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COMPILING CANADA'S QUARTERLY GROSS DOMESTIC PRODUCT: STATISTICS CANADA'S USE OF QUARTERLY SUPPLY-USE TABLES

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This document has been prepared by Jim Tebrake (Statistics Canada) and will be presented under item 19 of the draft agenda

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COMPILING CANADA'S QUARTERLY GROSS DOMESTIC PRODUCT: STATISTICS CANADA'S USE OF QUARTERLY SUPPLY-USE TABLES

Background

Statistics Canada produces two timely comprehensive measures of quarterly real economic growth—a monthly and quarterly estimate of real gross domestic product (GDP) by industry[1], using the production approach and a quarterly estimate of real gross domestic product by expenditure, using the expenditure approach. These measures of real economic growth are compiled independently and while the estimates are confronted with each other prior to release, they are not benchmarked to each other for a given quarter.

Statistics Canada has recently developed a set of experimental quarterly supply-use tables (QSU) to aid with the confrontation of estimates from the two quarterly measures of growth.

This paper highlights the usefulness of these tables (QSU) in improving the quality of the two measures as well as some of the challenges in developing the quarterly supply-use tables. The first part of the paper provides a short outline of the real GDP by industry program and the quarterly real GDP by expenditure program at Statistics Canada. The second section outlines the quarterly supply-use tables and how they are constructed. The paper concludes with an example of how the quarterly supply-use tables have been used to improve the overall quality of the two sets of estimates.

Quarterly real GDP by industry and by expenditure

Statistics Canada publishes estimates of monthly real GDP by industry approximately 60 days after the end of the reference period. These monthly estimates provide an excellent signal in advance of the quarter. The real gross domestic product (GDP) by industry program provides estimates of real GDP at basic price for approximately 215[2] industries, classified according to the North American Industrial Classification System. The data are estimated monthly and quarterly in volume terms, raw and seasonally adjusted—nominal estimates are not produced.

The starting point for the quarterly real GDP by industry program is benchmark estimates of real GDP by industry which originate from the annual Canadian *Input-Output Tables* (IOT). The IOT are available about two and half years after the end of the reference period. The quarterly real GDP by industry program can be viewed as an extension of the IOT. Real GDP by industry is estimated by projecting the relationship between real gross output and real valued-added, using a series of monthly and quarterly indicators. The core assumption of the program is that the volume of value-added generated from a given volume of output for a specific industry is generally constant over short periods of time.

Real measures of GDP by industry are estimated monthly for individual industries and then aggregated to arrive at total economic growth by month and by quarter. The quarterly real GDP by industry

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1 The supply and use tables that have been developed are only used in the quarterly space as Statistics Canada does not produce a monthly measure of expenditure-based real gross domestic product.

2 275 including aggregations

data are chained volume estimates. This means that the estimates for each industry and aggregate are obtained from a chained volume index multiplied by the industry's value-added in the reference year. For the period for which IOT have been compiled, the quarterly estimates are benchmarked to annually chained Fisher volume indexes of GDP obtained from the constant-price IOT. For the period for which IOT do not exist, the estimates are derived by chaining a Laspeyres volume index to the prior period. This makes the quarterly real GDP by industry estimates more comparable with the real GDP by expenditure data which is chained quarterly.

The data are seasonally adjusted using the X-12-ARIMA method.[3] Seasonal adjustment is made at the lowest level of aggregation, and seasonally-adjusted aggregates are obtained by summation.

The quarterly real GDP by expenditure program provides a measure of real quarterly GDP by aggregating the real expenditures of approximately 400 expenditure categories. The data are available approximately 60 days following the end of the reference period. The expenditure categories pertain to six institutional sectors namely households, non-profit institutions serving households, governments, financial corporations, non-financial corporations and non-residents.

Similar to the quarterly real GDP by industry program, benchmark estimates (in nominal terms) of GDP by expenditure originate from the IOT. To estimate real gross domestic product by expenditure on a quarterly basis, indicators of nominal expenditures and various price indexes are used to project the benchmark information.

Similar to the quarterly real GDP by industry program, seasonal adjustment for GDP by expenditure is generally made at the lowest level of aggregation, and seasonally-adjusted aggregates are obtained by summation.

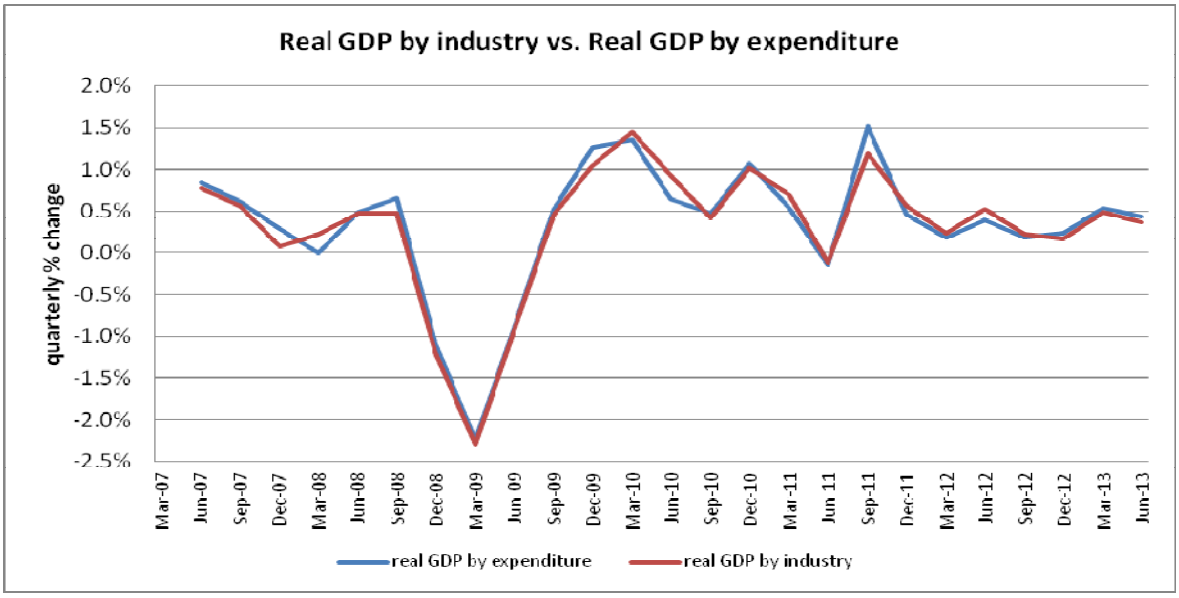
Canadian Quarterly Supply-Use Tables

While the two measures of real sub-annual GDP provide important perspectives on the state and evolution of the Canadian economy they are compiled independently and can provide different estimates of real growth.

The independent compilation process is both a strength and challenge. It constitutes a strength because the independent compilation of the estimates serves as an important quality check for the programs. As the separate estimates are compiled analysts from each program work together to confront the differences, share source data and use their collective professional judgment to bring the two measures into balance when differences exist.[4] A challenge with publishing two different measures of quarterly real GDP growth is one of communication. Users need to be educated that both measures are meaningful and can, and should, be used for current economic analysis. While the measures may diverge to a small extent in any given quarter, the direction and movement of the estimates rarely diverge. Statistics Canada has adopted the quarterly real GDP by expenditure measure as the official quarterly growth rate. The following chart shows the difference between the quarterly real GDP by industry rate of growth and the quarterly real GDP by expenditure rate of growth.

[3] Given that the real GDP by industry program is a monthly program, the data are seasonally adjusted monthly while the quarterly estimates are an aggregation of the monthly estimates.

[4] It should be noted that while the two measures are compiled independently the two systems do share a significant amount of source data which bring an added measure of coherence to the overall system.



There are a few conceptual / methodological differences between the two programs that could explain differences in the estimate of quarterly growth. One difference is the real GDP by industry program is at basic price while the real GDP by expenditure program is at market price. Another important difference relates to seasonal adjustment. Since the real GDP by industry program is a monthly program seasonal adjustment is performed monthly and aggregated to derive the quarterly estimates. The real GDP by expenditure program is a quarterly program and seasonal adjustment is done quarterly. Finally the different weights in the deflation process (one uses industry weights while the other uses expenditure weights) will impact estimates of quarterly real GDP growth.

Until recently the reconciliation process between the quarterly real GDP by industry and real GDP by expenditure was undertaken in an ad-hoc manner with analysts meeting on a regular basis during a production cycle to compare aggregate rates of growth. A rigorous tool was not used to undertake this confrontation process.

The lack of such a tool to facilitate the confrontation process led to the development of a set of experimental quarterly supply-use tables. Supply-use tables are based on the national accounting identity that "the amount of a product available for use within the economy must have been supplied either by domestic production or by imports. The same amount of the product entering an economy in an accounting period must be used for intermediate consumption, final consumption, capital formation (including changes in inventories) or exports." (2008 SNA p 14.4). The identity takes the form:

Output + imports = intermediate consumption + final consumption + capital formation + exports

Supply and use tables are an excellent tool that allow national account compilers to quickly identify incoherence and accuracy concerns in the source data, so as to improve the overall quality of the economic system.

In its simplest terms, the QSU tables represent a mapping of the real GDP by industry program and the real GDP by expenditure program into the supply-use identity.

In the Canadian context, these tables allow analysts in the real GDP by industry program to confront their production-based estimates with the real GDP by expenditure program within a supply=use

framework. The Canadian QSU tables are closely modeled after the program adopted by the Australian Bureau of Statistics in 2004.

The starting point for the QSU is the Canadian *Input-Output Tables* (IOT). The IOT contain a supply-use balance for 484 detailed commodities on an annual basis in current and constant dollars. The QSU tables are an extension of the current dollar IOT benchmarks which provides an annually balanced starting point. The quarterly supply-use tables measure, for each product or group of products and for the total economy, the balance between the total supply of a product and the total use of a product, and are represented by the following structure:

	Output
+	Imports
+	Margins
=	**Total supply**
	Intermediate consumption
+	Household final consumption expenditures
+	Government final consumption expenditures
+	Non-profit institutions serving household's final consumption expenditures
+	Gross capital formation
+	Exports
=	**Total demand**

The quarterly supply-use tables are in constant dollars – raw and seasonally adjusted. An example of the table is shown below:

Table 1 – Example Canadian QSU report

Quarterly Supply-Use

IEAD Production Cycle	SU Group	Commodity W Level	IMAD Industries	Pricing	Seasonal	Geography - Provincial	Add Number
2011 - Third quarter	SU24 - Industrial chemicals	All	All	$K - FBL	Yes	Can	14 - Add #14

		Calendar Year											
		⊟ 2008				⊟ 2009				⊟ 2010			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Supply Use	Supply Use 1	Value $000	Value $000	Value $000	Value $000	Value $000	Value $000	Value $000	Value $000	Value $000	Value $000	Value $000	Value $000
⊟ Supply	Output	7,142,074	7,065,526	7,000,887	6,125,020	5,439,826	5,389,525	5,425,520	5,548,035	5,947,003	5,922,515	6,013,829	6,336,531
	Margins	1,236,335	1,245,575	1,239,451	1,146,525	1,085,336	1,056,896	1,067,363	1,054,032	1,085,463	1,088,114	1,124,757	1,139,275
	Imports	4,079,445	4,051,589	3,783,857	3,621,671	3,301,776	3,353,064	3,374,984	3,290,505	3,695,117	3,593,795	3,587,596	3,410,740
	Total	12,457,854	12,362,690	12,024,195	10,893,216	9,826,938	9,799,485	9,867,867	9,892,572	10,727,583	10,604,424	10,726,182	10,886,546
⊟ Use	Intermediary Input	7,625,414	7,620,367	7,468,402	6,913,081	6,295,051	6,137,440	6,229,604	6,360,428	6,653,774	6,643,096	6,632,943	6,734,627
	Personal expenditures	4,092	4,138	4,181	4,189	4,215	4,231	4,254	4,256	4,329	4,402	4,405	4,460
	Inventories	(74,287)	131,124	34,096	187,312	6,536	(69,412)	(29,565)	(19,949)	52,052	31,717	145,150	(75,450)
	Exports	4,446,210	4,542,429	4,694,439	4,132,769	4,093,035	4,044,577	4,002,731	3,679,057	3,737,988	3,724,364	4,082,083	4,052,719
	Total	12,001,429	12,298,058	12,201,118	11,237,351	10,398,837	10,116,836	10,207,024	10,023,792	10,448,143	10,403,579	10,864,581	10,716,356
Grand Total		456,425	64,632	(176,923)	(344,135)	(571,899)	(317,351)	(339,157)	(131,220)	279,440	200,845	(138,399)	170,190

The product classification system underlying the QSU tables, found within the IOT, is referred to as the Input-Output Commodity Classification (IOCC). The IOCC is based on and closely aligned with the North American Product Classification System 2007 (NAPCS 2007). Most of the final demand classifications utilized by the quarterly real GDP by expenditure program also use classification systems based on NAPCS 2007. This helps with the conversion of the final demand expenditures in the quarterly real GDP by expenditure program to the IOCC used by the QSU program.

Given the fact that the detailed information (and time required) to construct detailed balanced quarterly supply=use tables does not exist, they are constructed based upon a series of assumptions and

approximations. The following outlines the main assumptions, approximations and data used to construct the Canadian QSU.

Output and Intermediate Use

The first step in estimating quarterly output and intermediate use by product in the QSU is to use the quarterly real GDP by industry estimates to project output and intermediate inputs by industry. This assumes that the ratio of output to intermediate inputs by industry demonstrates a certain amount of stability through time. For the majority of industries this assumption is valid as it is likely that large shifts in technology and structure evolve slowly over time.[5] Second, in order to move from industry to commodity it is assumed that in the current period (for which the IOT are not available) the industry/commodity ratio contained in the IOT for both output and intermediate inputs holds through time. For certain industries this is a valid assumption as changes in outputs and inputs occur gradually over time. In other cases, where products and technologies change rapidly, this assumption can introduce anomalies into the analysis. Table 2 illustrates the process by which output and intermediate inputs by IOCC are constructed from the quarterly real GDP by industry estimates and IOT benchmark data.

Table 2 – Calculating quarterly output and intermediate inputs

	2007Q1	**2007Q2**	**2007Q3**	**2007Q4**	**2008Q1**
Quarterly real GDP by industry					
33421 -Telephone apparatus manufacturing	580	602	615	583	570
ptp %		*3.8*	*2.2*	*-5.2*	*-2.2*
Projection from CIOT nominal (2007)					
GO.33421	551,426	572,344	584,385	554,594	542,236
ptp %		*3.8*	*2.1*	*-5.1*	*-2.2*
II.33421	467,170	484,886	495,082	469,853	459,375
ptp %		*3.8*	*2.1*	*-5.1*	*-2.2*
Apply the commodity/industry ratio from the CIOT 2007 benchmark year					
GO.33421	551,426	572,344	584,385	554,594	542,236
ptp %		*3.8*	*2.1*	*-5.1*	*-2.2*
GO.33421.3580	255,797	265,500	271,086	257,267	251,534
ptp %		*3.8*	*2.1*	*-5.1*	*-2.2*
GO.33421.3599	246,139	255,476	260,851	247,554	242,037
ptp %		*3.8*	*2.1*	*-5.1*	*-2.2*
II.33421	467,170	484,886	495,082	469,853	459,375
ptp %		*3.8*	*2.1*	*-5.1*	*-2.2*
II.33421.3621	47,754	49,565	50,608	48,029	46,958
ptp %		*3.8*	*2.1*	*-5.1*	*-2.2*
II.33421.3622	83,418	86,582	88,404	83,897	82,028
ptp %		*3.8*	*2.1*	*-5.1*	*-2.2*

Margins

The supply-use tables are valued at purchaser prices and therefore margins need to be added to the supply of goods and services. Given that sub-annual estimates of margins by commodity are not available, margins by commodity must be modeled within the QSU tables. First, the margin by commodity, margin

[5] The implication is that the further the QSU tables move away from the benchmark year the less reliable the estimates.

type[6] and final demand category are extracted from most recent IOT. These margins are then multiplied by the growth rate of the final demand quarterly series from the QSU, by final demand category and commodity. The margins are then aggregated by commodity across all final demand categories and margin types. The main assumption underlying this approach is that the margin rate for a particular commodity does not vary between the benchmark year and the current quarter. Internal research indicates that this hypothesis, for the most part, is valid for most commodities especially in constant dollars.

An example of the margin calculation is given in Table 3, below.

Table 3 – Calculating Margins

	2007Q1	**2007Q2**	**2007Q3**	**2007Q4**	**2008Q1**
CIOT nominal benchmark for final demand margins, computers and peripheral equipment					
Retail margin, personal expenditure, MPG334102	586,574				(2007 annual benchmark)
Retail margin, machinery and equipment, MPG334103	620,521				(2007 annual benchmark)
Final demand categories coming from QSU system					
Final demand, personal expenditure, K$, MPG334102	891,175	939,394	1,000,324	1,025,635	1,077,500
		5.4	*6.5*	*2.5*	*5.1*
Final demand, machinery and equipment, K$, MPG334102	2,298,348	2,412,354	2,401,023	2,558,522	2,679,487
		5.0	*-0.5*	*6.6*	*4.7*
Apply the movement of the final demand from QSU to the CIOT benchmark					
Retail margin, personal expenditure, MPG334102	135,547	142,881	152,148	155,998	163,887
Annual sum 2007	+---------- *586,574* ----------+				
ptp %		*5.4*	*6.5*	*2.5*	*5.1*
Retail margin, machinery and equipment, MPG334103	147,481	154,796	154,069	164,175	171,937
Annual sum 2007	+---------- *620,521* ----------+				
ptp %		*5.0*	*-0.5*	*6.6*	*4.7*
Cross-aggregation by commodity					
Retail margin, MPG334102	283,028	297,677	306,217	320,173	335,824
ptp %		*5.2*	*2.9*	*4.6*	*4.9*

Final Consumption Expenditure

Household final consumption expenditure within the quarterly real GDP by expenditure program is classified using a variant of the international COICOP classification system. The household final consumption expenditures are estimated for approximately 100 expenditure groups in nominal and real terms each quarter. These quarterly estimates are mapped to the IOCC through the use of a concordance file which allocates the 100 expenditure groups into the more detailed IOCC. The allocation of the aggregate expenditure data to the more detailed IOCC groupings is done through the use of the latest distributions derived from the most recent IOT. The allocation process is illustrated in Table 4.

[6] There are eight distinct margins in the IOT.

Table 4 – Distributional allocation using the IOT

	Input-Output Table		Quarterly Program	
	Final demand category	Distributional factors	Final demand category	Allocated values
IOCC - 1	20	20%		40
IOCC - 2	30	30%		60
IOCC - 3	50	50%		100
Total	100		200	200

Non-profit institutions serving household's final consumption expenditure is estimated quarterly as part of the real GDP by expenditure program in nominal and real terms. Within this program a single aggregate is produced. Within the QSU framework the aggregate expenditure is allocated to 9 goods or services. This allocation is based upon distributions derived from the most recent IOT.

Government final consumption expenditure is produced quarterly within the real GDP by expenditure program in nominal and real terms. The expenditures are classified by level of government (federal, provincial, municipal, and Aboriginal) and according to the nature of the expenditure (salaries and wages, consumption of fixed capital, other non-salary expenditures). In this case the real GDP by expenditure program provides more detail than what is required by the QSU tables and therefore allows for a good mapping to the higher level IOCC.

Gross Fixed Capital Formation

Gross fixed capital formation within the quarterly real GDP by expenditure program is either an aggregation of the IOCC or estimated at the detailed IOCC required by the QSU program. Data that are estimated at the IOCC level are fed directly into the QSU tables. Data that are estimated at a higher level of aggregation are distributed to the detailed IOCC using the distributional factors found in the most recent IOT.

Inventories

Inventories within the real GDP by expenditure program are classified by industry in nominal and real terms. The main industry groupings are manufacturing, retail trade, wholesale trade and other. Each industry grouping receives slightly different treatment in the QSU tables.

Within the real GDP by expenditure program, manufacturing inventories are classified into 16 industrial groups. First the inventories are partitioned into two groups—raw materials and output (finished goods, goods in process and goods for resale). The raw material inventories are then allocated to the IOCC using the most recent industry/product ratio for intermediate inputs in the IOT. The output inventories are also allocated to the IOCC using the most recent industry/product ratio for output in the IOT. The allocated inventories by IOCC are then aggregated (raw materials plus output) to derived final estimates by IOCC.

Retail inventories are classified in the real GDP by expenditure program into 19 industry groups. The allocation to the IOCC is done in two steps. First the inventories are allocated to the 100 final household expenditure classification groups. Second they are allocated from the 100 final household expenditure classification groups to the IOCC using the same allocation method that is used for final household consumption expenditure above, namely the quarterly retail commodity survey and a concordance file linking the 100 final household consumption expenditure classifications to the IOCC.

Wholesale inventories are classified according to 16 industry groups within the real GDP by expenditure program. The QSU tables utilize Statistics Canada's most recent wholesale commodity origin and destination survey to allocate the wholesale inventories to the IOCC. The wholesale commodity origin and destination survey is a periodic survey, with the latest estimates available for the year 2008.

For inventories of industries outside of manufacturing, retail and wholesale, the first step is to determine first whether the inventories represent inputs (raw materials) or outputs (goods in progress, goods for resale, and goods for sale). If it is determined that they represent inputs then the industry/product ratio for intermediate use from the CIOT is used to allocate the industry estimate to the IOCC. If it is determined that they represent outputs then the industry/product ratio for output from the IOT table is used.

Imports and Exports

The quarterly real GDP by expenditure program estimates imports and exports in nominal and real terms for 88 commodity groups each quarter—84 representing trade in goods and 4 representing trade in services. These 88 groups are a direct aggregation of the 264 commodity groups found in the QSU tables. For imports and exports of goods, the QSU program allocates the 84 groups to the 264 commodity level through the use of detailed quarterly import and export data derived from Canadian customs information. For imports and exports of services, the QSU program uses the latest distributional factors from the IOT tables to allocate the 4 service groups to the more detailed QSU groups.

The benefits of a QSU – A case study

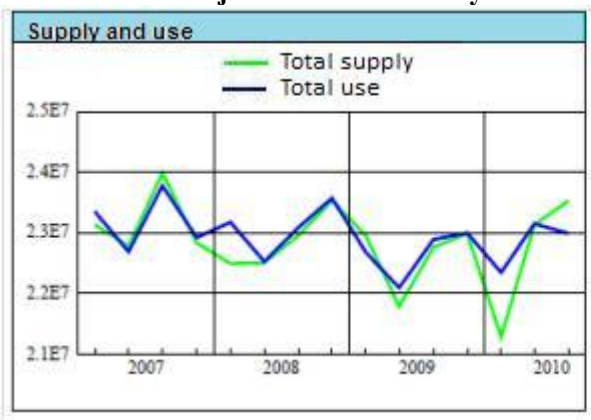
There are many benefits to the use of QSU tables in the compilation of quarterly GDP. In particular, they improve overall quality and efficiency in compiling the estimates. The best way to illustrate this point is through an example.

Over the last number of years the oil, mining and gas industry has been responsible for a large share of economic growth in Canada. The development of oil sands in Northern Alberta has led to a large amount of investment and increase in oil production and exports. The growth from oil production is captured in the quarterly real GDP by industry estimates while the growth in investment and exports are captured in the quarterly real GDP by expenditure estimates.

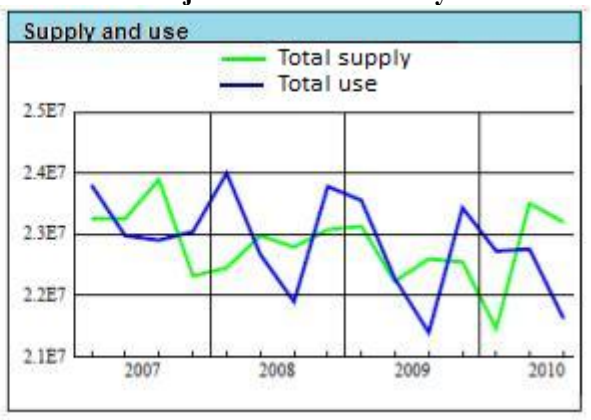
Starting in 2007 analysts began noticing larger than normal difference between the quarterly growth in real GDP by industry and real GDP by expenditure. Since production of crude petroleum was responsible for a large share of current period growth analysts focused on the energy products.

Supply and Use – Crude petroleum

Unadjusted for seasonality

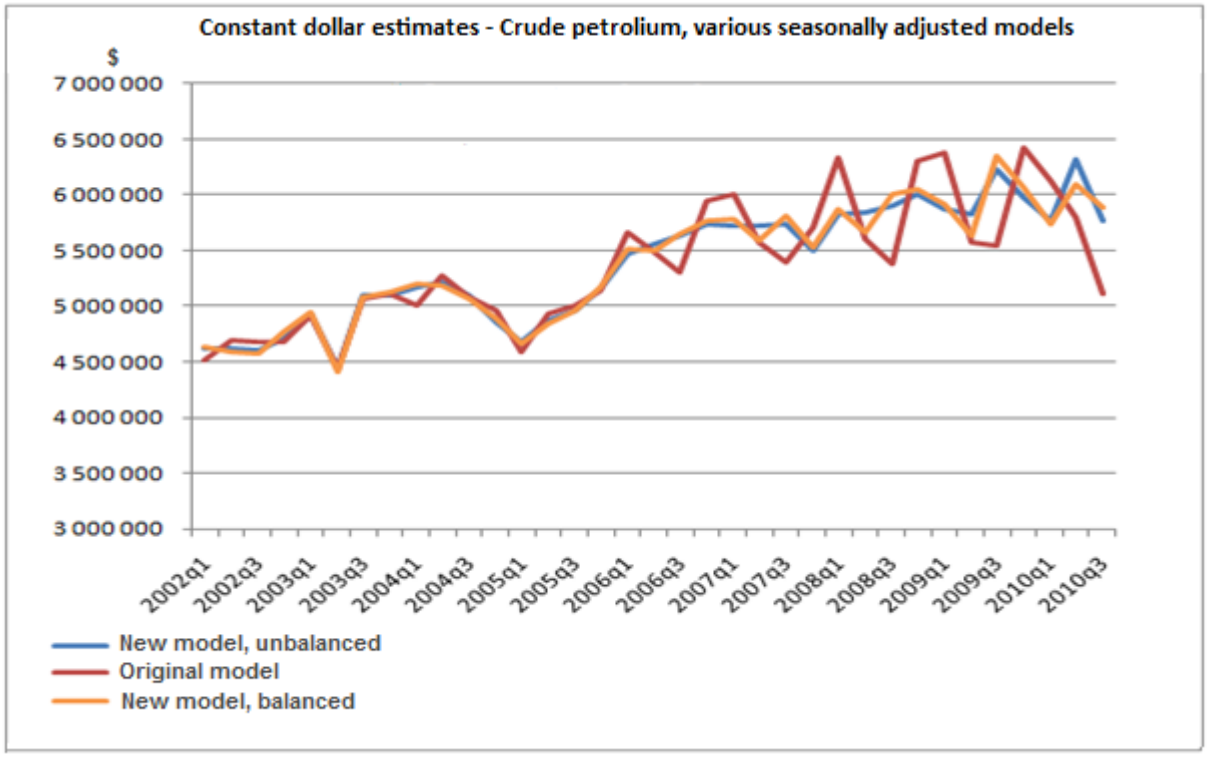


Adjusted for seasonality



A quick review of the QSU tables for crude petroleum uncovered the one of the problems. The production of crude petroleum estimates was using a different seasonal model from the exports, as the export model had been recently updated.

Analysts were able to adjust the seasonal models during the production process and narrow the gap between the two estimates.



Moving Forward

Statistics Canada has recently updated their QSU tables to reflect the changes made to the Canadian System of Macroeconomic Accounts as a result of the 2012 implementation of 2008 SNA. This included adding investment in research and development and splitting final consumption expenditures of non-profit institutions serving households from that of households.

Statistics Canada is now looking at developing current dollar estimates for selected commodities, which will allow analysts to better understand the impact the different treatment of prices has on the quarterly growth rates from the two programs.

Statistics Canada is also looking into developing current period annual supply=use tables for its provincial and territorial program. Statistics Canada produces very timely estimates of annual GDP by province and territory—well in advance of the release of the annual provincial and territorial input-output tables. Annual supply=use tables by province and territory will help with the reconciliation between the annual estimates of provincial and territorial real GDP by industry and the annual estimates of provincial and territorial real GDP by expenditure.