Economic Council
of Canada

Conseil économique
du Canada

[redacted]

Working Paper
Document de travail

Working Paper No. 22

The Interdependence of Industrial Activities

Tom Siedule

1991

ISSN 1180-3487

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Acknowledgments

I would like to thank Aftab Syed of the Input-Output Division, Statistics Canada, for explaining to me the complexities of the Canadian input-output data throughout the development of this project. His technical advice and comments on an earlier draft have contributed greatly to this paper. I am also grateful to Gordon Betcherman, Director of the Economic Council's research program on the growth of the service sector, for his unlimited patience during the course of this study. His comments at various stages surely improved the quality of the work. All errors and omissions remain, of course, my sole responsibility.

Foreword

The growth of the service sector is well documented in numerous publications and official statistics. The cause for the rise of the service sector is, however, a less-understood topic. One specific question that has attracted considerable public attention is whether the service sector has a life of its own or is dependent on the producing activities in the rest of the economy. This paper, which utilizes a sectoral input-output model to analyse the historical input-output data, attempts to provide us with an answer. It highlights the linkages between goods-producing and service-producing industries: goods-producing activities create demand for other goods and services in the production process. On the other hand, although the production of service activities does not require a large amount of inputs from goods-producing industries, service industries have to sell much of their outputs to goods-producing industries as intermediate inputs for goods production. The empirical results shed some light on the sources of the historical growth of the Canadian service industries and are also of some interest to researchers engaged in forecasting future service activities.

This paper was prepared by Tom Siedule, an economist on the staff of the Council. It was undertaken as part of the Council's research program on the growth of the service sector.

Judith Maxwell
Chairman

Abstract

The sectoral input-output analysis of this paper investigates the impacts of goods-producing activities on service industries and vice versa. The findings highlight the interdependence of industrial activities. We have learned that all goods-producing industries, especially resource-based industries, have substantial power in generating demand for services. On the other hand, very few service industries have noticeable potential to create demand for goods. These results may be traced to the need of the goods industries for other goods and services in the production process, which becomes a source of large multiplier effects in the economy. Service industries, however, do not have the same production attributes. Other than using their own outputs as inputs, service industries require relatively little goods and services to carry out their business. Overall, however, the activities of the goods and service industries are highly interdependent. Goods industries need the support of high-quality services, while service industries depend on the demand originating from goods production.

The growth of the economy and the interdependence of industrial activities have been the primary causes for the rapid growth in services. As the economy grew, the initial impact was the demand for more goods and services simultaneously. However, due to the requirements of the goods industries for services as inputs, the demand for more goods necessarily entailed further demand for services. The end result was rapid growth in the service sector.

Introduction

The ascendancy of service activities during the last few decades is perhaps one of the most interesting and mysterious empirical phenomena in modern economic history. Moreover, rapid growth in services has not been a unique empirical phenomenon in Canada only. It has been observed in practically all developed countries.

Not surprisingly, this has long been a popular topic of economic research. In 1940, Colin Clark already noticed the importance of the growth and shifts of primary, secondary, and tertiary industries.[1] In his seminal work on economic growth, Simon Kuznets also noted the relative growth of business, personal, professional, and government services prior to the 1950s.[2] Subsequent work, such as William Baumol's articles on the macroeconomics of unbalanced growth and Victor Fuchs' book on the service economy, continued to unravel the mystery.[3] Interest on this topic has reached a new high. This may partly be traced to the concern of a number of U.S. economists about the relative decline of the manufacturing sector in the economy.[4] In Canada, the remarkable growth of the service sector has also prompted researchers in academic communities and governments to revisit this topic.[5] This is one of the many studies that emerged from the Economic Council of Canada's research program on the growth of the service sector. The research work reported here represents an attempt to explain the phenomenal growth in Canadian service activities on the basis of an integrated sectoral input-output model.

Data Sources and Definitions

The major source of data for this paper is the "medium" (*M*) aggregation (in constant dollar) in Statistics Canada's input-output tables for the period 1971-85. In addition, industry employment data from the Labour Force Survey, expenditure data from the National Income and Expenditure Accounts, and Statistics Canada's gross domestic product at factor cost by industry in 1981 prices are occasionally used as supplementary information. The non-input-output-based data are always used as independent evidence and are not mixed in the formal analysis of the input-output data. Although all Statistics Canada's data sets are supposed to be compatible with each other, for reasons mentioned below, the non-input-output-based data should not be directly compared with the input-output data.

In this paper, in order to conform to the sectoral definitions and terminology used in other studies of the Economic Council's Employment and Service Economy Group, the term "goods-producing sector" is defined as consisting of agriculture, fishing and trapping, logging and forestry, mining, quarries and sand pits, manufacturing, and construction; "the nonmarket service sector" includes all educational services, health services, and public administration and defence; "the commercial service sector" is defined as all services in the economy minus nonmarket services. Although agriculture, fishing and trapping, and other industries are occasionally called "sectors" in the literature, they are always "industries" in this write-up. For some of these industries, they may consist of a business component and a government component. For example, in the gross domestic product (GDP) data set, there exist two separate time series for the mining industry: the first series covers the business sector's mining activities and the second refers to the GDP of the mining activities financed by government funds. In this paper, with the exception of the analysis of the input-output data, the business and government components of any industry in question are always aggregated into one industry series.

Because of the specific meaning of the terms "commercial services" and "nonmarket services" used in this paper, the terms "business" and "commercial" can no longer be used interchangeably. The term "business" retains its usual meaning, but the term "commercial services" refers strictly to the definition given above. Accordingly, the commercial service sector in this paper excludes all education, health and welfare services, and public administration and defence, but it includes all business and government activities in transportation, storage, communications, other utilities, wholesale trade, retail trade, finance, insurance, business services, and other services.

The industry data from the input-output tables are special cases. These data cover only the business sector of the economy. The input-output tables include educational services and health services as part of the input-output industrial structure. These are the services that are financed by Canadian business, not by government funds. If an educational institution or a hospital is partly financed by business and partly by government, then only the business portion is included in the input-output statistics. Therefore, in the analysis of the input-output data, the terms "goods-producing sector," "commercial service sector," and "nonmarket service sector" mean the business components of these sectors. Similarly, all of the industries in the input-output framework refer only to the business components of these industries.

Objective

The main objective of this paper is to shed some light on the source and cause of the relative decline of the goods-producing sector and to offer a plausible explanation of the growth of service-producing activities in recent decades. As indicated by the empirical evidence presented in *Employment in the Service Economy*,[6] the most important clients for many of the rapidly growing service industries are producers of goods and services. Therefore, for a comprehensive understanding of the development and growth of services over time, a systematic framework to trace the interindustry flows of goods and services is a prerequisite. From the input-output tables, we can easily track the disposition of outputs of individual industries. This elaborated analysis of data provides us with the evidence to either accept or reject the claim of industrial interdependence. For example, if the goods industries do not only supply buildings, energy, paper, and transportation equipment to service industries as inputs but also absorb large portions of service outputs in their production processes, then a case can be made for interdependence between the goods-producing and service industries. This ex post evidence by itself, however, tells us very little about the "cause and effect." It sheds no light on the question of which sector drives the economy. The primary task of this paper aims at solving this problem. By applying a special version of the sectoral input-output analysis to the Canadian input-output data, we hope to be able to see distinctly the consequence of growth in the goods industries on service activities and the impact of service growth on goods production.

The input-output analysis may potentially explain the historical development of sectoral outputs, but by itself it still does not satisfactorily account for the phenomenal growth of service employment. The last task of this paper is an attempt to link the results of the input-output analysis to the industry employment data for an explanation of service employment growth.

The remainder of this paper covers four major areas. First, we present a brief, historical perspective of sectoral shifts in output and employment. Then we discuss the available tools for analysing the service economy controversy. In two separate sections, which are the heart of this paper, we present the methodology and empirical results of our research work on industrial interdependence. Finally, we conclude with our thoughts and observations on the implications of the empirical findings.

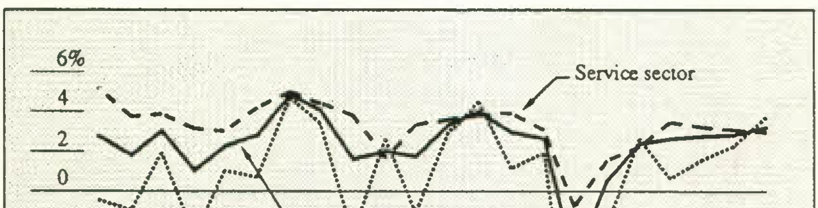
Perspective

In its proper historical perspective, the "service economy" controversy is not really a new topic. Economic historians may easily trace some of the debates on the topic back to ancient Chinese or Greek histories. In the modern era, as far back as 1940, Clark already identified the high propensity to consume services as an explanation for the spectacular growth of service activities.[7] Subsequent writers extended and amplified the controversy by expressing their concerns about the role of services in the economy. The emphases of the individual studies varied according to the central themes of the articles. Kuznets was one of the early scholars who observed the long-term changes in the structure of productions in developed countries: the shift away from agriculture to mining and manufacturing initially, then to the transportation and communication industries.[8] Baumol's articles addressed the consequence of unbalanced, sectoral growth on the economy in the long-run general equilibrium context.[9] Duchin, in her 1988 paper, used the input-output technique and U.S. data to examine the nature of service activities.[10] She concluded that manufacturing establishments had been the major buyers of the outputs of several of the largest service industries. Therefore, the weakening of the U. S. manufacturing base would harm rather than help service activities because the decline of the manufacturing sector would necessarily entail a reduction in the demand for the outputs of these service industries. Most recent U.S. studies were concerned primarily with the undesirable effects of letting the manufacturing sector decline continuously.[11] Although all studies inevitably touched upon the issue of rapid employment growth in the service sector, Fuchs was one of the few writers who built his dissertation around this topic.[12] Because of our interest in labour market issues, our discussion for the remainder of this paper will also emphasize the theme of output and employment growth in the service sector.

Charts 1 and 2 show the historical growth of sectoral output and employment for the period 1966-88. The year 1966 is obviously not the beginning of the ascendancy of service activities. The continuous revisions of the Canadian data and the changes to the Standard Industrial Classification make it difficult to compile long time series for industries. However, at the total

Chart 1

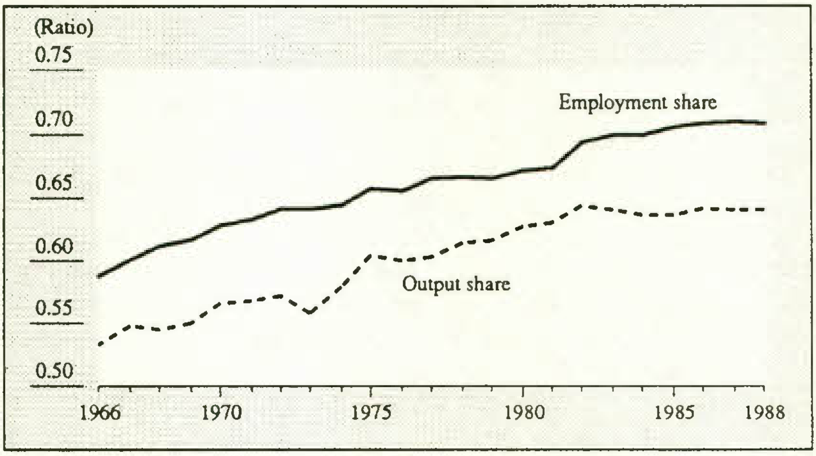
Employment Growth, Canada, 1967-88



SOURCE Based on data from Statistics Canada.

Chart 2

Service Sector's Share of Total Output and Employment, Canada, 1966-88



SOURCE Based on data from Statistics Canada.

goods and total service levels, it is safe to conclude that the trends depicted in Charts 1 and 2 actually started a few decades prior to 1966.

Our examination of the existing data and empirical evidence suggests that the popular explanations – including: 1) rapid growth in consumer demand for services, 2) relatively slow labour productivity growth in service industries, 3) goods producers' contracting out services formerly performed in-house, and 4) changes in intermediate demand for services as inputs – can, at their best, account for only a small fraction of the overall growth of the service sector.

Apparently, the growth of service employment in Canada remains an unsatisfactorily explained empirical phenomenon. However, every "effect" must have its "cause." Perhaps we simply need to approach the problem differently. Hence the present paper starts here: given the growth of the economy and the increasing complexity of all production processes, this paper uses a special version of the input-output analysis to evaluate the differential, direct and indirect effects of economic interactions on all goods-producing and service-producing activities.

Analytical Tools

Since the objectives of this paper are to trace the interdependence of industries and to search for a convincing explanation of the growth of service employment, full-system simulations of a nationwide econometric model may seem to be the right analytical technique for the task. This is an alternative that we have considered and used simultaneously with the development of the sectoral input-output analysis reported here.

The sectoral econometric model, developed in a paper by Curtis and Murthy, simulates the relationship between economic growth and the demand for goods and services and their relationship to sectoral output and employment.[13] The simulation designs and results are reported in considerable detail in Curtis and Murthy's paper. The simulations illustrate the relationship between sectoral activities and the income/expenditure of the nation and between national expenditure and sectoral output/employment. The results show that the goods and service sectors are closely intertwined because they are necessarily linked to the growth (or the lack of it) of the economy. However, they inevitably miss some of the most important links between the goods and service industries; the model simply has no means to track detailed interindustry transactions.

Problems associated with the use of econometric model simulations to study interindustry dependence are numerous. With the exception of the old CANDIDE model,[14] existing Canadian econometric models simply do not have the industrial detail that we need to track interindustry transactions. Although the CANDIDE model can still be physically "up and running," it has not been updated for a number of years. Furthermore, it only works with the input-output information of a single year and its ability to trace interindustry relationships over time is limited.

Another problem associated with the use of econometric model simulations to study the interdependence of industries is that all existing Canadian econometric models are basically stylistic representations of the National Income and Expenditure Accounts. Their output statistics are in terms of "value added," and their intermediate inputs are netted out "dollar for dollar" in all calculations. This means that these models are intrinsically not capable of tracking interindustry transactions of inputs and outputs – the central theme of this paper.

Therefore, at least for the time being, policy simulations of econometric models are imperfect instruments for studying interindustry dependence. This also explains our decision for choosing sectoral input-output analysis as the analytical tool for this paper.

Methodology

The input-output analytical technique and the time series of input-output tables for the period 1971-85 form the basis of our work on the interdependence of industries. Students of input-output analysis know that interindustry dependence is a fact of life in a developed economy. For example, the total output of grain in agriculture was $805.7 million (constant 1971 dollars) in 1972. From this gross output, $34.8 million worth was used by agriculture itself as intermediate inputs. For the remainder, $350.1 million went to the food industry, $19.9 million to the beverage industry, and $4.9 million to wholesale trade. Obviously, the output of one industry may become inputs for other industries. Interindustry transactions are not only common, they are necessary for a vibrant economy.

Although the input-output data provide ample evidence of interindustry transactions, they do not automatically become a systematic evaluation of the interdependence between industries. For example, for the food industry to produce one million dollars' worth of output, it buys a certain amount of services from service industries. At the same time, it also buys other commodities from the agriculture, fishing and trapping, forestry, and refined petroleum and coal products industries. These goods industries in turn also require other goods and services to fill the orders of the food industry. Although the process involves many transactions, they take place within a single production pass. In other words, for the system to satisfy the supply and demand requirements, all of these interindustry transactions have to take place within one production run for each industry. This is different from the concept of the long-run multiplier described in economic textbooks, which requires many rounds of consumer spending before the total multiplier effect materializes. The chain of events mentioned is not directly recorded in the input-output tables. The data in their raw form simply cannot reveal the total effect of one million dollars' worth of output from the food industry on the service industries.

Conceptually an input-output system consists of three sectors: 1) The processing sector that shows the interindustry transactions originating from industries' needs to use other industries' outputs as intermediate inputs in the production processes; 2) The payment sector that contains information on the primary inputs used by the producing industries. It is called the payment sector because it shows the industries' payments to the government in the form of indirect taxes, payments to workers in wages and salaries, and so on; and 3) The final demand sector that shows the goods and services (produced by industries) sold to public and private consumers. Although the statistical agencies of different countries may organize all three sectors differently to suit their specific economic structures, the most radical difference between the Canadian and other input-output systems lies in the processing sector. Since this is where all of the crucial information concerning interindustry transactions can be found, we briefly describe in the following paragraphs the specific features of the processing sector of the Canadian input-output system before presenting the technical details of the sectoral input-output model.

Students of input-output analysis are familiar with the square industry input-output matrix, with industries as its rows and columns to show the interindustry flows of outputs and inputs. This is the system taught in standard textbooks and used by the statistical agencies of many countries. The Canadian input-output system is, however, different from this standard model. Instead of using a square matrix to show the interindustry flows of outputs and inputs, the Canadian input-output system uses two rectangular matrices to show the input-output flows for each year. The first one (the output matrix) consists of the values of commodity outputs of individual industries, with its rows showing industries and columns denoting commodities. For example, in the 1971 output matrix of the input-output tables, agriculture produced $42.1 million (constant 1971 dollars) worth of forestry products, and the wood industry accounted for $43.7 million of the same product. Thus the commodity called "forestry products" was produced by the forestry industry as well as other industries. Although the amount produced by other industries was relatively small in comparison to the $1,286 million produced by the logging and forestry industry itself, they were nevertheless important entries in the accounting framework. Along with the output matrix, the Canadian system has an intermediate input matrix, which shows the values of the intermediate commodities used by individual industries, with the rows of the matrix denoting commodities and columns the individual industries. For example, in 1971, the commodity called "forestry products" was used as intermediate inputs in the production processes by the following industries: agriculture, logging and forestry, food, beverages, wood products, furniture and fixtures, paper and allied industries, fabricated metals, nonmetalic minerals, chemicals, and construction. However, since forestry products were not all produced by the forestry industry, we cannot see directly the interindustry transactions between the logging and forestry industry and the users (other industries) of forestry products. The Canadian system has the advantage of allowing for more detail to be shown because the number of commodities is always greater than the number of industries, but, for the purpose of tracing interindustry transactions, it presents a roadblock to the users. As explained below, the Canadian framework in practice has no real disadvantages to the experts, because they can transform the Canadian tables back to the more familiar Leontief "industry-to-industry" system. Nevertheless, the casual users of the input-output data will have difficulty in tracing the interindustry transactions from the raw data of the Canadian input-output tables.

Input-output models have been used extensively to evaluate the impacts of changes in final demand on the economy in many studies since the pioneer work of Leontief.[15] The developed models are useful for evaluating the effects of change in final demand components[16] on industry outputs. For example, researchers may calculate the direct and indirect effects on domestic industry outputs of a one-million-dollar increase in consumer spending on durable goods, or the direct and indirect effects on domestic industry outputs because of a one-million-dollar increase in domestic exports.[17] The initial driving forces of these analyses are always the changes in selected final demand components. Their effects on industry outputs must therefore be expressed in terms of "the direct and indirect effects of one dollar's worth of change in the selected categories of final expenditure on industry outputs." This is obviously not the same as the "effects of a dollar's worth of output for each goods-producing industry on the demand for services," which is the desired measure for gauging the interdependence of goods-producing and service-producing industries. This interdependence theme, which is of paramount importance to our paper, has generally been ignored in the literature. Miyazawa's work is the only input-output theoretical development that addresses this issue extensively.[18] The structure of Miyazawa's sectoral input-output model is similar to an interregional input-output model of two regions.[19] His work in this area is, therefore, more of an extension and a refinement of the existing analytical technique than a major breakthrough in input-output analysis. Miyazawa's contribution is, however, still substantial. His concept of industrial stimulative power and the mathematically derived formulas for capturing various aspects of interindustry interactions are novel and useful for studying industrial interdependence. His techniques form the basis of our present research, with some modifications to suit the Canadian input-output system. The technical specifications are as follows.

In an economic system, industry (gross) output minus intermediate input is by definition equal to final demand, which includes consumption, investment, inventories, exports, imports, gross current government expenditures on goods and services, and so forth. From this accounting identity and by simple matrix operation, we can obtain the well-known Leontief input-output system:

$$g \quad = \quad (I - A)^{-1} \quad * \quad f$$

.		.		.
.		.		.
.		.		.
output by industry		intermediate input requirement by industry		final demand by industry

I is an identity matrix and all other symbols are either matrices or vectors, whose definitions are noted above. The model states that output by industry is equal to the product of the total multiplier matrix (also known as the Leontief inverse) and final demand. After the system completes all transactions required for one production pass, the ultimate industry output of the economy can be calculated from the right side of the equation for any given final demand. These are the cornerstones of input-output analysis as expressed in textbook conventions. For the Canadian system, the algebra is more complicated, but the basic idea remains the same.

Following Statistics Canada's conventions and placing all goods-producing industries in the first part of the input-output system, the Canadian economy is expressed in algebraic terms as follows:[20]

$$g = [I - D(I - \mu - \alpha - \beta)H]^{-1}D[(I - \mu - \alpha - \beta)e^{*} + (I - \alpha - \beta)X_D + (\mathrm{I} - \mu)X_R]. \tag{1}$$

This is the basic input-output model of the Canadian economy, with all leakages – including imports, withdrawals from inventories, and government production of goods and services – incorporated in the system. The symbols are defined as follows:

g = a vector of gross output by industry;
I = an identity matrix (with its dimension consistent with the relevant matrix operations);
D = a matrix of domestic market share coefficients; each coefficient is calculated by dividing each element of the output matrix of the Canadian input-output tables by the corresponding total commodity output;
μ = a diagonal matrix of coefficients whose elements are calculated as the ratios of imports to "use," where "use" is defined as $Hg + e^{*} + X_R$;
α = a diagonal matrix of coefficients whose elements are calculated as the ratios of government production to "use," where "use" is defined as $Hg + e^{*} + X_D$;
β = a diagonal matrix of coefficients whose elements are calculated as the ratios of withdrawals to "use," where "use" is defined as $Hg + e^{*} + X_D$;
H = the industry technology matrix; in it, each member shows the value of a specific commodity input needed to produce one dollar's worth of output for the industry in question;
e^{*} = $(e_1 + e_2 + \ldots + e_{23} + e_{24})$, where e_1, e_2, and so on are vectors of the values of personal expenditure on goods and services, fixed capital formation, value of physical change in inventories (additions), and gross current government expenditure on goods and services;
X_D = a vector of the values of domestic exports; and
X_R = a vector of the values of re-exports.

$D(I - \mu - \alpha - \beta)H$ is a square matrix. Assuming that industries preserve their observed shares of the market for each domestically produced commodity irrespective of the levels of commodity production, this matrix is similar to the familiar Leontief input (technology) matrix, with its elements showing the values of the output of industry i used as inputs to produce one dollar's worth of output in industry j, after all leakages of the system have been properly netted out. The total multiplier matrix (i.e., the Leontief inverse) for the Canadian economy is then:

$$B^{*} = [\mathrm{I} - D(I - \mu - \alpha - \beta)H]^{-1}.$$

This is the Canadian equivalent to the well-known Leontief inverse. The Canadian input-output model, that is equation 1 above, states that after the system completes all transactions required for one production pass, the ensuing industry outputs of the economy can be calculated from the right side of the equation for any given final demand. However, the information that is important for understanding the interdependence of industries is still not available. For example, from this model, there is scant information as to which goods-producing industries have more power in stimulating the demand for services or vice versa.

The Miyazawa approach first subdivides the total economy into its constituent parts and then applies the input-output technique to them individually. By setting up each constituent part as an economy by itself while keeping all other sectors unchanged, one can calculate the importance of the internal interactions of the sector to the rest of the economy. This approach may be interpreted as an extension of the exogenization practice of the regional input-output model, in which all economic activities outside the region are by definition exogenous. The basic idea is simple: for the purposes of calculating the power of the internal propagation of a sector (e.g., the goods-producing sector), the Miyazawa approach sets all other parts of the processing sector (i.e., the service sector) as exogenous. This practice essentially transforms the general equilibrium nature of the Leontief model into a partial equilibrium framework. The merit of this technique is that it unambiguously captures the effect of one sector on the other segments of the economy. For example, it allows one to calculate the stimulative effect of goods production on the demand for the outputs of service industries, based entirely on the activity within the goods sector alone. Its relationship to the results of the total interactions (i.e., the total multiplier matrix) of the total economy, based on the Leontief system, has been mathematically derived by Miyazawa, and the quantitative difference between the Miyazawa and Leontief approaches will be addressed later in the empirical results section. At this point, notice that although the Leontief system calculates the effect of the interactions of the total economic system, it does not, by definition, quantify the "pure" effect of one sector's activity on other industries. Hence, it is not the proper model for studying the influence of goods-producing activity on service industries or vice versa.

Our sectoral input-output analysis is based on the methodology of sectoral input-output analysis developed by Miyazawa, with some modifications to suit the Canadian input-output data. Technically, the procedure is as follows.

The input matrix (i.e., the matrix which shows the goods and services needed to produce one unit of output in each industry in the system) of the input-output table is partitioned according to the industries' sectoral classifications. The input matrix becomes four submatrices:

$$\text{Canadian input matrix} = D(I - \mu - \alpha - \beta)H$$

$$\begin{array}{ccc} & \text{goods} & \text{services} & \\ = & \left[\begin{array}{c} P \\ S_1 \end{array}\right. & \left.\begin{array}{c} P_1 \\ S \end{array}\right] & \begin{array}{l} \text{goods} \\ \text{services} \end{array} \end{array}$$

P shows the goods needed to produce one unit of output in each goods industry; P_1 shows the goods required to produce one unit of output in each service industry; S_1 shows the services required to produce one unit of output in each goods-producing industry; and S shows the services required to produce one unit of output in each service industry.

Taking the goods sector by itself as an economy and following the same procedure used for the input-output analysis of the total economy, the internal multiplier matrix is derived for the goods sector, B.

$$B = (I - P)^{-1}.$$

This means that because each goods industry requires other goods as inputs in the production process, one unit of output in each goods industry leads to the production of additional outputs in the industries supplying the goods. The B matrix therefore provides information on the total units of goods to be produced by each goods industry.

The stimulative power of goods industries on service activity is:

$$B_1 = S_1 * B.$$

Why? Because B refers to the total units of goods outputs and S_1 the units of service inputs required to produce one unit of output in each goods industry, the product is, by definition, the units of services required to satisfy the demand of goods production. Similarly, we may also define the stimulative power of services on goods activity as:

$$T_1 = P_1 * T,$$

where T, defined as:

$$T = (I - S)^{-1},$$

is the internal multiplier matrix of the service sector.

B and T capture the internal propagation effects of the goods-producing and service sectors respectively. The multiplier effects manifested in these matrices are generally smaller than the corresponding figures shown in the total multiplier matrix, B^* (i.e., the Leontief inverse), of the total economy, because the Leontief inverse, in addition to the allowances for sectoral internal interactions, also allows direct and indirect interactions between the goods and service industries.

The method mentioned thus far should be quite straightforward to students of input-output analysis. Its basic idea is to partition the original input matrix of the total system and then to calculate the internal multiplier matrices of the goods-producing and service sectors separately. The novelty of the model developed by Miyazawa goes beyond these simple operations. In particular, his technique is capable of decomposing the original Leontief inverse (i.e., the total multiplier matrix of the whole system) into the internal multiplier matrices (defined above) and other components. This allows researchers to see the inherent properties of the interactions between the goods-producing and service sectors. The following is a summarized version of the model adapted to suit the Canadian input-output data. Since all derivations and proofs are given by Miyazawa, it is unnecessary to reiterate them here. The interested reader may, however, consult the cited work for more technical details.[21]

As described earlier, the total multiplier matrix (i.e., the Leontief inverse) of the Canadian input-output system is:

$$B^* = [I - D(I - \mu - \alpha - \beta)H]^{-1}. \qquad (2)$$

In order to see the relationship between the internal (sectoral) multiplier matrices, B and T, and the total multiplier matrix, we have to introduce the following matrices. Let

$B_2 = BP_1$;
$T_2 = TS_1$;
$K = (I - T_2B_2)^{-1}$; and
$L = (I - B_2T_2)^{-1}$;

where I denotes the identity matrix of the appropriate dimension, and all other symbols on the right side of the equations have been previously defined. Furthermore, define:

$M = KT$; and
$N = LB$;

where T and B are the internal multiplier matrices of the service and goods-producing sectors.

Miyazawa has proved that the total multiplier matrix (i.e., the Leontief inverse) can be expressed in terms of the internal multiplier matrices of the two sectors (goods-producing and service sectors) and the matrices defined above as follows:

$$
\begin{array}{cc}
 & \begin{array}{cc} \text{goods} & \text{services} \end{array} \\
B^* = & \left[\begin{array}{c|c} B + B_2MB_1 & B_2M \\ \hline MB_1 & \mathrm{M} \end{array}\right] \begin{array}{l} \text{goods} \\ \text{services} \end{array}
\end{array}
$$

$$
\begin{array}{cc}
 & \begin{array}{cc} \text{goods} & \text{services} \end{array} \\
= & \left[\begin{array}{c|c} N & NT_1 \\ \hline T_2N & T + T_2NT_1 \end{array}\right] \begin{array}{l} \text{goods} \\ \text{services} \end{array}
\end{array}
$$

This means that $B + B_2MB_1$ is the part of the Leontief inverse (see equation 2) that shows the total propagation effects (the result of the interactions of all goods-producing and service industries within the economic system) of all goods-producing industries. Its counterpart in the Miyazawa partial analysis is the internal multiplier matrix, B, of the goods-producing sector. Since $B + B_2MB_1$ contains two additive terms and one of them is the internal multiplier matrix, B, the second term, B_2MB_1, is by definition the part of the propagation effects in the goods-producing sector that is induced by goods used as inputs in the service sector. In other words, B_2MB_1 captures the propagation effects that are over and above the goods-producing sector's own activities. In his work, Miyazawa develops the concepts of external matrix multipliers and induced submatrix multipliers to explain the sources of B_2MB_1.[22] These technical details are too lengthy to be reiterated in this paper. For our purpose, we may simply note that the interpretation of $B + B_2MB_1$ given here has its theoretical origin in input-output analysis. Logically, we can also interpret the term $T + T_2NT_1$ in a similar fashion for service-producing activities.

Similar to the ways that we define the stimulative power of the goods-producing sector, B_1, and the stimulative power of the service sector, T_1, we can also calculate the stimulative power due to $B + B_2MB_1$ by $[S_1 * (B + B_2MB_1)]$ and the stimulative power due to $T + T_2NT_1$ by $[P_1 * (T + T_2NT_1)]$. Dividing the elements of the stimulative power matrices of the goods-producing and service sectors by the corresponding elements of $[S_1 * (B + B_2MB_1)]$ and $[P_1 * (T + T_2NT_1)]$, we have the values which show the relative importance of the internal interactions within the sectors versus the total interactions of all industries in the system, measured in terms of stimulative power discussed earlier. Mathematically, the operations are:

$$GEXP = B_1 (\div) [S_1 * (B + B_2MB_1)]; \text{ and}$$

$$SEXP = T_1 (\div) [P_1 * (T + T_2NT_1)];$$

where ($\div$) denotes the element by element division of two corresponding matrices.

The stimulative power defined by B_1 has the advantages of showing the "pure" effect of the goods industries on service industries. However, by its own nature, it is a partial equilibrium analysis, because the effect of the goods sector on the demand for services is calculated by multiplying the internal propagation of the goods sector by the service requirements of individual goods industries while keeping all service industries unchanged. The results of the partial equilibrium analysis are relevant and important, if it can be demonstrated that the stimulative power so calculated accounts for most of the "ideal" total stimulative power of the goods sector, that is, the pure stimulative power of the goods industries under the circumstance that all industries in the economy are allowed to interact with each other without any double-counting in the calculation. There exists no mathematical expression that can cleanly capture this concept. The term $[S_1 * (B + B_2MB_1)]$, while it has some double-counting by allowing goods industries to influence service industries and service industries to affect goods industries simultaneously, is the best approximation available. If the ratio of $\{B_1 (\div) [S_1 * (B + B_2MB_1)]\}$ is high, say 90 per cent or more, then we can safely conclude that the stimulative power calculation by the Miyazawa method is indeed meaningful. The results of this check are reported later in this paper.

Empirical Results

For the purposes of this paper, the extent of a goods industry's use of the outputs of the service sector as inputs in the production process is taken as a quantitative measure of the industry's dependence on services in its production process. On the other hand, the extent of a service industry's dependence on the orders originating from the goods sector becomes the measure of the service sector's dependence on the activities of the goods sector.

The demand for an industry's output may come from other industries' demand for it as intermediate inputs, or from public and private consumer demand, or from the demand of foreign countries. The criterion of dependence mentioned above may seem arbitrary, because it places its emphasis on the intermediate demand resulting from interindustry transactions. As far as the impact of international trade is concerned, service exports have so far been relatively limited. There is no reason to think that exporting services to the rest of the world can be dramatically improved in the medium-term future.

Also, historical evidence on the public and private demand for services has contributed little to the explanation of service growth. It is in this light that we may justify our focus on the interindustry transactions as the central theme of our empirical work.

Stimulative Power

Has the demand originating from the goods-producing industries been the most important factor driving the growth of services? The answer to this question can be found in the results of our analysis of the input-output data for the period 1971-85. For descriptive convenience, the discussion presented in this write-up, unless otherwise specified, refers to the empirical evidence of the 1985 data. Later on, a separate section will be devoted to the intertemporal variations of the results based on the analysis of the 1971-85 data.

Table 1 presents the stimulative power of goods-producing industries on service activity. The figures indicate which goods-producing industries had more stimulative power for generating service activities: the larger the figure, the more powerful is the goods-producing industry for generating demand for services. For example, a dollar's worth of output in the fishing and trapping industry in 1985 entailed a demand of \$0.0098 for the services of the transportation industry and a demand of \$0.0216 in finance and real estate services. Quantitatively, a goods industry might have different impacts on individual service industries. The logging and forestry industry illustrated this possibility. It had substantial power in generating demand for transportation services, but its effect on the accommodation, food, and beverages industry was negligible. This is an important feature and it should be valuable for policy formulation. If policymakers need to stimulate overall economic activity and some specific service activities simultaneously, then the stimulative power statistics show which goods industries should be helped and what subsequent effects such action will have on the service industries.

Out of 28 goods-producing industries, all of them had sizable stimulative power on at least one service industry, that is, a dollar's worth of output in any goods industry had the power to generate a demand of \$0.03 (or more) for services in at least one of the 18 service industries. The influence of goods-producing industries was not distributed evenly on all service industries. From the viewpoint of service industries, transportation, utilities, wholesale trade, finance and real estate, and business services were the most susceptible to the stimulative effects of goods production. In 1988, these five producer-service industries accounted for about 48 per cent of total gross domestic product of the service sector and 31 per cent of the real output of the total economy. Obviously, these service industries alone constituted a sizable portion of the Canadian economy. Along with other service industries that were also subject to the influence of the stimulative power of goods-producing activities, albeit to a lesser extent, this finding appears to support the claim of the "manufacturing matters" thesis.

The "manufacturing matters" slogan reached an emotional peak when Cohen and Zyman's book appeared in 1987.[23] Subsequently, many people, including Dornbusch et al. and Schmid also expressed similar sentiment.[24]

The origin of the "manufacturing matters" thesis may be traced to people's worry about the relative decline of manufacturing activity in the U.S. economy. The proponents of this doctrine maintain that manufacturing activity is the principal driving force of all economic activities. Their argument runs approximately as follows.

The manufacturing sector is the major source of research and development activity in the economy. Because manufacturing industries are producers of goods as well as consumers of other goods and services, they are directly or indirectly responsible for creating the majority of high-wage jobs. In the long run, an economy that loses its manufacturing base will lose its vitality. A service-based economy has, therefore, no engine to stimulate goods production as well as service activity.

In a sense, the empirical results given here confirm the claim of the "manufacturing matters" argument. However, the economic conditions of the two countries are different. In Canada, the resource industries play a much larger role in shaping the economy than their U.S. counterparts. Accordingly, the "manufacturing matters" slogan may be more appropriately changed to "goods-producing activities matter." Although manufacturing industries also generated noticeable demand for services, in quantitative terms, they generally could not match the stimulative power of resource industries. This result should not be construed as suggesting that policymakers should concentrate on fostering the growth of resource industries at the expense of manufacturing industries. Aside from the fact that some manufacturing industries (e.g., refined petroleum and coal products) also had strong stimulative power and are closely linked to resource industries, Canadians simply may not wish to sell their resources in raw form. The important lesson from this investigation is not that resources are more important than manufacturing production, it is rather that the production of resources occupies a pivotal position in the Canadian economy. Any meaningful industrial policy must recognize these special attributes of the Canadian economy.

Table 2 summarizes the stimulative power of service industries on goods production. With the exceptions of transportation and accommodation, food, and beverages services, the potential for service industries to stimulate goods production was generally weak. A comparison of the stimulative power estimates of services on goods industries with the statistics of Table 1 shows that

Table 1

Stimulative Power of Goods-Producing Industries[1] on Service Activity, Canada, 1985

	Goods industries[2]								
	1. AG	2. FIS	3. FOR	4. MIN	5. PET	6. QUAR	7. FOOD	8. BEV	9. TO
	(1981 dollars)								
Service industries[3]									
1. TRAN	0.0045	0.0098	0.1144	0.0131	0.0023	0.0587	0.0096	0.0031	0.0040
2. PIPE	0.0023	0.0027	0.0008	0.0028	0.0005	0.0018	0.0025	0.0030	0.0012
3. STOR	0.0001	0.0002	0.0034	0.0004	0.0001	0.0018	0.0003	0.0001	0.0001
4. COMM	0.0054	0.0022	0.0023	0.0027	0.0014	0.0046	0.0067	0.0069	0.0056
5. UTIL	0.0158	0.0034	0.0024	0.0278	0.0122	0.0225	0.0147	0.0143	0.0109
6. WTR	0.0355	0.0239	0.0136	0.0244	0.0074	0.0413	0.0436	0.0216	0.0219
7. RTR	0.0064	0.0079	0.0120	0.0038	0.0043	0.0161	0.0078	0.0048	0.0041
8. FIN	0.0357	0.0216	0.0539	0.0424	0.1971	0.0301	0.0238	0.0215	0.0219
9. INSU	0.0058	0.0034	0.0084	0.0069	0.0331	0.0041	0.0038	0.0033	0.0034
10. ROY	0.0065	0.0038	0.0093	0.0077	0.0370	0.0046	0.0042	0.0037	0.0039
11. DWE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12. BSER	0.0049	0.0046	0.0050	0.0172	0.0212	0.0063	0.0078	0.0137	0.0116
13. ED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14. HEAL	0.0000	0.0000	0.0002	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000
15. ACC	0.0002	0.0003	0.0005	0.0002	0.0007	0.0005	0.0001	0.0001	0.0001
16. AMUS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
17. PSER	0.0023	0.0029	0.0101	0.0028	0.0029	0.0130	0.0031	0.0033	0.0028
18. OSER	0.0032	0.0040	0.0129	0.0043	0.0046	0.0166	0.0043	0.0047	0.0040
Total services	0.1293	0.0914	0.2501	0.1573	0.3258	0.2228	0.1329	0.1049	0.0962

	Goods industries[2]									
	10. RU	11. PL	12. LE	13. TX	14. CL	15. WD	16. FU	17. PA	18. PR	19. PME
	(1981 dollars)									
Service industries[3]										
1. TRAN	0.0018	0.0019	0.0021	0.0017	0.0017	0.0366	0.0045	0.0159	0.0041	0.0042
2. PIPE	0.0032	0.0038	0.0017	0.0035	0.0010	0.0018	0.0020	0.0048	0.0015	0.0050
3. STOR	0.0000	0.0000	0.0001	0.0000	0.0000	0.0011	0.0001	0.0005	0.0001	0.0001
4. COMM	0.0079	0.0098	0.0082	0.0079	0.0083	0.0047	0.0080	0.0051	0.0225	0.0037
5. UTIL	0.0168	0.0224	0.0099	0.0177	0.0083	0.0173	0.0121	0.0547	0.0158	0.0289
6. WTR	0.0229	0.0297	0.0423	0.0335	0.0397	0.0362	0.0611	0.0281	0.0302	0.0349
7. RTR	0.0029	0.0044	0.0061	0.0034	0.0020	0.0097	0.0040	0.0079	0.0037	0.0034
8. FIN	0.0334	0.0211	0.0252	0.0195	0.0220	0.0317	0.0227	0.0221	0.0243	0.0163
9. INSU	0.0054	0.0033	0.0040	0.0031	0.0036	0.0048	0.0036	0.0033	0.0039	0.0025
10. ROY	0.0061	0.0037	0.0044	0.0034	0.0040	0.0053	0.0040	0.0037	0.0043	0.0028
11. DWE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12. BSER	0.0152	0.0119	0.0096	0.0091	0.0122	0.0077	0.0144	0.0087	0.0152	0.0088
13. ED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14. HEAL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15. ACC	0.0001	0.0001	0.0002	0.0001	0.0001	0.0003	0.0001	0.0002	0.0001	0.0001
16. AMUS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17. PSER	0.0023	0.0035	0.0037	0.0028	0.0015	0.0076	0.0025	0.0049	0.0026	0.0028
18. OSER	0.0036	0.0050	0.0052	0.0040	0.0025	0.0099	0.0039	0.0065	0.0040	0.0040
Total services	0.1225	0.1214	0.1233	0.1103	0.1075	0.1755	0.1438	0.1671	0.1331	0.1180

Table 1 (concl'd.)

	Goods industries[2]								
	20. FME	21. MACH	22. TEQ	23. ELEC	24. NME	25. RPE	26. CH	27. OMA	28. CON
	(1981 dollars)								
Service industries[3]									
1. TRAN	0.0028	0.0017	0.0053	0.0029	0.0034	0.0021	0.0031	0.0021	0.0094
2. PIPE	0.0024	0.0015	0.0011	0.0012	0.0083	0.0191	0.0121	0.0016	0.0014
3. STOR	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0003
4. COMM	0.0069	0.0092	0.0045	0.0139	0.0064	0.0026	0.0110	0.0117	0.0043
5. UTIL	0.0130	0.0096	0.0069	0.0086	0.0308	0.0124	0.0294	0.0094	0.0065
6. WTR	0.0326	0.0353	0.0175	0.0259	0.0239	0.0085	0.0277	0.0346	0.0498
7. RTR	0.0038	0.0026	0.0034	0.0024	0.0089	0.0040	0.0055	0.0027	0.0120
8. FIN	0.0180	0.0153	0.0091	0.0164	0.0255	0.1079	0.0366	0.0289	0.0184
9. INSU	0.0028	0.0024	0.0013	0.0026	0.0037	0.0180	0.0058	0.0047	0.0026
10. ROY	0.0031	0.0027	0.0014	0.0029	0.0042	0.0201	0.0065	0.0052	0.0029
11. DWE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12. BSER	0.0108	0.0119	0.0312	0.0115	0.0108	0.0164	0.0152	0.0156	0.0352
13. ED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
14. HEAL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15. ACC	0.0001	0.0001	0.0001	0.0001	0.0003	0.0004	0.0002	0.0001	0.0002
16. AMUS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

	Goods industries[2]								
	20. FME	21. MACH	22. TEQ	23. ELEC	24. NME	25. RPE	26. CH	27. OMA	28. CON
	(1981 dollars)								
17. PSER	0.0031	0.0020	0.0029	0.0019	0.0076	0.0030	0.0043	0.0020	0.0057
18. OSER	0.0044	0.0031	0.0050	0.0030	0.0100	0.0045	0.0061	0.0033	0.0087
Total services	0.1045	0.0981	0.0904	0.0939	0.1444	0.2197	0.1644	0.1227	0.1581

1 The increase in the output of each service industry that results from a one-dollar increase in the output of each goods industry.

2 Goods industries: 1. AG – agriculture; 2. FIS – fishing and trapping; 3. FOR – logging and forestry; 4. MIN – mining; 5. PET – crude petroleum and gas; 6. QUAR – quarries and sand pits; 7. FOOD – food; 8. BEV – beverages; 9. TO – tobacco; 10. RU – rubber; 11. PL – plastics; 12. LE – leather; 13. TX – textiles; 14. CL – clothing; 15. WD – wood; 16. FU – furniture and fixtures; 17. PA – paper and allied industries; 18. PR – printing and publishing; 19. PME – primary metals; 20. FME – fabricated metals; 21. MACH – machinery; 22. TEQ – transportation equipment; 23. ELEC – electrical goods; 24. NME – nonmetalic minerals; 25. RPE – refined petroleum and coal; 26. CH – chemicals; 27. OMA – other manufacturing; 28. CON – construction.

3 Service industries: 1. TRAN – transportation; 2. PIPE – pipeline transportation; 3. STOR – storage; 4. COMM – communications; 5. UTIL – utilities; 6. WTR – wholesale trade; 7. RTR – retail trade; 8. FIN – finance and real estate; 9. INSU – insurance; 10. ROY – government royalties on natural resources; 11. DWE – owner-occupied dwellings; 12. BSER – business services; 13. ED – educational services; 14. HEAL – health services; 15. ACC – accommodation, food, and beverages; 16. AMUS – amusement and recreation; 17. PSER – personal services; 18. OSER – other services.

SOURCE Estimates by the author, based on the analysis of input-output data from Statistics Canada.

Table 2

Stimulative Power of Service Activity[1] on Goods-Producing Industries, Canada, 1985

	Service industries[2]								
	1. TRAN	2. PIPE	3. STOR	4. COMM	5. UTIL	6. WTR	7. RTR	8. FIN	9. INSU
	(1981 dollars)								
Goods industries[3]									
1. AG	0.0007	0.0001	0.0005	0.0003	0.0001	0.0014	0.0080	0.0004	0.0007
2. FIS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3. FOR	0.0001	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000
4. MIN	0.0004	0.0007	0.0006	0.0002	0.0260	0.0003	0.0006	0.0008	0.0005
5. PET	0.0034	0.0698	0.0037	0.0010	0.0033	0.0018	0.0031	0.0043	0.0044
6. QUAR	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7. FOOD	0.0051	0.0011	0.0036	0.0025	0.0008	0.0054	0.0054	0.0035	0.0033
8. BEV	0.0004	0.0001	0.0003	0.0002	0.0000	0.0005	0.0003	0.0004	0.0004
9. TO	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10. RU	0.0052	0.0002	0.0013	0.0006	0.0002	0.0008	0.0014	0.0007	0.0006
11. PL	0.0010	0.0002	0.0057	0.0006	0.0002	0.0032	0.0028	0.0007	0.0006
12. LE	0.0004	0.0000	0.0001	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001
13. TX	0.0011	0.0001	0.0027	0.0004	0.0001	0.0008	0.0011	0.0003	0.0003
14. CL	0.0003	0.0001	0.0003	0.0002	0.0000	0.0002	0.0008	0.0002	0.0002
15. WD	0.0002	0.0000	0.0002	0.0001	0.0000	0.0020	0.0004	0.0001	0.0002
16. FU	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000
17. PA	0.0015	0.0004	0.0155	0.0010	0.0003	0.0070	0.0103	0.0013	0.0013
18. PR	0.0085	0.0033	0.0088	0.0103	0.0025	0.0147	0.0129	0.0151	0.0133
19. PME	0.0015	0.0001	0.0004	0.0002	0.0000	0.0017	0.0003	0.0002	0.0003

20. FME	0.0029	0.0005	0.0023	0.0015	0.0004	0.0038	0.0029	0.0017	0.0016
21. MACH	0.0011	0.0002	0.0010	0.0012	0.0002	0.0008	0.0005	0.0008	0.0007
22. TEQ	0.0137	0.0003	0.0022	0.0012	0.0003	0.0014	0.0009	0.0010	0.0010
23. ELEC	0.0039	0.0008	0.0026	0.0155	0.0006	0.0028	0.0017	0.0029	0.0031
24. NME	0.0007	0.0000	0.0003	0.0002	0.0000	0.0004	0.0002	0.0002	0.0002
25. RPE	0.0895	0.0048	0.0340	0.0095	0.0202	0.0248	0.0164	0.0128	0.0084
26. CH	0.0042	0.0007	0.0031	0.0019	0.0006	0.0036	0.0019	0.0020	0.0018
27. OMA	0.0013	0.0002	0.0017	0.0014	0.0006	0.0013	0.0013	0.0009	0.0009
28. CON	0.0409	0.0202	0.0334	0.0235	0.0284	0.0063	0.0097	0.0458	0.0178
Total goods	0.1896	0.1050	0.1256	0.0751	0.0859	0.0871	0.0843	0.0975	0.0631

Table 2 (concl'd.)

	Service industries[2]								
	10. ROY	11. DWE	12. BSER	13. ED	14. HEAL	15. ACC	16. AMUS	17. PSER	18. OSER
					(1981 dollars)				
Goods industries[3]									
1. AG	0.0000	0.0000	0.0004	0.0006	0.0005	0.0158	0.0017	0.0007	0.0007
2. FIS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000	0.0000
3. FOR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000
4. MIN	0.0000	0.0000	0.0002	0.0009	0.0008	0.0006	0.0007	0.0004	0.0003
5. PET	0.0000	0.0001	0.0012	0.0046	0.0013	0.0035	0.0019	0.0021	0.0018
6. QUAR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7. FOOD	0.0000	0.0001	0.0034	0.0050	0.0038	0.1622	0.0071	0.0033	0.0054
8. BEV	0.0000	0.0000	0.0003	0.0004	0.0003	0.0062	0.0007	0.0002	0.0004
9. TO	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10. RU	0.0000	0.0000	0.0007	0.0013	0.0010	0.0004	0.0014	0.0017	0.0013
11. PL	0.0000	0.0000	0.0007	0.0012	0.0010	0.0026	0.0016	0.0007	0.0014
12. LE	0.0000	0.0000	0.0001	0.0002	0.0001	0.0000	0.0006	0.0008	0.0002
13. TX	0.0000	0.0000	0.0004	0.0005	0.0037	0.0044	0.0008	0.0071	0.0006
14. CL	0.0000	0.0000	0.0002	0.0004	0.0004	0.0007	0.0005	0.0001	0.0005
15. WD	0.0000	0.0000	0.0002	0.0002	0.0001	0.0001	0.0002	0.0092	0.0003
16. FU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000
17. PA	0.0000	0.0000	0.0018	0.0021	0.0015	0.0071	0.0029	0.0025	0.0033
18. PR	0.0000	0.0002	0.0124	0.0205	0.0088	0.0059	0.0320	0.0048	0.0142
19. PME	0.0000	0.0000	0.0002	0.0004	0.0003	0.0001	0.0006	0.0003	0.0014
20. FME	0.0000	0.0000	0.0017	0.0027	0.0021	0.0011	0.0057	0.0017	0.0041
21. MACH	0.0000	0.0000	0.0007	0.0011	0.0009	0.0004	0.0013	0.0003	0.0013

22. TEQ	0.0000	0.0000	0.0010	0.0017	0.0011	0.0009	0.0018	0.0010	0.0016
23. ELEC	0.0000	0.0001	0.0026	0.0031	0.0029	0.0014	0.0037	0.0011	0.0034
24. NME	0.0000	0.0000	0.0002	0.0003	0.0004	0.0012	0.0004	9.0002	0.0004
25. RPE	0.0000	0.0002	0.0091	0.0123	0.0124	0.0137	0.0131	0.0203	0.0232
26. CH	0.0000	0.0000	0.0021	0.0032	0.0060	0.0016	0.0038	0.0255	0.0039
27. OMA	0.0000	0.0000	0.0010	0.0012	0.0054	0.0011	0.0055	0.0010	0.0026
28. CON	0.0000	0.0559	0.0042	0.0246	0.0043	0.0092	0.0108	0.0037	0.0034
Total goods	0.0000	0.0567	0.0462	0.0900	0.0602	0.2426	0.1004	0.0902	0.0769

1 The increase in the output of each goods industry that results from a one-dollar increase in the output of each service industry.

2 Service industries: 1. TRAN – transportation; 2. PIPE – pipeline transportation; 3. STOR – storage; 4. COMM – communications; 5. UTIL – utilities; 6. WTR – wholesale trade; 7. RTR – retail trade; 8. FIN – finance and real estate; 9. INSU – insurance; 10. ROY – government royalties on natural resources; 11. DWE – owner-occupied dwellings; 12. BSER – business services; 13. ED – educational services; 14. HEAL – health services; 15. ACC – accommodation, food, and beverages; 16. AMUS – amusement and recreation; 17. PSER – personal services; 18. OSER – other services.

3 Goods industries: 1. AG – agriculture; 2. FIS – fishing and trapping; 3. FOR – logging and forestry; 4. MIN – mining; 5. PET – crude petroleum and gas; 6. QUAR – quarries and sand pits; 7. FOOD – food; 8. BEV – beverages; 9. TO – tobacco; 10. RU – rubber; 11. PL – plastics; 12. LE – leather; 13. TX – textiles; 14. CL – clothing; 15. WD – wood; 16. FU – furniture and fixtures; 17. PA – paper and allied industries; 18. PR – printing and publishing; 19. PME – primary metals; 20. FME – fabricated metals; 21. MACH – machinery; 22. TEQ – transportation equipment; 23. ELEC – electrical goods; 24. NME – nonmetalic minerals; 25. RPE – refined petroleum and coal; 26. CH – chemicals; 27. OMA – other manufacturing; 28. CON – construction.

SOURCE Estimates by the Economic Council of Canada, based on input-output data from Statistics Canada.

the stimulative power was much stronger in the case of the goods-producing industries than in the case of service industries. Values of more than 0.03 are numerous in Table 1, whereas the estimates for the stimulative power of services on goods industries of such value are few.

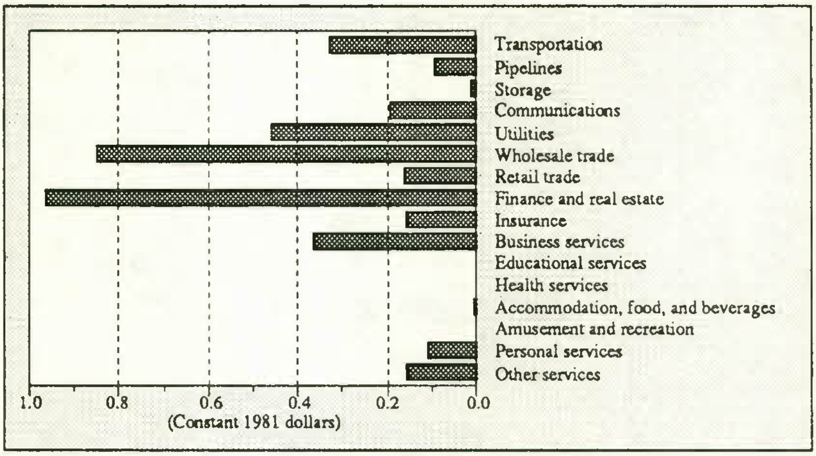
In 1985, one dollar of agricultural output had the power of generating $0.13 worth of demand for services, which is the sum of the figures under the column heading AG (agriculture) of Table 1. Generally speaking, the logging and forestry industry and the crude petroleum and gas industry had large stimulative power on service industries. Other primary goods-producing industries also had substantial influence on service activity. Among the manufacturing industries, all of them had some effect on the demand for services. However, only the stimulative power of the refined petroleum and coal industry could match the power of primary industries. In short, with the exception of the transportation and accommodation, food, and beverages services, the influence of all other service industries on goods-producing activity was negligible. The stimulative power of the transportation industry was widely distributed among many goods-producing industries. The stimulative power of the accommodation and food services came from their direct link to the food industry.

Table 1 shows the effects of each goods industries on individual service industries. This is an important source of information for policymakers involved in the design of specific measures to zero in on particular segments of the economy. However, for the purpose of measuring the sensitivity of individual service industries to goods production in general, we may simplify the results of Table 1 by summing up the figures for each row. For example, the total of the fourth row of Table 1 indicates that one dollar of output in each goods-producing industry would have generated a total demand of $0.2 for communication services. In this context, these figures represent the service industries' dependence on the demand originating from the goods-producing industries. Similarly, the sensitivity of each goods industries to service activities may be obtained by summing up the figures on each row of Table 2.

Charts 3 and 4 summarize the sensitivity calculations. In 1985, for one dollar of output in each goods-producing industry, the demand for services in the transportation industry would go up by $0.33 and the services of finance by $0.96. Only personal services (including accommodation, food, and beverages as well as amusement and recreation), education, and health services were relatively independent of the demand force originating from goods production. This generality does not apply to the other side of the coin, that is, the sensitivity of goods industries to service activity. With the exception of the refined petroleum and coal products and construction industries, goods-producing industries were generally not dependent on the demand originating from service activity.

Chart 3

Sensitivity of Service Industries to Goods-Producing Activity, Canada, 1985

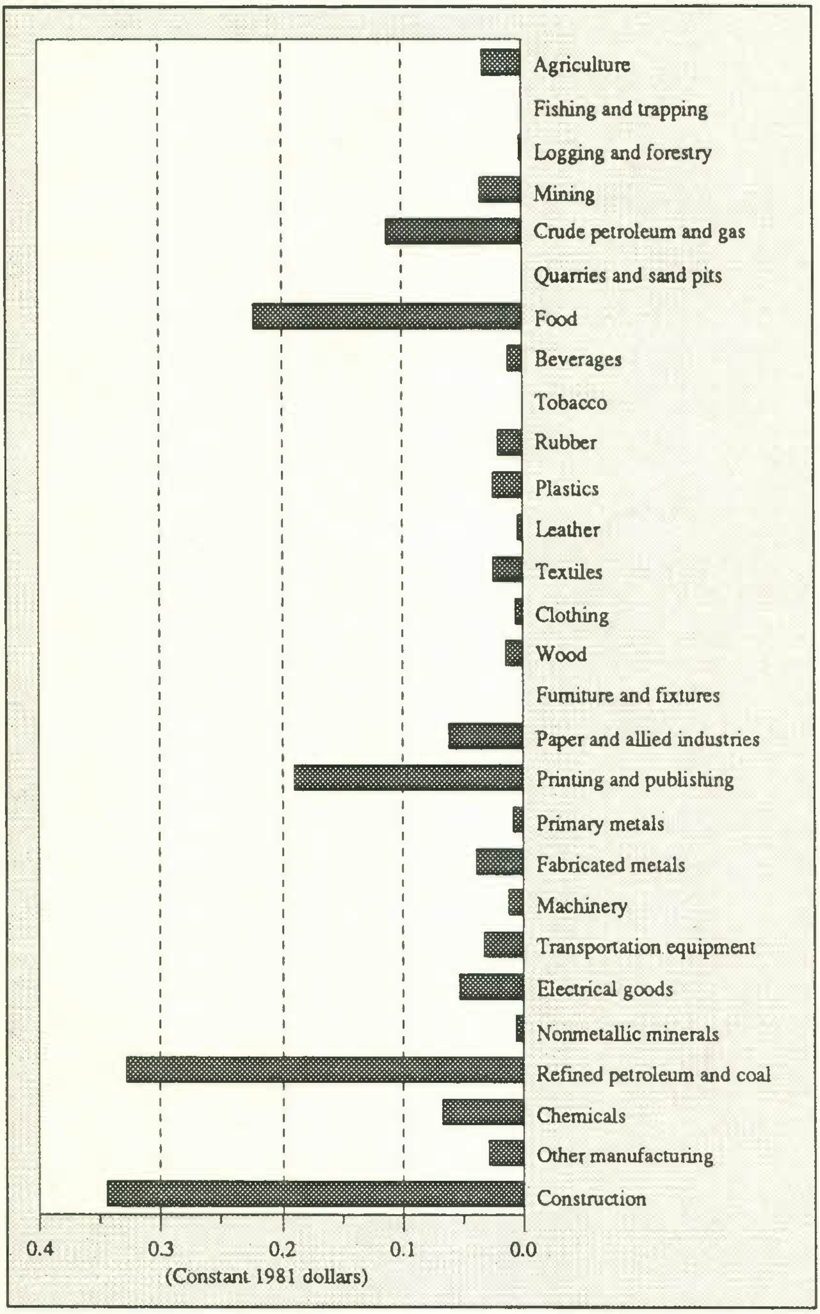


SOURCE Estimates by the author, based on data from Statistics Canada.

The discussion of empirical results thus far concentrated on the stimulative power of goods production on service activities and vice versa. Neither the stimulative power of goods-producing activities on the demand for goods nor the impacts of service production on service demand have been mentioned. Although we chose to emphasize the importance of intersectoral transactions, the analysis also gives information on intrasectoral influence. Technically, the internal multiplier matrices of the goods and service sectors, which we use to calculate the stimulative power of the goods and service industries, already give us this information. For example, the internal multiplier matrix of the goods sector shows that, starting with one unit of output for each goods industries, the necessity of buying other goods as intermediate inputs to meet the production requirements results in other goods industries producing many more units of outputs to meet the demand. This propagation effect within the sector is the intrasectoral influence that the present discussion addresses. A comparison of the 1971-85 internal multiplier matrices of the goods sector with those of the service sector indicates clearly that goods industries generally had much more power in generating demand for other goods than service industries in creating demand for more services. The reason is that service industries require relatively little goods and services to carry out their business. These characteristics of service activities did not only diminish the stimulative power of service industries to generate demand for goods production but also made them impotent in creating demand for services within the service sector. For example, in 1980, in the case of 93 per cent of the goods industries studied, one dollar's worth of output generated at least

Chart 4

Sensitivity of Goods-Producing Industries to Service Activity, Canada, 1985



SOURCE Estimates by the author, based on data from Statistics Canada.

\$0.30 worth of demand in the rest of the goods-producing sector. In contrast, only 17 per cent of the service industries generated an intrasectoral demand of similar magnitude. This also explains why the goods-producing industries had such pervasive power in generating demand for services. If the goods industries needed only services but no goods as intermediate inputs, then the internal propagation (multiplier) effect of the goods sector would be nonexistent. Under such unlikely circumstances, the power of the goods sector to create demand for services would also be limited.

Sectoral Propagation versus Nationwide Propagation

We mentioned earlier that the stimulative power calculated by the Miyazawa method is based on the concept of a partial equilibrium analysis. The relevance of these results, therefore, depends upon the relative explanatory power of the estimates in comparison to their counterparts of the general equilibrium framework. In other words, how much do we miss by using the internal propagation effects of the goods and service sectors individually rather than the total propagation effects of the economy? We propose to settle this issue by calculating the ratios of $GEXP = B_1 (\div) [S_1 * (B + B_2MB_1)]$ and $SEXP = T_1 (\div) [P_1 * (T + T_2NT_1)]$.

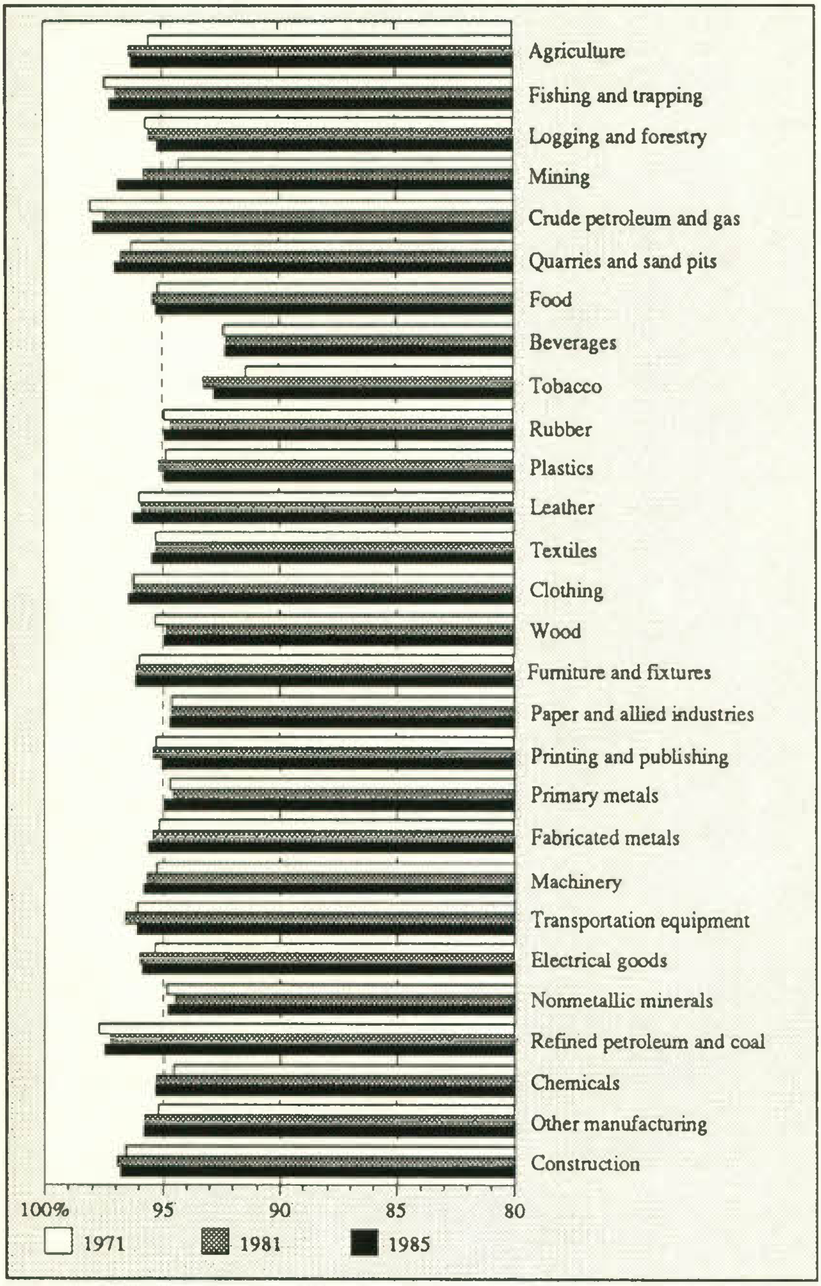
In each of these ratios, for example, B_1 is a matrix of coefficients of the stimulative power of the goods industries based on the internal propagation of the sector, whereas $[S_1 * (B + B_2MB_1)]$ is its approximated counterpart based on the propagation effects of the total economy. Quantitatively, high values for the *GEXP* and *SEXP* ratios are sufficient to vindicate the relevance of the Miyazawa approach. On the other hand, if the ratios are low, say 50 per cent or less, then they suggest that despite the neatness of the method too much has been left unexplained. Therefore, the usefulness of the results must also be questioned.

GEXP and *SEXP* consist of a 18*28 matrix and 28*18 matrix for each year of the sample period 1971-85. In other words, *GEXP* and *SEXP* are not two single matrices; they are two time series of matrices. Space limitation and the clumsiness of presenting 30 large matrices rule out the possibility of showing all of the results in detail here. As a compromise, the industrial averages of *GEXP* and *SEXP* for selected years are presented to provide the reader a historical perspective.[25] Charts 5 and 6 summarize the results.

The explanatory power of the Miyazawa-type estimates is immediately obvious. The ratios for the goods-producing industries exceeded 90 per cent throughout the period 1971-85, and most of them hovered around 95 to 98 per cent. The picture for the service industries on goods production was the same. This means that even though the Miyazawa approach is based on a partial

Chart 5

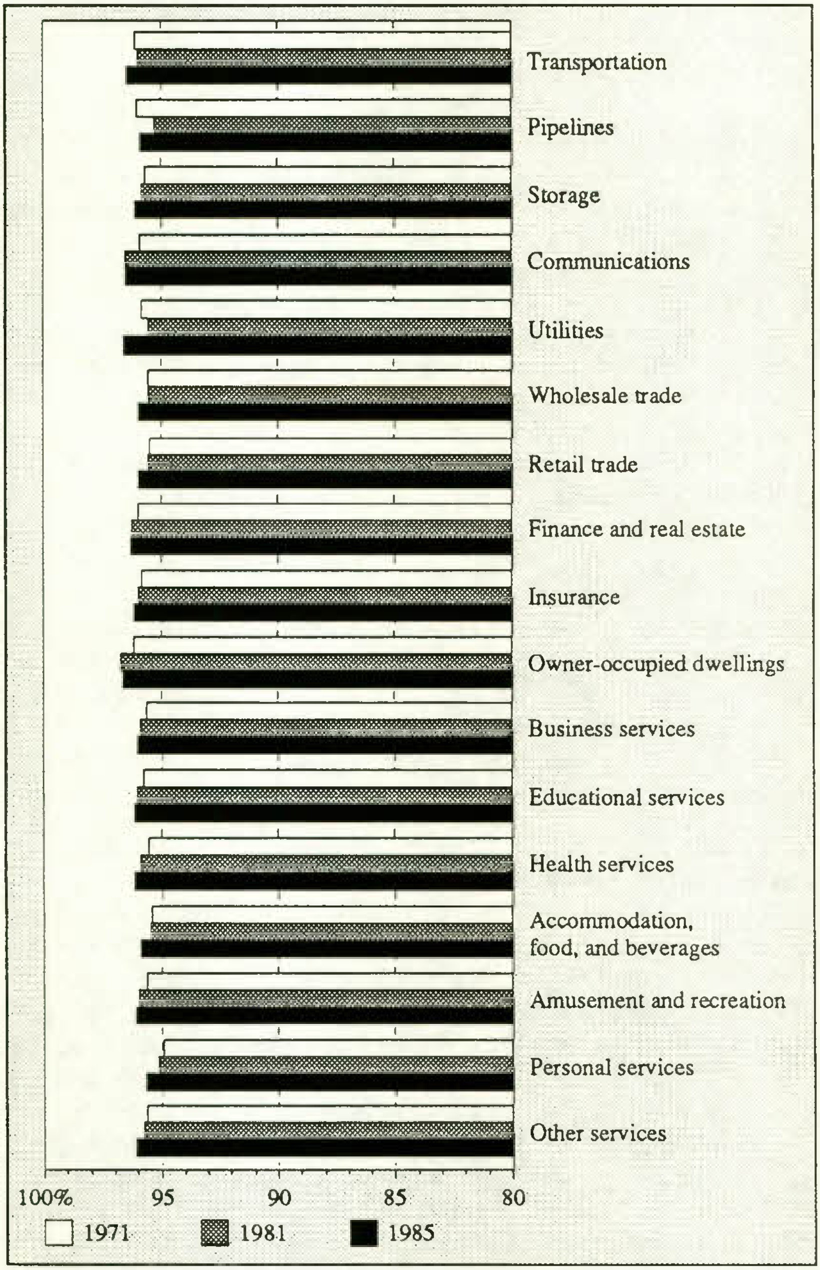
Comparison of Propagation Effects – Ratio of the Goods Sector to Total Economy, Canada, 1971, 1981, and 1985



NOTE See text on page 14 and note 25.
SOURCE Estimates by the author, based on data from Statistics Canada.

Chart 6

Comparison of Propagation Effects – Ratio of the Service Sector to Total Economy, Canada, 1971, 1981, and 1985



NOTE See text on page 14 and note 25.
SOURCE Estimates by the author, based on data from Statistics Canada.

equilibrium framework, it accounted for approximately 95 per cent of all possible actions for most of the goods and service industries. The stimulative power estimates based on this technique are, therefore, sufficient for describing the reality of interindustry dependence.

Intertemporal Comparison

Although the empirical work covers the period 1971-85, descriptive inconvenience and space limitation do not permit the presentation of each year in detail. Except where otherwise specified, the description of the sectoral input-output analysis thus far refers only to the historical data of 1985.

The sectoral input-output analysis has led to the conclusion that the stimulative power of the goods-producing industries on service activity is superior to that of the service industries on goods production. The question is whether or not the stimulative power has grown or eroded over time. Since the empirical work covers the period 1971-85, a critical review of the time series of the empirical results may be sufficient to answer this question. Table 3 reproduces the stimulative power of the goods industries on total service activity for 1971 and 1981. The results for the period 1982-85 are not included because they are numerically not comparable to those of the former period. The raw data for the period 1982-85 are in constant 1981 dollars, whereas the data for the period 1971-81 are in constant 1971 dollars. Because many input-output deflators are needed to calculate the constant-dollar figures for the input-output tables, the Input-Output Division of Statistics Canada has not yet been able to convert the two sets of data to a common basis. For this reason, a direct comparison of the results for the two periods should be avoided.

Of a total of 28 goods-producing industries, 25 had higher stimulative power in 1981 than in 1971. This suggests that the stimulative power of goods production on service activity has grown over time. The problem with this interpretation is that this is an oversimplification of the real picture. For example, in 1971, a dollar's worth of output in agriculture generated a demand of $0.0048 in transportation, $0.0341 in wholesale trade, and $0.0109 in retail trade. The corresponding figures for 1981 were $0.0058, $0.0391, and $0.0101. Clearly, the agriculture industry had more power in generating demand for the services of the transportation and wholesale trade industries in 1981 than in 1971, but this was not true for its influence on retail trade. The stimulative power of a goods-producing industry on "total" services is the sum of its stimulative power on 18 individual service industries. What is true for the service sector as a whole may not apply to each service industry.

A review of the basic formula may help to show the cause for possible changes in stimulative power over time.

The stimulative power of the goods sector on service activity = (the matrix of service requirements for producing one unit of output in each goods industry) * (the internal multiplier matrix of the goods sector).

It is difficult to compare a series of matrices over time, but we have not noticed any systematic changes in the service requirement term of the above formula. The internal multiplier matrix is determined by the production technology of

Table 3

Stimulative Power of Goods Production on Total Service Activity, Canada, 1971 and 1981

	1971	1981
	(1971 dollars)	
Agriculture	0.183	0.132
Fishing and trapping	0.091	0.112
Logging and forestry	0.269	0.288
Mining	0.130	0.209
Crude petroleum and gas	0.270	0.410
Quarries and sand pits	0.144	0.213
Food	0.134	0.162
Beverages	0.088	0.105
Tobacco	0.069	0.119
Rubber	0.107	0.118
Plastics	0.120	0.135
Leather	0.127	0.124
Textiles	0.099	0.101
Clothing	0.105	0.103
Wood	0.176	0.191
Furniture and fixtures	0.132	0.156
Paper and allied industries	0.155	0.191
Printing and publishing	0.124	0.132
Primary metals	0.122	0.167
Fabricated metals	0.107	0.129
Machinery	0.105	0.114
Transportation equipment	0.106	0.127
Electrical goods	0.114	0.102
Nonmetallic minerals	0.132	0.156
Refined petroleum and coal	0.236	0.329
Chemicals	0.154	0.184
Other manufacturing	0.124	0.145
Construction	0.152	0.174

SOURCE Estimates by the author, based on the analysis of input-output data from Statistics Canada.

the goods industries. The more goods industries need to purchase other goods as intermediate inputs, the larger the multiplier effect. This means that for the goods industries to have high stimulative power, they must buy from the goods as well as service industries. Thus, even if service requirements per unit of goods outputs remain unchanged, the stimulative power of the goods industries may still change over time because of changes in the technology of goods production.

In summary, whenever the structure of the economic system and the production technology change, the stimulative power changes. The change of stimulative power is, therefore, simply a reflection of the change of the industrial system over time.

Although the goods-producing industries appeared to have higher stimulative power in 1981 than in 1971, the relative ranking positions of the industries over time were more important than the changes in the absolute values of their stimulative power. We have seen that manufacturing industries showed significant but not outstanding stimulative power on service activities throughout the period 1971-85. By contrast, logging and forestry, crude petroleum and gas, wood products, and refined petroleum and coal products were the goods-producing industries with the most power for generating service activities in 1985 and in other years. We should also point out that the observed growth of the stimulative power of the goods industries was not a necessary condition for the goods sector to drive service growth. The important point is that the stimulative power of goods industries on service activity was always higher than services on goods. As long as the levels of outputs of the goods industries grew over time, because of the stimulative power effect, service industries grew automatically.

Growth in Service Employment

The main cause for the past service employment growth was due to the differentials in sectoral stimulative power. The growth of the economy and the attributes of the industrial structure (i.e., the superior power of the goods industries on services and the fact that service industries do not need a large amount of other goods and services in their production processes) tended to accelerate the growth of services over time. Differences in labour productivity levels also played important roles in determining the profiles of sectoral employment. The labour productivity of the goods-producing sector increased from \$31.2 thousand (constant 1981 dollars) to \$40.9 thousand between 1971 and 1989; likewise, the performance of the commercial service sector improved from \$22.9 thousand to \$32.8 thousand in the same period.[26] Because the productivity level of the goods sector was always higher than that of the service sector, the goods sector required a much larger increase in output to create one job than its service counterpart. Historical records show that with only a few occasional setbacks, a majority of the goods and service industries managed to grow over time, albeit sluggishly at times. When the growth took place, the initial impact was the demand for more goods and services. However, due to the interdependence of the goods and service industries, the demand for more goods necessarily entailed further demand for services. Along with the traditionally lower labour productivity levels in service industries, employment in the service sector ended up growing faster than in the goods-producing sector.

Conclusion

The empirical results of this paper demonstrate that the effectiveness of the goods and service industries are mutually intertwined. Although the production of service activities does not require a large amount of inputs from goods-producing industries in the production process, service industries have to sell much of their outputs to goods-producing industries as intermediate inputs for goods production. On the other hand, goods-producing activities demand a large amount of goods and services as intermediate inputs. Obviously, for goods-producing industries to remain competitive in the world market, high-quality inputs at the lowest possible prices are essential. Even without any formal analysis, the reader would have come to the same conclusion by a priori reasoning. The contribution of this paper lies in its ability to provide decision makers with some specific information. In particular, the analysis shows quantitatively which goods-producing industries have more power in generating demand for services and which service industries are more sensitive to the cyclical variations of goods-producing activities. Potentially, this information can help decision makers to analyse and predict the consequence of certain government policy measures.

As mentioned earlier, the phenomenal growth in service employment may trace its origin to the demand from the goods industries for services as intermediate inputs. What may happen if goods producers decide to import a large amount of services from the rest of the world? In view of the existing historical experience this may, perhaps, appear a far-fetched, hypothetical scenario. In the future, the advance of high technology may, however, make "importing services" a viable option to many Canadian producers. Goods producers will import services from foreign countries, if they find services abroad cheaper and better. The employment implication of this scenario is complex. "Cheaper and better" services from foreign countries may greatly improve the efficiency of Canadian goods production and, therefore, lower production costs significantly. In the long run, this may lead to an accelerating growth in this country's goods-producing activities. If the growth is large enough, then, other than "adjustment problems" related to switching from service-producing to goods-producing activities, the economy should have no difficulty in maintaining and creating high demand for Canadian workers. Under this circumstance, workers do not have to suffer. The term "large enough" is crucial. If the growth is not large enough, many of the service workers may not be able to locate gainful employment.

In view of the recent development in technology, "importing services" should not be interpreted as a fantasy in the medium-term context. Policymakers have certain options available to them. They may exercise their policy leverage to transform the "importing services" scenario into a reality or to allow the goods-producing and service sectors to develop as they have in recent decades. Whatever they do will have profound implications on employment opportunities for the Canadian labour force.

Notes

1 Colin Clark, *The Conditions of Economic Progress* (London: Macmillan, 1st ed. 1940, 3rd ed. 1957).

2 Simon Kuznets, ed., "Toward a theory of economic growth," *Economic Growth and Structure* (New York: W. W. Norton, 1965).

3 W. Baumol, "Macroeconomics of unbalanced growth," *American Economic Review* 57, no. 3 (1967):415-26; W. Baumol et al., "Unbalanced growth revisited: Asymptotic stagnancy and new evidence," *American Economic Review* 75, no. 4 (September 1985):806-17; and Victor R. Fuchs, *The Service Economy* (New York: National Bureau of Economic Research, 1968).

4 See, for example, Stephen S. Cohen and John Zysman, *Manufacturing Matters: The Myth of the Post-Industrial Economy* (New York: Basic Books, 1987); Rudiger Dornbusch et al., *The Case for Manufacturing in America's Future* (Rochester: Eastman Kodak Company, 1988); and Gregory Schmid, "Manufacturing: The key to future jobs," *Challenge* (November-December 1988):54-56.

5 See, for example, the Service Industries Sector Study Program (SISP), Department of Regional Industrial Expansion. A synopsis of the studies prepared for SISP can be found in "Service industries sector study program: Synopsis of studies," internal discussion paper, Department of Regional Industrial Expansion, Ottawa, April 1988.

6 Economic Council of Canada, *Employment in the Service Economy* (Ottawa: Supply and Services Canada, 1991).

7 Clark, *The Conditions of Economic Progress.*

8 Kuznets, "Toward a theory of economic growth."

9 Baumol, "Macroeconomics of unbalanced growth"; and Baumol et al., "Unbalanced growth revisited."

10 Faye Duchin, "Role of services in the U.S. economy," in *Technology in Services: Policies for Growth, Trade, and Employment* (Washington, D.C.: National Academy Press, 1988).

11 See Cohen and Zysman, *Manufacturing Matters: The Myth of the Post-Industrial Economy*; Dornbusch et al., *The Case for Manufacturing in America's Future*; and Schmid, "Manufacturing."

12 Fuchs, *The Service Economy.*

13 D.C.A. Curtis and K.S.R. Murthy, "Goods sector-service sector structural change and Canadian economic growth: A dynamic multisectoral modelling analysis," a paper prepared for the Economic Council of Canada, Ottawa, September 1989.

14 There are many versions of the CANDIDE model. The documentation for any version is sufficient to show its industrial details. See, for example, Michael C. McCracken, "An overview of CANDIDE 1.0," Economic Council of Canada, Ottawa, 1973.

15 See Wassily W. Leontief, *Input-Output Economics* (New York: Oxford University Press, 1966). For a list of models and applications based on the rectangular input-output tables, see Statistics Canada, *The Input-Output Structure of the Canadian Economy, 1961* (Ottawa: Queen's Printer, 1969).

16 These include consumer expenditures on durables/semi-durables/non-durables/services, business and government construction, business and government investments in machinery, inventories, exports, and imports.

17 For more details on the applications of the input-output model, see Statistics Canada, *The Input-Output Structure of the Canadian Economy, 1961.*

18 K. Miyazawa, *Input-Output Analysis and the Structure of Income Distribution* (Heidelberg: Springer-Verlag-Berlin, 1976).

19 For a description of input-output interregional models, see Harry W. Richardson, *Input-Output and Regional Economics* (London: Weidenfeld and Nicolson, 1972), pp. 53-82.

20 In Statistics Canada's notation, B is the industry technology matrix. We use the letter H to denote the industry technology matrix here and reserve the letter B for representing the internal multiplier matrix of the goods-producing sector. The matrix dimensions given in this write-up refer to the M aggregation in Statistics Canada's input-output tables used in this paper.

21 Miyazawa, *Input-Output Analysis and the Structure of Income Distribution.*

22 K. Miyazawa, "Internal and external matrix multipliers in the input-output model," *Histotsubashi Journal of Economics* 7, no. 1 (June 1966); and

Miyazawa, *Input-Output Analysis and the Structure of Income Distribution.*

23 Cohen and Zysman, *Manufacturing Matters.*

24 Dornbusch et al., *The Case for Manufacturing in America's Future*; and Schmid, "Manufacturing."

25 The statistics shown refer to the "column average of B_1 (÷) column average of [S_1 * $(B + B_2MB_1)$]" and the "column average of T_1 (÷) column average of [P_1 * $(T + T_2NT_1)$]" of the year in question.

26 This productivity measure refers to gross domestic product (constant 1981 dollars) per worker.