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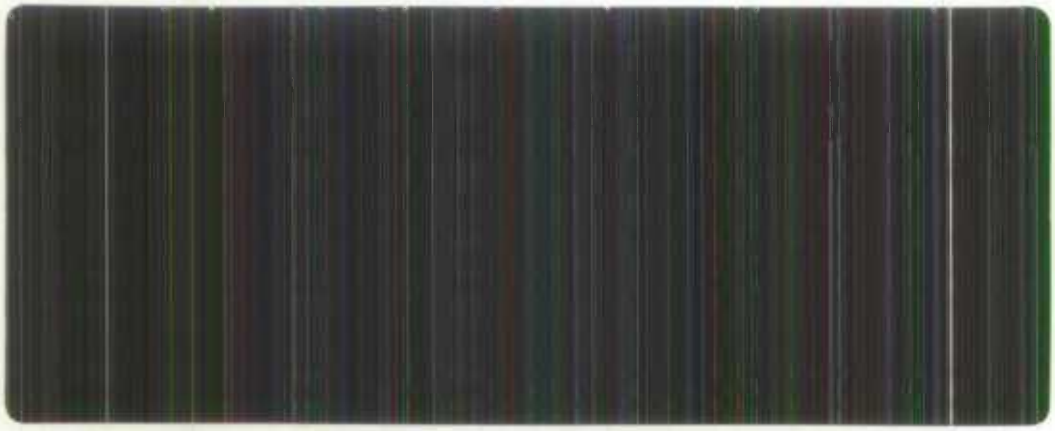

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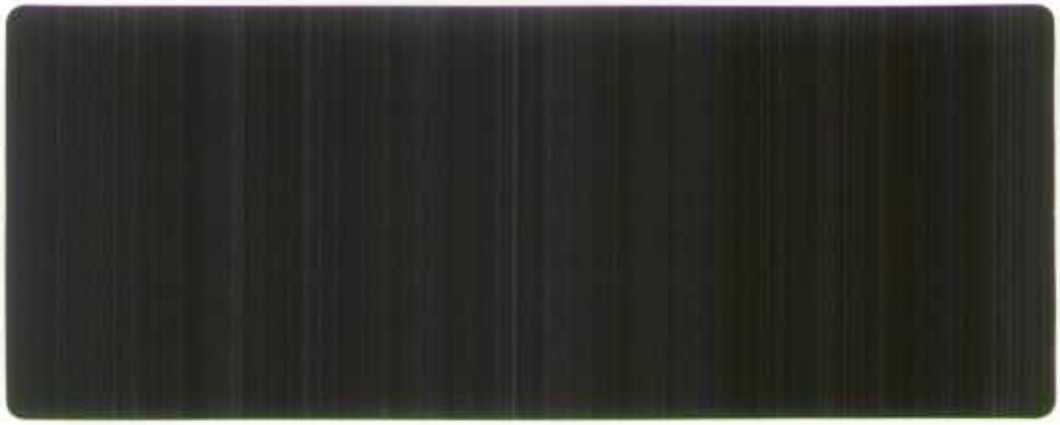

Input-Output
Technical Series

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Statistics Canada
National Accounts and Analytical Studies
System of National Accounts
Input-Output Division

Statistics Canada's Input-Output Model: General Description, Critical Analysis of Partially Closed Version and Alternative Solutions

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SUMMARY

The input-output table is an accounting framework of an economy's production system. The table shows the interconnections that exist between the various sectors of the economy when goods and services are produced. Using this framework of the economy, we can determine which goods and services are **required** to achieve a certain production level. The table allows us to show how the goods and services required to achieve a given production level are exchanged among the various industries in the economy that are brought into play to achieve that production level. Part of the goods and services required are imported from other countries.

This accounting framework of the production system allows us to answer various economic questions that are often asked. For example, we may want to know the relative importance of a particular industry in the overall economy. Or we may want to examine the impact of a given investment spending project on the economy. Or the input-output table can be used, within the framework of an industrial analysis, to find out what goods and services an industry needs in order to achieve a certain production level.

The input-output table lets us evaluate the **direct effects** of a spending project. These effects are measured in terms of production, income and employment. The production process set in motion by a spending project provokes a chain reaction in the economy, whereby industries supply inputs to other industries that are directly involved in the project. This spreading out of demand in the economy is at the origin of **the indirect effects.**

Gross production in the economy resulting from a spending project is made up of the total sales achieved by all the industries that participate in the production process. An industry's net value added production is the difference between the value of its sales and the cost of its purchases of inputs from suppliers. The less vertical integration there is in the economy, the more gross production exceeds net production. Overall net production in the economy is generally lower than the initial value of the project, because of imports.

The economic impact of a project in the so-called open input-output model is evaluated by estimating **direct and indirect effects** without taking into consideration the **spin-off effects** arising from the reactions of economic agents when production increases. The direct and indirect impacts of a project are evaluated on the basis of gross production, net or value added production, employment, imports, and revenues of various levels of government. The use of goods and services by intermediaries is also taken into account. The input-output model shows the total production of goods and services resulting from a spending project, and also, which industries produce the various goods and services associated with the spending project.

The information provided by the input-output table can be disaggregated by province.

The sequence of the economy's reactions to a variation in demand described in the open input-output model is incomplete. Another series of effects of a different type, **known as spin-off effects**, generally follows the first reactions of the economic system. This second wave may be greater if the initial impact is significant.

In attempting to evaluate the effects of the second sequence of reactions in the economy, it is customary to add to the input-output model a mechanism whereby one can measure the spin-off effects arising from the spending of income associated with the employment created by the initial impact of a spending project.

This then gives us what is called a closed model, or more precisely, a model with partial closure on consumption. This partial closure can be criticized in several respects, and under these conditions the calculation of economic impact with a closed model is difficult to interpret. The results may lack credibility and, when this is the case, for the benefit of users of the input-output model, Statistics Canada should not offer economic impact solutions with partial closure on consumption. As an alternative solution, Statistics Canada is willing to assist the user in carrying out a certain number of additional simulations, which would provide a more appropriate estimate of the spin-off effects. The user knows best the economic circumstances associated with the demand impact to be simulated, and should be the person best able to formulate the appropriate hypotheses for evaluating the spin-off effects.

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I. DESCRIPTION OF THE INPUT-OUTPUT TABLE

I. A. Introduction

The input-output table is an accounting framework of an economy's production system. The table shows the interconnections that exist between the various sectors of the economy when goods and services are produced. Using this framework of the economy, we can determine which goods and services are **required** to achieve a certain production level. The table allows us to trace how the goods and services required to achieve a certain production level are exchanged among the various industries in the economy that are brought into play to achieve that production level.

This accounting table of the system of production allows us to answer various economic questions that are often asked. For example, we may want to know the relative importance of a particular industry in the overall economy. Or we may want to examine the impact of a given investment spending project on the economy. We can also examine the effects of a particular government project on the production of goods and services in the economy. The input-output table can also be used, within the framework of an industrial analysis, to find out which goods and services an industry needs in order to achieve a certain production level. The input-output table also lends itself to an analysis of the effects of changes in the supply of goods and services and/or, if preferred, in the provision of goods and services by the various industries operating in Canada. For example, we could evaluate the impact of an energy shortage on the production of goods and services (a halt in the production of electricity or an interruption in the oil supply), or the effect of a strike in a strategic sector, such as the transportation of merchandise.

It should be pointed out that the data from the input-output table are **compatible** with the concepts of **national accounts**. In the economic accounts published by Statistics Canada, gross domestic spending is established quarterly or annually. Total demand for goods and services directed to **Canadian industries** represents what is known as the final demand. It is divided into the following categories:

- consumption (goods and services)
- capital spending (construction, machinery, equipment)
- government (public services and goods and services)
- exports (goods and services).

The input-output table thus allows us to trace the production of goods and services necessary to meet the final demand in the economy. From the data provided by the economic accounts, we can produce a statement of the production of goods and services by the various industries necessary to meet the final demand. It should, however, be pointed out that there is generally a shortfall of national producers to meet

the final demand, and that some of the goods and services required to satisfy this demand are **imported** from abroad. Thus, we have to rely upon imports not only to meet the final demand in general, but also in the case of the more specific analyses that we have already mentioned (importance of an industry, effects of a spending project or government program, etc...). The notion of the **overall supply** of goods and services in the economy thus includes the **production** of the various industries on Canadian territory, and the **imports** from the various countries with which we have trade connections.

In summary, the input-output table allows us to trace the various goods and services produced by the **various industries** in the economy that are brought into play by a spending project or other economic events, and also to indicate which goods and services must be **imported** to ensure that there is a **balance** between **the supply and demand** of goods and services in the economy.

I. B. Direct and Indirect Effects

Production

A frequent use of Statistics Canada's input-output model thus consists of analyzing the effects of a given spending project on the economy, in terms of production and employment. This may involve an investment project or a public sector project, or an analysis of the effects of an industry's output. In the various cases, the analysis may present itself in the following form:

- First of all, information must be available on the nature of the project under consideration. If it is an investment or public sector project, the cost of the project and its main components must be known (building, machinery, equipment, office supplies and materials, etc...). The more information that is available about the project, the more precise the analysis will be, since there will be less reliance on **estimates** of demand based on the data on demand composition available from the input-output table. From pertinent information on the project or industry to be analyzed and, if necessary, using the detailed data on demand composition that are available from the input-output table, we can obtain a detailed breakdown of the purchases of goods and services associated with the project that is being analyzed.

- Once this information is collected, the demand for goods and services associated with the project or industry examined is directed in the input-output table to the industries that produce

these goods and services. As a first step, the demand is directed to the main industries that are capable of meeting it. In the case of a project to build a factory, the construction industry will be directly involved. Industries selling equipment for the factory will also be directly involved. These are examples of direct effects. They will be expressed in terms of production to meet the demand; the **income** corresponding to this production and distributed to the production factors (capital and labour); and **employment.** It should be pointed out that part of the direct effects may appear in the form of **imports**. For example, certain types of machinery that must be bought for the projected factory are often imported from foreign producers.

- The production process set in motion by the demand for goods and services does not stop here, since the industries directly involved will, in turn, require materials, supplies, equipment and services to meet the demand. All of this demand for goods and services that will be passed on to the other sectors actually represents the inputs or production factors that the industries directly involved need for their production purposes.

This expansion of the demand will spread out in the economy; industries that supply inputs to the industries directly involved will, in turn, buy goods and services from their suppliers, sub-contractors, and other industries with which they have commercial links. This chain reaction will continue, and all of the production, income, and employment generated by this spreading out of demand in the economy will represent what is known as the **indirect effects**. Here again, part of the indirect effects will appear in the form of imports; the various industries that supply goods and services must sometimes, in turn, import goods and services from other countries.

In this respect, the proportion of imports in relation to the demand depends on the nature of the project. For example, to carry out certain industrial investment projects, Canada must count upon a considerable volume of imports. These imports represent **leakages** outside the production circuit in Canada, and **reduce the magnitude** of the direct and indirect economic impacts of the project.

Thus, the input-output table shows which **industries** are involved in the production chain as they respond to the demand. But the input-output table also supplies information on the **goods and services** involved in the production process. Production of goods and services can also be broken down by industry; the input-output table answers the question "Who produces what?" The data from the table show whether a given good or service is **produced** by a given industry or is **imported**. In this respect, it should be pointed out that a given product is not necessarily produced by a single industry, but can

be produced by several industries. The data on the input-output table also answer another question, "Who buys what?" For the various industries involved in the production chain, it will show the purchases of goods and services that are necessary for the production processes of these industries.

To understand the accounting balance between demand and production, we must make a distinction here between an industry's gross production and its net, or value added, production. When an industry is involved in the production chain to meet the demand, it sells its production to other industries. It is then useful to know the value of the sales achieved by an industry when analyzing the impact of a project or the importance of an industry.

In this respect, gross production in the economy, or the sum of the gross outputs of the various industries involved in the production process, reflects a dimension of the economic structure. Thus, if we consider an economy that is largely vertically integrated, that is, made up of firms that produce a large part of the inputs that it needs for the purposes of production, there would then be a more limited number of intermediary transactions associated with a certain production level of goods and services. In short, the total value of the gross output would be less than in a case where vertical integration was less extensive. When vertical integration is less developed, firms require a greater range of suppliers or sub-contractors, and more intermediary transactions occur to achieve a certain production level.

On the other hand, it must be recognized that an industry's gross output does not represent its net contribution to the output of the economy as a whole. In fact, an industry's sales figures include the purchase value of inputs produced by other industries. Thus, the sales value or gross output of an industry cannot be used to evaluate production in the economy, since the same production that circulates from one industry to another would be counted several times. Therefore, to establish an industry's net contribution to the economy's output, the value of inputs purchased must be subtracted from its sales. This gives us a figure for that industry's **net production,** which represents its contribution to the total production of goods and services in the economy, that are necessary to meet the demand. At this stage, we can introduce the **notion of a multiplier**, which is found in works dealing with input-output tables and the use of these tables. This notion of a multiplier is a **purely accounting notion** and does not reflect the behaviour of economic agents, as does the theory of the Keynesian income multiplier, which will be discussed later. The gross production multiplier compares the total value of the gross output with the value of net economic output. Thus, the multiplier is the ratio between gross production and net production. The less extensive the economy's vertical integration, the higher this multiplier will be; thus, there would then be more inter-industrial transactions to achieve a given net production level.

Moreover, net production is equal to the income distributed to the factors of production (capital and labour) that are brought into play to achieve a given level of

output.Thus, an industry's net production, also called value added, is equal to the sum of earned income (salary and other remuneration) and **earnings on capital** (profits, interest, rent and other income). If value added is evaluated at market price, the indirect taxes that various levels of government levy on transactions in the economy must be added. **The sum of the value added generated by various industries at the direct and indirect levels represents the economy's overall production level resulting from a given project or from the activity of an industry whose economic importance is to be evaluated.**

But the overall output of the various industries will generally be **lower** than the value of the initial project, because goods and services are also imported by the various industries. This brings us to the following accounting balance: the effect of a given spending project will be equal to the sum of the net outputs of the industries directly and indirectly involved, plus imported goods and services.

In the literature concerning input-output models, an input-output model is said to be **open** when the impact of a given spending project or the importance of an industry is evaluated on the basis of the direct and indirect effects generated, measured by the value added that is created by the various industries involved in the production chain. The meaning of the term "open" in the context of the input-output model **does not refer** to the more common notion of "open economy;" that is, an economy where trade with other countries represents an important part of its economic activity. Here, the term **"open"** has a meaning peculiar to input-output techniques, and means **a model where there are no spin-off effects.** Only the production of goods and services required by industries to meet a given level of demand is accounted for, without the reactions of the economic agents in the form of price adjustments, earned income spending (in the form of consumption, investments,) etc... In short, in terms of input-output techniques, a model is said to be open when no spin-off effects are taken into consideration.

Under these conditions, if we examine the economic impact of a spending project, we can find an **income** multiplier (not to be confused with the gross output multiplier defined above) that is **less than one** since the economic impact of a given project is only measured by the output generated directly or indirectly in the economy and because of the effects of the leakages due to imports. In such a model, we do not measure the other economic effects (discussed later) resulting from the reaction of economic agents. As the effects of the leakages increase, the value of the multiplier drops further below one. Inversely, in a case where there are no imports, we would have an income multiplier equal to one[1].

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[1] *If instead of producing to meet the demand, certain industries used their inventories, the multiplier would then be less than one, even in the absence of imports.*

Thus, the input-output model allows us to establish the output, by industry, that is directly or indirectly generated by a variation in demand. We can thus trace the economic contribution, in the form of production or income, derived from the sales of industries involved in meeting the demand. The accounting balance between supply and demand is such that the production generated will be at most equivalent to the amount of demand. In an economy like Canada's, where foreign trade is important, output is generally less than the value of the project under consideration because of the leakages related to imports.

Employment

To evaluate the output generated by a demand impact, the input-output model uses a simplified model of the firm's production process. We assume that technology is **stable** and that variations in output have no impact on the productivity or efficiency of production processes. We also assume that the capital stock (factory, machinery, buildings, etc..) on hand in the various industries is generally **sufficient to meet a variation in demand.** This general hypothesis may not, however, be appropriate in specific cases. For example, when examining the impact of a considerable capital spending project that has very specific characteristics, certain industries may not be capable of meeting the demand for goods and services required to carry out the project. In such a case, as we will show later, it is possible to circumvent this difficulty with the help of additional calculations.

If the capital stock in the economy is considered to be fixed in the short-range, the other factor of production, labour, will vary with production volume. The production function for each industry has coefficients that make it possible to **link net production to employment.** In this way, the manpower required to attain a given production volume can be evaluated. The sum of all jobs in the industries directly involved to meet a demand for goods and services makes up the volume of direct employment; thus, we can speak about the direct "creation" of employment. The total employment required in the industries indirectly involved constitutes the volume of indirect employment or indirect "creation" of employment. The sum of direct and indirect employment provides the overall impact on employment associated with total production in the economy to meet a given change in final demand.

Since the input-output table allows us to break down the income associated with production into salaries, profits and other income, we can also evaluate the total payroll and benefits corresponding to the employment volume generated by production. We can also determine the average salary for the total number of jobs, or in terms of direct and indirect employment.

Tax assessment

The input-output model also allows us to estimate income taxes levied on the factor of production, namely: taxes on salaries, and taxes on profits and other income. Data from tax legislation are used to obtain an estimate of these taxes. This calculation can be quite straightforward and appear, for example, in the form of an actual average tax rate multiplied by the salaries, in the case of individual income tax, and by the firms' profits, in the case of corporate income tax. The calculation can also be more precise. For example, we could vary the tax rate with the average salary level by industry; this would reflect the progressive structure of income tax. In the case of corporations, we can also use the two-rate structure as a function of the average level of profits. Finally, indirect taxes are estimated for the various transactions that take place in the economy between industries, and between industries and the buyers who initiated the project under examination. This evaluation is carried out with the help of tax legislation that defines the tax rates and tax bases to which the rates apply. Taken together, these calculations provide an estimate of total income taxes associated with a project, and of the taxes collected by the various levels of government in Canada. Finally, it should be pointed out that the total tax assessment represents the sum of the assessments in regard to both direct and indirect effects.

Summary

At this stage, the results of a simulation with the open input-output model can be summarized this way:

* Direct effects:
  - income or output (value added)
  - imports
  - employment
  - tax assessment

* Indirect effects:
  - income or output (value added)
  - imports
  - employment
  - intermediary use of goods and services
  - tax assessment

Gross output is the total gross production of the various industries, whereas the total value added is the net production. The range of goods and services required to meet the demand can be determined by the model, as can the various industries that produce these goods and services. Also, the gross production of the various industries involved can be determined, as well as their net output, and the goods and services produced by the various industries involved. All of these results are for the Canadian economy as a whole.

I. C. Provincial breakdown

Often, we wish to know the breakdown by province of the economic impact of a given project. For example, we may wish to know the impact of a nation-wide project on each province. Or, when an investment spending project is undertaken in a given province, we may wish to know what its effects will be on output and employment in that province or outside the province. The input-output interprovincial model shows us to what extent a province can benefit from an investment project or any other spending project. If a province must depend to a great extent on the production of industries from the other provinces to meet the demand, there will then be significant leakages out of the province, and the direct and indirect impact of the project could be proportionally quite small. Inversely, the more self-sufficient a province is in producing the goods and services necessary to meet the demand, the more the value of the multiplier will approach one. In short, the same principles discussed above concerning imports also apply with regard to a province. In this case, a province may import goods and services from the other provinces or from other countries. As the overall rate of imports increases, the multiplier relating to direct and indirect effects decreases.

In order to regionalize the results of the impact calculation, we assume that each province's share of the national output is constant over the short-term. This allows us to distribute production among the provinces. By determining the production by province, we can estimate employment. This way, we can find all the information available nationally on a provincial level, in terms of production, employment and provincial tax revenues. Production and employment for a province can also be broken down in direct and indirect terms.

As far as accounting balances are concerned, the regionalized version of the input-output model gives us the following relation: the sum of the outputs **by province** plus imports from other countries will be equal to the value of the project under examination. This is the same accounting balance that we mentioned above, except that,in this case, output is broken down by province. In this accounting balance, a province's imports from another province are counted as output for that exporting province. For the purposes of an economic impact analysis, it may be useful to know the **flow of trade in goods and services** between provinces. However, the flow of trade between provinces does not have to appear when the results are consolidated at the national level, nor when they are summarized for an individual province.

II. INTERPRETATION AND SCOPE OF THE RESULTS

II. A. Main Hypotheses of the Input-Output Model

In order to understand the scope of the results of a calculation made with the help of the input-output model, it would be appropriate to review the hypotheses that underlie this working tool.

The input-output model uses data on the flow of goods and services in the economy which are reconciled with data from the national accounts. The data for the total production of all industries are equal to the GDP. Data pertaining to final demand correspond, within broad categories, to data from the GDP. The data used to construct the model are for one year. We assume that the relationships observed in the economy over the course of the year are constant. We formulate the hypothesis that production technology is constant and that industries **exchange goods and services in a constant proportion**. To represent economic reality in an approximate way, we take a "snapshot of the economy," which is assumed to be invariable, when we carry out calculations with the aid of the input-output model. This hypothesis is formulated from a short term perspective, since we know that after a certain interval of time, the structure of exchanges between industries will change and technologies will be modified.

This hypothesis regarding the consistency of economic relationships between industries is at the basis of the so-called "linear" model; that is, a model in which the values **have a relationship of complete proportionality among themselves**. Thus, if we consider the effects of a 10 million dollar investment project, the results obtained, multiplied by ten, are valid for an impact of 100 million dollars, as long as the variation in demand maintains the same economic structure (with the relative share of the various goods and services remaining constant in that category of demand which is changing).

More precisely, the main hypotheses concerning the consistency of technology and inter-industrial relationships may be presented as follows:

- The value of the input (factor of production) from each of the industries represents a **fixed proportion** of the value of the total output (production) of the industry, and it does not depend on the composition of the output.

- All the industries in the economy **keep their market share for each of the goods and services** produced on Canadian territory, regardless of the output level of the industries.

- The economy has the production capacity needed to absorb increases in demand and useof the labour factor increases proportionally with output.

- Since the economy has the capacity necessary to meet the demand, prices are constant and therefore relative prices do not change. There cannot therefore be any reallocation of resources in the economy as a consequence of a variation in relative prices. For example, when salaries in the economy increase in relation to the cost of capital, capital tends to be used more efficiently or intensively in order to mitigate the effect of the increase in salaries or again, firms may change the composition of their inputs when relative prices change. These mechanisms of reallocating resources are not taken into account in the input-output model.

These hypotheses demonstrate the limitations of the input-output model as a tool for evaluating the economic impact of a variation in demand. **It is a short-term approximation of interindustrial operations in the economy.**

However, this analytical tool offers great flexibility in use, which allows us to circumvent some of the limitations just mentioned. With the help of additional calculations which will be discussed later, it is possible to adapt the input-output model to various types of analyses. Moreover, it should be pointed out that, since the data for the input-output model are regularly updated by Statistics Canada, the model generally reflects recent production technologies in the Canadian economy.

II. B. Meaning of the results in the open model

The input-output model discussed above represents what is called the open model. We specified that, within the framework of an input-output analysis, the term "open" has a particular meaning. With such a model, the measurement of the economic impact of a spending project or of the importance of an industry is limited to the chain reaction between industries that we described; this gives us an inter-industrial distribution of the production necessary to meet a variation in demand. These direct and indirect effects on production and employment make up what is actually a first level of reaction by the economy as the result of a given spending project. However, other reactions by economic agents will generally play a role in the economy, especially in the case of a large project. When employment increases in various industries, the salaried workers will, in turn, spend their incomes to buy goods and services. This spending mechanism will stimulate production and employment in other industries. This other chain reaction is the basis of the **Keynesian multiplier,** which is different from the multiplier described above in relation to the input-output open model.

Because of the hypotheses of the input-output model, we assume that a 100 million dollar project would have an impact in terms of employment and income that would be ten times greater than a 10 million dollar project. However, the model does not make any other distinctions between the two impacts. Actually, the greater the impact, the more we will generally see the effects of adaptation or adjustment on the part of economic agents. A significant increase in the production of various industries will create pressure on production capacities, and increase the firms' profits. This combination of effects may lead to an increase in investments to expand production capacity, or modernize an industry's equipment. This represents a second level in the economic effects associated with a spending project.

The **sequence of reactions** in the economy to a variation in demand as described in the open input-output model is **therefore incomplete**. There is another series of effects of a different nature called the **spin-off effects**, that generally follow the economic system's initial reactions, and this second wave may be greater if the initial impact is considerable, particulary when we take into account the reactions on the part of the enterprises in the affected industries. This second level of reaction that depends on the **response of economic agents**, represents what is known as the **spin-off effects.**

III . CLOSED MODEL OR MODEL WITH SPIN-OFF EFFECTS

III. A. Description of the closed model

In attempting to evaluate the effects of the second sequence of reactions in the economy, it is customary to add to the input-output model a mechanism that is intended to measure the spin-off effects due to the spending of income associated with the employment created by the initial impact of a spending project. The object is to take into account the reactions of persons who have earned an income as a result of output generated by the initial spending project.

The total payroll is known, as is the supplementary earned income (fringe benefits), and the income of self-employed workers generated as the result of employment created by the initial demand impact. We simply subtract income taxes on salaries and add transfer payments, in order to obtain a measure of the income available for consumption purposes. Subsequently, using an estimate of the propensity to consume, we can establish the consumption of goods and services by these workers. This consumption represents a sort of second "spending project" that will bring about another sequence of direct and indirect production in the economy, which is similar to that already described. Again, employment will be created to meet this additional demand. These new jobs will have a corresponding total employment income that will, in turn, be spent in the form of consumer goods and services. The process continues this way and the effects will eventually damper as the propensity to consume drops below one. The leakages into

savings will act in such a way that this spending mechanism will be progressively exhausted.

If we add the income and employment created by this spending mechanism, we can obtain an estimate of the **spin-off effects.** The higher **the salary share** in the income created by the initial project and the marginal propensity to consume, the greater these effects will be. A **closed input-output model**, or more precisely an input-output model with partial closure on consumption, measures the spin-off effects by adding to the input-output model a consumer goods spending mechanism[2]. Closure is partial because it only affects the spending mechanism related to consumer goods and services.

If we compare the income associated with the direct and indirect effects plus the income associated with the spin-off effects, with the value of the initial impact, we arrive at a multiplier that is **higher than one;** this serves as an estimate of the Keynesian multiplier found in macro-econometric models[3].

III. B. Assessment of the closed model

First of all, we should remember that the input-output model is a **static** model, and that we do not know the **time horizon** nor the phase of the economic cycle within which the economic impacts will take place. The model with partial closure on consumption provides estimates of the effects of a Keynesian multiplier, but we do not know how these effects will spread out over time.

The closure on consumption isolates only one facet of spin-off effects in the second sequence of reactions in the economy. We assume that **only consumers will react** to the increase in employment and workers' incomes. In fact, income on capital (mainly profits) will also increase. If the spending project is quite large, pressure on production capacities will be created and this, in conjunction with an increase in profits,

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[2] *Here again, the term "closed" is used in the particular context of input-output models. In general, in economics, the terms "closed model" or "closed economy" are used to describe an economy where there is no trade with foreign countries. Within the framework of input-output models, a closed model is one where the spin-off effects are at least partly taken into account.*

[3] *The input-output model used by Statistics Canada does not take into account the money market or the rate of interest. Without the effects of the rate of interest on economic activity, the Keynesian multiplier in the input-output model with partial closure on consumption is the one found in elementary economics manuals, and is calculated as follows:*

$\frac{1}{1-b(1-t)}$ *where b is the marginal propensity to consume and t, the rate of taxation on personal income.*

can lead to capital spending on non-residential construction, machinery, and equipment. Moreover, the increase in the firms' profits may also be at the origin of various other expenditures (such as research and development), which are ignored in the closed model. Furthermore, the model does not take into account the spending on residential construction that the increase in household income may bring about. Thus, an important weakness of the model with partial closure on consumption derives from the fact that it only takes into consideration one spin-off effect; namely, the consumer spending mechanism, and it neglects the other reactions of economic agents.

Moreover, because of the lack of a capital spending mechanism, a spending project will have a relatively higher multiplier effect if it favours **labour-intensive** production techniques, since only consumer spending by workers is taken into consideration in the second sequence of reactions. In a case where industries that use capital-intensive production techniques are involved to a greater extent, the multiplier is relatively smaller, because we do not estimate the spin-off effects associated with increased capital spending by the firms affected by the project.

Moreover, using constant coefficients to evaluate the employment required to achieve the level of production needed to meet a variation in demand for goods and services results, in certain cases, in overestimating employment, and therefore income from employment, and consequently consumer spending in the second sequence. Particularly in a period when the economy is not operating close to its full capacity, firms regularly "hoard up" labour, preferring to keep paying underemployed workers, rather than having to face the costs of layoffs and hiring. Under such conditions, the increase in demand results in an increase in productivity in the economy, and an increase in the working hours of underemployed labour, which tend to limit increases in employment. The input-output model, with its hypotheses on proportionality, cannot take these adjustments into account. If we overestimate the required employment, this error in estimation will then be reflected in an upward bias of the **value of the multiplier,** since we will overestimate employment income and consumer spending.

A similar reservation applies to the assumption of a constant propensity to consume when evaluating consumer spending. The propensity to consume **varies** as a function of the nature of employment, average salary level, the economic situation (in a weak economy, households pay their debts and save more, whereas they spend more in a stronger economy). A constant propensity to consume may thus produce an upward or downward bias on the value of the multiplier. Finally, as we have indicated, capital spending by households on residential construction is not measured. This spending depends on household income and several other variables such as interest rates - which are not included in the model.

Finally, a more fundamental criticism may be raised in respect to the use of the input-output model with partial closure on consumption to estimate spin-off effects. Not only is the mechanism for generating spin-off effects incomplete, but the model itself, **by**

virtue of its construction, does not take into account important macro-economic equilibrium relationships. Under these conditions, the value of the Keynesian multiplier obtained **using partial closure becomes even more difficult to interpret.**

In effect, the input-output model only deals with the **real sector** of the economy concerned with the **production** of goods and services by industries, and the **exchanges** of goods and services between industries that are necessary to achieve this production level. The input-output model assumes that prices are constant, and does not take into account the interaction that exists between the real sector of the economy and the financial sector (interest rates, exchange rates,etc.).

The impact of a spending project will vary during the different phases of the economic cycle and will also be affected by the nature of the Central Bank's monetary policy. In a strong economy, prices and salaries will increase when an increase in demand accentuates economic activity. An increase in prices tends to slow down the increase in economic activity. Also, an increase in economic activity will result in an increase in the demand for money by economic agents. Pressure on the demand for money will push interest rates up. The extent of this increase in interest rates will be dependent on the response of monetary policy decision makers. A rise in interest rates has, in turn, a feedback effect on the real sector. **It rations the allocation of resources** in the economy: some consumer spending or investment projects will no longer occur or be deferred. This supplanting effect caused by the increase in interest rates reduces the value of the multiplier in a general equilibrium context.

Furthermore, in an open economy such as Canada's, we must take into account the effect of increases in prices, salaries, and the rate of interest on the exchange rate. In a system with a flexible exchange rate, a rise in interest rates tends to increase the value of the Canadian dollar, and this creates a certain supplanting effect with regard to Canadian exports. Such effects can also reduce the value of the Keynesian multiplier.

Also, depending upon the position of the economy in relation to the economic cycle (strong or weak economic situation,etc.), the effect of inflationary trends on the labour and capital markets, and the attitudes of monetary policy decision-makers in view of these trends, we will obtain **multiplier effects which may vary greatly** for any given spending project. The multiplier effect may also vary with the **length of the period of analysis**. In the short run, the value of the multiplier is higher, but when we forecast over a longer period, the value of the multiplier diminishes, or may even become negative[4]. The decrease in the value of the multiplier over a longer time period is explained by the impact of the interest rate or the exchange rate changes on the real sector, and by the fact that this impact takes a certain time before it is felt.

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[4] *Simulations carried out with macro-econometric models of the Canadian economy will produce different values for the multiplier, depending upon the hypotheses used and the economic circumstances. In certain cases, a negative value is actually obtained for the multiplier when the supplanting effects are significant.*

III. C. Some conclusions

The use of a Keynesian spending multiplier with the help of an input-output model with partial closure on consumption raises numerous problems. Within the framework of the input-output model, partial closure gives greater importance to a partial category of spin-off effects related to consumer spending by employed individuals, and neglects spin-off spending that may be carried out by firms. The determination of the spin-off effects will also depend upon the **nature** of the impact, its **amplitude**, and the **phase** of the economic cycle at the time the project starts. The input-output model used to calculate the spin-off effects **mechanically** by partial closure on consumption cannot take all these factors into account. In fact, to take these various economic circumstances into consideration, the calculation cannot be carried out mechanically, and requires the intervention of the analyst, as we will show later.

Finally, in a more general context, where we take into account general equilibrium relationships in the economy, and in particular the interactions that exist between the real and financial sectors, the value of the multiplier obtained by partial closure becomes even more difficult to interpret. **The value of such a multiplier may in fact not be very credible when we consider dimensions such as monetary policy, inflation, interest rates and exchange rates.**

Under these conditions, it appears preferable, for the benefit of the users of the input-output model of the Canadian economy, that **Statistics Canada not offer mechanical impact solutions with partial closure on consumption.** Such an analytical tool is too simplistic, and the results may be doubtful or debatable. Thus, Statistics Canada is willing to offer the user the possibility of doing a certain number of additional simulations to serve as a basis for the estimation of spin-off effects. The user best knows the economic circumstances associated with the demand impact to be simulated and should be the person best able to formulate the appropriate hypotheses to evaluate the spin-off effects.

IV. ALTERNATIVES TO PARTIAL CLOSURE

To carry out simulations equivalent to partial closure with the help of the input-output model, it is not necessary for Statistics Canada to incorporate into its model a mechanism which, automatically and without distinction, will calculate the spin-off effects associated, for example, with workers' spending. The user of the input-output model can ask for **additional simulations** which will serve as a basis for the calculation of the spin-

off effects[5]. By specifying the conditions for doing these simulations, the user will get much more accurate, made-to-measure results, which better reflect the economic circumstances related to the simulation.

The user should be the one who can best measure the amplitude of the spin-off effects, based on prior knowledge of the pertinent economic circumstances. To this end, the user must first of all analyze the economic conditions that will prevail over the time period in which the project impacts will occur. In order to establish a sequence of additional spending, for example, and evaluate the economic impacts associated with consumer spending by workers, the user should examine factors such as the following, which relate to the spin-off effects regarding consumption:

- The main industries involved in meeting the demand of the initial project can be studied in order to determine whether the additional economic activity will give rise to an increase in productivity, or to the hiring of new workers. If orders can be filled by increasing productivity, or extending working hours, the spin-off effects will be significantly less than in a case where employment must be increased. The state of the production capacities of the industries concerned, and the point in the economic cycle at which they will become involved, are various indicators that can be used to determine the impact on employment.

- If the industries involved must hire new workers, the average salary level can be determined, and we can estimate propensity to consume, with the help of various data, on the basis of available income. Also, we can modulate the spin-off effects of consumption by examining the economic situation at the time the impact takes place: the propensity to save tends to increase in a period of economic slowdown or high interest rates, when consumers pay back their debts. Such economic circumstances tend to reduce noticeably the magnitude of the spin-off effects.

- In the case of more specific projects, such as a major engineering undertaking, it is often necessary to import labour from outside Canada or the region (province) where the impacts are to be measured. These workers will leave the province once the work is finished, and will not spend very much in the region while work is

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[5] *In this respect, in the model with partial closure on consumption, we should emphasize the fact that transposing workers' available income into the amount of consumer spending (via the propensity to consume) injected into the economy, is equivalent to doing* ***a second simulation,*** *in which the spending project is in fact made up of this consumer spending. e sequence of injecting consumer spending continues, and ends when the new spending to be reinjected eventually becomes negative.*

going on. Thus, we must estimate that share of the workers' income which will actually be spent in the country (or province) where we wish to measure the economic impact.

We can devise various other factors that should be taken into account in the case of various spending projects, whose impacts we may want to measure. Once the analysis is completed, we can enter new data into the input-output model to estimate the spin-off effects associated with consumer spending. For example, estimated consumer spending by workers hired for the initial project will represent a second impact, to be inserted into the model.

As for the spin-off effects related to expenses by firms, we can examine factors such as the following:

- For the industries that will be most closely involved in the project, we can determine whether, in the short run, they have sufficient production capacity to meet the demand. Contrary to the hypotheses of the input-output model, and as we have already indicated, industries may invest, and increase their production capacity, in order to meet the demands of the spending project. We can then estimate the capital spending, which will lead to additional spending in relation to the initial project.

- In cases where industries have sufficient capacity, using different information sources, we can try to evaluate how the profits earned through the activity related to the spending project will be used. For example, firms may proceed with capital spending on modernization and diversification; or a business may spend part of the profits onresearch and development or market strategy expenses (advertising, expanding the sales network, etc)[6]. Once we have assembled the information on how the firms will spend the profits generated by the initial project, we can take into account otherspending carried out by firms in the input-output model. Again, the results must be calibrated to take into account the economic situation at the time we estimate the spending will take place.

- We must also take into account notable characteristics of the project for which we want to simulate the economic impact. For example, the project may contain **specific requirements concerning the sourcing of inputs**. In this case, input-output coefficients from the

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[6] *Obviously, profits may not lead to any direct spending by an industry if they are used, for example, to pay back debts or to pay out dividends. In the case of dividends, we could estimate, with the help of additional information, how this income will be spent by the recipients.*

model may have to be adjusted to account for these particularrequirements. This modification could noticeably change the economic impact results of the initial project, and lead to a different evaluation of the spin-off effects. In particular, in the case of special projects, several investment components may have to be **imported**. In this case, the import coefficients in the input-output model maygreatly underestimate the flow of imports required. This deficiency can easily be corrected by the provision of a list of the main components of the investment project that must be imported. The magnitude of the initial impact will then be **reduced** but will better correspond to the project data. The calculation of the spin-off effects will then be adjusted to take into account the effects of imports associated with the project.

- Finally, the calculation of spin-off effects must take into account the length of the **forecast period**. Spending by firms as a result of an increase in profits can be spread over a relatively longer period of time than that associated with consumer spending. Thus, we have to specify the forecast period for which we want to make the calculations. In the longer run, **spin-off effects may affect the structure** of the economy more deeply than in the short run. For example, an investment project carried out by an industry following the completion of the initial project could reduce the flow of imports into the economy as a whole. From a longer term perspective, we could evaluate the gains accruing to the economy from the decline in import coefficients.

Thus, a study of the characteristics of the main industries involved in the initial project should allow us to determine the necessary data for taking additional impacts into account in the input-output model, in order to estimate the spin-off effects.

The estimation of additional injections of spending for simulations using the input-output model, on the basis of appropriate economic information which the user can gather, represents a more precise and credible method of analysis for evaluating spin-off effects, than the use of an input-output model mechanically, with partial closure on consumption. In this way, the user can prepare an economic impact study with much more credible foundations.

Another approach to using the input-output model consists of calculating first of all the total economic impact of a spending project with the help of a macro-econometric model of the Canadian economy. Such a model allows us to calculate the various effects of a project on production and employment, and the calculation takes into account the effects of the financial sector on the real sector of the economy when evaluating economic impacts. Once a project's economic impact, including the spin-off effects, is

established, we can then enter the total volume of production which we have obtained into the input-output model. Inserting the production volume into the input-output model allows us to know what the composition of production and employment by sector, as well as intermediary production requirements. The input-output model also allows us to find out the types of goods and services produced, and by which industries; in this way, we can calculate the gross production of the various industries, and their output in terms of goods and services. We can also evaluate the tax revenues accruing to the various levels of government. In short, this process will give us **all the information the input-output model can supply**, even though the model has not been used to calculate the economic impact. This is a way of circumventing the problems associated with using the input-output model for the calculation of spin-off effects, while **taking advantage of the economic information** that this model can provide. In this regard, certain organizations that use macro-econometric models to simulate the impact of various projects sometimes add to their econometric model a version of the input-output model in order to produce the economic information that we have described.

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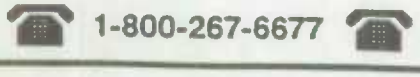
For faster service  **1-800-267-6677**

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