited by several factors. First, it is an analysis that focuses on the Atlantic region as a whole and ignores variations at the level of the provinces and especially of the economic subregions. Second, the results of the analysis provide only a partial glimpse of current trends in the region's economy. Although the profile of the software and computer-services sector gives us an idea of the latest developments there, the analysis does not present the overall characteristics at the regional level. Third, the study deals very little with the impact of labour market movements on the skills currently in demand.

The Davis and Hulett study is interesting for several reasons. Although it does not address the evolution of skill requirements in the knowledge industries, the authors do examine the impact of knowledge and new technologies on skills structure in the primary industries.³⁵ Such a perspective is particularly appropriate for the Atlantic provinces, given the economic importance of the region's primary sector. According to this study, as each branch of the primary sector adopts new knowledge-based technologies, there is an increase in the demand for more skilled workers.

Other studies focus specifically on regional aspects of the labour market evolution in the Atlantic provinces. Beaudin's study, for example, sheds a great deal of light on manpower trends at the level of the economic region. Writing in 1994, the author stressed that "the lack of qualified human resources in subregions is mainly caused by the fact that regional economies are unable to retain skilled workers due to the limited choices for the application of knowledge, limited advancement possibilities, non competitive salaries and in worst cases the relative lack of social infrastructures and services. This is then a vicious cycle which must be broken, for the dynamics of these regions now depends and will in the future increasingly depend on a diversified, mobile and qualified labour force."³⁶ Such comments still resonate today. It is clear, therefore, that if we want to break this vicious circle, all stakeholders must first be equipped with the analytical tools they need to cope with the growing complexity and increasingly rapid evolution of labour markets.

35. C. Davis and L. Hulett, *Knowledge-Based Skills Gaps in the Natural Resources Sector in Atlantic Canada*, report prepared for the conference Skills Development in the Knowledge-Based Economy (Moncton: ACOA, 1999).

36. M. Beaudin, *Regional Labour Market Dynamics in Atlantic Canada*, study conducted for ACOA (Moncton, 1994), p. vi.