Relations industrielles
Industrial Relations

The Effects of Technological Changes on the Labour Market in Canada

Sunder Magun

Aller au sommaire du numéro

Découvrir la revue

Citer cet article

The Effects of Technological Changes on the Labour Market in Canada

Sunder Magun

The objective of this paper is to analyse, by using national input-output framework, the effects of technological changes on levels of employment by industry and occupation.

The Canadian labour market is expected to undergo major changes in its structure over the next twenty five years. Technological changes will alter the character of jobs and industries: they will be different from that of today. The current speed of technological progress has raised serious employment-related concerns about the consequences of change in industry. It is feared that the change will lead to the disappearance of traditional occupations and to the «de-skilling» of many present jobs. Serious bottlenecks are expected to develop in the labour markets: there will not be enough jobs for available skills and not enough people with needed skills. The result will be technological unemployment for some workers. It is also feared that certain groups, such as women and younger and older workers, will be seriously affected. The emerging technologies are expected to displace a large number of these workers. These workers will have to adapt to new technological changes, to learn new skills and then to move to other or new industries. Adjusting to these structural changes in the labour market is likely to be a major challenge to Canadians in the future.

The objective of this paper is to analyse, by using the national input-output framework, the effects of technological changes on levels of employment by industry and occupation. The analysis by occupation is new. Are the above-mentioned employment-related concerns justified? In what in-

dustries is employment declining or rising? Likewise, in what occupations is employment falling or rising? How much of the change in employment by industry and occupation is due to changes in technology and how much is due to changes in final demand?

There is no consensus on the employment effects of new technology. The forecasts range from optimism to pessimism. The optimists believe that the introduction of new devices into the production process will result in higher productivity, higher aggregate demand, higher economic growth, greater employment expansion, a shorter workweek, a higher general standard of living and wide-spread prosperity. The pessimists, on the other hand, believe that new technology, with its emphasis on labour-saving methods of production, will result in recession, persistent long-run structural unemployment and wide-spread poverty. Both these points of view seem to be rather exaggerated; they are based upon a limited analysis of technological and economic factors, and a lack of awareness of basic historical trends in the Canadian economy.

The question of the effects of technological changes on employment has been widely discussed in the history of economic thought. Technological changes affect directly the pattern of demand for labour in two ways: they either lead to the development of new products and services, which create a new pattern of demand for skills and occupations, or to new methods of production, which change the pattern of manpower requirements. In addition to these direct effects, technological factors have large indirect effects: technology reduces unit costs and relative product prices, increases aggregate final demand, and, as such, increases the demand for labour through higher output. Through direct and indirect effects, the emerging technology creates demand for new skills and jobs and phases out the traditional ones. What is important for labour market policy is a balance between the job creation and job displacement impacts of new technology and the resulting adjustment problems technology creates in the labour market.

Two approaches are often used to analyse the impact of technological progress on employment, one is micro and the other macro. The micro approach, which is more commonly used, measures the effect of a specific technology factor, such as the development of microprocessor or laser technology or biotechnology, on employment in a given industry or in a small group of related industries. The macro approach, on the other hand, measures the *overall* impact of technological change on the broad spectrum of the national economy. Since technological progress has pervasive effects on many industrial sectors concurrently, it is useful to use the inter-industry approach. Therefore, we have used the input-output framework which

takes into account the forward and backward interrelationships between industrial sectors and the *direct* and *indirect* effects of technological changes.

It is essential to point out an important caveat: it is not right to claim that the technical input-output structure of a given economy completely captures all the dimensions of technology underlying its production processes. Technology consists of a large and multi-dimensional body of scientific, technical and social knowledge that determines production processes. In most cases, the limits of technology are broad and difficult to define: it is impossible to provide a complete description of the production process and the technology underlying it. Since progress in technology is incremental and production processes are changing constantly, it is not easy to identify on-going changes in an economy. Even if we succeed in identifying the changes, it is hard to collect adequate data on them. However, the technology factor, although this is not the only factor, has an important influence upon the changes in the input-output structure of an economy. By analysing the changes in the input-output structures in constant dollars over a period of time one can gain some useful insights regarding the effects of changing production process technology on the levels of output and employment. This paper endeavours to do this analysis.

The paper is divided into four parts. Following the introduction, the open version of the Canadian Input-Output model (I-0 model) is described and some procedures derived from the model. We then analyse the effects of changing I-0 coefficients and final demands on levels of output and employment by industry and occupation. It is interesting to examine occupational changes brought about by changes in technical input-output coefficients and by changes in the bill of final demands. Finally the main findings and the overall conclusion of this research are summarized.

BASIC METHODOLOGY — INPUT-OUTPUT MODEL AND SOME PROCEDURES

The Canadian open I-0 model, with given industry technology and fixed market shares, can be written as follows:[1]

$$g = [1 - DB]^{-1} De \quad (1)$$

where:

g = vector of gross outputs by industry, in constant 1971 dollars;

1 Dominion Bureau of Statistics, *The Input-Output Structure of the Canadian Economy 1961*, catalogue No. 15-501 occasional, August 1969, pp. 135-64.

D = matrix of market shares, in constant 1971 dollars;

B = industry technology matrix, in constant 1971 dollars;

e = vector of final demands less imports by commodity, in constant 1971 dollars.

The I-0 model can be used to measure the impact of a change in the bill of final demand upon output and employment by industry. In addition, this model can be adapted to measure the influence of technical change on a labour market.

We can re-write equation (1) as follows:

$$g_t = Q_t F_t \quad (2)$$

where:

$Q_t = ((1\text{-}DB)^{-1})_t$

$F_t = (D_t e_t)$

F_t is a vector of final demand by industry.

Subscript t stands for time: 1971 or 1979. F_t is used in three forms:

$$F_{79} = (D_{79} e_{79})$$
$$F_{71} = (D_{71} e_{71})$$
$$\hat{F}_{79} = (D_{71} e_{79})$$

The latest I-0 table available for analysis is for the year 1979.

By following equation (2), it is possible to separate changes in gross outputs by industry into two components: (a) due to changes in technical coefficients of production and (b) due to changes in the final demand. When we multiply the 1979 final demand by the 1971 inverse matrix (Q_{71}), we get the simulated gross output ($Q_{71} \hat{F}_{79}$) which would have been produced in 1979 had we used the 1971 input-output coefficients of production and the market share matrix, with the fixed 1979 final demand. The difference between the simulated gross output and the actual gross output ($Q_{79} F_{79}$) indicates changes in gross outputs due solely to changes in technical coefficients of production, arising principally from changes in input-output production recipies and secondarily from changes in market shares. On the other hand, when we subtract the actual 1971 gross output ($Q_{71} F_{71}$) from the simulated gross output ($Q_{71} \hat{F}_{79}$), the difference shows changes in the gross output attributable to the change in final demand. We can re-write these relationships in the following equation:

$$Q_{79} F_{79} - Q_{71} F_{71} = (Q_{79} F_{79} - Q_{71} \hat{F}_{79}) + (Q_{71} \hat{F}_{79} - Q_{71} F_{71}) \quad (3)$$

Equation (3) notes that the actual difference between the 1979 and the 1971 gross outputs is equal to sum of the difference $(Q_{79} F_{79} - Q_{71} \hat{F}_{79})$ between the actual 1979 and the simulated gross output and the difference $(Q_{71} \hat{F}_{79} - Q_{71} F_{71})$ between the derived and the actual 1971 gross output. The first difference on the right side of Equation (3) refers to changes in gross output due to changes in technical coefficients and the second difference due to changes in final demand. Technology effect is measured by keeping final demand constant, but changing technology; and demand effect is measured by keeping technology constant, but changing final demand.

We now introduce here some output notation which is used to perform matrix computations with the I-0 model.

g_1 = column vector of the 1979 actual gross output $(Q_{79} F_{79})$ by industry;

g_2 = column vector of the 1971 actual gross output $(Q_{71} F_{71})$ by industry;

g_3 = column vector of the simulated gross output $(Q_{71} \hat{F}_{79})$ by industry. The 1979 bill of final goods is produced by using the 1971 industry technology and market shares matrices.

Equation (3) can be re-written in the following way:

$g_1 - g_2 = (g_1 - g_3) + (g_3 - g_2)$ (4)

The demand for labour in a given industry is derived from an industry output level. Employment level required for each industry is obtained by combining industry gross output with its respective direct labour coefficient — employment (in workers employed) per dollar of output. Employment-output relationships can be written algebraically as follows:

$n_1 = \hat{L}_{79} g_1$ (5)
$n_2 = \hat{L}_{71} g_2$ (6)
$n_3 = \hat{L}_{71} g_3$ (7)

where:

$\hat{L}_t$ = a diagonal matrix with elements of direct industry labour coefficients arranged along the principal diagonal.

n_1 = vector of actual level of employment required to produce g_1 (1979 gross output) by industry;

n_2 = vector of actual level of employment required to produce g_2 (1971 gross output) by industry;

n_3 = vector of derived labour requirements (in workers employed) by industry. This vector produces employment levels required to produce g_3 gross output with the 1971 direct labour coefficients.

Analogous to Equation 4, changes in employment requirement by industry can be factored out as (a) a result of changes in the technical coefficients of production function and (b) as a result of changes in the bill of final demand. This procedure can be formally described by the following equation:

$$n_1 - n_2 = (n_1 - n_3) + (n_3 - n_2) \quad (8)$$

where:

$n_1 - n_2 =$ actual change in required employment between 1971 and 1979;

$n_1 - n_3 =$ change in required employment due to technical coefficients;

$n_3 - n_2 =$ change in required employment due to changes in demand.

Equation (8) analyses labour requirement by industry. We can now go one step further and link industry employment with occupational dimension. It is possible to distribute industry employment across various occupational groups. To do this we require industry-occupation matrices for 1971 and 1979. Statistics Canada has produced industry-occupation matrices for the census years 1971 and 1981. The 1981 census matrix has been made consistent with occupational definitions of the 1971 census matrix. First we create an adjusted industry-occupation matrix for 1979 by applying a proportionality factor. The actual procedure used to create the adjusted 1979 matrix is as follows:

$$A_{79} = A_{71} + 0.8 (A_{81} - A_{71}) \quad (9)$$

where:

$A_t =$ industry-occupation matrix with a dimension of 265 industries by 496 occupations;

$0.8 =$ a scalar proportionality factor, which refers to the length of time elapsed between 1971 and 1979.

The industry aggregation used in A_{79} and A_{71} is different from that of I-0 industry M aggregation. Therefore, both matrices are re-aggregated to make them consistent with the I-0 classification. The recast matrices, which have a dimension of 39 industries by 80 occupational groups (3-digit CCDO[2]), are labelled as $\overline{A}_{79}$ and $\overline{A}_{71}$. Each element in $\overline{A}_t$ matrix relates to a number of workers in a given industry and occupation. Each industry row provides frequency distribution of workers by occupation for a given industry. $\overline{A}_t$ is converted into industry-occupation coefficient matrix, C_t, by dividing industry row by row total. The new matrix C_t is used to distribute industry employment across 80 occupational groups.

---

2   CCDO = Canadian classification and dictionary of occupations.

We now go back to industry-employment column vectors: n_1, n_2 and n_3. After transposing these vectors to make them row vectors ($ń_1$, $ń_2$, $ń_3$), they are then multiplied by C_t. Thus, the actual matrix multiplication procedure used is given below:

$$z_1 = ń_1 C_{79} \quad (10)$$
$$z_2 = ń_2 C_{71} \quad (11)$$
$$z_3 = ń_3 C_{71} \quad (12)$$

z_1 = row vector of actual 1979 employment distributed by 80 occupational groups;

z_2 = row vector of actual 1971 employment distributed by 80 occupational groups;

z_3 = row vector of derived employment distributed by 80 occupational groups. Here employment by occupation is computed on the assumption that the 1979 bill of final demand is produced by using the 1971 I-0 and market share structure, direct labour coefficients and industry-occupation coefficient matrix.

For each occupation, absolute changes between two time periods 1979 and 1971 can now be split into those arising from changes in technical production structure of the national economy, consisting of I-0 tables, market shares matrix, direct labour coefficients and industry-occupation coefficient matrices, and into those arising from changes in bills of final demand. Thus,

$$z_1 - z_2 = (z_1 - z_3) + (z_3 - z_2) \quad (13)$$

where:

$z_1 - z_2$ = observed employment changes in each occupation between 1979 and 1971;

$z_1 - z_3$ = employment changes in each occupation attributable to changes in technical production structures, and

$z_3 - z_2$ = employment changes in each occupation attributable to changes in final demand.

EMPIRICAL FINDINGS -- CHANGES IN GROSS OUTPUT AND EMPLOYMENT

Changes in Gross Output by Industry

To analyse the changes in employment, it is essential to understand the causes of change in output. The demand for labour is determined by level of

output. Following equation (4), changes in gross output are split into two components: (a) those originating from changes in technical coefficients and (b) those originating from changes in final demand. In Table 1, both components are shown in terms of absolute changes. When we look at the absolute changes, which are more real changes and which also take into account the influence of different sizes of industries, two patterns stand out: (i) the influence of changing final demand is positive and large in all industries over the whole period from 1971 to 1979 and (ii) the influence of changing technical coefficients is positive in some industries and negative in others. Although both influences are positive and re-inforcing to each other for the total business sector as a whole, changing coefficients increased gross output in 20 industries, and decreased in 19 industries offsetting, to some extent, the positive effects on output arising from changing demand.

The greatest positive impact of technical coefficient change on output occurred in (38) services to business management, (35) other finance, insurance and real estate, (30) communication, (26) chemical and chemical products industries and (7) services incidental to mining. Except chemical and chemical products industries, which form part of the manufacturing sector, all these industries belong to the service-producing sector. On the opposite scale, the largest declines in gross output occurred in (19) primary metal industries, (22) transportation equipment industries, (12) textile industries, (28) construction industry, (20) metal fabricating industries and (17) paper and allied industries. Except the construction industry, these industries belong to the manufacturing sector.

It is instructive to examine the reasons for changes in gross output due to the variations in input-output structures. Since the final demand was fixed for calculating the changes in output, the changes in gross output due to changes in technical coefficients, in fact arose from changes in intermediate output -- intermediate deliveries mostly going to other industries. Technical progress changes constantly the structure of production recipies, and consequently, industrial establishments substitute certain types of intermediate inputs for others, and become more specialized by fabricating a specific kind of component in volume or by performing specialized services for other industries. More specialization often increases the requirement of intermediate input. The re-allocation of resources which technological changes dictate increases gross output for some industries and decreases for others. In the industries where the largest decreases in gross output were recorded, intermediate deliveries from them to other industries also went down. Conversely, in the industries where largest increases in gross output were recorded, intermediate output requirements from them to other industries also went up.

It is already noted that the effect of final demand on gross output is positive in all industries. Of the 62 billion dollars increase in gross output over the period from 1971 to 1979, 58 billion dollars (i.e. 94 percent) originated from the changes in final demand and four billion dollars (i.e. 6 percent) from the changes in technical coefficient of production. The larger effect of demand is attributable to an increase of 40 percent in the final demand for the total business sector over the same period. The demand effects vary substantially across various industry groups. This is expected since the increasing final demand does not affect all industries to the same extent. The largest absolute increases in gross output due to changes in final demand were observed for (35) other finance, insurance and real estate, (22) transportation equipment industries, (28) construction, (29) transportation and storage, and (33) retail trade. Conversely, the smallest increases in gross output were recorded in (3) fishing, hunting and trapping, (11) leather industries, (9) tobacco products industries, (4) metal mines, (7) services incidental to mining, (6) non-metal mines and quarries, (13) knitting mills and (40) other personal and miscellaneous services.

The large demand effects have increased total gross output in all industries. Even in the industries where technology has negative influences on output, the demand effect has offset more than the decline in gross output. In 19 industries the changes in final demand and in technology coefficients tended to offset rather than re-inforce each other. On the contrary, there is a tendency for both changes to re-inforce each other in the remaining 20 industries. One important point is worth noting: the industries which experienced the smallest output increases had relatively smaller positive demand effects and, in most cases, negative technology influences. On the other hand, the industries which recorded the largest output increases had, in most cases, relatively larger demand effects and above average positive technology effects.

Changes in Employment by Industry

It is possible to convert output changes into employment changes by industry. By following equations (5), (6) and (7), employment level required for an industry is computed by combining industry gross output, calculated under different technical production structures of the national economy, with its respective direct labour coefficient — employment (in workers employed) per dollar of output. And, by following equation 8, changes in employment requirement by industry are split into two components: (a) due to changes in technical coefficients of production and in direct labour coefficients, and (b) due to changes in final demand. The components, represen-

ting the cause of change in employment, are displayed in Table 2, both in terms of absolute and relative changes. At the level of total commercial economy, it is possible to produce the same 1979 final demand basket of goods and services with 8 percent less labour by using the 1979 technology than by using that of 1971. In other words, we can say that the technological progress over the 8-year period has made it possible to produce the same bill of goods by employing 8 percent fewer workers — representing a loss of approximately 626 thousand jobs. The decline in employment for the total business sector occurred in spite of the fact that the change in gross output due to variations in I-0 technical structures was positive. It is, thus, evident that the decline in employment arose from the decrease in direct labour coefficient over the 1971-79 period. The reduction in this coefficient was around 9 percent for the commercial economy over the same time period. Although the effect of technological progress on jobs was negative, the influence of changing final demand on employment was positive and very large, and acted as a counterbalance. The negative effect of technology was completely offset by the demand influence. The latter influence contributed 2.3 million jobs, with a net increase of 1.7 million after allowing for a reduction in jobs due to technological changes.

The technological effect on employment varies substantially from industry to industry. Looking at first absolute changes in employment (Column 5 in Table 2), the technology effect, with fixed final demand but changing technology, is positive only in eight industries and, therefore, labour using. In all other industries it is negative and, as such, labour-saving, with a reduction in workers employed ranging from 100 thousand for transportation and storage to 2 thousand for petroleum and coal products. Among the eight industries where the technology effect is positive, the job gains range from 94 for mineral fuels to 74 thousand for services to business management.

The two important factors determining industry variation in employment due to technical changes are: (a) changes in industry gross output arising from changes in technical coefficients of production and (b) changes in industry direct labour coefficients (job-output ratios). While the former factor has already been examined, it is useful to examine closely the influence of the latter factor on employment. In general, decreases in direct labour coefficients are observed in all industries except (5) mineral fuels, (40) other personal and miscellaneous services, (3) fishing, hunting and trapping, and (39) accommodation and food services. The increases in the direct labour coefficients for the first two industries are relatively large, showing apparently no improvement in labour productivity.

There is a considerable variation among industries in the rates of decline in the labour coefficients. Over the 1971-79 period, the largest declines in the coefficient, showing outstanding gains in labour productivity, occurred in communication (33 percent decline), knitting mills (31 percent), services incidental to mining (30 percent), electrical products industries (30 percent), chemical and chemical products industries (29 percent), textile industries (27 percent), machinery industries (27 percent) and clothing industries (25 percent). Most of these industries fall under the manufacturing industries division. The strongest gain in productivity in communication industry, which is on top of this list, is attributable to outstanding developments in microelectronics. Conversely, the smallest decreases in the labour coefficient were observed for construction industry (0.4 percent decline), education and health (1.2 percent), retail trade (2.3 percent), other finance, insurance and real estate (3.2 percent), primary metal industries (3.9 percent), and amusement and recreation services (5.6 percent). All these industries except construction and primary metal, belong to the service-producing sector. Large rates of decrease in the direct labour requirements were recorded for most metal working industries (I-0 industry code numbers 19 through 23). The noticeable exception, as pointed out earlier, is (19) primary metal industries where the decrease was very small. Rubber and plastic products (10) showed an above average large decrease in the labour coefficient over the period from 1971 to 1979.

Out of the top ten industries[3] for which gross output increased most rapidly, seven industries registered declines in employment because of their relatively large reductions in the direct labour coefficient. In the remaining three industries (7, 38 and 35), reductions in the labour coefficient failed to offset the increase in output, and, thus, their employment growth was both positive and above average. Employment in fishing, hunting and trapping industry, which is among the four industries with increases in the direct labour requirement, increased despite a decline in gross output. Employment in mineral fuels, arising from changing technology with fixed final demand, did not grow because the increase in the labour coefficient compensated fully for the reduction in gross output. In the other two industries (40 and 39) with increases in the direct labour coefficient, employment growth was positive because both gross output and labour coefficients arose.

We now examine more closely *absolute* changes in labour requirements by industry (Column 5 in Table 2), with fixed final demand but changing technology. As pointed out earlier, while the technology effect is positive in eight industries, it is negative in the remaining 31 industries. The largest declines in employment occurred in [29] transportation and storage (100

---

3   I-0 industry code numbers, 7, 38, 30, 20, 26, 10, 35, 31, 29 and 25.

thousand employment decline), [1] agriculture (86 thousand), [23] electrical products industries (58 thousand), [33] retail trade (53 thousand), [22] transportation equipment industries (43 thousand), [12] textile industries (39 thousand), [30] communication (35 thousand), [32] wholesale trade (34 thousand), [14] clothing industries (33 thousand), [20] metal fabricating industries (32 thousand), [17] paper and allied industries (32 thousand), [8] food and beverage industries (31 thousand) [19] primary metal industries (28 thousand) [18] printing and publishing (26 thousand) and [2] forestry (24 thousand). Most of these industries fall under the manufacturing industries division. Furthermore, around half of them fall among the group with the largest *absolute* decline in gross output.

On the opposite scale, the largest employment increases occurred in [38] services to business management (74 thousand employment increase), [40] other personal and miscellaneous services (58 thousand), [35] other finance, insurance and real estate (29 thousand), [39] accommodation and food services (20 thousand), [7] services incidental to mining (7 thousand), [3] fishing, hunting and trapping (3 thousand), [36] education and health services (1 thousand) and [5] mineral fuels (94 only). All these industries, except fishing, hunting and trapping; and mineral fuels, relate to the production of services in the economy. The service-producing industries with the largest employment increases also recorded positive *absolute* changes in gross output.

It is also instructive to compare industry-by-industry *relative* changes in labour requirements, computed under the assumption of fixed final demand but changing technologies. Because of the differing size of the industries, a comparison of relative changes gives a better perspective with respect to where each industry stands in relation to others in terms of impact of technology on employment. Table 3 displays percentage changes in industry labour requirements to deliver the 1979 final demand with the 1971 and the 1979 technologies. Whether we compare absolute changes or relative changes, one general pattern stands out: The largest, or large, decreases in employment are observed for the manufacturing industries, while small decreases or increases in labour requirements are recorded in service-producing industries. Relatively the largest declines in employment due to technological changes occurred in [13] knitting mills (37 percent decline), [12] textile industries (36 percent), [23] electrical products industries (33 percent), [2] forestry (27 percent), [14] clothing industries (25 percent), [9] tobacco products industries (24 percent), [11] leather industries (21 percent) and [18] printing and publishing (20 percent). Except [2] forestry, all these industries belong to the manufacturing industries division. On the other hand, relatively small decreases in employment are recorded in [3] amusement and recreation services (8 percent decline), [32]

wholesale trade (7 percent), [33] retail trade (4 percent) and [28] construction industry (1 percent). Except construction industry, all these industries belong to the service sector.

The effect of final demand, calculated by assuming fixed technical coefficients but changing final demand, is positive in all industries. The largest absolute increases in employment due to changes in final demand are observed for [33] retail trade, [29] transportation and storage, [35] other finance, insurance and real estate, [38] services to business management, [32] wholesale trade, [39] accommodation and food services and [28] construction industry. It may be noted that most industries in this group fall under the service-producing sector. Furthermore, the industries, with the largest absolute increases in employment, also registered large absolute increases in gross output, attributable to variations in final demand. Conversely, the smallest absolute increases in employment due to changes in final demand were observed for [4] metal mines, [9] tobacco products industries, [11] leather industries, [6] non-metal mines and quarries, [25] petroleum and coal products industry, [3] fishing, hunting, trapping, and [7] services incidental to mining. Most of these industries also registered small absolute increases in gross output, arising from variations in final demand. One key point is worth-noting: the demand effect has offset more than the decline in employment in 24 industries with negative technology influence on employment. In the remaining 7 industries with negative technology effect, the demand effect has failed to provide a complete counterbalance and, as a result, absolute total employment levels went down in 1979. The seven declining industries are [1] agriculture, [4] metal mines, [9] tobacco products industries, [11] leather industries, [12] textile industries, [13] knitting industries and [23] electrical products industries.

Changes in Employment by Occupation

Technological changes, by altering the functional content of jobs, and knowledge and skills required from workers, have an important influence on occupational structure. To measure the influence of technology, we distribute employment changes by industry across different occupations. By following equation (13), employment changes are split into two components: (a) those which arise from technological changes and (b) those which arise from changes in final demand. These components, representing causes of change in employment by 80 occupational groups, are displayed in Table 4. First, we look at absolute changes in manpower requirements due to changes in technical coefficient.

It is obvious from Table 4 that there is a considerable variation among industries in employment changes by occupation. While the technology effect is positive in 31 occupational groups, the effect is negative in the remaining 49 groups. For those occupations with positive technology effects on employment, the job gains range from 107 for [517] sales occupations, services to 168 thousand for [113/114] other managers and administrators. And, for those occupations with negative technology effect on employment, the declines in labour requirements range from 94 for [619] other service occupations to 125 thousand for [513/514] sales occupations, commodities. Over the period 1971-79, the largest declines in employment due to technical changes, occurred in sales, commodities [513/514]; other clerical and related occupations [419]; material-handling and related occupations, n.e.c. [931]; other farming, horticultural and animal-husbandry occupations [718/719]; farmers [711]; motor transport operating occupations [917]; stenographic and typing occupations [411]; occupations related to management and administration [117]; metal machining occupations [831]; fabricating, assembling and repairing occupations: textile, fur and leather products (855/856); and other construction trades occupations [878/879]. On the opposite scale, the largest increases in employment, with positive technology effect, occurred in other managers and administrators [113/114]; book-keeping, account-recording and related occupations [413]; food and beverage preparation and related service occupations [612]; farm management occupations [713]; occupations in mathematics, statistics, system analysis and related fields [218]; occupations in fine and commercial art, photography and related fields [331]; other teaching and related occupations [279]; other occupations in medicine and health [315]; fabricating, assembling and repairing occupation: wood products [854]; and occupation in social work and related fields [233].

The effect of changing final demand is positive in *all* occupations, and ranges from 182 workers for occupations in religion [251] to 286 thousand workers for sales occupations, commodities [513/514]. One important thing to note is that the demand effect has offset more than the decline in employment in all occupations with negative technology influence, except in 12 occupations where the demand effect has failed to provide a complete counterbalance. As a result, absolute total employment levels in these occupations went down in 1979. The twelve declining occupations are: other farming, horticultural and animal-husbandry occupations [718/719]; farmers [711]; other sales occupations [519]; metal machining occupation [831]; textile processing occupations [826/827]; wood machining occupations [835]; other processing occupations [829]; other transport equipment operating occupations [919]; water transport operating occupations [915]; officials and administrators unique to government [111]; clay, glass and stone processing, forming and related occupations [815]; and occupations in religion [251].

CONCLUDING REMARKS

In this paper we have measured, by using the input-output framework, the global impact of technical changes on the broad spectrum of the Canadian labour market. Changes in employment by industry are split into two components: (a) due to technological change, arising from changes in technical coefficients of production and in direct labour coefficients, and (b) due to changes in final demand. Technology effect is measured by keeping final demand constant, but changing technology; and demand effect is measured by keeping technology constant, but changing final demand. It is essential to point out here one important assumption underlying our analyses. Although this paper postulates that the phenomena of changes in technology and changes in final demand are unrelated and separate, both phenomena are, in fact, inter-related. The improved technology incorporated into methods of production affects the relative prices of goods and services and, as a result, the level and composition of final demand.

At the level of total commercial economy, it is possible to produce the *same* 1979 final demand basket of goods and services with 8 percent less labour by using the 1979 technology than by using that of 1971. In other words, we can say that the technological progress over the 8-year period has made it possible to produce the same bill of goods and services by employing 8 percent fewer workers — representing a loss of approximately 626 thousand jobs. Although the effect of technological progress on jobs was negative, the influence of changing final demand on employment was positive and very large, and acted as a counterbalance. The negative effect of technology was completely offset by the demand influence. Over the 1971-79 period, the latter influence contributed 2.3 million jobs, with a *net* increase of 1.7 million jobs after allowing for a reduction in jobs due to technological changes.

In conclusion, technological progress has pervasive effects on many industries. The effects are generally labour-saving: employment in most industries has fallen as a result of changes in input-output structures and in direct labour coefficients. The manufacturing sector seems to bear the brunt of technological changes: technology is eroding the employment-generating capacity of the manufacturing industries. Growing final demand has provided an important counterbalance to the labour-displacement effect of technological changes. The demand effect has offset more than the decline in imployment in most industries. Will the large counterbalancing influence of the demand effect continue in the 1980s and 1990s? With growing aggregate demand, the fear of technological unemployment occurring in the future seems unfounded. Growing demand would offset the labour-displacement effect of technological change. However, it is certain that the

emerging technologies will create large manpower adjustment problems in many industries, requiring active labour market adjustment policies. The overall policy implication of this research is that the policies of managing aggregate demand, adjusting to structural changes in the labour market and promoting technical progress in the economy are closely inter-related, and should, therefore, be pursued concurrently.

REFERENCES

CARTER, A.P., «Changes in the Structure of American Economy, 1947 to 1958 and 1962». *Review of Economics and Statistics,* 1967, Vol. 49, pp. 209-224.

—————, *Structural Change in the American Economy,* Cambridge, Massachusetts, Harvard University Press, 1970.

—————, «The Economics of Technological Change», *Scientific American,* Vol. 214, No. 4, 1966, pp. 25-31.

CHOATE, Pat, *Retooling the American Work Force,* Washington, D.C., Northeast-Midwest Institute, July 1982.

COOPER, C.M., and J.A. CLARK, *Employment, Economics and Technology — The Impact of Technological Change on The Labour Market,* New York, St. Martin's Press, 1982.

ECONOMIC COUNCIL OF CANADA, *Productivity Growth Through Technical Change,* David W. Slater, *(Notes for an appearance before The Standing Senate Committee on National Finance),* March 1983.

—————, *The Bottom Line, (Technology, Trade and Income Growth),* Ottawa, 1983.

FREEMAN, Richard B., «The Work Force of the Future: An Overview», *Work in America the Decade Ahead,* Toronto, Van Nostrand Reinhold Company, 1979, pp. 58-79.

HAMRIN, Robert D., «The Information Economy», *The Futurist,* Vol. XV, No. 4, August 1981, pp. 25-26.

HART, Gary, «Investing in People for the Information Age», *The Futurist,* February 1983.

GOURVITCH, Alexander, *Survey of Economic Theory of Technological Change and Employment,* New York, Augustus, M. Kelley, Publishers, 1966.

HEERTJE, Arnold, *Economics and Technical Change,* London, Weidenfeld and Nicolson, 1973.

INTERNATIONAL LABOUR ORGANISATION, *New Technology: Their Impact on Employment and the Working Environment,* Geneva, 1982.

LABOUR CANADA, *In the Chips: Opportunities People Partnerships,* Ottawa, Publications Distribution Centre, Labour Canada, 1982.

LEONTIEF, Wassily W., «Structural Change», in W. Leontief, et al. (eds), *Studies of Economics and Statistics,* Vol. XLVII, No. 4, 1953.

————, «The Distribution of Work and Income», *Scientific American,* September 1982, Vol. 247, No. 3, pp. 188-204.

————, «Technological Advance, Economic Growth, and the Distribution of Income», *Population and Development Review,* Vol. 9, No. 3, September 1983.

LEVITAN, Sar A., and Cliford M. JOHNSON, «The Future of Work: Does It Belong To Us Or To Robots?», *Monthly Labour Review,* September 1982, Vol. 105, No. 9, pp. 10-14.

MENZIES, Heather, *Women and the Chip,* Montréal, Institute for Research on Public Policy, 1981.

MANN, Jitendar S., «Input-Output Models and Technological Change: Some Explorations in Methology», *Agricultural Economics Research,* Vol. 27, January 1975.

NATIONAL SCIENCE FOUNDATION, *The Process of Technological Innovation: Reviewing The Literature,* Washington, D.C., 1983.

PEITCHINIS, Stephen G., *Computer Technology and Employment, Retrospect and Prospect,* 1984.

ROYAL COMMISSION ON THE ECONOMIC UNION AND DEVELOPMENT CANADA, *Prospects for Challenges and Choices,* April 1984.

STATISTICS CANADA, *The Input-Output Structure of the Canadian Economy,* Vol. I, Cat. No. 15-501 Occasional, Ottawa, The Queen's Printer, 1969.

————, *The Input-Output Structure of the Canadian Economy, 1971-1979,* Catalogue 15-201E Annual, 1983.

————, *The Input-Output Structure of the Canadian Economy in Constant Prices, 1971-1979,* Catalogue 15-202E Annual, 1983.

STONEMAN, Paul, *The Economic Analysis Technological Change,* Oxford University Press, 1983.

SYED, Aftab A., *Structural Change, 1961-71: An Input-Output Analysis,* Working Paper (79-05-15), Structural Analysis Division, Statistics Canada (Unpublished), May 1979.

————, *Intertemporal Analysis of Structural Change in the Canadian Economy,* Working Paper (Unpublished), (78-09-30), September 1978.

THORNTON, Peter, «Technology and Employment: The Prospect to 1990», *International Journal of Social Economics,* Vol. 7, No. 1, 1980, pp. 24-36.

VACCARA, B.N., «Changes over Time in Input-Output Coefficients for the United States», in A.P. Carter, and A. Brody (eds), *Applications of Input-Output Analysis,* Vol. 2, Amsterdam, North Holland, 1970.

TABLE 1

Causes of Change in Gross Output, Business Sector, Canada, 1971-79
(In Millions of 1971 Dollars)

Input-Output Industry Code (M — Aggregation)	Total Gross Output		Changes in Gross Output		
	1971 (1)	1979 (2)	Total (3)	Due to Final Demand (4)	Due to Coeffi-cients (5)
1. Agriculture	4938	5590	+652	+805	−153
2. Forestry	1341	1794	+453	+659	−207
3. Fishing, hunting, & trapping	220	269	+49	+66	−17
4. Metal mines	2133	2316	+183	+132	+50
5. Mineral fuels	2031	2559	+528	+588	−60
6. Non-metal mines & quarries	603	773	+170	+160	+10
7. Services incidental to mining	402	1018	+616	+148	+468
8. Food & beverage industries	9434	11695	+2261	+1947	+314
9. Tobacco products industries	570	648	+78	+105	−27
10. Rubber & plastics products ind.	1212	2112	+900	+693	+207
11. Leather industries	429	490	+61	+73	−12
12. Textile industries	1741	2384	+644	+986	−343
13. Knitting mills	462	589	+126	+190	−64
14. Clothing industries	1507	2047	+540	+514	+26
15. Wood industries	2348	3441	+1093	+1143	−50
16. Furniture & fixture industries	806	1012	+206	+336	−130
17. Paper & allied industries	4112	5302	+1190	+1408	−218
18. Printing & publishing	1698	2567	+869	+858	+11
19. Primary metal industries	5119	5922	+803	+1433	−630
20. Metal fabricating industries	3686	4955	+1269	+1512	−243
21. Machinery industries	2008	3889	+1882	+1334	+447
22. Transportation equipment ind.	7354	11028	+3674	+4161	−487
23. Electrical products industries	3024	4190	+1166	+1280	−114
24. Non-metalic mineral prod. ind.	1550	2061	+511	+459	+51
25. Petroleum & coal products ind.	2220	3263	+1044	+939	+105
26. Chemical & chemical prod. ind.	2962	4619	+1656	+1173	+484
27. Misc. manufacturing industries	1242	1669	+428	+486	−58
28. Construction industry	16488	20195	+3707	+3975	−268
29. Transportation & storage	7802	11856	+4054	+3623	+432
30. Communication	2776	5743	+2967	+1958	+1008
31. Elec. power, gas, other utilities	2458	4181	+1724	+1456	+267
32. Wholesale trade	5955	8444	+2488	+2541	−53
33. Retail trade	8302	11548	+3246	+3455	−209
35. Other finance, ins. & real estate	10467	16773	+6305	+4868	+1437
36. Education & health services	2167	3045	+878	+876	+2
37. Amusement & recreation services	773	1384	+610	+608	+2
38. Services to business management	3341	7106	+3765	+1994	+1771
39. Accommodation & food services	3736	5536	+1800	+1750	+50
40. Other personal & misc. services	1208	1521	+313	+293	+20
44. Total business sector	149004	211110	+62105	+58327	+3778

NOTE: Details may not add due to rounding

TABLE 2

Causes of Change in Employment, Business Sector, Canada, 1971-79
(Thousands of Workers Employed)

Input-Output Industry Code (M — Aggregation)	Total Labour Requirements		Changes in Labour Requirements		
	1971 (1)	1979 (2)	Total (3)	Due to Final Demand (4)	Due to Coeffi-cients (5)
1. Agriculture	502	497	−4	+82	−86
2. Forestry	60	65	+5	+29	−24
3. Fishing, hunting, & trapping	20	30	+10	+6	+3
4. Metal mines	61	53	−8	**	−9
5. Mineral fuels	22	35	+13	+13	**
6. Non-metal mines & quarries	20	21	+1	+5	−4
7. Services incidental to mining	18	32	+14	+7	+7
8. Food & beverage industries	221	233	+12	+43	−31
9. Tobacco products industries	10	9	−1	+2	−3
10. Rubber & plastics products ind.	45	62	+17	+24	−7
11. Leather industries	28	26	−2	+4	−7
12. Textile industries	69	69	*	+38	−39
13. Knitting mills	24	21	−3	+10	−12
14. Clothing industries	100	101	1	+34	−33
15. Wood industries	93	123	+30	+45	−15
16. Furniture & fixture industries	45	52	+7	+19	−12
17. Paper & allied industries	119	128	+9	+41	−32
18. Printing & publishing	86	103	+17	+44	−26
19. Primary metal industries	113	126	+13	+41	−28
20. Metal fabricating industries	139	163	+24	+57	−32
21. Machinery industries	71	101	+30	+50	−20
22. Transportation equipment ind.	151	189	+39	+82	−43
23. Electrical products industries	123	120	−4	+55	−58
24. Non-metalic mineral prod. ind.	52	57	+5	+15	−10
25. Petroleum & coal products ind.	14	18	+4	+6	−2
26. Chemical & chemical prod. ind.	77	86	+9	+30	−21
27. Misc. manufacturing industries	58	66	+8	+24	−16
28. Construction industry	558	680	+123	+129	−7
29. Transportation & storage	376	451	+75	+175	−100
30. Communication	144	200	+56	+91	−35
31. Elec. power, gas, other utilities	65	90	+25	+38	−13
32. Wholesale trade	344	457	+113	+147	−34
33. Retail trade	930	1264	+334	+387	−53
35. Other finance, ins. & real estate	336	521	+185	+156	+29
36. Education & health services	77	107	+30	+29	+1
37. Amusement & recreation services	45	77	+31	+38	−7
38. Services to business management	268	489	+221	+147	+74
39. Accommodation & food services	298	458	+160	+139	+20
40. Other personal & misc. services	159	253	+94	+36	+58
44. Total business sector	5941	7633	+1693	+2319	−626

NOTE: Details may not add due to rounding

* Very small negative change.   ** Very small positive change.

TABLE 3

**The Impact of Technological Change on Employment,
1971-79 — Percentage Change in Industry Labour Requirements to
Deliver 1979 Final Demand with 1971 and 1979 Technologies,
Business Sector, Canada**

		Percentage Change in Labour Requirements
A.	*Largest decreases in employment*	*1971-79*
13.	Knitting mills	−37
12.	Textile industries	−36
23.	Electrical products industries	−33
2.	Forestry	−27
14.	Clothing industries	−25
9.	Tobacco products industries	−24
11.	Leather industries	−21
18.	Printing & publishing	−20
17.	Paper & allied industries	−20
26.	Chemical & chemical products ind.	−19
27.	Misc. manufacturing industries	−19
22.	Transportation equipment ind.	−18
19.	Primary metal industries	−18
29.	Transportation & storage	−18
16.	Furniture & fixture industries	−18
21.	Machinery industries	−17
20.	Metal fabricating industries	−17
24.	Non-metalic minerals prod ind.	−15
30.	Communication	−15
1.	Agriculture	−15
6.	Non-metal mines & quarries	−15
B.	*Large decreases in employment*	
4.	Metal mines	−14
31.	Elec power, gas, other utilities	−13
25.	Petroleum & coal products ind.	−12
8.	Food & beverage industries	−12
15.	Wood industries	−11
10.	Rubber & plastic products industries	−10
C.	*Small decreases in employment*	
37.	Amusement & recreation services	−8
32.	Wholesale trade	−7
33.	Retail trade	−4
28.	Construction industry	−1
D.	*Increases in employment*	
5.	Mineral fuels	+0.3
36.	Education & health	+1
39.	Accommodation & Food services	+5
35.	Other finance, ins. & real estate	+6
3.	Fishing, hunting & trapping	+13
38.	Services to business management	+18
7.	Services incidental to mining	+29
40.	Other personal & misc. services	+30

TABLE 4

Causes of Changes in Employment by Occupation
Business Sector, Canada, 1971-1979
(Number of Workers Employed)

CCDO No. 1	Occupational Group Titles	Total Workers Employed		Change in Worker's Employed		
		1971	1979	TOTAL	Due to Final Demand	Due to Technical Coefficients
111	Officials and Administrators unique to Government	5,748	5,392	-354	3,568	-3,923
113/114	Other Managers and Administrators	100,421	310,911	210,490	42,630	167,859
117	Occupations Related to Management and Administration	147,687	172,328	24,641	67,382	-42,741
211	Occupations in Physical Sciences	22,464	24,041	1,577	8,824	-7,247
213	Occupations in Life Sciences	5,522	9,459	3,937	2,172	1,765
214/215	Architects and Engineers	67,648	99,269	31,621	31,409	213
216	Other occupations in Architecture and Engineering	57,469	85,726	28,258	26,393	1,865
218	Occupations in Mathematics, Statistics, Systems Analysis and Related Fields	17,199	32,746	15,547	8,329	7,217
231	Occupations in Social Sciences	4,596	9,319	4,723	2,190	2,533
233	Occupations in Social Work and Related Fields	5,657	12,294	6,637	3,402	3,235
234	Occupations in Law and Jurisprudence	17,941	30,821	12,880	9,746	3,133
235	Occupations in Library, Museum and Archival Sciences	1,746	3,780	2,034	816	1,218
239	Other Occupations in Social Sciences and Related Fields	450	954	504	187	317
251	Occupations in Religion	458	452	-6	182	-188
271	University Teaching and Related Occupations	2,059	3,291	1,232	768	464
273	Elementary and Secondary School Teaching and Related Occupations[2]	20,941	25,896	4,956	7,837	-2882
279	Other Teaching and Related Occupations	8,644	18,082	9,438	4,050	5,389
311	Health Diagnosing and Related Occupations[3]	4,475	7,344	2,870	1,427	1,443
313	Nursing, Therapy and Related Assisting Occupations[4]	20,999	31,445	10,446	8,093	2,353

Code	Occupation					
315	Other Occupations in Medicine and Health[5]	17,542	29,542	12,000	7,052	4,947
331	Occ. in Fine and Commercial Arts, Photography & Related Fields	27,432	45,638	18,206	12,247	5,954
333	Occupation Performing and Audiovisual Arts	13,401	25,144	11,743	9,347	2,395
335	Occupations in Writing	13,161	23,238	10,077	7,038	3,039
336/337	Occupations in Sport and Recreation	7,855	15,695	7,840	5,423	2,417
411	Stenographic and Typing Occupations	217,023	269,737	52,715	99,229	−46,515
413	Book-keeping, Account-Recording and Related Occupations	317,371	554,614	237,243	138,819	98,424
414	Office Machine and Electronic Data-processing Equipment Operators	39,160	59,236	20,076	17,837	2,238
415	Material Recording, Scheduling and Distributing Occupations	14,293	193,764	50,781	59,687	−8,906
416	Library, File and Correspondence Clerks and Related Occupations	142,983	17,748	3,580	6,498	−2,918
417	Reception, Information, Mail and Message Distribution Occupations	116,594	153,699	37,105	62,429	−25,324
419	Other Clerical and Related Occupations	185,949	192,486	6,537	84,587	−78,050
513/514	Sales Occupations, Commodities	689,089	850,119	161,029	285,765	−124,736
517	Sales Occupations, Services	91,152	133,907	42,755	42,647	107
519	Other Sales Occupations	34,780	31,302	−3,478	11,224	−14,702
611	Protection Service Occupations	39,212	52,732	13,520	18,769	−5,249
612	Food and Beverage Preparations and Related Service Occupations	219,815	333,795	113,980	102,878	11,102
613	Occupations in Lodging and Other Accomodations	39,780	56,232	16,452	18,459	−2,007
614	Personal Service Occupations	74,914	93,197	18,283	21,716	−3,432
616	Apparel and Furnishing Service Occupations	29,303	33,186	3,883	8,136	−4,254
619	Other Service Occupations	138,087	194,185	56,098	56,192	−94
711	Farmers	246,569	237,787	−8,781	40,181	−48,962
713	Farm Management Occupations	20,421	33,633	13,212	3,455	9,757
718/719	Other Farming, Horticultural and Animal Husbandry Occupations	246,716	227,012	−19,704	45,506	−65,210

Code	Occupation					
731	Fishing, Hunting, Trapping and Related Occupations	22,264	31,827	9,562	6,400	3,163
751	Forestry and Logging Occupations	51,791	55,427	3,636	24,392	−20,756
771	Mining, Quarrying, including oil and Gas Fields Occupations	54,718	55,460	741	10,644	−9,903
811	Mineral and Ore Treating Occupations	6,884	7,482	598	1,450	−852
813/814	Metal Processing and Related Occupations	45,171	64,310	19,139	17,618	1,521
815	Clay, Glass and Stone Processing, Forming and Related Occupations	16,821	16,618	−203	5,151	−5,354
816/817	Chemicals, Petroleum, Rubber, Plastic and Related Materials Processing Occupations	31,320	38,063	6,743	13,376	−6,634
821/822	Food, Beverage and Related Processing Occupations	116,683	140,075	23,392	29,871	−6,479
823	Wood Processing Occupations, Except Paper Pulp	34,791	44,001	9,211	16,475	−7,264
825	Pulp and Papermaking and Related Occupations	33,436	40,172	6,736	11,780	−5,043
826/827	Textile Processing Occupations	38,258	36,866	−1,392	19,161	−20,554
829	Other Processing Occupations	8,165	6,909	−1,256	1,829	−3,086
831	Metal Machining Occupations	87,978	85,195	−2,783	39,756	−42,539
833	Metal Shaping and Forming Occupation, Except Machining	118,658	149,988	31,330	47,575	−16,245
835	Wood Machining Occupations	14,298	12,907	−1,391	6,320	7,710
837	Clay, Glass, Stone and Related Materials Machining Occupations	5,855	8,394	2,539	2,084	455
839	Other Machining and Related Occupations	13,468	15,315	1,847	6,084	−4,237
851/852	Fabricating, Assembling Occupations, Metal Products n.e.c.	54,183	82,916	28,733	28,060	672
853	Fabricating, Assembling, Installing and Repairing Occupations: Electrical and Electronic and Related Equipment	81,765	103,125	21,360	35,749	−14,388
854	Fabricating, Assembling and Repairing Occupations: Wood Products	20,736	34,578	13,842	8,939	4,902
855/856	Fabricating, Assembling and Repairing Occupations: Textile, Fur and Leather Products	147,541	157,613	10,072	52,344	−42,272

857	Fabricating, Assembling and Repairing Occupations, Rubber, Plastic and Related Products	22,684	33,218	10,533	11,354	−820
858	Mechanics and Repairmen, n.e.c.	236,033	296,078	60,045	97,612	−37,567
859	Other Product Fabricating, Assembling and Repairing Occupations	62,514	72,410	9,896	26,337	−16,440
871	Excavating, Grading, Paving and Related Occupations	75,388	89,584	14,197	24,199	−10,002
873	Electrical Power, Lighting and Wire Communications Equipment, Erecting, Installing and Repairing Occupations	91,699	111,357	19,658	37,571	−17,913
878/879	Other Construction Trades Occupations	377,183	441,348	64,165	102,515	−38,350
911	Air Transport Operating Occupations	6,960	12,444	5,484	3,238	2,246
913	Railway Transport Operating Occupations	27,507	27,533	26	12,614	−12,587
915	Water Transport Operating Occupations	14,288	13,844	−444	6,416	−6,861
917	Motor Transport Operating Occupations	243,965	297,617	53,653	101,369	−47,716
919	Other Transport Operating Occupations	4,723	4,262	−461	1,608	−2,069
931	Material-Handling and Related Occupations, n.e.c.	196,634	205,973	9,339	76,061	−66,722
951	Printing and Related Occupations	40,956	52,166	11,210	20,180	−8,970
953	Stationary Engine & Utilities Equip. Operating Occupations	31,629	33,305	1,676	13,503	−11,826
955	Electronic & Related Communications Equip. Operating Occupations, n.e.c.	5,704	7,318	1,614	3,509	−1,895
959	Other Crafts and Equipment Operating Occupations, n.e.c.	4,278	7,872	3,594	1,630	1,963

1 Relates to Canadian classification and dictionary of occupation (CCDO) numbers.
2 Includes teaching occupations in private schools.
3 Includes private physicians and surgeons; dentists; veterinarians; chiropractors; and health and treating occupations, n.e.c.
4 Includes health and medicine occupations in private hospitals.
5 Includes private pharmacists, dietitians, optometrists, medical technicians, etc.
Note: Details may not add due to rounding.

Les effets des changements technologiques sur le marché du travail au Canada

L'objet de cet article est d'analyser, en utilisant le modèle canadien intrant-extrant, les effets des changements technologiques sur la situation de l'emploi par industrie et par propension. Dans quelles industries l'emploi diminue-t-il ou augmente-t-il? De même, dans quelles professions ou métiers l'emploi baisse-t-il ou s'accroît-il? Dans quelle mesure les modifications dans les emplois sont-ils attribuables aux changements dans la technologie et dans quelle mesure sont-elles attribuables à la demande finale? Puisque le progrès technologique a des conséquences profondes sur plusieurs secteurs industriels concurremment, nous avons utilisé le modèle intrant-extrant qui tient compte des interrelations dans le mouvement d'avance et de recul entre les secteurs industriels ainsi que des effets directs et indirects des changements technologiques.

Les changements dans l'emploi par industrie se divisent en deux composantes: a) le changement technologique, résultant des transformations qui se produisent dans les coefficients intrant-extrant et dans les coefficients directs du travail; b) le changement dans la demande finale. On a mesuré l'effet de la technologie en conservant constante la demande finale, mais en modifiant les coefficients techniques de production; et on a mesuré l'effet de la demande en conservant les coefficients techniques constants, mais en modifiant la demande finale. Au plan de l'économie commerciale totale, il est possible de produire la même quantité de biens et de services, sous forme de demande finale, en 1979 avec huit pour cent moins de main-d'oeuvre en recouvrant à la technologie de 1979 plutôt que celle de 1971. En d'autres mots, nous pouvons dire que le progrès technologique au cours de ces huit années a rendu possible la production de la même quantité de biens de services en employant huit pour cent moins de travailleurs, ce qui représente une perte d'environ 626 000 emplois. Bien que l'influence du progrès technologique sur les emplois soit négatif, l'influence du changement dans la demande finale sur l'emploi fut de beaucoup positif et a par conséquent fait contrepoids. L'effet négatif de la technologie fut plus que compensé par l'influence de la demande. Pour la période 1971-1979, cette dernière influence a permis la création de 2 300 000 emplois, soit une augmentation nette de 1 700 000 emplois même après avoir concédé une perte d'emplois attribuable aux changements technologiques.

L'effet de la technologie sur les emplois varie considérablement d'une industrie à une autre. Parmi les 39 industries considérées dans le présent article, l'effet de la technologie, fondé sur la demande finale fixe mais en changeant les coefficients techniques de production est positif dans huit industries seulement et il suppose par conséquent une plus grande utilisation de main-d'oeuvre. Dans toutes les autres industries, il est négatif et, par conséquent, suppose une économie de main-d'oeuvre. Il en ressort la situation générale suivante: de très fortes ou fortes diminutions d'emplois s'observent dans les industries manufacturières, alors que les diminutions plus faibles ou les augmentations dans la demande de main-d'oeuvre, se retrouvent dans

les entreprises de services. Proportionnellement, les déclins les plus marqués dans l'emploi attribuables aux changements technologiques se retrouvent dans l'industrie du tricot (37 p.c.), l'industrie du textile (36 p.c.) l'industrie des accessoires électriques (33 p.c.), l'exploitation forestière (27 p.c.), l'industrie du vêtement (25 p.c.), l'industrie du tabac (24 p.c.), l'industrie du cuir (21 p.c.) et l'industrie de l'imprimerie (20 p.c.). À l'exception de l'exploitation forestière, toutes ces industries appartiennent à la division des industries manufacturières ou du secteur secondaire.

L'effet de l'augmentation de la demande finale sur l'emploi, calculé en présumant des coefficients techniques fixes mais en modifiant la demande finale, est positif pour toutes les industries. Parmi les 31 industries avec effet technologique négatif sur l'emploi, l'effet de la demande a compensé plus que le déclin dans l'emploi dans 24 de ces industries. Dans les sept autres avec effet technologique négatif, l'effet de la demande n'a pas réussi à le combler complètement et, comme résultat, les niveaux de l'emploi total absolu dans l'ensemble avaient baissé en 1979. Ces industries sont l'agriculture, les mines et les métaux, l'industrie des produits du tabac, les industries du cuir, des textiles, du tricot et des accessoires électriques.

Les changements technologiques, en modifiant les contenus d'exécution des tâches et la compétence requise des travailleurs ont une influence considérable sur la structure professionnelle de la main-d'oeuvre canadienne. Pour estimer l'influence des changements technologiques sur l'emploi par métier, nous avons disposé, en utilisant la nomenclature du recensement du Canada 1981 par industrie et métier, les changements survenus dans la main-d'oeuvre par industrie pour les différents types d'occupation.

Il y a une variation considérable parmi les industries au sujet des modifications de l'emploi par métier. Alors que l'effet technologique est positif dans 31 groupes professionnels, cet effet est négatif dans les 49 groupes qui restent. Pour les métiers dont l'effet est positif en matière d'emploi, l'augmentation des emplois varie de 107 pour les postes de vendeurs de service à 168 000 pour les autres postes de directeurs et d'administrateurs. Et pour les métiers comportant des effets technologiques négatifs sur l'emploi, les déclins dans la demande de main-d'oeuvre varie de 94 pour les autres travailleurs de service à 125 000 pour les postes de vendeurs de biens de consommation.

L'effet du changement de la demande finale est positif dans tous les métiers et il va de 182 pour les fonctions de membres du clergé à 276 000 pour les postes de vendeurs de biens de consommation. Un point important à noter, c'est que l'effet de la demande a plus que comblé le déclin dans l'emploi pour tous les métiers ou professions où l'influence de la technologie est négative, sauf pour 12 métiers où l'effet de la demande n'a pas réussi à assurer un contrepoids total. Résultat: les niveaux d'emploi absolus dans les occupations avaient diminué en 1979. Ces occupations sont les suivantes: autres agriculteurs, horticulteurs et éleveurs, exploitants agricoles, autres travailleurs spécialisés dans la vente, usineurs de métaux, travailleurs de la transformation des textiles, travailleurs du bois à la machine, autres usineurs, autre personnel d'exploitation des transports, personnel de la navigation, fonctionnaires et administrateurs de la fonction publique, confectionneurs de produits en argile, en verre et en pierre et travailleurs assimilés et les fonctions de membres du clergé.

On peut conclure que le progrès technologique a des conséquences profondes sur plusieurs industries canadiennes. Les conséquences favorisent généralement l'économie de travail: l'emploi a diminué dans la plupart des industries à cause de changements dans la structure intrants-extrants et dans les coefficients directs de travail. Le secteur manufacturier semble avoir à soutenir le choc des changements technologiques: la technologie érode la capacité des industries manufacturières de générer des emplois. La croissance de la demande finale a contrebalancé dans une large mesure l'effet du déplacement des travailleurs engendré par les changements technologiques. La grande influence compensatrice de l'effet de la demande se conti-nuera-t-elle au cours des décennies 1980 et 1990? Grâce à la croissance de la demande en général, la crainte du chômage technologique pouvant survenir dans l'avenir n'apparaît pas fondée. La demande croissante compenserait l'effet des déplacements technologiques. Cependant, il est certain que les technologies en voie d'émerger créeront des problèmes d'ajustement de la main-d'oeuvre dans plusieurs industries, ce qui exigera des politiques agissantes d'adaptation du marché du travail. Le but principal de cette recherche, c'est de faire en sorte que les politiques destinées à orienter la demande dans sa totalité, en s'ajustant aux changements structurels sur le marché du travail et en favorisant le progrès technique dans l'économie, soient forte-ment interreliées et puissent, par conséquent, se poursuivre concurremment.

LE STATUT DE SALARIÉ EN MILIEU DE TRAVAIL

Préface, Gilles FERLAND — **Introduction**, Jacques BÉLANGER, Rodrigue BLOUIN, Fernand MORIN, Jean SEXTON — Le statut de salarié en milieu de travail: la problématique, Rodrigue BLOUIN — Les notions de salarié en droit du travail, Jean Denis GAGNON — **Commentaires**, René DOUCET, Louise PARENT — Évolution des conditions de travail des salariés établies d'autorité, André C. CÔTÉ — **Commentaire**, Guy PIUZE — L'institution-nalisation des rapports collectifs du travail. Réalité d'aujourd'hui et de demain?, Fernand MORIN — **Commentaire**, Robert P. GAGNON — **Table ronde** — Le régime actuel de travail des salariés: où en sommes-nous?, Claude DUCHARME, Monique SIMARD, Laurent THIBAULT — Évolution du statut du salarié en raison des nouvelles formes d'emploi. L'exemple du travail à temps partiel au Québec, Colette BERNIER — **Commentaire**, Esther DÉOM — Nouvelles formes d'organisation du travail, nouveaux modes de gestion et leur incidence sur le statut du salarié, Laurent BÉLANGER — **Commentaire**, Marcel CÔTÉ — Le salarié et la gestion générale de l'entreprise, Harold BHÉRER — **Commentaire**, Clément GODBOUT — Les rapports collectifs du travail: rétrospective et pers-pectives, Jean MARCHAND — **Annexe:** La participation des travailleurs aux décisions dans l'entreprise, Jacques BÉLANGER — Supplément: Quarante ans au service des relations industrielles, James THWAITES, Mario LAJOIE, Hélène BOIS-BROCHU.

ISBN 2-7637-7079-7   1 volume - 296 pages - 1985 - $17.00

Les Presses de l'Université Laval

Cité universitaire   C.P. 2447, Québec, P.Q., Canada
                                                      G1K 7R4