

Value-added exports: measurement framework

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July 3, 2014

1. Introduction

Globalization has brought about an increase in the gross flows of trade. While an important measure of the interconnectedness of economies, this increase in gross flows cannot be easily related to domestic value-added. To fill this important analytical gap, Statistics Canada is publishing a value-added exports database that provides a set of analytical measures of trade to complement the basic statistics on the gross exports and imports of goods and services.

The value-added exports database shows the exports and imports of industries, as well as the direct and indirect impacts of each industry's production for exports on total value-added¹, jobs, and imports. These estimates provide a measure of the importance of each industry's exports for the entire economy. The database also includes the indirect impacts of all production for exports on each specific industry, thereby providing a measure of an industry's total reliance on exports beyond its own direct exports. Figures are separately articulated for U.S. and non-U.S. exports and imports.

The basic measurement framework relies on modelling methods that quantify the contribution of exports to domestic value-added and employment. These methods are based on tracking imports and domestic inter-industry transactions related to the production of exports. The main data sources are the input-output (IO) tables, which are published by Statistics Canada with a three year lag from their reference period. Geographic detail on U.S. and non-U.S. trade, which is not available from the IO tables, is compiled from merchandise trade and balance of payment statistics. Goods are attributed to the country of origin or destination in accordance with the customs-based merchandise trade statistics and services in accordance with balance of payments statistics. The industry jobs figures are from the Labour Productivity Measures.

The rest of this document is divided as follows. Section 2 provides a description of the database variables. Section 3 explains the basic measurement framework. Section 4 presents numerical examples of some of the basic calculations. Section 5 briefly compares the Canadian value-added exports framework to the Trade in Value-Added (TiVA) database published by the OECD and WTO and finally some basic evidence from the 2010 figures is shown in an annex to help illustrate the discussions.

2. The Value-added exports database

The data are presented according to the input-output industry classification system, which consists of 234 industries at the detailed level. The list and description of the variables in the database are provided in Table 1. Both the export and import figures exclude re-

¹ Value-added represents the contribution of labour and capital to the production process. Its components are labour income, gross operating surplus (or profits) and taxes net of subsidies on production. The sum of value-added by all industries plus taxes net of subsidies on products is equal to Gross Domestic Product (GDP). Section 4.1 provides further explanations on the calculations of value-added and GDP.

exported imports. Re-exports are products that are imported and that are subject to a change in ownership but that are not subject to any substantial transformations in the domestic economy before being exported². Exports from inventory withdrawals are also excluded from the figures to avoid exaggerating the share of exports in each year's total production.

Table 1 List and description of variables

Variable	Title	Description
YEAR	Year	Figures are currently available from 2007 to 2011
INDUSTRY	Industry	233 industries, classified according to the input-output NAICS-based industry classification.
X	Exports	Domestic exports, excluding re-exports.
VA	Value-added	Value-added at basic prices by industry.
VADX	Direct value-added exports	Direct value-added attributable to the industry's exports.
VAX	Value-added exports	Total value-added attributable to the industry's exports. The sum of direct value-added and the value-added generated in all other upstream industries.
VAXFD	Value-added due to foreign demand	The impact on an industry's value-added from exports by all industries. Includes direct value-added from the industry's own exports and all indirect value-added from all other industries' exports.
VAXS	Services value-added embodied in exports	Domestic services value-added embodied in exports
M	Imports	Imports.
MUSE	Imports of intermediate inputs	Imports of intermediate inputs.
MX	Imports embodied in exports	The sum of direct and indirect imports embodied in the production of exports.
L	Jobs	Total number of jobs.
LDX	Direct jobs embodied in exports	Direct jobs attributable to the industry's exports.
LX	Total jobs embodied in exports	Total jobs attributable to the industry's exports. The sum of direct jobs and the jobs generated in all other upstream industries.
LXFD	Jobs due to foreign demand	The impact on an industry's jobs from exports by all industries. Includes direct jobs from the industry's own exports and all indirect jobs from all other industries' exports.

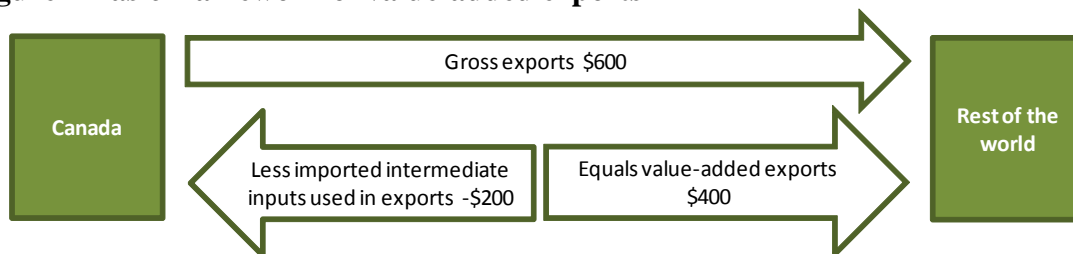
² In 2010, re-exports accounted for around 6 % of total Canadian exports.

3. Measurement framework

In general terms, the contribution of exports to domestic value added is based on removing the double counting of all imported intermediate inputs used in the production of exported goods and services. Intermediate inputs are the goods and services, excluding fixed assets, consumed in the production process.

Figure 1 illustrates the basic framework of value-added exports. As shown in this example, value-added exports are equal to the value of gross exports less the value of imported intermediate inputs used in the production of the exported products ($\$400 = \$600 - \$200$). These imported inputs must account for the consumption of imports in both the industry producing the exports as well as all upstream industries supplying inputs to the exporting industry.

Figure 1 Basic framework of value-added exports



Value-added exports are derived from calculations that are based on the rectangular, industry-by-product IO tables³. The IO tables show the use of products and primary inputs by industries in the production of supplies to other industries and to final expenditures as well as the type of final expenditures by product. The information contained in the rectangular input-output tables can be rearranged schematically in the supply and use framework shown in Figure 2. The tables are organized as matrices and vectors to illustrate the mathematical framework. Capital letters denote matrices, the small letters vectors, and the attachment of a superscript (T) the transposes of matrices and vectors.

The rectangular input-output tables show the supply of products by domestic producers (V) and from imports (m), value-added components by industry (W), the uses of products by industries (U) domestic final demands (f) and exports (x). Exports are articulated by product but not by supplying industry and similarly, imports are articulated by product but not by purchasing industry. Two basic accounting identities characterize the system: the total supply of each product must equal its total uses and the total output of an industry must equal its total inputs.

³ Certain adjustments to the published IO tables are introduced to enhance the precision of the input-output models. Enhanced detail is generated for the retail, wholesale, and transportation margins to better align the margin demand with their producing industries. The fictive industries are eliminated and their inputs are proportionally allocated to the industries consuming the fictive products.

Figure 2 Input-output framework

Supply table				
	Industries	Total commodity output	Imports	Supply
Products	V^T	q	m	q + m
Total industry output	g^T			

Use table			
	Industries	Final uses	Use
Products	U	f + x	iU + f + x
Value added	W		
Total industry inputs	g^T		

Legend

V^T = transpose of output matrix (product by industry)
 q = vector of product output
 g^T = transpose of industry output vector
 m = vector of imports by product
 U = use of intermediate inputs matrix (product by industry)
 W = value added components matrix (components by industry)
 f = vector of domestic final demand by product
 x = vector of exports by product

In the input-output modeling framework⁴, industry output is related to the sum of domestic demands for intermediate inputs and final consumption and foreign demand (exports) through the following accounting identity⁵:

$$g = D[(I - \hat{\mu})(Bg + f) + x] \quad (1)$$

where D is a matrix of industry market shares by product of dimensions industry by product, used to allocate products to their industry of origin

$$D = V[\text{diag}(q)]^{-1} \quad (2)$$

⁴ For further information on input-output models see Miller and Blair (2009).

⁵ For the sake of simplicity, the following presentation abstracts from the roles of inventory withdrawals, and other minor leakages from current production such as used goods and scrap.

B is a matrix of intermediate input coefficients, of dimensions product by industry, used to estimate the intermediate inputs required to produce industry outputs

$$B = U[\text{diag}(g)]^{-1} \quad (3)$$

and $\hat{\mu}$ is a diagonal matrix of import shares by product, which is defined as the share of imports in total domestic demand; more easily calculated as the share of imports in total supply net of exports, and which is used to calculate import leakages from domestic production

$$\hat{\mu} = \text{diag}(m)[\text{diag}(q - x + m)]^{-1} \quad (4)$$

By isolating g in equation (1), domestic output by industry can be defined as a function of two basic elements, final expenditures and an inverse which embeds all inter-industry transactions required to produce those final expenditures:

$$g = [I - D(I - \hat{\mu})B]^{-1}D[(I - \hat{\mu})f + x] \quad (5)$$

The bracketed inverse, generally referred to as the Leontief or input-output inverse, $[I - D(I - \hat{\mu})B]^{-1}$, creates a link between final expenditures and all required production activities, inclusive of direct and all indirect (upstream) production activities. Focusing on the exports portion of final expenditures, the contribution of foreign demand to value-added by all industries, VAX , can thus be derived from:

$$VAX = \hat{v}[I - D(I - \hat{\mu})B]^{-1}Dx \quad (6)$$

where \hat{v} is a diagonalized vector of value-added to output ratios by industry, of dimensions industry by industry.

A useful term embedded in equation (1) is Dx ; the pre-multiplication of the exports vector x by the market share matrix D , provides an estimate of gross exports by industry.

Similarly to equation (6), the contribution of exports to jobs, LX , can be defined as

$$LX = \hat{l}[I - D(I - \hat{\mu})B]^{-1}Dx \quad (7)$$

where \hat{l} is a diagonalized vector of jobs to output ratios by industry, of dimensions industry by industry.

The value of imports both directly and indirectly embodied in exports, MX , can be derived from the industry import coefficients and the exports-related outputs of industries:

$$MX = \hat{\rho}[I - D(I - \hat{\mu})B]^{-1}Dx \quad (8)$$

where $\hat{\rho}$ is a diagonalized vector of import shares by industry, derived through the multiplication of the average import shares by product and the input coefficients matrix:

$$\hat{\rho} = \text{diag}(\mu' B) \quad (9)$$

The Leontief inverse accounts for all upstream impacts on the output of an industry as well as direct impacts. Measures that focus on the direct impacts of exports on value-added, $VADX$, excluding impacts on upstream, supplying industries, do not require the use of the inverse and can be simply derived from the pre-multiplication of the shares of industry outputs associated with exports (Dx) by the industry value-added to output ratios, as shown in equation (10); and similarly for the direct impact of exports on jobs, LDX , through the industry jobs to output ratios, in equation (11):

$$VADX = \hat{\nu} Dx \quad (10)$$

$$LDX = \hat{l} Dx \quad (11)$$

Aside from measuring impacts of all exports on each specific industry, it is also possible to measure the impacts of an industry's exports on the rest of the economy. This information can be derived from information in the rows of the Leontief inverse, as opposed to focusing on information in the columns as was done above. $VAXFD$, the impact of exports by all industries on an industry's value-added can be derived from:

$$VAXFD = [\hat{\nu}[I - D(I - \hat{\rho})B]^{-1} \text{diag}(Dx)]i \quad (12)$$

Similarly $LXFD$, the impact of an industry's exports on jobs in all other industries can be derived from:

$$LXFD = [\hat{l}[I - D(I - \hat{\rho})B]^{-1} \text{diag}(Dx)]i \quad (13)$$

Product imports are converted into industry imports, M , based on the assumption that imported products have the same industry of origin as domestically produced products:

$$M = Dm \quad (14)$$

Imports of intermediate inputs by industry, $MUSE$, are based on multiplying the intermediate inputs of industries by the average import shares of products:

$$MUSE = \mu' U \quad (15)$$

The two main underlying assumptions of the model relate to the homogeneity of production functions and the proportional allocation of supply. The first assumption is that each industry produces all its different outputs using a single production function. The second assumption is that each exported product is produced by industries based on their average market shares among domestic producers; and that all domestic demands are supplied from domestic industries and imports in proportion to their shares in total domestic demand by product.

These simplifying assumptions undermine the precision of the modeled estimates. The industries of origin of exports and of inputs used in their production, including the imported inputs, may differ from what average market shares may indicate; thus undermining the precision of the estimates. Furthermore, the use of a single industry-level production function may not properly reflect the differentiated production functions of domestic and world-market oriented firms, especially in the context of the growing globalization of production. In reality though, this latter assumption may not be as limiting as it may first appear. The high level of detail provided by the Canadian supply-use tables (234 industries by 470 products) likely classifies producing units and their products into highly homogeneous groupings.

4. Numerical example

This section provides a numerical example to illustrate the basic calculations. The first part provides an overview of the supply and use tables; the second part shows the calculations required for estimating the direct impacts of exports; and the third part shows the slightly more involved methods required to derive the total impacts of exports.

The estimates generated in sections 4.2 and 4.3 are only for demonstrative purposes. The high level of aggregation of the data undermines the precision of the calculations. Furthermore, for the sake of simplicity, the demonstration abstracts from the more differentiated treatment of certain elements such as re-exports and the expenditures of Canadian households while abroad.

4.1 Input-output tables

Tables 2 and 3 provide a numerical example of the industry-by-product input-output tables organized into the supply-use framework⁶. The supply table (Table 2) shows the output of products by domestic industries and international imports of products. The last row of the supply table shows total output by industry, total imports and total supply. The last column of the supply table shows total supply by product as the sum of domestically produced and imported products.

The use table (Table 3) shows the use of goods and services by product and by type of use, i.e. as intermediate consumption of industries, final use for consumption, gross capital formation and exports. It also contains the components of value-added by industry, i.e. labour income, gross mixed income, gross operating surplus, and other taxes net of subsidies on production. The last column of the use table shows total uses by product as the sum of domestic uses and international exports.

⁶ For further information on the supply-use framework see United Nations (2009).

Table 2 Supply table

Products	Output				Total output	Imports	Total supply
	Primary	Construction	Manufacturing	Services			
Agriculture and forestry	62	0	1	0	63	9	73
Mining	170	0	1	0	171	38	209
Utilities	43	0	0	8	52	1	52
Construction	0	260	0	0	260	0	260
Manufacturing	1	0	537	3	541	381	922
Services	10	2	36	1,959	2,008	89	2,098
Taxes net of subsidies on products						-3	-3
Total	286	263	576	1,971	3,095	515	3,610

Table 3 Use table at basic prices

Products	Input				Final uses						Total uses
	Primary	Construction	Manufacturing	Services	Final consumption expenditures by households	Final consumption expenditures by NPISH	Final consumption expenditures by government	Gross fixed capital formation	Changes in inventories	Exports	
Agriculture and forestry	14	1	31	2	10	0	0	0	-1	17	73
Mining	17	14	75	5	3	0	0	8	2	85	209
Utilities	3	0	9	15	22	0	0	0	0	2	52
Construction	4	0	1	28	0	0	0	226	0	0	260
Manufacturing	26	72	197	118	181	0	0	65	-1	264	922
Services	51	60	96	687	623	24	366	74	1	115	2098
Taxes net of subsidies on products	-3	2	0	4	76	0	0	15	0	0	95
Value added at basic prices	173	113	167	1111	0	0	0	0	0	0	1564
Taxes net of subsidies on production	6	5	2	59	0	0	0	0	0	0	72
Compensation of employees	44	70	101	624	0	0	0	0	0	0	839
Gross mixed income	7	20	1	166	0	0	0	0	0	0	193
Gross operating surplus	115	19	63	263	0	0	0	0	0	0	460
Total	286	263	576	1971	915	24	366	389	1	483	5273

As previously mentioned, there are two basic identities that characterize the supply and use tables. Total supply by product is equal to total uses by product and total output by industry in the supply table is equal to total input by industry in the use table.

The different approaches to measuring value-added and GDP from the supply and use tables are shown in Figure 3. The two different methods of measuring value-added and the three different methods of measuring GDP are conceptually equivalent and provide exactly the same values when derived from balanced supply and use tables.

The production approach: provides an estimate of value-added at basic prices as the difference between output and intermediate consumption of each industry. The sum of value-added by all industries plus taxes net of subsidies is equal to GDP at market prices. Often value-added at basic prices is also referred to as GDP at basic prices.

The income approach: also provides an estimate of value-added by industry or for the aggregate economy and can be obtained from summing the contributions of labour and capital to the production process. It is equal to the sum of labour income, gross operating surplus, gross mixed income⁷, and taxes less subsidies on production. Similarly to the production approach, the sum of value-added by all industries plus taxes net of subsidies is equal to GDP at market prices.

The expenditure approach: provides a measure of GDP at market prices for the aggregate economy. It is equal to the sum of the final consumption expenditures of households, Non-Profit Institutions Serving Households (NPISH) and government, gross capital formation, and exports net of imports.

Figure 3 Measurement of value-added and GDP

Production		Income		Expenditure	
Total output	3,095	Taxes less subsidies on production	72	Final cons. exp. of households	915
- Intermediate consumption	-1,527	+ Compensation of employees	839	+ Final cons. exp. of NPISH	24
- Taxes net of subsidies on products	-4	+ Gross mixed income	193	+ Final cons. exp. of government	366
		+ Gross operating surplus	460	+ Gross capital formation	389
				+ Exports	483
				- Imports	-515
= Value added at basic prices	1,564	= Value-added at basic prices	1,564		
+ Taxes less subsidies on products	99	+ Taxes less subsidies on products	99		
= Gross domestic product	1,663	= Gross domestic product	1,663	= Gross domestic product	1,663

⁷ Gross mixed income combines both the labour income and the gross operating surplus of some of the unincorporated enterprises controlled by the household sector. The two are combined into one 'mixed' income due to the statistical difficulty of deriving separate income flows for the labour and capital components of these units.

4.2 Direct impact of exports

The direct impacts of exports on industry output are derived by converting exports by product into industry exports through industries' average market shares by product. The direct impact on value-added is subsequently derived by applying industries' value-added coefficients to the output values derived in the first step. These steps are further explained below.

The average product market shares by industry, matrix D, derived from the outputs by industry is shown in Table 4. It is equal to the value of each product output divided by its total output. Taking manufacturing as an example (column 4 of Table 4), Table 2 shows output of manufacturing products by the primary industries out of total output of manufacturing products, $1 / 541 = .001$, for the manufacturing industry as $537 / 541 = .99$ and for the services industry $3 / 541 = .01$.

Table 4 Product market shares, D matrix

Products	Agriculture and forestry	Mining	Utilities	Construction	Manufacturing	Services
Industries						
Primary	0.98	0.99	0.84	0.00	0.00	0.01
Construction	0.00	0.00	0.00	1.00	0.00	0.00
Manufacturing	0.02	0.01	0.01	0.00	0.99	0.02
Services	0.00	0.00	0.15	0.00	0.01	0.98
Total	1.00	1.00	1.00	1.00	1.00	1.00

The input coefficients (or technology functions) of industries are shown in Table 5. These coefficients are derived from the input table and show the amount of inputs required to produce one unit of output. They are derived as the value of inputs divided by total inputs of each industry. The coefficients are split into two matrices, one for intermediate inputs, *B*, and one for the value-added components; for simplicity in this case only the sum of the value-added components is shown, *w*. For example, the value-added coefficient of manufacturing is derived from table 3 as the sum of the value-added components divided by the industry's total inputs $(2 + 101 + 1 + 63) / 576 = .29$.

Table 5 Technology coefficients

B matrix, input coefficients

Products	Industries			
	Primary	Construction	Manufacturing	Services
Agriculture and forestry	0.05	0.00	0.05	0.00
Mining	0.06	0.05	0.13	0.00
Utilities	0.01	0.00	0.02	0.01
Construction	0.02	0.00	0.00	0.01
Manufacturing	0.09	0.27	0.34	0.06
Services	0.18	0.23	0.17	0.35
Taxes net of subsidies on products	-0.01	0.01	0.00	0.00

v^T vector, value added coefficients

Value added at basic prices	0.60	0.43	0.29	0.56
Total	1.00	1.00	1.00	1.00

As discussed in section 3, the formulation Dx , the pre-multiplication of the exports vector x , by the market share matrix D , provides a conversion of exports by product, as they appear in the SUTs, to exports by industry. The first column of Table 6 shows the result of these calculations. Taking the example of the services industry, the sum of an element by element multiplication of the last row of the D matrix by the exports vector, shows $(.15 * 2) + (.01 * 264) + (.98 * 115) = 114$; the share of the services industry in the production of utilities, manufacturing, and services times the export values of each of these products respectively is the value of exports by the services industry.

Pre-multiplying the exports by industry from Dx by the value-added coefficient of each industry (v) generates an estimate of the direct impact of exports on value-added, shown in the last column of Table 6. For example, the services industry value-added coefficient from v times the industry's exports $(.56 \times 114) = 65$.

Table 6 Direct gross and value-added exports by industry

Industry	Direct gross exports by industry Dx	Direct value added exports by industry $\hat{v}Dx$
Primary	103	62
Construction	0	0
Manufacturing	265	77
Services	114	65
Total	483	204

4.3 Total impact of exports

Quantifying the total impact of exports requires going beyond the direct impacts generated in the exporting industry to including all other upstream impacts on economic activity. A schematic view of these interactions is provided in figure 3. Exports by product originate in domestic production and their direct impact on value-added is described in section 4.2. However, purchases of intermediate inputs by the exporting industry are supplied from either imports or a second round of output by domestic producers. Similarly, these second round producers generate value-added and further purchases of domestically produced and imported intermediate inputs. This process can iterate for several rounds until it converges to trivial effects on the economy. In this manner, the value of an export can be fully decomposed into its constituents: the direct and indirect impacts on value-added and the indirect impacts on imports.

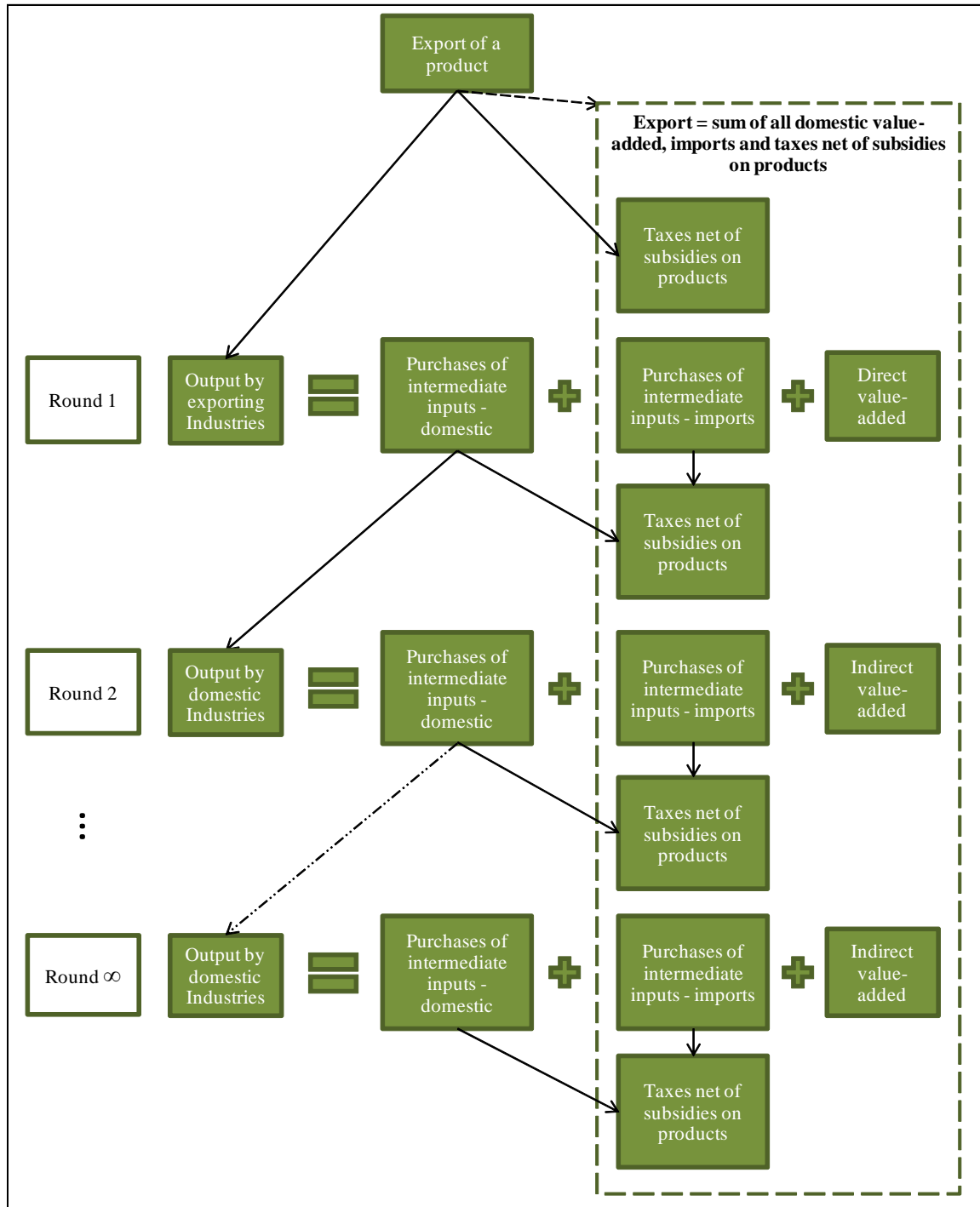
The round-by-round impacts described in figure 4 are calculated by tracking the inter-industry transactions required to produce the exports:

- i) The market shares matrix, D , allocates the demand for exports to their producing industries.
- ii) The intermediate inputs coefficient matrix, B , converts industry outputs into the required demands for intermediate inputs.
- iii) The μ matrix derives the imports associated with the demand for intermediates and thus simultaneously the residual demand for output from domestic producers.
- iv) The market shares matrix, D , allocates demands for domestic intermediate inputs to their producing industries.
- v) Steps ii to iv are repeated until the impacts become trivial. With this method, less than ten iterations usually account for most of the impacts.

Equation (14) formalizes the impact of these iterative steps on industry output. The sum of the power series is merely an approximation of the IO inverse calculated in equation (3).

$$\begin{aligned}
 g^* &= Dx + D(I-\mu)BDx + (D(I-\mu)B)(D(I-\mu)B)Dx + (D(I-\mu)B)^3Dx + \dots \quad (16) \\
 &= [I - D(I - \hat{\mu})B]^{-1}Dx
 \end{aligned}$$

Figure 4 Total impact of exports



It is possible to examine any stage of the process by extracting the impact on industry output of the relevant terms from the right-hand-side of equation (16). Subsequent application of industry coefficients can be used to extend the analysis to other variables. Thus, the vector of value-added coefficients, v , can be applied to the industry outputs generated, g^* , to derive the impact on value-added. Similarly, the import shares by industry coefficients vector, ρ , can be used to derive the value of imports.

Average import shares assumption

As discussed in the previous section, intermediate purchases must be allocated between domestic producers and imports. Multiplying the input coefficients by the import shares by product generates the import shares by industry. Table 7 shows the values of μ , the import shares by product vector. The table also shows $\hat{\mu}B$, the import shares by product by industry, and their column sums, the vector ρ , which provides the value of total import shares by industry.

The import shares by product measure the observed average proportion of imports in domestic demands. This average however may hide a large heterogeneity in import shares by industry⁸ and may thus lead to a misallocation of upstream impacts on imports and value-added.

Table 7 Import shares by product and by industry

Products		Industries			
		Primary	Construction	Manufacturing	Services
	μ	$\hat{\mu}B$			
Agriculture and forestry	0.17	0.01	0.00	0.01	0.00
Mining	0.30	0.02	0.02	0.04	0.00
Utilities	0.01	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00
Manufacturing	0.58	0.05	0.16	0.20	0.03
Services	0.05	0.01	0.01	0.01	0.02
Total	0.16	ρ' vector, import coefficients by industry			
		0.09	0.19	0.25	0.05

⁸ Some information on import shares by demand category are available from the IO tables and it is used to differentiate import, re-exported imports and purchases of Canadian households while abroad.

Total inter-industry impacts

The values of the IO inverse matrix are shown in Table 8. The matrix tabulates all the upstream impacts on the output of each row industry of deliveries to final demand by the column industry. For example, a one dollar's worth of exports by manufacturing will lead to 20 cents of output by primary industries, 1 cent by construction, 1.20 dollars by manufacturing (inclusive of the original export of 1 dollar's worth) and 33 cents by services.

Table 8 IO inverse

	Industries			
Industries	Primary	Construction	Manufacturing	Services
Primary	1.12	0.08	0.20	0.03
Construction	0.02	1.01	0.01	0.02
Manufacturing	0.07	0.16	1.20	0.06
Services	0.30	0.38	0.33	1.51

Multiplying through the columns of the IO inverse by the value of industry exports (from Table 6) generates an estimate of their total upstream impacts on all industries' outputs, as shown in Table 9. Impacts on industries' value-added and imports are derived from the application of the respective industry coefficients to industry output levels. As expected, the sum of impacts on value-added and imports, $368 + 116 = 484$, is almost equal to the value of gross exports (Table 3). The difference of one is accounted for by the impact of taxes net of subsidies on products which for the sake of simplicity has been ignored.

As an alternative to weighting the industry outputs, the inverse itself could have been weighted by industry value-added to output coefficients to provide a more direct relationship between a 1 dollar delivery to final demand and the upstream impacts on value-added by industry. This weighting could have been similarly applied to import coefficients or any other variable for which a direct relationship to industry output can be reasonably assumed such as jobs coefficients.

Table 9 Total inter-industry transactions related to exports

	Industries				
Industries	Primary	Construction	Manufacturing	Services	Total
Output					
Primary	115	0	53	3	171
Construction	2	0	3	3	8
Manufacturing	7	0	317	7	331
Services	31	0	89	173	293
Total	155	1	462	186	803
Value-added					
Primary	69	0	32	2	103
Construction	1	0	1	1	3
Manufacturing	2	0	92	2	96
Services	18	0	50	98	165
Total	90	0	175	103	368
Imports					
Primary	10	0	5	0	15
Construction	0	0	1	0	1
Manufacturing	2	0	81	2	84
Services	2	0	5	9	15
Total	14	0	90	11	116

5. Comparison of VAE to the OECD-WTO Trade in Value-added database

The OECD and WTO have jointly published a Trade in Value-added (TiVA) database (OECD-WTO 2012). The TiVA database is calculated from a world input-output table and provides detail for 40 countries and 18 industries. The world input-output tables allow for the estimation of a large number of analytical variables and geographical detail that cannot be derived from the Canadian input-output tables.

The advantage of a world input-output table is that it allows tracking intermediate inputs as they cross geographic boundaries and industrial processing stages on their destination to foreign or possibly domestic final demands. Thus, the TiVA database tracks foreign value-added by industry and geography, including any recursive impacts on the domestic economy. The main weakness of the TiVA database, however, is the lower precision of its estimates due to the high industrial aggregation level used and the adjustments to

national figures required to balance multilateral international trade—which is often contradictory in official statistics—across the different national IO tables.

Unlike the TiVA, the Canadian value-added exports database has no information on activities in the rest-of-the-world and thus cannot track 1) imports and their value-added content by country or 2) exports beyond their initial geographic destination. The VAE is not a tool for tracking the global value-added chain but rather, as its name indicates, it is a tool for tracking the impact of exports on the Canadian economy. Its main comparative advantages though are the greater industrial detail, the greater precision of the available variables, and the availability of additional information on jobs.

In general, the TiVA database is a very useful tool for international comparisons while Statistic's Canada's VAE is more appropriate for analyses that focus on the Canadian economy.

References

Miller and, R.E., and P.D. Blair, 2009, "Input-Output Analysis: Foundations and Extensions," Cambridge University Press, New York.

Organization for Economic Co-operation and Development – World Trade Organization, 2012, "Trade in Value-Added: Concepts, Methodologies and Challenges", OECD, Paris.

United Nations, 2009, System of National Accounts 2008, United Nations, New York.