BEA BRIEFING

Experimental Quarterly U.S. Gross Domestic Product by Industry Statistics

By Carol A. Robbins, Thomas F. Howells, and Wendy Li

THE ECONOMIC downturn that began in December 2007 emphasized the importance of timely, high-quality statistical data. Timely statistical data serve a function similar to the gauges on the dashboard of a car, providing indicators of the economy's current performance, including measures of acceleration and deceleration and measures of weakness or unusual activity. Gross domestic product (GDP) by industry data, which provide detailed statistics about specific industries, have long been an important set of economic dashboard data, allowing for a more nuanced analysis of the entire economy.

While almost all developed economies produce quarterly—or in some cases even monthly—statistics on GDP by industry, the Bureau of Economic Analysis (BEA) currently releases these statistics only annually.

However, BEA has been exploring the idea of producing GDP by industry at more frequent intervals since 2003. And with the recent expansion of improved source data available from the Census Bureau, particularly for the services sector, BEA is now in a position to begin producing GDP by industry statistics on a quarterly basis and has proposed such a program in its 2011 budget request. Over the next several months, BEA plans to release a series of papers detailing the proposed methodology, updating the experimental estimates to incorporate the upcoming comprehensive revision of the annual industry statistics, and incorporating several methodological enhancements. BEA aims to begin releasing quarterly GDP by industry statistics regularly in 2011 if funds are available and is seeking comments and suggestions.

In general, producing quarterly or monthly GDP by industry statistics involves some well-known tradeoffs. Other countries that produce such statistics tend to rely on source data that are more limited than the source data available for annual statistics (see the box "GDP by Industry in Other Countries"). For this reason, these higher frequency GDP by industry statistics often rely on assumptions from annual and benchmark statistics about the relationships between industry inputs, outputs, and value added.

But even though quarterly and monthly statistics in general are less detailed than annual statistics, they

GDP by Industry in Other Countries

Many countries produce quarterly GDP by industry statistics. And as part of the methodological development work for BEA's quarterly GDP by industry statistics, the methods and experiences of several other countries were reviewed.

Most of these countries use single deflation; that is, they adjust their value-added estimates using a single price measure. Other countries use a double-deflation approach, which relies on the input-output accounts to separately account for output and input prices. And some countries use a mix of approaches.

For example, Canada currently produces annual and monthly GDP by industry statistics and aggregates its monthly statistics to produce a quarterly version. Similar to the annual statistics produced by BEA, Statistics Canada uses double deflation and an input-output framework to estimate its annual GDP by industry statistics. Statistics Canada's industry statistics also rely on output indicators for the most recent periods, when comprehensive data from annual surveys are not available. Statistics Canada's monthly GDP by industry statistics are released approximately 2 months after the end of the reference month.

For monthly statistics, monthly data series for output or inputs are used as indicators, under the assumption that their changes in volume (quantity) reflect changes in the volume (quantity) of value added with reasonable accuracy. For monthly GDP by industry, the primary method used is single deflation of this volume (quantity) of value added. In addition, Canada is currently undertaking research to produce quarterly input-output accounts.

provide several benefits. Quarterly GDP by industry statistics would supplement other timely industry data—such as employment, wages and salaries, and price statistics—allowing for more complete analysis of business-cycle dynamics and the sources of economic growth. Quarterly GDP by industry statistics would also inform and enhance the currently published set of quarterly national accounts statistics. These improvements could be made by incorporating information from the quarterly GDP by industry set of data, particularly in areas where there are discrepancies or gaps in the data used for quarterly income-based and expenditure-based GDP statistics.

This *BEA Briefing* provides a first look at the most recent experimental quarterly GDP by industry statistics, which were developed using an improved methodology, and suggests that these statistics can provide valuable dashboard-type economic information, especially about the pace and direction of economic growth by industry sector.

Methodology

BEA has developed these experimental quarterly GDP by industry statistics in a two-phase research effort. In the first phase, BEA developed nominal, or current-dollar, GDP by industry estimates based on adjusted gross domestic income data by industry from BEA's quarterly national accounts statistics. These estimates were adjusted for inflation using a single-deflation procedure; that is, the value-added estimates were deflated using price indexes for gross output.

In the second phase, BEA developed an improved methodology that (1) accounts separately for changes in input and output prices, a method known as double deflation, and (2) uses a "balanced" framework that draws on information from BEA's input-output (I-O) accounts to align the estimates with inputs, outputs, and value added across the economy. These second-phase results are the focus of this article, which includes comparisons between the two methods.

Both phases of the experimental GDP by industry statistics use a time series of indicators to extrapolate growth from an initial quarterly base period. For the single-deflated estimates, the subsequent quarter's nominal value added is derived from the growth in industry-level income measures from the national income and product accounts (NIPAs). These nominal estimates of value added by industry are then deflated with an implicit price deflator for industry gross output. This deflation step requires separate indicators for the growth in nominal and real output. These quarterly indicators are drawn from the NIPAs and from other statistical sources, including the Census Bureau's Quarterly Services Survey. In a final step, aggregate quarterly real value added is then estimated using the familiar Fisher-Ideal index-number formula used at BEA.[1]

The improved methodology can be described in three broad steps:

- The most recent set of annual I-O tables is extrapolated forward using quarterly indicators. These indicators include statistical survey data on sales, receipts, shipments, wages and salaries, and industrial production as well as NIPA statistics. At this stage in the development of the experimental statistics, intermediate inputs are treated as the residual between gross output and value added.
- The extrapolated quarterly use tables are balanced in an I-O framework to ensure consistency among estimates of domestic output, domestic supply, and intermediate and final uses. For more information abut these fundamental relationships, see the box "Three Approaches to Measuring Gross Domestic Product." For the quarterly statistics, this involves extrapolating and balancing a series of use tables, which show the commodities used by an industry to create output, along with the intermediate and final uses of each commodity. The balancing process ensures two simultaneous conditions. First, that each industry's output equals its intermediate inputs plus its value added components, and second, that the sum of intermediate and final uses for each commodity is equal to its gross output.
- Price-adjusted measures of GDP by industry are prepared using double deflation, which allows gross output and intermediate inputs to be deflated separately, an advantage over the single-deflation approach. This method allows relative prices to affect output and intermediate uses differently. This in turn allows real gross output and real intermediate uses to grow at different rates, which is more realistic in many circumstances.

A first look at quarterly results

If quarterly GDP by industry statistics were produced regularly, it is likely that they would initially be made available following the third release of quarterly GDP from the NIPAs.[2] Two examples drawn from the experimental estimates show the kind of information that would be available to users about 4 months after the reference period.

Transportation and warehousing. This sector is not shown separately in the final demand components of GDP. Thus, quarterly statistics for this sector and its contribution to real growth are not

1. For a description of this work, see Yuskavage 2007.
2. The third release of the NIPAs comes about 90 days after the end of the reference quarter.

available in the existing quarterly NIPA data.[3] The experimental quarterly statistics show a decline in real value added, starting in the third quarter of 2007 and continuing through the fourth quarter of

3. Several nominal components of industry value added are published in the quarterly NIPAs, including compensation and corporate profits.

Three Approaches to Measuring Gross Domestic Product

National accountants have three alternative approaches to calculate gross domestic product (*GDP*), or the unduplicated value of goods and services produced in the domestic economy. These three approaches are income, expenditure, and production. Each approach has different source data requirements. In practice, BEA considers the expenditure-based approach to be the most reliable because it is based on more comprehensive source data.

This section presents these approaches algebraically. The relationships between the different approaches are shown in the "Illustrative Use Table."

The income-based approach measures the "factor" incomes earned through production in the domestic economy—capital and labor—along with other items. Labor income is measured as employee compensation, including wages and salaries and supplements to wages and salaries. The main components of capital income, or gross operating surplus (*GOS*), include capital consumption allowance, corporate profits, rental income, proprietors' income, and net interest.[1] The other item includes taxes on production and imports less subsidies (*TOPI*). The use table shows gross domestic income in the lower half of the shaded portion of the table. GDP measured as the income earned in production equals

$$GDP(I) = comp + GOS + TOPI,$$

where *comp* is employee compensation.

In contrast to the income-based approach, both the expenditure-based approach and the production-based approach to estimating GDP use commodities, or products, as the primary building blocks. In the table, commodity output is shown as the row totals on the right edge of the table. Industry gross output is shown as the column totals in the lower shaded edge of the table. The use of commodities by industries, or intermediate inputs (*II*), is shown in the shaded central portion of the table.

The expenditure-based approach measures the use of commodities as components of final demand, *e*, where these final expenditures on commodities, *c*, are the familiar categories of consumption (*C*), investment (*I*), government expenditures (*G*), and net exports (*X*–*M*).

GDP by expenditure is

$$GDP(E) = C + I + G + X - M = \sum_{c} e\ .$$

As the table shows, this GDP measure is a net concept because final uses are the sum of total production of commodities (right edge of the table), less the sum of intermediate uses of commodities by industries (shaded central portion of the table). Algebraically, if V_{ci} is the production of commodity *c* by industry *i*, and U_{ci} is the intermediate use of commodity *c* by industry *i*, then *GDP(E)* equals

$$GDP(E) = \sum_{c}\sum_{i}[V_{ci} - U_{ci}] = \sum_{c} e\ .$$

Rearranging the terms in this expression shows the third approach to measuring GDP—the sum of value added across all industries, or the production-based approach. Each industry's value added is represented by the value of the commodity output it produces less the commodities consumed in production. For each industry *i*, gross output and intermediate inputs equal

$$GO_i = \sum_{c} V_{ci}\ ,$$

and

$$II_i = \sum_{c} U_{ci}\ ,$$

respectively. Gross output less intermediate inputs for each industry equals industry value added—that is,

$$VA_i = GO_i - II_i\ .$$

Summing value added across all industries gives the third measure of GDP,

$$GDP(P) = \sum_{i} VA_i\ .$$

Gross output by industry (lower edge of the table) less intermediate inputs equals total value added, or *GDP(P)*.

Since these three approaches to measuring GDP are conceptually equivalent, they should produce the same estimate. In practice, they produce different estimates because each approach relies on different source data. How are these different empirical results reconciled? The approach used by BEA for its quarterly GDP estimates in the NIPAs is to publish both the expenditure-based and the income-based statistics, along with the statistical discrepancy (*SD*) between them (*SD=GDP(E) – GDP(I)*). The statistical discrepancy provides users with an indication of the size of the measurement error between GDP measured by these two approaches. Because of the relative superiority of the source data for the expenditure-based approach statistics, the statistical discrepancy is shown as an income side component. No statistical discrepancy is produced for BEA's GDP by industry statistics, because these statistics are controlled to be equal to expenditure-based GDP.

1. Corporate profits and proprietors' income include an inventory valuation adjustment and a capital consumption adjustment. GOS also includes the current surplus of government enterprises less subsidies.

2008 (chart 1). This decline became evident with the release of the advance annual GDP by industry statistics in April of 2009. Quarterly data showing the decline, by contrast, would have been available in early 2008.

Wholesale trade. This sector is also not separately shown in the NIPA final demand statistics. While monthly data on wholesale trade sales from the Census Bureau are used as an indicator of business cycle activity, these sales data are a limited measure of the contribution of this activity to GDP. The reason for this is that wholesale trade's output is measured as the difference between these wholesale trade sales and the cost of goods sold. Conceptually, the balanced framework used for the quarterly statistics is better able to account for this. Additionally, separately deflating gross output and intermediate inputs

Acknowledgments

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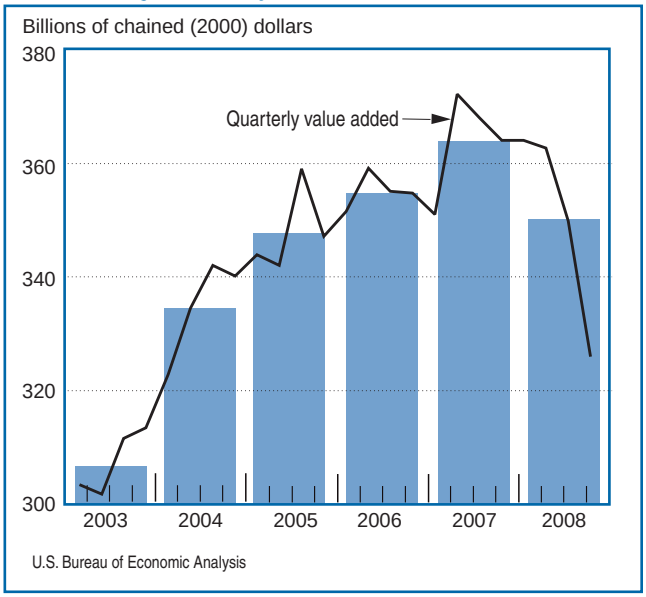
Chart 1. Real Value Added for Transportation and Warehousing, Quarterly and Annual



Illustrative Use Table Showing Three Measures of GDP in a Balanced Framework

		Agriculture, mining, utilities, and construction	Manufacturing	Services	Government as producer	Private consumption (C)	Private investment (I)	Government consumption and investment (G)	Exports less imports (X–M)	Total commodity output
Commodities	Agriculture, mining, utilities, and construction	Intermediate inputs (II)				Final demand GDP(E)				Gross output (GO)
	Manufacturing									
	Services									
	Government									
Value added	Compensation	Value added (VA) GDP(I) GDP(P)								
	Taxes on production and imports less subsides									
	Gross operating surplus									
	Total industry output	Industry gross output (GO)								

GDP(I) measured by income-based approach
GDP(P) measured by production-based approach
GDP(E) measured by expenditure-based approach

U.S. Bureau of Economic Analysis

results in a more refined measure. The GDP by industry statistics show a decline that began in the fourth quarter of 2007 (chart 2).

Comparing GDP and value added

Compared with the NIPA estimates of GDP, the experimental GDP by industry statistics generally show the same direction of change and roughly the same magnitude.[4] The balanced, double-deflated trend matches the trend of the GDP changes more closely and is less volatile than the trend of single-deflated statistics (table 1 and chart 3). Importantly, in 2008, with the economy in recession, the balanced, double-deflated real value-added aggregate provided the correct direction of change, while the single-deflated aggregate did not.

4. These experimental statistics were prepared with data released before the July 2009 comprehensive revision of the NIPAs.

Chart 2. Real Value Added for Wholesale Trade, Quarterly and Annual

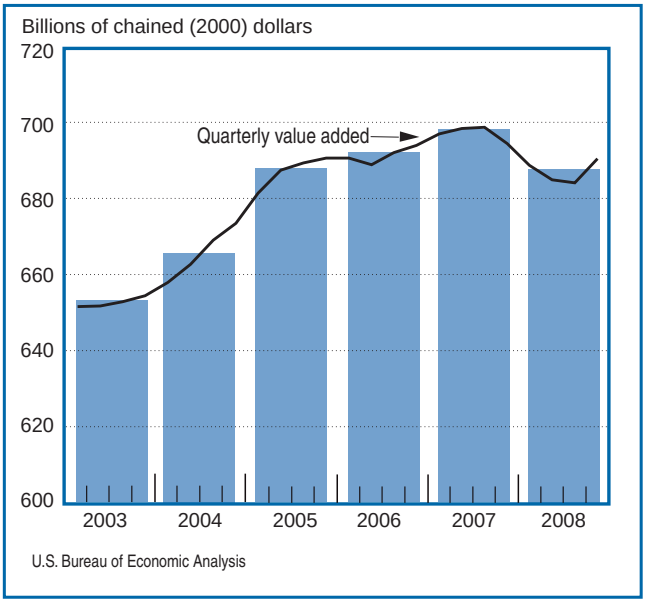


Table 1. Comparison of Average Quarterly Percent Change and Mean Absolute Deviation in Gross Domestic Product and Value Added

	Gross domestic product[1]		Value added			
			Double deflated		Single deflated	
	Change from preceding period (percent)	Mean absolute deviation	Change from preceding period (percent)	Mean absolute deviation	Change from preceding period (percent)	Mean absolute deviation
2004	3.15	0.39	2.76	0.32	2.31	0.73
2005	2.69	0.73	2.61	0.77	2.06	1.24
2006	2.45	1.30	1.86	1.04	2.94	1.84
2007	2.36	2.42	1.76	2.14	1.51	2.50
2008	–0.79	2.78	–1.46	1.92	0.11	2.06

1. Based on data released before the July 2009 comprehensive revision of the national income and product accounts.

Single versus double deflation

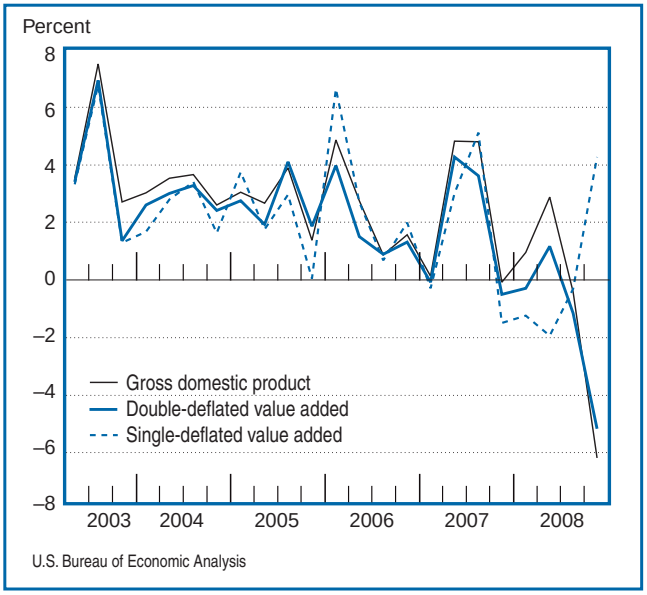
The phase 1 methodology, which relied on single deflation, is simpler than the current methodology, which relies on a balanced, double-deflated approach. Under the phase 1 methodology, each industry's gross output price index is used to deflate industry value added. This method implicitly assumes that intermediate-input prices change at the same rate as output prices. When this assumption is correct, the resulting real value-added measures closely match those obtained using double deflation in the balanced estimates.

However, the single-deflation procedure can give misleading results when substantial changes in prices for intermediate inputs are not immediately passed though to purchasers. This can happen during periods when overall economic growth is changing rapidly. For particular industries, this can also happen when key input costs, such as costs for energy and fuels, change rapidly. This was the case for the domestic economy in late 2005 and again in 2008, as shown by the producer price index for fuels and related products and power (chart 4).

For a particular industry, the impact of different input and output prices can be substantial. Charts 5 and 6 show an example from the computer products manufacturing industry where gross output and intermediate input prices were changing at different rates. Chart 5 shows that intermediate input prices fell more slowly and then rose more rapidly than gross output prices between 2006 and 2008.

When this happens, balanced, double-deflated measures of value added can be expected to outperform

Chart 3. Quarterly Growth Rates of Real GDP and Value Added, Single and Double Deflated



single-deflated measures. Applying the gross output price index to nominal value added results in a measure of growth of real value added that is too low (chart 6). This is because single-deflation does not allow for the observed more rapid growth rate of intermediate input prices in the calculation of real value added.

For all industries combined, the difference between gross output prices and intermediate input prices is shown in chart 7; intermediate input prices rise at a higher rate than gross output prices through the third quarter of 2008. Consequently, double deflation will shrink real intermediate inputs, tending to raise real value added. Conversely, in the fourth quarter of 2008 intermediate input prices decrease more sharply than gross output prices. This tends to lower real value added. These effects help to explain chart 3, where single deflation of nominal value added using the gross output price index underestimates the growth rate of real value added from the fourth quarter of 2007 to the

Chart 4. Producer Price Index for Fuels and Related Products and Power

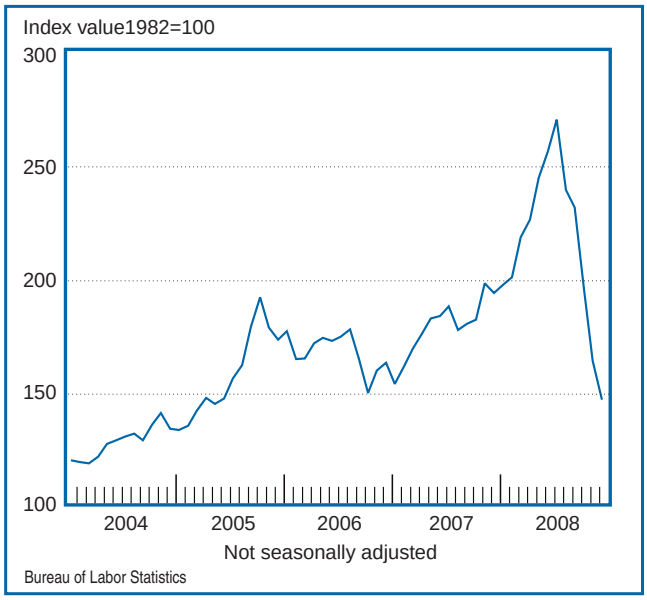


Chart 5. Growth Rates of Gross Output and Intermediate Input Price Indexes for Computer Products

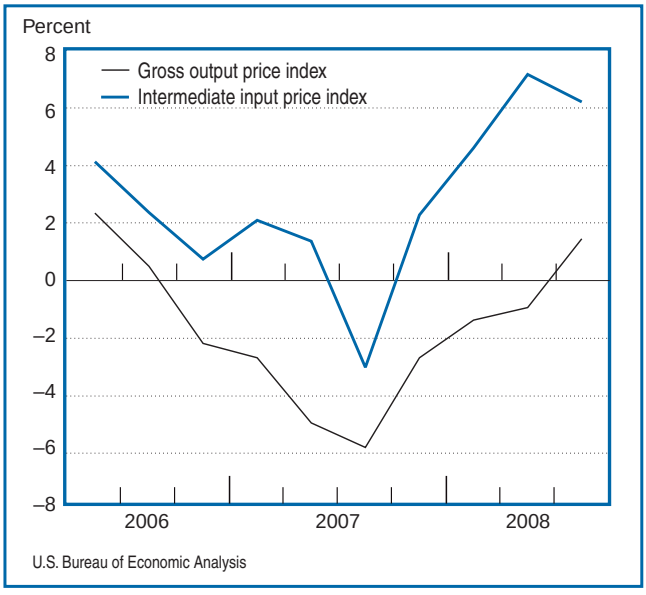


Chart 6. Growth Rates of Real Value Added for Computer Products, Single and Double Deflated

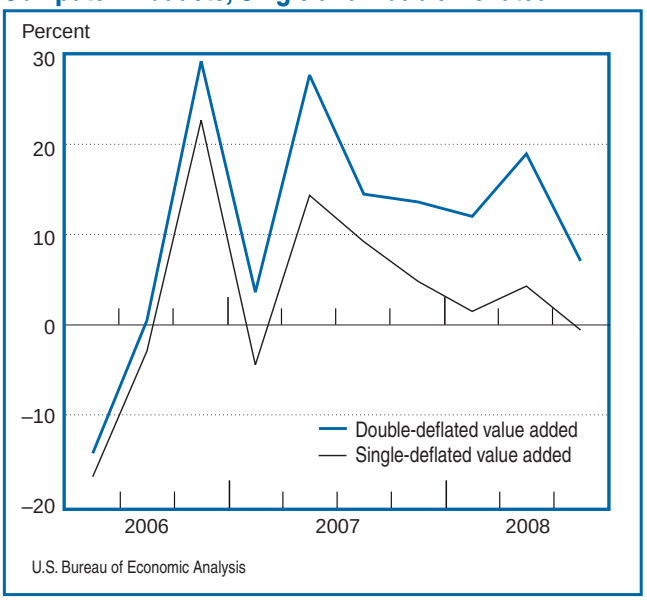
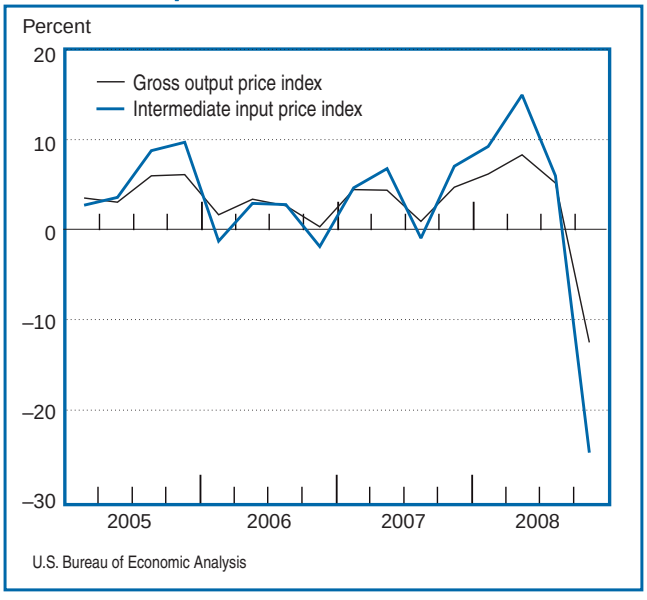


Chart 7. Growth Rates of Gross Output and Intermediate Input Price Indexes for All Industries



third quarter of 2008 then overestimates this growth in the fourth quarter of 2008.

A future benefit: A third measure of quarterly GDP

According to the methodology used for the balanced, double-deflated statistics, quarterly income data are used to estimate value added by industry, and Census Bureau and other statistical data are used to estimate gross output. Intermediate inputs are treated as a residual, the difference between the two. This can lead to implausible ratios of intermediate inputs to gross output for industries where profits cause gross operating surplus to change dramatically between quarters. A preferred approach would be to develop a better indicator of intermediate inputs and allow the gross operating surplus (a component of value added) to adjust as the residual.

Good source data for intermediate inputs will make it possible for quarterly GDP by industry statistics to eventually provide a separate indicator of real GDP measured through real value added by industry. Because expenditure-based GDP and value added both represent total output in the economy less the intermediate consumption of commodities, conceptually they are equivalent aggregates (see the box "Three Approaches to Measuring Gross Domestic Product"). Regularly produced, double-deflated quarterly GDP by industry statistics could serve an important diagnostic purpose, adding to the toolkit used to ensure the quality of economic statistics. At that point, balanced estimates of GDP by industry could be used to help identify discrepancies and to fill data gaps for the quarterly GDP accounts. Thus, quarterly GDP by industry statistics could serve as both a timely gauge of the pace and direction of economic activity as well as a "check engine" indicator for overall GDP statistics.

Next steps

While this paper has shown some of the initial results from the experimental quarterly double-deflated estimates, there is more work that needs to be done before these statistics can be released on a regular basis. To that end, BEA is seeking comments, which can be e-mailed to IndustryEconomicAccounts@bea.gov; please address comments to Brian C. Moyer. In their current form, the quarterly statistics align closely with the corresponding annual statistics. This year's experimental quarterly statistics were created with industry indicators for gross output at an aggregate industry level rather than at the commodity level, which is used for the annual industry accounts. A next step in the development of these statistics is to identify and incorporate quarterly indicators at the commodity level. This shift, which will bring the methodology closer to that of the annual industry statistics, can be expected to improve the quality of the quarterly statistics by improving the match between commodities and prices. The following schedule outlines a timeline for completing the quarterly GDP by industry work by 2011, based on the availability of resources.

- Spring 2010. Develop quarterly commodity-level indicators.
- Fall 2010. Develop double-deflated quarterly statistics that are benchmarked to published annual data and are consistent with the 2010 comprehensive revision of GDP by industry statistics.
- Summer 2011. Release prototype quarterly GDP by industry statistics shortly after the third release of quarterly GDP in the NIPAs. In addition, a time series of quarterly GDP by industry statistics back to 2005 would be released.

While the work described in this article is still in an experimental phase, quarterly GDP by industry statistics potentially serve two important functions for economic measurement of the domestic economy. First, these timely statistics can add to the existing set of "dashboard indicators" on the pace and distribution of economic activity. Second, they hold promise as a diagnostic tool to improve the accuracy of overall GDP measurement.

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