Aggregating Sub-Annual Current Price Value of Changes in Inventories to Annual Totals under Condition of Inflation - An Inherent Dilemma

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Abstract

Under any degree of inflation, high or low, one observes that the value of changes in inventories (VPC) is generally different when it is calculated at the quarterly interval and the four quarters are aggregated into a year compared with its calculation done at the yearly interval. This is troubling, particularly because the VPC plays an exceptionally important role in the measurement of the value of output. It is argued in this paper that it is an inherent problem as one of the basic axioms of annual accounts is violated, namely, the assumption of price homogeneity over an accounting period. Given this inherent problem, some pragmatic alternatives need to be considered: a) the flows reflected in annual accounts supersede the flows reflected in the quarterly aggregations, the rationale being that for calculation of VPC, the annual data sources are always of better quality; b) the aggregation of the totals of the four quarters supersedes the totals of the annual accounts, the rationale being that in conditions of inflation, there is more price homogeneity during quarterly intervals than during annual intervals; c) allow the two aggregations, quarterly accounts adding to an annual accounts and annual accounts developed directly from annual data , remain different. The third alternative is the one that we prefer in Canada and is in practice.

Introduction

Among the many distortions of financial reporting caused by changes in the general price level (inflation or deflation) is the problem that the aggregate of data for the sub-periods that compose a given period may well be different from the corresponding data for the period as a whole. As is explained in the 1996 OECD publication entitled: "**Inflation Accounting : A Manual on National Accounting Under Conditions Of High Inflation"** (in short **Inflation Accounting**), prepared by Peter Hill, factors that can

produce this situation include uneven fluctuations throughout the period in either or both transaction flows (including inventory turnover) and general price levels. This note is concerned with a specific aggregation problem arising from changes in inventories.

When price changes occur while goods are held in inventory, one observes that the value of changes in inventories (VPC) is generally different when it is calculated at the monthly interval and the three months are aggregated into a quarter compared with its calculation done at the quarterly interval; similarly, the VPC is different when it is calculated at the quarterly interval and the four quarters are aggregated into a year compared with its calculation done at the yearly interval. This is troubling, particularly because the VPC plays an exceptionally important role in the measurement of the value of output. By and large, the current price value of output of any good produced equals the value of its sales and other uses plus the value of changes in its inventories. Once the VPC is different, the value of output is different, the value added is different and this difference is carried forward to all the sequence of accounts, up to the closing balance sheet when it is eliminated. Is this difference inherent or a result of surveys of varying quality for different intervals?

Principles of measurement

Let us first look at the principles underlying its measurement in the national accounts. The 1993 SNA states: "The basic principle underlying the measurement of changes in inventories is that output should be recorded at the time it is produced and valued at the same price whether it is immediately sold or otherwise used or entered into inventories for sale or use later. No output is recorded when goods produced previously are withdrawn from inventories and sold or otherwise used. It follows that entries into inventories must be valued at the basic prices prevailing at the time of entry, while withdrawals must be valued at the prices at which they are then sold." (paragraph 6.58). It further states: "When prices are stable, the measurement of changes in inventories is relatively simple. However, when there is inflation, significant price increases may occur while goods are held in inventory. Holding gains accruing on goods held in inventory after they have been produced must not be included in the value of output" (paragraph 6.59).

The principle underlying the measurement of VPC is well stated in the 1993 SNA but it does not provide any **operational** guidelines for aggregation of VPC from sub-annual data into an annual series when the sub-period price changes are significant. When the sub-period price changes are significant, the economic principles underlying the process of aggregation by which annual accounts are constructed need to be reexamined. The above noted OECD document on **Inflation Accounting** states: "Simple addition of the values of flows occurring at different points of time throughout the accounting period as a whole may not necessarily produce the most meaningful and useful annual accounts under conditions of high inflation" (page 31). A basic axiom of current price national accounts for any period, monthly, quarterly or annual, is that there is price homogeneity over that period. Though this is not explicitly stated in the 1993 SNA, it is implicitly assumed so. This axiom is explicitly stated in the IMF's Textbook on Quarterly National Accounts Compilation, draft March 2000 (in short IMF's Quarterly Textbook).

In paragraph 1.10 of the IMF's Quarterly Textbook , it is stated that, at times of high inflation, annual national accounts are less useful because one of the basic axioms of annual accounts is violated, namely, the assumption of price homogeneity over time. Although this axiom never fully applies in practice (unless inflation is zero and relative prices are stable), with low inflation, the usefulness of annual accounts is not hampered too much. However, in a situation of high inflation, summing up the current price data from quarterly accounts over a year becomes meaningless. Under conditions of high inflation, the **Inflation Accounting** manual recommends to restate the sub-period accounts into constant price level (CPL) accounts such that the weights reflect the underlying economic reality. Note that in the CPL accounts for the sub-periods, the same price level is used throughout the year.

High inflation or moderate inflation or significant price changes for sub-periods within an accounting period result in similar **conceptual** difficulties for aggregation purposes, though their intensities are different. To emphasise this point, the OECD's **Inflation Accounting** document states: "...It is worth noting that the procedures indicated above for the calculation of annual indices as weighted averages of sub-period indices using CPL values as weights should be applied even under conditions of low or zero inflation. Consider the limiting case of zero inflation in which the general index of inflation remains constant from sub-period to sub-period. Although there may be no general

inflation, some degree of variation in relative prices is bound to be present in the accounts if only because of seasonal variations in prices" (page 52). It further states:"As soon as there is even moderate inflation it becomes imperative to do so using CPL accounts if precise and reliable measures of year to year quantity and price changes are required" (page 53). Thus, in principle, annual accounts are meaningful only when the sub-period price changes are insignificant. Insignificant price changes produce, by definition, insignificant holding gains for changes in inventories. Thus, there is an inherent difference between the VPC for an annual total calculated by aggregating it from four quarters and calculated directly from annual changes in stocks when there are any holding gains in the sub-periods.

Statistical difficulties

In addition to the general reasons mentioned above, there are several specific statistical reasons why the results from the different intervals are generally not the same: the data sources are different; the data sources on the needed detail on composition of goods held in inventories, their turnover period and the prices charged for individual commodities are of poor quality at the annual interval but are rarely available at the sub-annual intervals. Additional conceptual and practical complications arise in valuing output and inventories in sectors, such as agriculture, whose output is subject to seasonal fluctuations in price due to changing demand or supply conditions over time. The 1993 SNA states: " Suppose an annual crop is harvested at one point of time, put in storage and then gradually sold off, or used over the remaining twelve months. Suppose further that the price gradually rises to reflect the increased scarcity of the good until the next harvest. In the absence of general price changes, the increase in the price of the good while being stored must be interpreted as measuring the value of an addition to work-in-progress.... The goods withdrawn from storage some months after the crop is harvested are economically different from those that entered because of the changing supply conditions over time." (Paragraph 6.108). Further to the conceptual issue just noted, there is the practical problem of not knowing what the actual price received is going to be when crops are sold through some type of marketing boards. Thus one must record an initial price for the quarterly accounts to be revised later when the actual price gets known. This approach, or one similar to it, is used in Canada for valuing output of wheat: the Canadian Wheat Board, considered as farmers' cooperative, receives a significant portion of the harvest and pays an initial

price to farmers; its profits, known only when the wheat is sold many quarters later, are given back to farmers as final payment. It is the total payment, initial plus final that determines the net income of farmers and, hence, the value of their output, accruing for the period when the crop was produced.

The practical difficulties in measuring VPC are overwhelming for any interval, more so for sub-annual series, such that, in many OECD member countries, there is no independent estimate of VPC; instead, it is residually estimated, thus it includes all the errors of the other accounts. For example, of the 18 countries listed in a recent OECD document, **Quarterly National Accounts Sources and Methods by OECD Member Countries** (Paris 1996), 9 countries-Austria, Finland, France, Germany, Italy, Netherlands, Norway, Spain, Switzerland- calculate VPC as the difference between the production based GDP and all the components except VPC of the expenditure based GDP, thus it contains the errors from both sides of the accounts. The other 9 countries-Canada, United States, Japan, Australia, New Zealand, Denmark, Sweden, Turkey and United kingdom- make independent estimates, with data sources of varying quality, relatively good for those sectors for which physical quantities are available to mediocre and poor for others.

As noted above, once the VPC is different, the valuation of output and of holding gains is also different and the difference arising from the sub-period (say quarters) addition of values of flows to arrive at a higher interval (say a year) seems inherent as the holding gains occur when price of goods in the opening inventory is different from the price of goods in the closing inventory for a specific interval. Within an accounting period, be it monthly, quarterly or annual, VPC and holding gains are typically recorded by referring to the book values of opening inventory and closing inventory. If there is no opening inventory and there is no closing inventory within an accounting period, it is more than likely that the value of both VPC and holding gains would be set at zero even if there are price movements and there are physical changes of inventories during that period. This difference in current price valuation is demonstrated using an example, listed in the following table, of a producing unit A, producing only a single good B, using its quarterly and annual data.

Statistical example

Unit A produces in the first quarter 100 tons of good B, and the basic price per ton in the market is $10. Thus, the value of output is $1000. There is no opening inventory at the beginning of the first quarter. Nothing is sold from the first quarter's output and the entire output is added to inventory. The value of output is $1000 and the value of the goods entering into inventory is also $1000, as recommended by the 1993 SNA. In the second quarter, Unit A does not produce any output and the price jumps to $15 per ton. The entire stock from the first quarter is now sold for $1500. Thus, goods withdrawn from inventory are valued at $1500. There is now a holding gain of $500 from goods held in inventory. This, again, is consistent with the recommendation of the 1993 SNA. Nothing is left in inventory at the end of the second quarter. Unit A produces 200 tons of good B in the third quarter and the price collapses to $8 per ton. 80 tons are
sold and the rest is added to inventory. Output is valued in the third quarter at $1600 (200 tons at $8), sales are valued at $640 (80 tons at $8), and the goods entering into inventory are valued at $960 (120 tons at $8). Unit A does not produce any output in the fourth quarter as it has 120 tons of stock in inventory. Price goes up to $12 in the fourth quarter and Unit A sells its entire stock of 120 tons for $1440 (120 tons at $12). Withdrawals from inventory are valued at $1440 and Unit A makes a holding gain of $480, as the goods entering into inventory at the end of the third quarter are valued at $960.

Let us now summarise the economic activity in each of the four quarters. In the first quarter, output is valued at $1000 and is reflected in an addition to inventory at $1000. In the second quarter, withdrawals from inventory are valued at $1500, the sales are $1500, and unit A makes a holding gain of $500. In the third quarter, output is valued at

Current Price VPC , Output and Holding Gains

	Y0	Q1	Q2	Q3	Q4	Q1..4	Y1
Output quantity		100		200		300	300
Sale quantity		0	100	80	120	300	300
Unit sale price	10	10	15	8	12		
Output value		1000		1600		2600	3580
Sale value		0	1500	640	1440	3580	3580
Inventory-opening quantity		0	100		120	0	0
Inventory-closing quantity		100		120		0	0
Inventory-change in quantity		100	-100	120	-120	0	0
Inventory-opening book value		0	1000	0	960	0	0
Inventory-closing book value		1000		960	0	0	0
Inventory-change in book value		1000	-1000	960	-960	0	0
VPC		1000	-1500	960	-1440	-980	0
Inventory- holding gain		0	500	0	480	980	0

$1600, sales are valued at $640, and the addition to inventory is valued at $960; again, there is a balance between supply and use. In the fourth quarter, sales are valued at $1440, withdrawals from inventory are valued at $1440, and unit A makes a holding gain of $480. Adding all four quarters together, output equals $2600 ($1000+$1600), sales are valued at $3580 ($1500+$640+$1440), the value of changes in inventory is minus $ 980 ($1000-$1500+$960-$1440). The value of output for all four quarters at $2600 accounted for by sales at $3580 less VPC of $980. The holding gain of $980 is not included in the value of output or in VPC.

We now ask unit A in an annual survey, to provide information on output, sales and changes in inventory. Unit A reports that it produced 300 units in the year and sold all of them; there was no opening inventory and there is no closing inventory. The entire output of 300 tons is valued at the transaction price of $3580 in the market; thus, the

supply is balanced with use. In this example, the construction of an annual account by adding four quarters generates value of output of $2600, while constructing the annual account from the annual survey generates value of output of $3580, a difference of $980. The same difference of $980 also emerges on the expenditure side: the value of changes in inventory arrived at by adding four quarters produces a value of minus $980 whereas it is zero from the annual survey.

Three alternatives

We have already noted that the 1993 SNA does not provide any operational guidelines on aggregation over goods and services and over intervals of time within a given accounting period and that the OECD's **Inflation Accounting** manual has specifically raised the issue of aggregation of quarterly accounts for annual accounts. There are two alternative ways to present annual accounts derived from annual surveys and annual accounts derived from the aggregation of four quarters for value of output, value of changes in inventory and values of holding gains:

a. The flows reflected in annual accounts supersede the flows reflected in the quarterly aggregations, the rationale being that for calculation of VPC, the annual data sources are always of better quality. In our example, this means that the unit price used for valuing quarterly output is the actual unit sale price, whenever the sale occurs during the accounting period. Thus, the value of the first quarter's output of 100 units is $1500 and the value of the third quarter output is $2080 (640+1440). As noted above, this approach is in the spirit of the 1993 SNA recommendation for valuing output and changes in inventory for goods subject to seasonal fluctuations, and which are stored for future sale, as in agriculture.

b. The aggregation of the totals of the four quarters supersedes the totals of the annual accounts. The sales total remains the same at $3580. The value of annual output is $2600, and of VPC is minus $980. The value added of the annual accounts is lower by $980, as there are holding gains of $980 to be deducted. This approach does not require revision of the quarterly accounts and it follows the guidelines in the 1993 SNA for all sectors except those, like agriculture, where the higher values of the stored goods are not due to a price change but to an additional quality. The negative value of $980 of changes in inventory, when there is zero physical change of inventory

remains counter-intuitive.

Note that both of the above alternative approaches produce identical closing balance sheets for the producing unit. The quarterly accounts aggregation approach compared with the annual accounts approach has lower financial assets in the amount of $980, but it has an additional $980 in holding gains in the revaluation account. The annual accounts approach, compared with the quarterly accounts approach, has higher financial assets of $980 but there are no holding gains in the revaluation account.

c. The problem is inherent under any degree of inflation, high or low, as long as we produce current price quarterly and annual accounts. Hence, a third alternative could be considered namely, to allow the two aggregations, quarterly accounts adding to an annual accounts and annual accounts developed directly from annual data, remain different.

The 1993 SNA, as noted above, does not provide guidelines for inter-temporal aggregation within a given period. However, the OECD **Inflation Accounting** manual does provide a solution to this inherent problem with its recommendation to restate the current price quarterly accounts into CPL accounts (under all conditions of inflation, more strongly under conditions of high inflation). In the absence of developing quarterly CPL accounts or until CPL accounts become popular among the OECD member countries, some compromise convention needs to be developed. The issue that must be addressed is which alternative better reflects the underlying economic data during the period, in the most transparent way possible, both from the perspective of compilers and users.

Present Canadian Practice

In Canada, the quarterly and annual income and expenditure accounts are produced using both income approach and expenditure approach. Conceptually, the two approaches should yield identical value of total GDP but in practice the results are always different. An exhaustive probing is done to uncover any possible errors in either side of the accounts. Once this is done and the two totals are still not the same, the difference is divided by two. One half of the difference, called statistical discrepancy, is added to the income side and the other half with an opposite sign is added to the

expenditure side of the accounts such that the two are now identical in value. This Canadian practice is unique amongst the OECD member countries. All other member countries add the total difference to one side of the accounts, either explicitly or implicitly. Our practice derives from a conviction that once all the possible errors have been corrected, it is not proper to assume that the remaining errors belong to only one side of the accounts. Note that in the input-output accounts, no statistical discrepancy is shown.

The Canadian quarterly income and expenditure accounts are produced with a lag of two months from the reference quarter. The VPC component of the quarterly expenditure on GDP (like other components) is independently estimated (unlike the residual estimation technique used in many European countries) by broad industrial sectors. At the end of February, the initial estimates of the fourth quarter of the preceding year, along with the annual data are released. During the year, the quarterly accounts continue being revised as new and revised data become available. At the end of May at the time of the first quarter release, the data for the latest four years and seventeen quarters are subject to revision. This is the time when the results from the annual input-output tables are incorporated in the accounts. Note that the annual national input-output tables are produced with a lag of 28 months from the reference year. Thus, for example in May 2000, the results of final input-output tables for 1996 and preliminary tables for 1997 are used as benchmarks in the national accounts for 1996 and 1997 and both the quarterly and annual data are revised consistently. However, the VPC is not benchmarked, thus we continue to have two independent estimates of VPC, one in the income and expenditure accounts and the other in the input-output tables. This practice needs some elaboration for proper understanding.

On the expenditure side of the income and expenditure accounts, all components (in aggregate and detail) -such as household expenditures, government expenditures, gross fixed capital formation, exports and imports of goods and services- are identical in the two sets (input-output and income and expenditure accounts) except VPC. The VPC of the input-output tables is identical in value only of the sum of VPC and published statistical discrepancy of the expenditure side of the income and expenditure accounts. Similarly, on the income side , wages and salaries, mixed income (net income of the unincorporated business), net taxes (taxes less subsidies) on production are identical in the two sets of accounts , except gross operating surplus. Gross

operating surplus in the input-output accounts is identical in value of the sum of gross operating surplus and published statistical discrepancy of the income side of the income and expenditure accounts. This convention, of course, assures that the aggregate GDP at market prices is identical in the two sets and it derives from several pragmatic considerations. There is a detailed reconciliation process in place before the input-output benchmarks are incorporated in the income and expenditure accounts. Initial input-output estimates in total and in detail are reviewed by the professionals of the income and expenditure accounts division. The sources of differences in each area are analysed and discussed for arriving at a consensus estimate for both sets of the accounts. This process lasts over several weeks of March and April and benchmark estimates are agreed upon by the staffs of both the accounts and the senior management for again all the elements of final expenditures except VPC. The VPC estimates in both sets are also challenged and major differences are discussed, analysed and are narrowed, where possible. Given the inherent conceptual and statistical difficulties for calculating VPC, we recognise that there is no perfect answer. Thus, VPC calculated at quarterly intervals and aggregated to annual totals is not forced to agree with the annual total calculated in the input-output framework. It is recognised that VPC in the input-output tables continues to contain some margin of error. Similarly, it is recognised that VPC in the quarterly accounts continues to have several weak spots. Thus our pragmatic practice is to publish annual VPC in the input-output tables which is equal in total to the VPC in the income and expenditure accounts (estimated using quarterly intervals and the quarterly values aggregated to annual totals) **plus** the statistical discrepancy. This Canadian compromise permits users to have VPC by broad industry groups in the income and expenditure accounts and the commodity composition of VPC in the input-output tables. The final differences are not huge but are not suppressed, thus users can make their own judgement on how far they should carry the analysis on VPC and draw conclusions.

Concluding remarks

Given the importance of this topic, it is incumbent upon the national accountants throughout the world to reexamine the issue of measurement of VPC at sub-annual and annual intervals under conditions of inflation and arrive at a consensus (or provide a majority view) on the following: a) recommend to restate the current price quarterly accounts into CPL accounts as very well articulated in the OECD **Inflation Accounting**

Manual or b) annual calculations supersede the calculations made at quarterly intervals or c) the aggregation of the four quarters supersede the annual calculations or d) allow the two aggregations remain different. In the absence of CPL accounts, this paper has argued that given the inherent problem of aggregation under any condition of inflation, the preferred solution, both from the perspective of compilers and users of data, is to allow the two aggregations remain different.