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Estimating More Timely Input-Output Accounts:

A Synthetic Approach

By

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By

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Abstract

Input-output updating methods typically use algorithmic techniques to adjust a set of coefficients to conform to current data. This paper describes an alternative approach used in the Canadian input-output accounts which seeks to enhance the timeliness of the tables by combining traditional updating and balancing techniques with the most recent data sources. It presents synthetic input-output estimates for two years and compares them with benchmark estimates. The results show that when all of the required data are anchored on a previous benchmark year, most input-output components can be estimated with relatively small estimation error. Results based on data which are two years away from input-output benchmarks are obtained at the cost of substantially larger errors but provide information useful for improving the quality of more current National Accounts estimates. Synthetic estimates of the input-output accounts improve the timeliness problem by at least a full year.

I Introduction

In Canada, benchmark input-output accounts are produced annually. A full set of transaction matrices, consisting of output, input, and final demand matrices as well as commodity margins has been produced at the National level for every year from 1961 to 1989. The compilation of such detailed accounts serves a number of purposes. For instance, they provide benchmarks for the current price Gross Domestic Product (GDP) in the quarterly income and expenditure accounts and the monthly GDP by industry in

*The authors wish to thank Kishori Lal, Philip Smith, Darryl Rhoades and Claude Simard for their useful comments on the Draft of this paper. Thanks are also due to Krishna Murty and Aftab Syed. Krishna Murty developed the methodology for calculating taxes on a more current basis.

constant prices[1]. Furthermore, they provide National control totals for Provincial GDP by industry in current and constant prices. Thus, a principal raison d'être of the annual Canadian input-output accounts is to provide support for, and to anchor, the more current production accounts of the Canadian System of National Accounts (CSNA). The annual input-output accounts also provide the essential ingredients of the annual multifactor productivity program which depends on detailed input and output matrices in both prices. The traditional labour productivity measures depend on components of GDP by industry in current prices (e.g. labour income, net income and other operating surplus) which are only provided by the annual accounts[2]. Being an integrated framework, the accounts are also relied on for regular feedback to subject-matter divisions in order to enhance the quality of the basic data.

An additional role of input-output accounts is to provide a disaggregate picture of the production account of the economy through time. They are used extensively to describe or analyze industrial dynamics within an integrated framework. In particular, analysis of changes in industry structure such as the evolution of

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[1]Additionally, Canadian input-output accounts are the only source for the following annual products:

- GDP (including components of GDP) by industry in current prices;
- Detailed estimates of taxes and subsidies in current prices by commodity and by industry;
- Personal expenditure by detailed commodity in current and constant prices;
- Detailed estimates of capital expenditure cross-classified by commodity and industry in current and constant prices;
- Estimates of gross output and inputs cross-classified by industry and commodity;
- Government expenditure, exports and imports cross-classified by commodity and categories of final demand in current and constant prices.

[2]See *Aggregate Productivity Measures*, Statistics Canada, Catalogue 15-204.

market shares and production technology and changes in income distribution (the composition of GDP) which occur at the industry level are derived from input-output accounts.

The benchmark input-output accounts are currently produced with a time lag of 2½ years from the reference year[3]. This paper presents a methodology developed to estimate more timely input-output accounts for Canada with an approximate lag of one year from the reference year.

II Background

In view of the pivotal role of input-output accounts in the Canadian System of National Accounts, the need to produce more timely input-output tables has been recognized for some time. However, the principal impetus for the development of more current input-output tables came in 1990 when the federal government of Canada slated the introduction of a Goods and Services Tax (GST) (replacing the manufacturers' sales tax) effective January 1, 1991 and, as a result, the role of net taxes (i.e., taxes net of subsidies) in commodity prices acquired greater prominence. Measuring the cumulative indirect tax content of final purchases--the sum of all types of commodity taxes levied on goods and services directly and indirectly--is a traditional application of input-output tables. A more current input-output account was

[3]During each annual production cycle, a preliminary set of accounts is produced for the latest data year while, simultaneously, the accounts for the previous data year are made final. Thus each production cycle results in accounts for 2 consecutive years which are analyzed and released together.

needed to calculate, for each commodity, total net taxes paid by final users both directly at the point of purchase and indirectly as they are paid by upstream producers in the business sector. Accordingly, Input-Output Division was given a marginal resource increase of two person-years to produce the current price input-output accounts for 1988 and 1989 by mid-1990. In June 1990, the synthetic input-output accounts described in this paper were developed for 1988 and 1989 to facilitate the measurement and analysis of the impact of indirect taxes within the framework of the CSNA[4]. The synthetic input-output accounts were subsequently compared with the preliminary benchmark accounts for 1988 and 1989 to assess the extent of estimation error of the new accounts. These appraisals showed encouraging results for the synthetic estimates as we will see in section V of the paper.

The paper is organized as follows. Section III reviews some of the updating techniques reported in the literature[5]. Section IV presents the methodology of the synthetic input-output accounts. Section V evaluates these estimates in relation to the preliminary

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[4]The synthetic input-output tables provided the takeoff point needed for the publication of several statistical measures within the CSNA. Among them were: 1) Indirect taxes less subsidies allocated to final demand; 2) Indirect taxes less subsidies at 1986 prices, allocated to final expenditure; 3) Effective tax rates; 4) Gross domestic product at factor cost in 1986 prices; and 5) Implicit price indexes, indirect taxes less subsidies. For a fuller discussion of these measures see Smith (1990).

An additional by-product of the project was that Statistics Canada obtained expenditure-based GDP at factor cost. GDP data at factor cost (in constant prices) were already being produced monthly and now they are also estimated from the expenditure side of the Accounts. Comparison and analysis of these two measures based on two different approaches are helpful in calibrating these estimates.

[5]The methods reviewed here are by no means exhaustive.

benchmark input-output accounts. The last section contains a summary of the results and concluding comments.

III Review of Updating Techniques

In an international context, input-output accounts are usually the least current of economic statistics owing to their complex estimation procedure and the massive data sources they must incorporate. The time lag for publication of input-output tables has been considerable in most countries, often taking several years between the reference year and date of publication. Moreover, tables are not usually compiled for each successive year, but may be compiled every few years or only on an occasional basis. This situation has encouraged research into updating techniques to make input-output tables more relevant and useful.

Although each updating exercise is distinct in some important way, three broad approaches can be readily identified in the literature. The first approach described here can be called an algorithmic approach. It is an attempt to update input-output data by estimating them through a predetermined algorithm as a function of coefficients in a base year (usually the most recently available year) and data on marginal totals. The data used may include the commodity price vector as well as current year controls. The controls are usually sum totals for rows (or total intermediate use by industry) and sum totals for columns (or total intermediate use by commodity). The best known and most widely discussed of these methods is the RAS technique introduced by R. Stone and G. Brown in 1962. It is an operational technique which utilizes the coefficient matrix of the base year and three data vectors from the reference year, namely, industry gross output, industry total intermediate use and the values of intermediate use by commodity (usually known as the intermediate outputs vector) to adjust the coefficient matrix to become consistent with the known information for the current year. The most advantageous and attractive feature of RAS seems to be its analytical clarity and operational simplicity. A technical coefficient matrix can be "adjusted" or updated through a series of iterative normalizations which force the distribution of the initial coefficients to conform alternately to the row and to the column totals given for the exercise. After a number of iterations, the process necessarily converges on a unique and non-negative coefficient matrix which is consistent with both industry gross output and commodity totals. Furthermore, the RAS technique allows exogenous information to be incorporated into the solution. Although it is a fast and reliable operational tool, RAS has a number of inherent limitations[6]. Its principal limitation stems from the scanty information that is used to generate the updated coefficient matrix. In a square input-output framework, for instance, with n industries and n commodities, values of a coefficient matrix of size n^2 is determined by two vectors of size n only, leaving a very large number (n^2-2n) of degrees of freedom.

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[6]For a fuller discussion of issues related to the estimation performance of the RAS technique, see Allen (1974) and Snower (1990).

Accordingly, Allen (1974) found that substantial improvements in accuracy can be gained by adding relatively small amounts of information into the RAS procedure[7]. Another important limitation of RAS is that it provides no mechanisms to improve the distribution of values of the final demand matrix.

A related updating method is known as the HM method, introduced by McMenamin and Harding (1974). This procedure is similar to RAS in most respects, but extends the iterative estimation procedure to the coefficients of the final demand matrix and generates estimates of industry value added[8].

In a recent article, Snower (1990) proposes an updating technique which extends the RAS method to incorporate price movements in addition to the data on marginal totals used by other methods. This is an iterative technique known as TAU. It substantially increases the amount of information used, and the quality of estimates generated, by an algorithmic method which is very similar to RAS.

Another distinct approach is to determine the entire coefficient matrix as the solution to a linear programming problem, with gross outputs and row and column totals for intermediate inputs as constraints. This is a non-iterative approach introduced

[7]Allen (1974), pp. 223. See also his summary of limitations of the RAS technique.

[8]For a fuller discussion of this method, see Tcharkari (1987), pp. 19-21.

by Matuszewski *et. al.* (1964) and uses the same ingredients as the RAS procedure to update input-output coefficients. The new coefficient matrix is defined as that matrix which, while meeting the control totals, represents the smallest overall departure from old coefficients (i.e., the unweighted sum of growth rates of all coefficients is smallest). In other words, the objective function of the linear program is specified as the minimum overall set of changes to the base year coefficients which would make them consistent with the reference year's output and input data. The linear programming method enjoys essentially the operational advantages of RAS, but does not estimate the actual coefficients with the same degree of accuracy. A comparison of the performance of RAS and linear programming estimates by Davis, *et. al.* found that, in every respect in which they were compared, coefficients estimated by the RAS method were superior. In particular, RAS produced coefficients with smaller average absolute errors and produced a larger number of estimated coefficients which were closer to the actual coefficients (compared to the linear programming technique).

A second broad approach may be called the *ex ante* approach, as distinct from the *ex post* methods which characterize all conventional statistical data collection[9]. Unlike the traditional input-output data which are collected after an event has occurred, this approach proposes to estimate directly the technical

[9]For an example of techniques and estimates which take the *ex ante* approach see Fisher *et. al.*

coefficients of a present or future input-output table. Fisher *et. al*, for instance, proposes to compile these coefficients by obtaining judgemental estimates of technical relationships directly from experts of relevant industries. Expert judgements would typically be obtained by field interviews, where such expertise exists, and the responses to interview questions would be quantified and normalized into coefficients.

The third distinct approach may be described as a synthetic approach. In particular, this approach begins by estimating a complete set of input, output and final demand transaction matrices by combining data from survey sources and projections from the most recent benchmark coefficients. These estimates are then subjected to balancing procedures used in the production of benchmark estimates. Both the U.S. Bureau of Economic Analysis annual accounts and the estimation of the Canadian accounts discussed below fall into this category.

In the United States, benchmark input-output accounts are available with a five year lag. For example, the 1987 benchmark accounts are slated for release at the end of this year, while the annual input-output tables for 1988 will, understandably, be available in March of this year. The estimation of the annual accounts, prepared by the U.S. Bureau of Economic Analysis, may be summarized as follows[10]. Industry gross output totals are first

[10] See Planting (1987), pp. 42-3.

established, mostly using survey data. The commodity composition of industry output is then estimated using the proportions of the last benchmark. These output totals are deflated and multiplied by the last benchmark coefficients to obtain intermediate inputs, and the results are then reflated (by commodity) into current prices. In estimating the final demand matrix, inventories, net exports of goods and services and government purchases of goods and services are developed from actual data while estimates of personal consumption expenditures and gross private domestic fixed investment are derived using commodity flow procedures.

IV The Canadian Synthetic Approach

In Canada, the synthetic approach employs the most recent monthly estimates of real GDP by industry, details of current price final expenditure estimates published in the Quarterly National Income and Expenditure Accounts, supplementary data from various subject-matter divisions of Statistics Canada, blueprints of taxes and subsidies along with their control totals developed in Input-Output Division, and the iterative procedures usually employed to produce the annual benchmark input-output accounts. The Canadian methodology is unique in that it benefits from two sets of estimates already available in the CSNA: the monthly estimates of gross domestic product by industry in constant prices[11] on the income side and, on the expenditure side, all expenditure

[11]Monthly estimates of GDP are published in *Gross domestic product by industry*, Statistics Canada Catalogue 15-001, Monthly. These estimates are released two months after the reference month.

components of the quarterly estimates of income and expenditure accounts in current prices[12]. Both sets of estimates are anchored to the latest benchmark input-output tables.

The procedure for developing the Canadian synthetic input-output accounts can be divided into four phases: estimating values in the gross output and input matrices, estimating values in the final demand matrix, estimating margins by commodity, and finally iterative balancing of the tables in purchaser's price and transformation of the tables to a producer's price base (or approximate basic value, in the United Nations terminology).

To describe various phases of this procedure we need to define the notations and input-output relationships presented in Chart 1[13].

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[12]Quarterly national income and expenditure accounts are published in *National Income and Expenditure Accounts*, Statistics Canada Catalogue 13-001, Annual. These estimates are released two months after the reference quarter.

[13]For a fuller description of the Canadian rectangular input-output framework see *The Input-Output Structure of the Canadian Economy* 1961-1981, Statistics Canada Catalogue 15-510.

CHART 1

Components of the Synthetic Input-Output Tables in the Framework of the Canadian Input-Output Accounts

	COMMODITIES	INDUSTRIES	FINAL DEMAND CATEGORIES						TOTAL
			C	I	N	G	X	-M	
COMMODITIES		U	F						q
OTHER INDIRECT TAXES LESS SUBSIDIES		t'_U	t'_F						t
GDP		h'	y'						
INDUSTRIES	V								g
TOTAL	q'	g'	e'						

Notations

- V — matrix of values of industry outputs (industry by commodity) at producers' prices
- U — matrix of values of intermediate inputs (commodity by industry) at purchaser's price
- t_U — vector of non-commodity taxes net of subsidies by industry
- t_F — vector of non-commodity taxes by categories of final demand
- t — total of non-commodity taxes net of subsidies
- h — the vector of gross domestic product by industry
- $g = Vi$ — vector of total industry gross outputs
- $q = V'i$ — vector of total commodity outputs
- F — matrix of final demand values at purchaser's price, consisting of the following submatrices:
  - C — submatrix of values of personal expenditure
  - I — submatrix of fixed capital formation by businesses and governments
  - N — submatrix of the values of physical change in inventories
  - G — submatrix of the government current expenditure on goods and services
  - X — submatrix of domestic exports and re-exports of goods and services
  - M — submatrix of imports of goods and services
- y — vector of labour income and depreciation paid directly by final demand categories.

Note: The layout of the synthetic input-output tables shown here differs from the way the accounts are published. In the published accounts, the U and the F matrices are compiled in approximate basic values with margins and commodity taxes appearing in separate rows. The tax vector would then include the commodity tax row in the input and final demand matrices. The synthetic tables provide no breakdown of components of industry GDP.

(i) Estimating Values in the Gross Output and Input Matrices

The first phase of the procedure consists of estimation of inputs and outputs in current prices. As a first step, the vector of real (constant price) industry GDP is taken from the monthly estimates of real GDP. These estimates are based on a host of industry gross output indicators and the assumption that the production technology of business sector industries has not changed between the two time periods, i.e., that the gross output-GDP proportions in constant prices are the same as those in the previous period[14]. Without any additional assumptions, we can estimate the industry gross output vector (in constant prices)for the year **t** by projecting the preceding year values by the change in real industry GDP (denoted by **h**) between the year **t** and **t-1** from monthly data sources.

$$g_t^{*k} = (H_{t-1}^k)^{-1} H_t^k g_{t-1}^k \qquad (1)$$

Where **g** is a vector of industry gross output and **H** is, for both time periods, a diagonal matrix whose elements are taken from elements of the vector of gross domestic product by industry, or **H = Diag (h)**. The subscript **k** signifies that values are in constant prices. An asterisk is used throughout the paper to denote a vector or matrix which is a synthetic estimate, as distinct from the data used by the estimation procedure.

[14] See reference in footnote 10 for an outline of the methodology of monthly estimates of GDP.

In the next step we assume that intermediate input coefficients remain unchanged in constant prices[15]. Intermediate inputs of industries in constant prices can then be estimated by post-multiplying the preceding year's input matrix by the change in industry real output between **t** and **t-1**. Estimates of real outputs for **t** are given by equation (1) while estimates of outputs for **t-1** are obtained from the preceding year's benchmarks

$$U_t^{*k} = U_{t-1}^{k}\ (G_{t-1}^{k})^{-1}\ G_t^{*k} \tag{2}$$

where **U** is the (commodity by industry) matrix of intermediate inputs and **G = Diag (g)** defined above.

To arrive at an initial estimate of the intermediate use matrix in current prices[16], the real estimates of equation (2) are inflated with the vector of prices **P** (by commodity)[17]

$$U_t^{*} = PU_t^{*k} \tag{3}$$

where **P = Diag (p)**.

Using the analogous assumption that real industry market shares have remained constant between **t** and **t-1**, a gross output

[15]An alternative approach to this procedure would be to use current price coefficients. Such an approach may be investigated to examine its merits compared to that noted here.

[16]For some industries such as Agriculture and related services industries, Construction and Finance, insurance and real estate, current price estimates of both outputs and inputs were developed in the Input-Output Division using the latest available basic source data in current prices.

[17]**P** is a vector of the ratio of commodity prices between **t** and **t-1**.

matrix in current prices can be estimated as in equation (2) by multiplying the preceding year's output matrix (in constant prices) by the change in industry gross output between **t** and **t-1**.

$$V_t^{*k} = (G_{t-1}^k)^{-1} \; G_t^{*k} \; V_{t-1}^k \tag{4}$$

The output matrix in constant prices is then post-multiplied by the diagonal matrix of prices to obtain the first current price estimate of the output matrix

$$V_t^* = V_t^{*k} \; P \tag{5}$$

The estimated **V** in current price is then summed over commodities in equation (6) to obtain total industry gross output in current prices

$$g_t^* = V_t^* \; i. \tag{6}$$

As the accounting framework in Chart 1 shows, the gross output (or Make) matrix, the intermediate use matrix and the vector of industry gross domestic product are related to one another by the following relationship

$$g = U'i + t_u + h \tag{7}$$

namely, the gross output of an industry is equal to the sum of its intermediate inputs (in purchaser's price), non-commodity taxes (net of subsidies) and GDP. We have already developed estimates of industry gross output and intermediate inputs. Having developed the control totals and industry detail of non-commodity taxes and subsidies (in current prices) from basic source data, we can derive residually the vector of industry gross domestic product **h**.

$$h_t^* = g_t^* - (U_t^{*\prime} i + t_u) \qquad (8)$$

This completes the first estimates of output and use matrices in current prices. We now estimate values of the final demand matrix.

(ii) Estimating Values of the Final Demand Matrix

The second phase of this procedure is to make an initial estimate of the final demand matrix (including vector **y**). As the accounting framework in Chart 1 shows, this matrix specifies the disposition of all goods and services to final uses such as personal expenditure by households and non-profit institutions, investment by both governments and businesses, inventory change, government expenditure on goods and services, and net exports. These categories are also articulated in the income and expenditure accounts. As mentioned earlier, the published quarterly income and expenditure accounts in current prices is an important data source for synthetic updating purposes, because preliminary estimates of expenditures on GDP are published two months after the reference quarter.

The initial estimate of the final demand matrix consists of calculating the commodity breakdown of each category of expenditure (**C**, **I**, **N**, **G**, **X** and **M**) while maintaining the sub-control totals provided in the Income and Expenditure accounts. The submatrix **C** is obtained by reclassifying the commodity detail available for this category in the Income and Expenditure accounts into the concording input-output commodity classification. Where adequate commodity breakdown is not available, preceding year coefficients are adjusted for price changes and used to obtain the required detail.

The submatrix **I** requires estimates of investment (fixed capital formation) broken down by investing industry[18] and by the commodity classification of input-output tables. Aggregate expenditures on construction and on machinery and equipment are taken from the quarterly income and expenditure accounts. The industry and commodity breakdown for investment in all types of construction are obtained from the annual Capital Expenditures Survey. The commodity breakdown of machinery and equipment is obtained by reference to the few commodity details available in the Income and Expenditure accounts and available industry coefficients[19].

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[18]Fixed capital formation is estimated by industry because it helps in balancing of industry-specific capital goods. For example, judgement on the use of telephone cable can be made only if we have information on the level of fixed capital formation for the telephone industry.

[19]By "Coefficient" we always refer to coefficients from the last benchmark input-output accounts.

For the submatrix **G**, data on GDP components (wages and salaries and depreciation) are available in the income and expenditure accounts while the commodity detail of inputs is obtained using benchmark coefficients. The commodity details of inventories are obtained similarly. The commodity details of imports and exports however, are obtained from the data bases of International Trade Division and the Balance of Payments Division of Statistics Canada.

The procedure outlined so far results in an initial estimate of the final demand matrix in current purchasers' prices--i.e., matrix $\mathbf{F}^*$ and vector $\mathbf{y}^*$. It may be noted that this matrix and the estimated matrices for output, intermediate use and industry GDP are not consistent with one another at this stage. In other words, they do not satisfy the commodity supply and demand identity shown in the accounting framework of Chart 1.

(iii) Estimating Margins by Commodity

Before the balancing process can begin, margins need to be estimated by commodity. The calculation of the trade margins generally followed procedures similar to those used for benchmark estimates[20]. Transport margins, however, were calculated by multiplying the last benchmark transport rates by the deflated value of commodities and by reflating the constant price values by

[20] See *Service Industries in the Canadian Input-Output Accounts*, Statistics Canada Catalogue 15-601E No. 2 - Occasional, for a description of the benchmark methodology.

weighted prices of transport services and making appropriate adjustments so that they agree with control totals of transport margins.

By contrast, tax margins for the synthetic tables were calculated by the same procedures that are used for benchmark accounts[21]. As such, they have been able to play a role in calibrating the estimates already produced in the final demand matrix for various transactions. The Canadian input-output tables distinguish 16 types of taxes, and as many control totals must be established from basic sources such as public accounts and correspondence. Information on taxes such as the federal sales tax and Provincial sales taxes is not available by commodity. Hence estimates for each type of tax is made with reference to documents on tax legislation. In this estimation procedure, the sums of estimated taxes are compared with the precalculated control totals and the differences analyzed. These differences are a potential source of new information for this phase of estimation. They may indicate, for instance, that an under- or over-statement in the value of some expenditure (or expenditure by some Provinces) needs to be adjusted. Problems in the control total of taxes may also surface. In fact, the analysis of tax data for 1988 and 1989 using the input-output framework led to an adjustment in the control

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[21]Where information on taxes by commodity are not available, margin estimates are based on tax blueprints. The blueprints have been developed in consultation with tax officials of the federal and provincial governments. See Yusuf Siddiqi and P.S.K. Murty "Commodity Indirect Taxes in the Canadian Input-Output Accounts, 1984" in Statistics Canada (1986).

The blueprints for 1988 and 1989 were developed by the Public Sector section of Input-Output Division headed by Krishna Murty. This section is responsible for the calculation of all taxes.

total of commodity taxes obtained from the income and expenditure accounts.

(iv) Balancing the Input-Output Tables - General

To provide a perspective on the balancing process, let us look at the three phases of balancing. They are: industry balance, commodity balance at purchasers' prices, and transformation of the purchasers' tables into producers' prices (approximate basic value). In the "industry balance" phase, data on outputs and inputs, by industry and by categories of final demand, are assembled and analyzed. First the control totals of output and intermediate input, and the subtotals for materials, energy and services are established and then the commodity composition of the subtotals is determined. Primary inputs are also estimated during this phase. The sum of industry primary inputs and intermediate inputs equals industry total input, which equals industry total output. Control totals by final demand categories are also established at this stage.

Commodity supply (domestic plus imports) and commodity demand (as intermediate use and final use) are established and balanced in the "commodity balance" phase. Since data on industrial output from survey sources are collected in producers' prices while purchases of inputs are only observed in purchasers' prices, a consistent valuation system must be established in the commodity balance stage. The differences between the two valuation systems are known as margins. Seven commodity margins are distinguished in the Input-Output Accounts: retail, wholesale, transportation, tax, gas, storage, and pipeline margins. The commodity balance phase involves first estimating the values of relevant margins for each commodity. The total supply of each commodity (the sum of production, imports, and margins) is then compared with total demand or disposition. Varied and unpredictable differences immediately become apparent. Supply must equal disposition for each commodity. The under- or over-allocation of commodities is examined and eliminated. Several reasons could account for a discrepancy: production may be unreported or misclassified; imports and exports may be improperly valued or misclassified; servicing of foreign equipment in Canada may, for instance, show up as a merchandise export rather than a service export or import; valuation and timing may be inconsistent, etc. These problems are tackled through investigation, often by going back to basic records to locate the sources of such imbalances. Experience has shown that using the commodity balance approach, with detailed accounting of output, use and final demand transactors, causes major problems to surface. At this stage, even the previously determined industry balances are called into question. After a number of iterations, the system reaches equilibrium, with both industries and commodities in balance.

The final stage involves the transformation of intermediate and final demand values into approximate basic values. This phase consists of allocating each margin to users of intermediate commodities and to final demand categories. This phase partially overlaps with the previous phase, because a commodity margin is, in effect, the sum of the margins paid by all users of a commodity. In this final phase, individual commodity margins are reviewed and, where necessary, adjusted between commodities, while the total margin estimate for the business sector remains unchanged.

(v) Balancing Procedure for the Synthetic Tables[22]

The balancing procedure for the synthetic tables closely follows the iterative process described above so that all input-output estimates are kept consistent. The preparation of synthetic tables, however, places an additional demand on the balancing procedure. As a diagnostic tool, industry balance and commodity balance phases typically identify disequilibria which are due to imperfections in data collection, economic measurement techniques and commodity and industry classifications. In the synthetic context, industry and commodity imbalances may also indicate other phenomena. In general, intermediate input and gross output coefficients change over time because of new relative prices, technical progress with or without new factor proportions, and

[22]It is not generally appreciated that economies of scale in the compilation of estimates can best be achieved by producing input-output tables annually. Such a course is recommended even when the source data are less detailed. The annual tables bring a time series dimension to the data analysis which must be taken into account even when occasional tables are produced. As such, there would not be a significant saving in resources from resorting to less frequent input-output tables.

market share and product mix changes which are due to a multitude of diverse market forces. In the balancing process of the synthetic input-output tables, efforts are made to identify the sources of disequilibria. For instance, the industry output and intermediate input subtotals established in the industry balance phase must be analyzed for changes due to new production technology or new product mixes which are known to have occurred within a given industry. Similarly, analyses done in the commodity balance phase help to establish whether the given domestic and export demand for a commodity is compatible with the new production and market share levels which emerged from the industry balance phase. The balancing procedures provide an occasion for ameliorating the estimates with traditional tools of input-output identities and extraneous industry information. However, it is not always possible for balancing procedures to identify and incorporate structural changes, or the appropriate impact of relative price changes, into the synthetic estimates. Hence, these tables cannot be a substitute for the benchmark input-output accounts.

V Evaluation of Synthetic Estimates

Synthetic input-output estimates for a full set of transaction matrices were developed for 1988 and 1989 before preliminary tables were compiled for each year. The estimates were developed at the historical link level of aggregation[23]. In this section the synthetic accounts for 1988 and 1989 are compared with Medium level[24] aggregations of benchmark input-output tables.

There are a number of ways in which the synthetic estimates can be evaluated for their accuracy. Since they are the best estimates of input, output, final demand and impact matrices prior to the compilation of the benchmark tables, it is important to know quantitatively how certain aggregates from these tables differ from those of the preliminary benchmarks. These comparisons reveal the magnitude of errors we should expect if they were to be used as advanced estimates of the actual input-output accounts. These differences are not forecast errors in a strict sense, because they also reflect revisions in the source data between the projections used to estimate the synthetic accounts and the benchmark estimates which come on stream later. Synthetic estimates also incorporate the latest update in source data which have been too late to be incorporated into the monthly GDP or the quarterly income and expenditure estimates. In other instances, where the preparation of the benchmark estimates have benefited from the early feedback

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[23]Benchmark input-output accounts can be presented for three levels of commodity and sector detail:

Industry	Commodity	Final Demand	Period
190	602	136	1961-1980
216	602	136	1981-1987
216	626	136	1988-onward

To convert the various series into a consistent one, a historical link series has been created consisting of 161 industries, 485 commodities and 136 categories of final demand.

[24]The Medium level of aggregation details 50 industries, including 3 fictive industries, 100 commodities and 28 categories of final demand. This level of aggregation allows a close concordance with quarterly estimates of final expenditure compiled in the Income and Expenditure accounts.

provided by synthetic results, "forecasting error" does not accurately describe such differences. For instance, the synthetic tables indicated an error in the tax data. Nevertheless, certain aggregates from these estimates are directly compared with their benchmark counterparts, in terms of absolute differences, in order to show their distance from their ultimate target. In evaluating the impact matrix, where a number of measures can be used to characterize the differences[25], comparisons focus on the predictive capabilities of the synthetic versus benchmark-based impact matrices to present intuitively simple results.

[25] For instance, an entropy measure can be used to provide an index of these differences, or a weighted absolute difference measure can be used to aggregate the differences.

TABLE 1

ESTIMATES OF FINAL EXPENDITURE ON GDP FROM THE SYNTHETIC ACCOUNTS AND ABSOLUTE DIFFERENCES FROM BENCHMARK DATA (%)

	MEDIUM LEVEL CATEGORY	EXPENDITURE ($ Millions) 1988	EXPENDITURE ($ Millions) 1989	ABSOLUTE ERROR (%) 1988	ABSOLUTE ERROR (%) 1989
1 PE	MOTOR VEHICLES, PARTS & REPAIR	27,582	28,740	0.5	0.7
2 PE	FURNITURE & HOUSEHOLD APPLIANCE	10,863	11,875	1.1	6.7
3 PE	OTHER DURABLE GOODS	16,040	17,677	0.1	2.8
4 PE	CLOTHING & FOOTWEAR	20,307	21,567	0.6	2.4
5 PE	OTHER SEMI-DURABLE GOODS	15,220	16,413	0.3	2.5
6 PE	FOOD & NON-ALCOHOLIC BEVERAGES	39,400	41,845	1.0	4.0
7 PE	MOTOR FUELS & LUBRICANTS	10,581	11,460	1.4	0.3
8 PE	ELECTRICITY,GAS & OTHER FUELS	11,649	12,567	0.4	2.7
9 PE	OTHER NON-DURABLE GOODS	32,935	35,488	0.6	0.2
10 PE	GROSS RENT(IMPUTED & PAID)	62,497	69,377	0.1	0.1
11 PE	RESTAURANTS & HOTELS	22,465	24,560	0.4	5.1
12 PE	NET EXPENDITURES ABROAD	1,347	2,043	0.0	32.0
13 PE	OTHER SERVICES	79,722	87,095	0.2	1.2
14 CON	MANUFACTURING	3,234	3,755	0.0	10.7
15 CON	MINING,QUARRYING & OIL WELLS	7,167	6,071	0.0	2.3
16 CON	HOUSING & REAL ESTATE COM	44,316	48,670	0.6	2.8
17 CON	OTHER BUSINESS	21,083	24,466	0.0	0.7
18 CON	GOVERNMENT	10,835	12,290	0.2	2.8
19 M&E	MANUFACTURING	14,427	16,534	1.4	0.0
20 M&E	MINING,QUARRYING & OIL WELLS	1,514	1,221	0.0	8.1
21 M&E	OTHER BUSINESS	26,325	27,501	4.2	2.5
22 M&E	GOVERNMENT	2,869	2,990	0.0	9.8
23 INV	INVENTORIES	6,569	4,352	69.6	11.3
24 EXP	DOMESTIC EXPORTS	155,084	159,043	0.6	0.6
25 RX	RE-EXPORTS	3,643	3,828	0.1	1.0
26 IMP	IMPORTS	(154,299)	(162,524)	0.4	1.9
27 GCE	GOVT GROSS CURRENT EXPENDITURE	127,937	136,859	0.7	2.2
28 GCE	GOVT SALE OF GOODS & SERVICES	(14,642)	(15,617)	0.6	3.3
	WEIGHTED MEAN**			0.9	1.9

* Categories of final expenditure are designated as follows: PE denotes personal expenditure categories, CON denotes construction investment expenditure, M&E indicates investment expenditure on machinery and equipment while INV refers to inventories, EXP to exports, RX to re-exports, IMP to imports and GCE refers to current expenditures by the government sector. Brackets around figures indicate that the values are negative entries.

** Weighted mean, the weights being the share of absolute value of each of the expenditure categories in their total.

The most crucial components of the synthetic input-output tables are estimates of expenditure on gross domestic product (expenditure-based GDP) and of gross domestic product by industry (income-based GDP). Table 1 presents synthetic estimates of expenditure on gross domestic product by final sectors of the economy for both years. The table also shows the absolute values of the differences between these and the benchmark estimates at the Medium level of aggregation. They indicate that most categories of expenditure were estimated with remarkably small error for 1988. With the exception of inventories, all categories of expenditure were estimated with less than 5% absolute error for this year. It may be noted that estimates of net expenditure abroad are obtained from balance of payments sources so that errors indicated in Table 1 reflect only revisions in the source data. Errors in the estimation of inventories, however, are entirely attributable to the synthetic estimation procedures which treat inventories as a balancing item in the goods market, a repository of estimation errors for other categories (such as valuation timing error in the international trade data). In the benchmark estimates, inventories, like other expenditures, are reconciled with relevant divisions and all the errors in the source data are resolved as far as possible through consultation with subject-matter divisions.

For 1989, all but 7 estimates had errors of less than 5% in absolute value. However, these errors were much larger than for 1988. We can compare the combined error of the two sets of estimates through a weighted mean absolute error, the weights being the relative share of the absolute value of each of the expenditure categories in their total. Errors for 1989 were more than twice as large as those for 1988, pointing to a marked deterioration in the accuracy of estimates. The synthetic estimates rely on the latest input-output structure (1987 in this case), both in estimating values of intermediate use and some components of final expenditure. The quarterly income and expenditure estimates and the real industry GDP--the starting points for this exercise--were also based on the same 1987 benchmark year. Clearly the coefficients become less relevant the further the estimation period is from the benchmark year. It should be expected, then, that the 1989 estimates which were more distant from the benchmark year and had never been revised would lead to synthetic estimates with larger errors for individual expenditure categories.

TABLE 2

ESTIMATES OF GDP BY INDUSTRY IN THE SYNTHETIC ACCOUNTS AND ABSOLUTE DIFFERENCES FROM BENCHMARKS (%)

MEDIUM LEVEL INDUSTRY	GDP BY INDUSTRY ($ Millions) 1988	1989	ABSOLUTE ERROR (%) 1988	1989
1 AGRICULTURAL & RELATED SERVICES IND	12,133	11,313	6.8	5.1
2 FISHING & TRAPPING INDUSTRIES	1,230	1,039	0.3	3.7
3 LOGGING & FORESTRY INDUSTRIES	3,625	3,355	2.3	10.3
4 MINING INDUSTRIES	9,242	8,870	1.2	5.3
5 CRUDE PETROLEUM & NATURAL GAS	7,134	7,447	9.3	16.2
6 QUARRY & SAND PIT INDUSTRIES	785	848	1.2	5.1
7 SERVICE RELATED TO MINERAL EXTRACT.	2,158	1,676	0.6	5.9
8 FOOD INDUSTRIES	11,408	11,939	8.0	9.8
9 BEVERAGE INDUSTRIES	2,608	2,439	6.6	8.2
10 TOBACCO PRODUCTS INDUSTRIES	767	823	2.4	0.6
11 RUBBER PRODUCTS INDUSTRIES	1,126	1,250	0.3	9.6
12 PLASTIC PRODUCTS INDUSTRIES	2,170	2,267	4.7	0.8
13 LEATHER & ALLIED PRODUCTS IND.	525	555	7.6	8.5
14 PRIMARY TEXTILE & TEXTILE PROD. IND	2,399	2,365	1.9	2.3
15 CLOTHING INDUSTRIES	2,833	3,079	0.3	2.6
16 WOOD INDUSTRIES	5,617	5,980	7.1	10.0
17 FURNITURE & FIXTURE INDUSTRIES	2,102	2,190	9.1	6.5
18 PAPER & ALLIED PRODUCTS INDUSTRIES	10,933	10,981	1.8	8.6
19 PRINTING, PUBLISHING & ALLIED IND.	6,521	7,064	1.8	0.8
20 PRIMARY METAL INDUSTRIES	8,681	8,453	1.2	5.3
21 FABRICATED METAL PRODUCT INDUSTRIES	7,089	7,731	1.5	0.5
22 MACHINERY INDUSTRIES	4,307	4,297	0.6	6.9
23 TRANSPORTATION EQUIPMENT INDUSTRIES	13,754	14,307	2.9	6.1
24 ELECTRICAL & ELECTRONIC PRODUCTS	7,863	8,212	1.9	0.1
25 NON-METALLIC MINERAL PRODUCTS IND.	3,903	4,171	4.7	14.2
26 REFINED PETROLEUM & COAL PRODUCTS	1,731	1,265	24.6	342.8
27 CHEMICAL & CHEMICAL PRODUCTS IND.	9,048	8,993	3.1	3.4
28 OTHER MANUFACTURING INDUSTRIES	2,597	2,750	0.1	2.7
29 CONSTRUCTION INDUSTRIES	36,077	40,126	1.8	1.3
30 TRANSPORTATION INDUSTRIES	19,884	21,023	0.0	4.1
31 PIPELINE TRANSPORT INDUSTRIES	1,834	1,919	5.9	9.4
32 STORAGE & WAREHOUSING INDUSTRIES	706	791	23.3	34.0
33 COMMUNICATION INDUSTRIES	14,582	15,827	0.2	1.9
34 OTHER UTILITY INDUSTRIES	17,311	18,034	0.2	2.8
35 WHOLESALE TRADE INDUSTRIES	28,576	30,950	0.5	1.6
36 RETAIL TRADE INDUSTRIES	34,030	36,366	0.5	2.0
37 FINANCE & REAL ESTATE INDUSTRIES	41,908	47,106	0.3	0.8
38 INSURANCE INDUSTRIES	3,487	3,271	1.6	8.3
39 GOVT. ROYALTIES ON NAT. RESOURCES	3,897	4,052	12.2	14.7
40 OWNER OCCUPIED DWELLINGS	34,206	38,187	0.6	1.3
41 BUSINESS SERVICE INDUSTRIES	22,147	25,068	3.3	4.9
42 EDUCATIONAL SERVICE INDUSTRIES	992	1,068	1.6	3.7
43 HEALTH SERVICES INDUSTRY	11,001	11,835	0.7	1.1
44 ACCOMMODATION & FOOD SERVICE IND.	13,917	15,161	2.1	0.9
45 AMUSEMENT & RECREATIONAL SERVICES	5,023	5,417	6.2	12.6
46 PERSONAL & HOUSEHOLD SERVICE IND.	5,083	5,769	1.0	2.8
47 OTHER SERVICE INDUSTRIES	6,698	7,444	7.1	6.9
WEIGHTED MEAN			2.1	3.8

The synthetic estimates of GDP by industry are presented in Table 2 and compared with the benchmark results for the same years in terms of the absolute value of the estimation error, or the difference between the synthetic estimate and the actual estimate. For 1988 some 26 industries' GDP--accounting for about 70% of total business sector GDP--were estimated with less than 2% absolute error. Estimates with less than 5% absolute error were achieved for 34 industries which produced about 85% of business GDP. By contrast, 1989 estimates with less than 2% error were obtained for only 12 industries producing about 48% of business GDP, while estimates with less than 5% error, for 23 industries, covered about 74% of business GDP. All but 3 estimates of 1988 industry GDP were produced with less than 10% error. Government royalties on natural resources, Storage and Warehousing and petroleum were the only cases where errors exceeded 10% for 1988. Estimates for these industries also showed the largest absolute error in 1989[26]. Over all, errors in industry GDP estimates for 1988 were considerably smaller than those for 1989. The weighted mean absolute error, which is a measure of overall error, increased from 2.1% in 1988 to 3.8% in 1989, indicating the expected deterioration in accuracy as we move away from the benchmark year.

[26]The large error for GDP of Refined petroleum and coal products industry in 1989 is related to a large increase in the price of crude oil which was not matched by a similar increase in the price of refined petroleum.

TABLE 3

PREDICTIONS OF SYNTHETIC IMPACT MATRICES AND DIFFERENCES FROM PREDICTIONS OF BENCHMARK IMPACT MATRICES
($ Millions)

MEDIUM LEVEL INDUSTRY	1988 PREDICTED GROSS OUTPUT	1988 DIFFERENCE (%)	1989 PREDICTED GROSS OUTPUT	1989 DIFFERENCE (%)
1 AGRICULTURAL & RELATED SERVICES IND	21064	-0.5	21641	-0.9
2 FISHING & TRAPPING INDUSTRIES	1487	-11.7	1314	-20.5
3 LOGGING & FORESTRY INDUSTRIES	7501	-8.0	7872	-11.6
4 MINING INDUSTRIES	8780	-1.2	8814	-5.4
5 CRUDE PETROLEUM & NATURAL GAS	12269	1.8	12486	-3.8
6 QUARRY & SAND PIT INDUSTRIES	993	6.6	1029	4.4
7 SERVICE RELATED TO MINERAL EXTRACT.	3708	-0.1	3008	-4.5
8 FOOD INDUSTRIES	35425	0.4	36143	-0.6
9 BEVERAGE INDUSTRIES	6185	-1.1	5907	0.5
10 TOBACCO PRODUCTS INDUSTRIES	1709	1.7	1842	-0.8
11 RUBBER PRODUCTS INDUSTRIES	1331	-5.9	1204	-1.1
12 PLASTIC PRODUCTS INDUSTRIES	3592	-1.3	3648	-2.5
13 LEATHER & ALLIED PRODUCTS IND.	794	0.6	764	0.4
14 PRIMARY TEXTILE & TEXTILE PROD. IND	3130	0.6	2937	-2.9
15 CLOTHING INDUSTRIES	6485	0.3	6839	1.5
16 WOOD INDUSTRIES	13926	0.3	14223	1.4
17 FURNITURE & FIXTURE INDUSTRIES	4502	3.5	4777	5.2
18 PAPER & ALLIED PRODUCTS INDUSTRIES	22469	0.5	22369	1.1
19 PRINTING, PUBLISHING & ALLIED IND.	10367	0.2	10883	0.4
20 PRIMARY METAL INDUSTRIES	17160	1.5	16657	1.3
21 FABRICATED METAL PRODUCT INDUSTRIES	11378	1.0	12036	-1.3
22 MACHINERY INDUSTRIES	5649	-0.7	6180	-4.9
23 TRANSPORTATION EQUIPMENT INDUSTRIES	32839	-3.2	35952	-4.8
24 ELECTRICAL & ELECTRONIC PRODUCTS	10243	-3.6	10793	-4.8
25 NON-METALLIC MINERAL PRODUCTS IND.	5809	4.3	5792	5.5
26 REFINED PETROLEUM & COAL PRODUCTS	11494	1.6	12996	-0.6
27 CHEMICAL & CHEMICAL PRODUCTS IND.	13636	3.1	14216	-4.3
28 OTHER MANUFACTURING INDUSTRIES	3811	3.4	3812	-0.7
29 CONSTRUCTION INDUSTRIES	89227	0.2	98717	0.1
30 TRANSPORTATION INDUSTRIES	34356	0.2	36317	1.0
31 PIPELINE TRANSPORT INDUSTRIES	2382	-0.4	2613	6.4
32 STORAGE & WAREHOUSING INDUSTRIES	1043	12.6	1064	18.8
33 COMMUNICATION INDUSTRIES	17905	0.7	19066	2.0
34 OTHER UTILITY INDUSTRIES	18312	0.3	19508	-2.8
35 WHOLESALE TRADE INDUSTRIES	38212	0.2	40876	2.8
36 RETAIL TRADE INDUSTRIES	49649	0.0	52819	-0.2
37 FINANCE & REAL ESTATE INDUSTRIES	65352	-2.6	73173	-3.2
38 INSURANCE INDUSTRIES	9227	2.7	9346	1.7
39 GOVT. ROYALTIES ON NAT. RESOURCES	3152	12.8	3201	14.9
40 OWNER OCCUPIED DWELLINGS	44770	0.0	49760	0.0
41 BUSINESS SERVICE INDUSTRIES	24804	-2.8	28193	-3.9
42 EDUCATIONAL SERVICE INDUSTRIES	1625	0.0	1864	0.0
43 HEALTH SERVICES INDUSTRY	14473	-0.1	15539	0.2
44 ACCOMMODATION & FOOD SERVICE IND.	23162	-0.1	27183	-2.1
45 AMUSEMENT & RECREATIONAL SERVICES	7726	-2.1	7857	-0.6
46 PERSONAL & HOUSEHOLD SERVICE IND.	5957	0.7	6512	1.7
47 OTHER SERVICE INDUSTRIES	8696	-6.4	9765	-9.7
48 OPERATING, OFF., CAFET. & LAB. SUP.	22920	-4.0	23540	-0.9
49 TRAVEL, ADVERTISING & PROMOTION	18938	-1.8	20433	-1.4
50 TRANSPORTATION MARGINS	15595	-1.2	15731	1.0

Although a primary use of synthetic accounts is related to estimates of industry GDP within the framework of a balanced input-output table, it can also be used to support traditional output determination models to assess the impacts of hypothetical exogenous changes in demand[27]. It is useful to measure the accuracy of the inverse matrix constructed from synthetic estimates. A natural way to evaluate their accuracy would be to compare the predicted industry gross outputs for a given change in final expenditure using the synthetic compared to actual impact matrices. In order to make these comparisons sensitive to the relative importance of different expenditure categories, we use the actual (benchmark) values of final expenditure on GDP for this test. In other words, we calculate the necessary industry gross outputs needed to fulfil the entire actual final expenditure by each category of final demand, using alternately the actual and the synthetic impact matrices. The resulting industry gross outputs are presented in Table 3. They show that for all but 3 cases for 1988 and 4 cases for 1989, predicted gross output values with the synthetic model differed from those using the actual model by less than 10%. In fact, in 32 of the 50 industry impacts reported, the differences were less than 2% (in absolute value) between predictions of the actual and predictions of the synthetic impact matrices for 1988. For 1989, only 28 cases show errors of less than 2%.

[27]For a full description of the impact matrix of the Canadian input-output tables see Statistics Canada (1987).

VI Summary and Concluding Remarks

Input-output accounts have a central function within the Canadian System of National Accounts. In addition to providing benchmarks, much of the statistical integration and reconciliation of varied data sources in the production accounts hinge on reliable but timely input-output accounting. While the quality and reliability of the accounts have long been established and internationally acknowledged, their timeliness has always fallen short of users' demands and expectations. The synthetic approach described in this paper seeks to improve the timeliness of the accounts.

Most attempts by practitioners to deal with the inherent time lag of input-output tables have taken an algorithmic approach to "updating" input-output coefficients, involving mechanical adjustments which bring the coefficients into conformity with available control totals. We have shown in this paper that a synthetic approach similar to that taken by the U.S. Bureau of Economic Analysis in its annual accounts is a feasible and effective alternative.

The procedure used in the estimation of synthetic input-output accounts involved the integration of data on final expenditures (by category of end user) developed in the Quarterly Income and Expenditure accounts and estimates of monthly GDP in constant prices (both of which are anchored to the 1987 benchmark input-output accounts) which are available on a preliminary basis. Other important ingredients are the input-output structure of the latest benchmark year, timely tax and subsidy data and the latest available updates to source data. Unlike the RAS technique, this approach utilizes the full details of final demand and industry outputs and inputs but does not take the marginal totals as fixed. By incorporating independently developed data sources into the input-output framework, inconsistencies and valuation problems are uncovered, be they outputs, inputs or final demand. Synthetic estimates can thus be a good tool for providing early feedback to the SNA and subject-matter divisions so that their preliminary or projected estimates can be improved. An equally important contribution of the synthetic accounts is that they provide a more timely impact matrix, compared to the benchmark accounts which come on stream about two years later. The synthetic impact matrix is crucial to current efforts at Statistics Canada to calibrate these two data sources each time they are published.

The statistical accuracy of the synthetic impact matrix is assessed in the last part of this paper. It should be noted that benchmark input-output tables are the only valid source of statistics on the production and demand structure of the economy. As synthetic estimates are based on well informed judgements of how to combine projections and partial information within an accounting framework, they necessarily leave out structural changes and the impact of relative prices. A new set of industry market shares following expanded free trade initiatives, a new set of production techniques resulting from a protracted recession or simply a new set of consumer preferences would be fully reflected only in benchmark input-output tables which incorporate such information. In this light, what accounts for the remarkably small estimation errors for 1988 is that the key data sources are based on a set of input-output benchmarks for one year earlier and the most recent updates to source data are used in the estimation procedure. We cannot conclude that similarly reliable synthetic estimates could be produced if the final expenditure and real industry GDP projections were based on a synthetic account in the base year (1987) and coefficients from a synthetic input-output table were used. Estimates for 1989 provide a tentative indication of the magnitude of errors in the synthetic accounts if the key data sources (and input-output coefficients) were based on benchmark data for two years earlier[23].

We have measured the performance of the synthetic approach by comparing some important elements of the synthetic tables with the actual benchmark values. These include expenditure on GDP for a 28

[23]We can only infer from the results presented here that if final expenditures were based on synthetic, rather than benchmark, input-output estimates for 1987, they would incorporate the errors shown in Table 1 into their estimates. Estimates of expenditure for the following year would thus compound these with errors which are normally found in their own estimates compared to benchmark values. A comparison of errors showed that those presented in Table 1 are strongly correlated with the difference between the quarterly income and expenditure accounts and the benchmark values. This indicates that errors would indeed compound if synthetic rather than benchmark estimates were used. Projection errors in the monthly real GDP data are more difficult to analyze and compare with those in Table 2 because, unlike the synthetic estimates, they are in constant prices. However, errors in their growth rates compared to constant price benchmarks are correlated with growth rates in Table 2 and support the compounding effect noted above.

- category breakdown and GDP by industry at the M level of input-output tables with a 47-(real) industry breakdown.

For industry GDP, 1988 estimates with less than 5% absolute error were produced for 34 out of the 47 industries accounting for about 85% of the business sector GDP while, for expenditure on GDP, most categories were estimated with less than 2% error. Results for 1989 which is two data years after the benchmark year show an expected reduction in accuracy. For instance, industry GDP is estimated with less than 5% absolute error for only 23 of 47 industries producing 74% of the business sector net output.

An additional benefit of the synthetic estimates, also assessed for accuracy in this paper, is the reduced time lag in making the impact matrix available to users. For both 1988 and 1989, they predict the impact of hypothetical final expenditures on most industries' gross output with less than 5% error.

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