Quarterly GDP by Industry
Progress and Prospects [1]

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Background

      Users of data from BEA's Industry Accounts have often asked about the possibility of BEA providing quarterly GDP-by-industry estimates. Many researchers and industry analysts would like to have more frequent industry estimates and would prefer to not wait several months after the end of the year for the first view of industry performance in the prior year. Aside from timeliness, many users are interested in having a complete set of industry estimates that are consistent with quarterly GDP and that can be used to assess how various sectors of the economy contribute to and are affected by business cycles and other near-term economic developments. Several other nations provide quarterly, even monthly, GDP-by-industry estimates. The Federal Reserve Board's monthly index of industrial production provides timely, high-frequency data for manufacturing, mining, and utilities, but similar data are not available for the broad services sector. Quarterly GDP by industry data would help address those needs.

      BEA currently provides quarterly estimates of national income (NI), without capital consumption adjustment, by industry for 15 private industry groups, government, and the rest-of-the-world. These estimates are released in NIPA table 6.1D along with the "final" quarterly NIPA estimates three months after the end of the quarter. NI for domestic industries differs from GDP because it excludes consumption of fixed capital (CFC) and the statistical discrepancy. In addition, some of the components of the gross operating surplus are estimated on a company basis rather than an establishment basis. Most importantly, real (inflation-adjusted) estimates are not available. GDP-by-industry estimates would provide a more complete measure of quarterly changes in industry shares of GDP and would also provide the quantity and price indexes that are needed to measure industry contributions to quarterly real GDP growth and inflation.

      BEA first started to seriously consider providing quarterly GDP-by-industry estimates in 2003 as part of developing new initiatives for the fiscal year 2004 strategic plan. The acceleration of BEA's annual GDP-by-industry estimates in 2003 responded to a long-standing interest in more timely industry output estimates, but it also stimulated interest in more frequent industry estimates. In addition, the Census Bureau had just

announced plans for conducting a new quarterly survey of services industries. Finally, BEA's continuing regular release of quarterly estimates from the travel and tourism satellite accounts (TTSA), starting with the fourth-quarter of 2001, suggested that quarterly industry estimates were feasible. Quarterly GDP-by-industry was announced as a new initiative in BEA's fiscal year 2004 strategic plan. This paper presents a progress report on the research efforts for quarterly GDP-by-industry by describing the proposed methodology, presenting illustrative estimates, and discussing future work.

Proposed Methodology

In trying to determine an appropriate methodology for quarterly GDP-by-industry estimates, BEA first turned to the methodologies used for the accelerated annual GDP-by-industry estimates and the quarterly TTSA estimates. In May 2003, BEA published advance annual estimates of GDP-by-industry for the year 2002 using an abbreviated methodology designed to take advantage of the limited source data available early in the year. These advance annual estimates are now routinely released each April and are revised in December when more complete source data become available. The quarterly TTSA estimates, which represented the first attempt by the Industry Accounts Directorate to prepare quarterly estimates, were developed in response to requests about the impact on certain industries of the September 11th 2001 terrorist attacks. BEA had previously developed TTSA estimates for selected years, but had not prepared time-series estimates.

For the advance annual program, the estimates of nominal value added by industry are based on income by industry detail--much of it unpublished--from the NIPAs, and the estimates of real value added by industry are based on a single-deflation method using the gross output price index rather than the more data-intensive double-deflation method. Research for the advance annual estimates had demonstrated that these methods would yield reliable current-dollar estimates for broad industry groups but not necessarily for detailed industries, and that the reliability of the real estimates was sensitive to business-cycle fluctuations and sharp changes in relative prices. Results from the published advance annual estimates have largely confirmed those initial findings, and improvements continue to be made to the methodology. For the quarterly TTSA estimates, BEA developed a methodology that was based on extrapolating benchmark

annual gross output estimates for selected industries using detailed, seasonally-adjusted quarterly source data from the NIPAs and other industry sources. The resulting growth rates were found to be reliable and consistent. BEA has since enhanced the methodology to provide historical estimates, real (inflation-adjusted) estimates, and employment.

For the proposed quarterly GDP-by-industry estimates, BEA combined features of both the advance annual and the quarterly TTSA methodologies. For the nominal (current-dollar) estimates, initial quarterly estimates for each of the three major components of industry nominal value added are extrapolated forward using underlying industry source data from the quarterly NIPA estimates. These components are compensation of employees, taxes on production and imports less subsidies, and gross operating surplus (GOS)[2]. For example, compensation of employees by industry is extrapolated with the sum of unpublished quarterly estimates of W&S by industry and supplements by industry. After the initial extrapolation, the sum of the industry estimates for each component is adjusted to match the NIPA total. Value added by industry is the sum of the three adjusted values.[3] Value added summed over all industries equals GDP.

Real value-added by industry estimates (except for farms and general government) are obtained by deflation with the industry's gross output price index. The gross output price index is an implicit price deflator calculated as nominal gross output divided by real gross output. Estimates of nominal and real gross output by industry, as with the TTSA industry estimates, are quarterly extrapolations of initial values using source data from the NIPAs, the Census Bureau, the Federal Reserve Board, and other government and private sources. Most of the underlying detailed industry price indexes are producer price indexes (PPIs) and consumer price indexes (CPIs) obtained from BLS, and chain-type price indexes for PCE and PES obtained from the quarterly NIPAs.

Illustrative Estimates

BEA started compiling the source data for experimental quarterly GDP-by-industry estimates in Spring 2005, about two years after first proposing the new initiative.

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[2] GOS is defined to include the NIPA statistical discrepancy.
[3] Estimates for farms and for general government are obtained directly from the NIPA Gross Value Added by Sector estimates (NIPA table 1.3.5). The NIPAs also provide quarterly price and quantity indexes for these sectors. These two sectors account for about 12 percent of GDP.

Most of the required data were obtained from BEA's National Economic Accounts directorate. Data collection started with the first quarter of 2003 and has continued after each release of the final "current" quarterly GDP estimate, about three months after the end of the quarter. After developing an initial starting value for the first quarter of 2003, quarterly industry estimates were prepared for each subsequent quarter, through the first quarter of 2007, by linking the changes in the current-estimates. These experimental estimates are based on the NIPA GDP data that were available at the time (i.e., same vintage) and from other (non-NIPA) sources that are mostly from the same vintage. As a result, the experimental estimates do not reflect data from subsequent annual revisions of the NIPAs and the industry accounts. Illustrative results are discussed below for private-goods producing industries and for private-services producing industries.

Volatility of Quarterly Estimates

Not surprisingly, the experimental quarterly real value-added estimates are more volatile than quarterly real GDP, for both private goods-producing and private services-producing industries. Volatility is much greater, however, for the goods-producing sector than for the services-producing sector. This result is also not surprising because we know from the NIPAs that quarterly real GDP for goods and for structures are more volatile than GDP for services. Table 1 compares volatility in the experimental real

Table 1.-- Deviations of Quarterly Real Growth Rates from Annual Rates for
GDP Goods and for Private Goods-Producing Industries, 2004-2006

	Real GDP for goods				Real value added for private goods-producing industries		
Period	2004	2005	2006	Period	2004	2005	2006
Q1	2.1	4.2	9.6	Q1	3.3	-2.6	9.0
Q2	3.4	3.9	4.6	Q2	-6.4	4.1	-4.1
Q3	6.6	5.8	3.4	Q3	6.8	10.1	3.3
Q4	3.7	1.5	1.1	Q4	2.5	-5.6	-3.6
Annual Average	4.7	4.3	5.0	Annual Average	3.1	1.8	1.9
Mean Deviation	-0.7	-0.5	-0.3	Mean Deviation	-1.6	-0.3	-0.8
Mean Absolute Deviation	1.7	1.2	2.6	Mean Absolute Deviation	3.5	5.6	5.0

Note: Quarterly growth rates are at annual rates. Annual averages are year-over-year rates calculated from quarterly indexes. Real GDP for goods data are from the 2007 annual revision.

value-added estimates for private goods-producing industries with NIPA-based real GDP for goods. Volatility is higher in the industry estimates than in the NIPA estimates as measured by the deviation of quarterly growth rates from the annual average. Mean deviations are very similar, especially for 2005 and 2006, but mean *absolute* deviations for goods-producing industries are substantially larger, indicating greater volatility for the industry estimates.

Differences in the definition and measurement of the industry and NIPA series affect the comparability of the volatility measures. Volatility for GDP goods is reduced somewhat by the inclusion of relatively stable trade margins and transport costs in the market value of final goods. Volatility for goods-producing industries is increased somewhat by the inclusion of the farm and mining industries. It is also worth noting that quarterly fluctuations in the experimental *nominal* value added by industry estimates are very similar to fluctuations in quarterly national income by industry, but the value added estimates are less volatile than national income. This is most likely due to the inclusion in nominal value added of the inherently stable consumption of fixed capital.

Nominal vs. Real Value Added

Nominal value added by industry estimates for both the goods-producing and services-producing sectors show considerable variation over the period, both relative to one another and relative to nominal GDP. Chart 1 shows percent changes at an annual

Chart 1. -- Nominal Value Added

Percent Change at Annual Rate
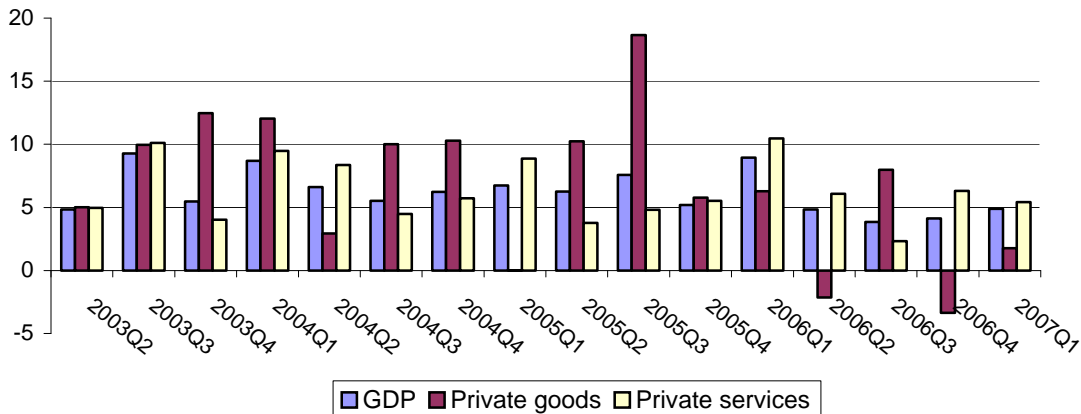
rate for nominal GDP and for the two broad industry groups. Over the 16 quarters, goods-producing industries increased 10 percent or more (annual rate) seven times, even though nominal GDP never increased more than 9.3 percent. In 2005 Q3, the quarter that included Hurricanes Katrina and Rita, private goods-producing nominal value added increased 18 percent, partly due to large increases in energy-related industries. Nominal value added for goods-producing industries actually declined in both the second and fourth quarters of 2006, as did national income for this sector. Private services-producing industries were on average less volatile, but still differed significantly from GDP in several quarters.

Real value added growth rates are slightly more volatile than nominal growth rates for both goods- and services-producing industries. As shown in chart 2, real GDP did not decline in any quarter during the 16-quarter test period but real value added for goods-producing industries declined in six of the quarters. Real value added for services increased each quarter, but the increase was only 0.1 percent 2006 Q3, largely due to a

Chart 2.--Real Value Added
Percent Change at Annual Rate
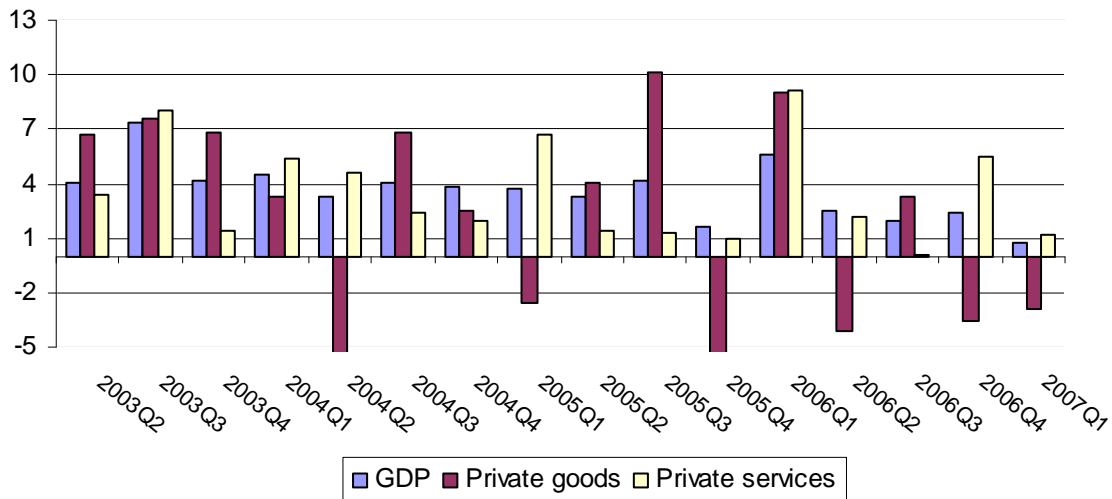
decline in finance, insurance, real estate, rental, and leasing. These patterns of change in quarterly real value added by industry suggest that the performance of the goods and services industry groups is not symmetric over the course of the year and that some

industries can both decline and increase in the same year. These findings may have important implications for the analysis of business cycles.

Aggregation Issues

Many of BEA's data users want to understand how industries contribute to and are affected by business cycles and other short-term economic developments. Accordingly, the results for real value added growth by industry group should be viewed in the context of the growth of aggregate real value added for all industries. Real GDP from the NIPAs and real value-added for all industries from the Annual Industry Accounts are conceptually equivalent, but they can differ in practice due to differences in source data and estimation methodology. In a consistent estimating framework such as an I-O use table with consistent source data, both nominal and real GDP will equal nominal and real value-added aggregated over all industries.

In BEA's annual industry accounts, nominal value added for all industries always equals nominal GDP because the methodology constrains the two to be the same. No such constraint, however, is imposed on the aggregate real estimates, which can often differ significantly. For the regular integrated annual industry accounts that are released

Chart 3.--Real GDP and Real Value Added for All Industries

in December and that are based on a complete double-deflation methodology, these differences are usually small, 0.2 percentage points at the most. For the advance annual industry estimates that are released in April, these differences are sometimes as much as 0.5 percentage points, even after adjustments are made to approximate the effects of double deflation for certain industries. BEA has stated previously that aggregate differences in the advance annual estimates are mostly due to not using the double-deflation method, but that differences in the quality and consistency of the source data also play a role.

For the illustrative experimental quarterly real GDP-by-industry estimates, chart 3 shows that the aggregate real growth differences (at annual rates) are reasonably close for most quarters but are still relatively large for some. On average, the differences become smaller over the 16-quarter test period. For example, over the entire period the mean difference is -0.7 percentage points and the mean absolute difference is 1.1 percentage points. Starting with 2005 Q1, the mean deviation drops to -0.3 percentage points and the mean absolute deviation falls to 1.0 percentage points. The better performance over the last two years is partly due to improvements in the source data and in the implementation of the prototype methodology. These improvements could not be completely replicated for the earlier period. Some of the improvement is also due to somewhat smaller and less frequent increases in imported and domestic energy prices, as explained below.

Reasons for Differences

BEA has determined that two factors contribute importantly to aggregate real value-added differences when using the single-deflation method: large changes in import prices and incomplete pass-through of large changes in domestic prices. The single-deflation method for calculating real value added by industry works well when both gross output and intermediate input prices increase or decrease at about the same rate. Under these conditions, the value-added price index behaves much like the gross output price index, so the latter becomes a good proxy for the industry's value-added price index. When these conditions do not hold, the gross output price index either overstates or understates the value-added price index, and as a result, real value added for an industry is understated or overstated. If the differences in price index growth rates are not large,

the estimates for broad industry groups will not be significantly affected and real value added aggregated over all industries will closely approximate real GDP.

Aggregate price index estimates will differ, however, if imported intermediate input prices are changing rapidly, or if large domestic industry price changes are not completely passed through to final users in the current period. Imported intermediate input prices affect GDP directly but with the opposite sign. Other things equal, rising prices for imported intermediate inputs reduce the GDP price index and falling prices for imported intermediate inputs increase the GDP price index.[4] These relationships hold with the double-deflation method as well, as imported intermediate input prices are factored into the calculation of real value added by industry and in the aggregation over all industries. Single deflation with the gross output price index, however, will not capture this import price effect.

If domestic industry price changes are fully passed through to final users in the current period, then the aggregate gross output price index tends to equal or closely approximate the aggregate value added (GDP) price index. This is because the price change is reflected in both the market value of GDP final uses and in the GOS (i.e., profits) component of nominal value added. If pass-through of these price changes is not complete, or if it takes place over several quarters, then the aggregate gross output price index tends to overstate the GDP price index when large price increases occur and tends to understate the GDP price index when large price declines occur. In a simple example, industry A increases the gross output price that it charges industry B, but industry B absorbs the increase. Prices for GDP and aggregate value added do not change, but the average (aggregate) change in gross output prices is positive.

Chart 4 shows quarterly percent changes at annual rates for selected aggregate price indexes: GDP, GDP Purchases, and All Industries Value Added. GDP Purchases is included because it is a good readily-available quarterly indicator of the effect of import prices on the GDP price index and thus it may signal when single deflation is problematic. GDP Purchases is defined as the price index for GDP including imports and excluding exports, and it is designed to measure changes in the prices paid by domestic

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[4] Price changes for imports consumed in final uses, such as personal consumption expenditures (PCE), will not affect the GDP price index if the same price index is used for both imports and PCE. This is because these expenditures are included in both imports and PCE but with opposite signs.

consumers. Research has indicated that the gross domestic purchases price index behaves much the same as a price index for GDP plus imported intermediates, so the purchases price index can be viewed as a proxy for what the all-industry value-added price index *would* be if the only source of difference were the import price effect described above. In 12 of the 16 quarters, the all-industry VA price index deviated from the GDP price index in the same direction as the GDP purchases price index. The major reason--but not the only reason--that the all-industry VA price index does not match the proxy gross domestic purchases price index appears to stem from incomplete pass-through of large domestic price changes. Energy prices have been extremely volatile the last few years, which coincides with the testing period for the experimental quarterly GDP-by-industry estimates.

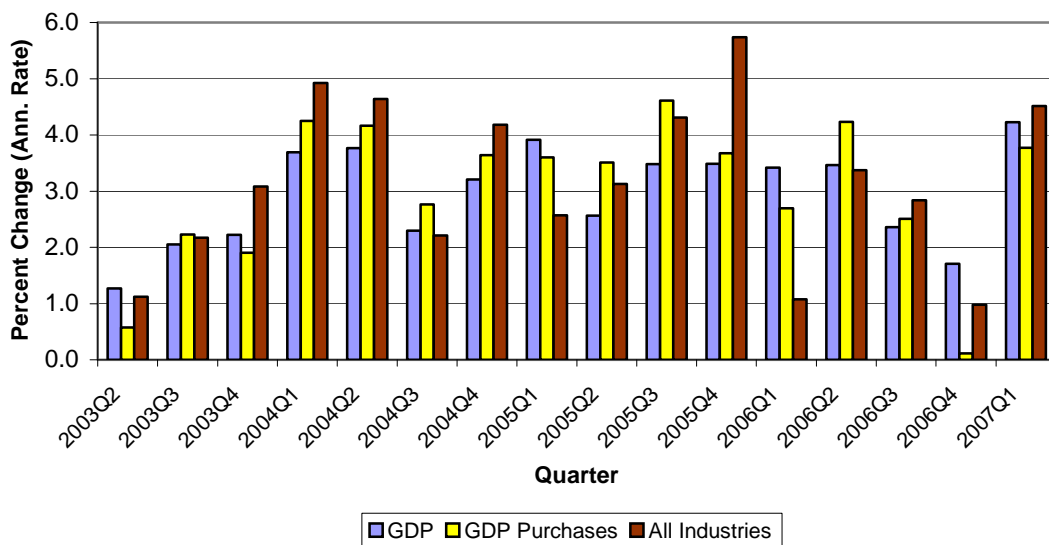## Chart 4.-- Aggregate Price Changes

Chart 5 shows price changes at an annual rate for selected energy products: imported petroleum, gross output for the domestic oil and gas industry, and gross output for the refined petroleum and coal products. Quarters with large declines in imported petroleum prices are associated with smaller increases in the gross domestic purchases price index, and vice versa. Domestic energy prices have also been quite volatile over this period and, to the extent that pass-through of these domestic price changes has not been complete, the aggregate value-added price index overstates or understates its proxy price index. Unlike the import price effect, the incomplete pass-through effect is a

complex dynamic that is not clearly observed in the data and is difficult to model. This is partly because pass-through may never be complete, or it may be completed over several quarters, or it may vary from quarter to quarter, confounding attempts to isolate the effects of large price changes in the current quarter. The effect is perhaps most apparent, however, in 2005 Q4 and 2006 Q1. Both crude and refined petroleum prices increased tremendously in 2005 Q4 and declined tremendously in 2006 Q1. In 2005 Q4, the aggregate VA price index substantially exceeded the proxy gross domestic purchases price index and in 2006 Q1 it substantially fell short of the proxy price index.

Chart 5.-- Selected Energy Prices
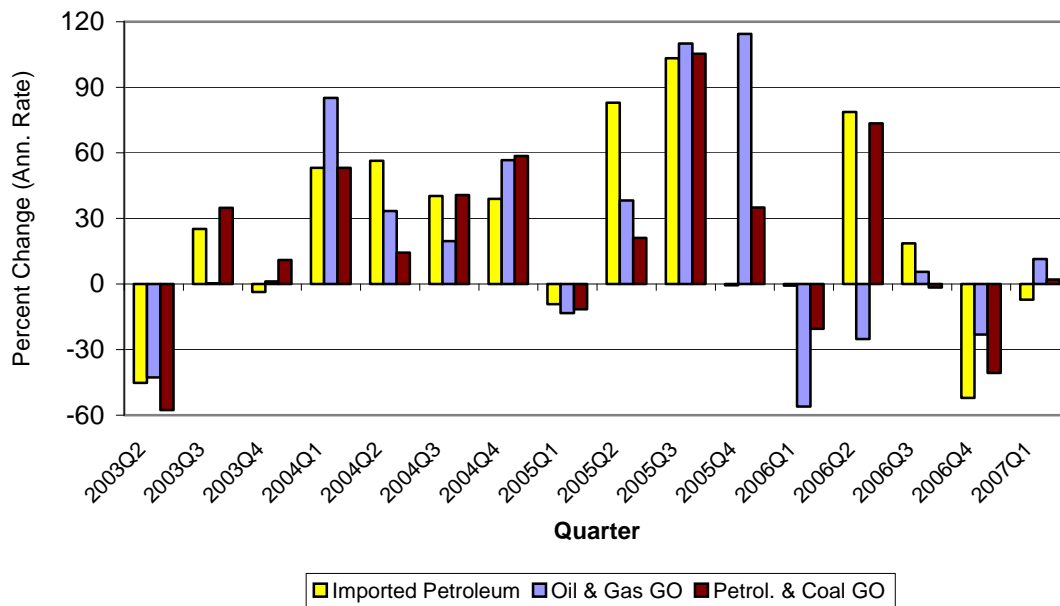
Implications for Methodology

Aggregate differences in real output measures have implications for the quarterly GDP-by-industry methodology. When prices of imported intermediate inputs change sharply, the all-industry aggregate VA price index, assuming complete pass-through of large domestic price changes, should closely approximate the price index for GDP including imported intermediate inputs. This is because, in the aggregate, the single-deflation methodology using the gross output price index does not capture the effect of imported intermediate inputs. If the aggregate all-industry price index closely matches the proxy GDP purchases price index, then its deviation from the actual NIPA GDP price index is most likely due to imported intermediates, and adjustments can be made to the

value-added price indexes for industries known to use these imports. If the all-industry

VA price index differs significantly from the proxy price index, we can assume that

incomplete pass-through of domestic price changes is playing a key role. However, even

if we know that energy prices are responsible and which industries are most affected, it is

difficult to determine how much of an adjustment should be made in specific industries

for incomplete pass-through. More research is needed on this challenging topic.

Industry Detail

For the quarterly GDP-by-industry estimates, BEA proposes to provide the same

level of industry detail as in national income by domestic industry. This consists of 15

broad private industry groups, government, and aggregates for manufacturing and private

industries. In addition, special aggregates would be provided for private goods-

producing industries and for private services-producing industries. Table 2 presents

Table 2. -- Percent Changes in Value Added by Industry Group, 2007 Q1
(seasonally adjusted at annual rates)

	Nominal	Real
Gross Domestic Product [1]	4.9	0.7
Private industries	4.6	0.3
Agriculture, forestry, fishing, and hunting	30.1	-12.0
Mining	-24.5	-27.9
Utilities	0.3	-11.9
Construction	-13.2	-15.2
Manufacturing	10.1	7.3
Durable goods	6.8	5.7
Nondurable goods	14.5	9.2
Wholesale trade	11.6	5.6
Retail trade	1.5	-0.1
Transportation and warehousing	3.7	-1.4
Information	20.4	20.6
Finance, insurance, real estate, rental, and leasing	-4.4	-6.5
Professional and business services	14.1	6.6
Educational services, health care, and social assist.	4.5	-1.4
Arts, entertainment, recreation, accom., & food ser.	25.4	20.6
Other services, except government	5.6	2.1
Government	7.0	1.0
Addenda:		
Private goods-producing industries	1.8	-2.9
Private services-producing industries	5.4	1.2

[1] GDP estimates are from before the July 2007 annual NIPA revision.

illustrative quarterly detail and estimates for the first quarter of 2007 based on the experimental estimates that were prepared after the final first-quarter GDP release on June 28.

Table 2 also reveals the degree of variability in quarterly value-added by industry growth rates. Among the 15 private industry groups, nominal value added increased or decreased more than 10 percent (annual rate) for eight groups, with the average for all private industries at 4.6 percent. Changes exceeded 20 percent for four industry groups, two in the goods-producing sector and two in the services-producing sector. For the most part, these large changes were due to very large changes in the gross operating surplus component of value added, rather than in compensation of employees or taxes on production and imports less subsidies. Within the GOS component, corporate profits were usually the driving force behind the change.

Estimates of real value-added by industry also showed considerable variability for this quarter. Changes were not always in the same direction as the nominal value-added estimates due to the behavior of the industry's estimated value-added price index. For example, real value added for transportation and warehousing declined 1.4 percent despite an increase of 3.7 percent in nominal value added. This was due to an increase in the estimated value-added price index of more than five percent. Real GDP increased only 0.7 percent at an annual rate. This reflects a decline of -2.9 percent for private goods-producing industries and an increase of 1.2 percent for private services-producing industries. Government increased 1.0 percent. Real value added declined for 8 of the 15 private industry groups, including three in the services sector. The largest decline in the goods-producing sector was in mining (-27.9 percent) and the largest decline in the services-producing sector was in finance, insurance, real estate, rental, and leasing (-6.5 percent).

Release and Revision

Quarterly GDP-by-industry estimates would be based on the final quarterly GDP and GDI data from the NIPAs and, according to one scenario, would be released about 15-30 days after the NIPA release, a lag of 3.5 to 4 months after the end of the reference quarter. The final quarterly GDP release contains the most complete set of income by

industry data for extrapolating nominal value added by industry. Non-NIPA source data for gross output and price indexes are also complete at that time. Estimates for the first quarter would be released in mid-July. Subsequent quarterly estimates would be released in mid-October, mid-January, and late April. Because the first-quarter GDI estimates are often significantly revised when the annual NIPA revision is released in late July, BEA would consider releasing revised first-quarter estimates when the second-quarter estimate is released in mid-October.

Each April, the quarterly GDP-by-industry estimates for prior years would be revised to incorporate the results of the most recent (usually the previous July's) annual NIPA revision and the previous December's annual industry accounts revision, as well as April's advance annual GDP-by-industry estimates for the prior year. For nominal value added estimates, these revisions will insure that, for each industry, the sum of the four quarters equals the most recent annual value added estimate and that, for each quarter, the sum of industry value added over all industries equals GDP for that quarter. The annual revisions will require the interpolation of quarterly estimates to match annual totals and the adjustment of estimates to meet both annual industry and quarterly NIPA controls. BEA is also considering making revisions to value-added price indexes to incorporate the most recent annual estimates. One thorny issue that needs to be resolved concerns inconsistencies in year-over-year quarterly estimates based on different vintages of NIPA annual revisions.

Time Frame and Future Plans

For the remainder of fiscal year 2008, BEA plans to continue testing and evaluating the methodology for both the nominal and real quarterly GDP-by-industry estimates. This testing and evaluation will allow us to make necessary refinements and enhancements to the methodology and source data. For example, we would like to develop better methods of estimating the gross operating surplus by industry on a quarterly basis, especially when there are large changes in the statistical discrepancy or when large adjustments are needed to match aggregate totals. We also need to investigate how to incorporate revised W&S data from the BLS QCEW program that is incorporated into the NIPA compensation estimates with a one-quarter lag. For the real

value-added estimates, research is needed to better understand the sources of differences in aggregate price indexes, including imported intermediate inputs and incomplete pass-through of price changes. Work on developing processing systems and annual revision procedures will also start during this period.

During fiscal year 2009, we anticipate completing the systems development work for quarterly estimates and plan to test procedures for conducting annual revisions. Dry-runs of annual revisions in April 2009 and April 2010 will allow us to identify problems with revision procedures and make necessary corrections. We also plan to develop standardized analysis and review tables that will allow us to evaluate the experimental quarterly estimates as though they were intended for publication. Value added estimates will be evaluated in light of data on gross output by industry, related estimates from the quarterly NIPAs, and other sources such as the industrial production index and the quarterly services survey. In fiscal year 2010, estimates for 2010 Q1 will be released in mid-July along with estimates for earlier quarters. Fiscal year 2011 will see the release of estimates for the other quarters of 2010. Quarterly estimates for earlier years will be revised in April 2012.

Another important area for research concerns testing the gross output quantity-extrapolation method for calculating real value added by industry. This method was tested as part of the research for the advance annual estimates, but BEA decided the single-deflation method overall yielded better results. However, when prices are volatile on a quarterly basis, the gross output quantity extrapolation method may work better. This method would still be subject to the bias associated with imported intermediate inputs, but the bias associated with incomplete pass-through of domestic price changes should be smaller. The data developed for this research could also be used to test the feasibility of a quarterly production-based measure of real GDP, despite the absence of quarterly data on intermediate inputs by industry. This method is used by other countries that produce alternative measures of quarterly real GDP. The same industry output data could also be used to develop quarterly output indexes for services industries.