Integrated Industry-Level Production Account for the United States: Intellectual Property Products and the 2007 NAICS

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Abstract

Ongoing structural change in the U.S. economy due, in part, to globalization, the spread of information and communications technology, and the Great Recession, has reinforced the need for an up-to-date decomposition of aggregate GDP to industry-level sources of growth. This approach, typically labeled "KLEMS" accounts has been developing at an accelerating rate within the international community and has garnered significant attention in recent years. Partly in response, the U.S. Bureau of Economic Analysis and the U.S. Bureau of Labor Statistics collaborated to introduce an integrated industry-level production account for the United States, spanning the years 1998-2010 (Fleck, Rosenthal, Russell, Strassner, & Usher, 2013). In this paper, we update the integrated industry-level production account through 2012 in order to incorporate the results and methodological changes of the 2013 comprehensive revision of the U.S. national income and product accounts, the 2007 benchmark input-output account, and the times series of integrated GDP by industry and annual input-output accounts for the United States. We trace the sources of U.S. economic growth and productivity using our updated account, and provide new estimates of the contributions of expanded investments in intangible capital—intellectual property products, including research and development and entertainment, artistic, and literary originals.

1 Introduction

Economic growth in the U.S. since 1995 has been characterized as containing several unique episodes: the Information Technology (IT) Investment boom between 1995 and 2000, the period of Jobless Growth over the 2000-2005 period, and the Great Recession and Recovery period that began around 2007 and continues through today.[2] At the same time, ongoing structural trends that predate this period have continued, and remain a focal point for both economists and policy makers: increasing globalization of the marketplace, the ongoing spread of information and communications technology, and the continued effect of the skills gap on the U.S. labor market.

These broad trends and unique growth episodes are identifiable at the aggregate level. For example, BLS estimates that between 1995 and 2000, the contribution of information technology capital to the growth in GDP and labor productivity was about double when compared to the periods before and after the IT-boom.[3] Furthermore, (Jorgenson, Ho, & Samuels, Forthcoming) analyzes the period between 2000 and 2005, a period typically associated with "Jobless Growth" and estimates that multifactor productivity growth (MFP) accounted for an unusually large share of aggregate GDP growth (about 44% during this period, compared to 23% over the 1948-2010 period).

The macro perspective obscures many of the pertinent details on the sources of growth. Between 2000 and 2005, estimates at the industry level indicate that almost half of this aggregate productivity was due to productivity growth originating in the Information Technology (IT) producing industries. In (Jorgenson, Ho, & Samuels, 2014), IT-producing industries accounted for a little over 3% of nominal aggregate value added but for almost 50% of aggregate MFP! The role of IT in growth and productivity continues to garner attention from the research community, including (Gordon, 2014), (Jorgenson, Ho, & Samuels, 2014), (Byrne, Oliner, & Sichel, 2013), among others.

Furthermore, the impact the Great Recession was not balanced across industries. For example, according to Bureau of Economic Analysis (BEA) data, between 2007 and 2012, real value added declined in Construction and Nondurable goods manufacturing, but increased substantially in Mining industries, Professional and business services, and within the Federal government. On the labor side, using data from (Jorgenson, Ho, & Samuels, 2014), the aggregate college skill premium paid to workers was basically unchanged between 2005 and 2010. But at the industry level, over that same period, the college wage premium increased significantly in transportation-related industries and decreased substantially in finance-related industries, again emphasizing the importance of industry-level analysis of aggregate trends.[4]

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[2] (Jorgenson, Ho, & Samuels, Forthcoming)
[3] For further information see Multifactor Productivity Trends, 2012, www.bls.gov/news.release/archives/prod3_04032014.pdf.
[4] (Jorgenson, Ho, & Samuels, 2014)

The differences in the dynamics of growth across sub periods after 1995, in combination with the longer term structural changes that continue to influence the economy have reinforced the need for an up-to-date decomposition of aggregate GDP to the industry-level sources of growth. This decomposition is important not only for analyzing growth history, but also for evaluating growth prospects as the economy continues to recover from the financial crisis. For example, (Jorgenson, Ho, & Samuels, Forthcoming) argues that it's important to consider industry specific sources of growth, and shows how to incorporate this feature into aggregate projections of labor productivity and GDP growth.

In this paper, we present a new industry-level dataset that is useful for analyzing the underlying trends in aggregate economic growth.[5] The dataset combines industry-level output and intermediate inputs from the BEA GDP by industry accounts with information on capital and labor inputs from the BLS Productivity Program to form an internally consistent industry-level production account that is consistent with the aggregate GDP account published with the July 2013 comprehensive revision of the National Income and Product Accounts (NIPAs) and the January 2014 comprehensive revision of the Industry Economic Accounts.[6]

One of the most important features of our dataset and analysis is that it treats industry-level spending on intellectual property products, for example research and development (R&D), as an investment good. Since the seminal contributions of (Griliches, 1979) and (Romer, 1994) economists have been stolidly focused on quantifying the role of R&D in economic growth and productivity. By treating spending on R&D as an investment that yields a flow of capital services over time, the contribution of intellectual property products to growth and productivity can be analyzed using the same framework as other capital goods in the dataset that we analyze.

The dataset that we present in this paper is an update of (Fleck, Rosenthal, Russell, Strassner, & Usher, 2013). The incorporation of expenditures on R&D and on entertainment, artistic and literary originals expands the boundary of U.S. GDP and its related measures. The treatment of R&D includes both the estimates of own-account spending on R&D as investment and the R&D produced by industry that is sold to others. Expenditures on entertainment, artistic and literary originals only includes own-account spending. The updated account also includes statistics through the year 2012, allowing for a more-complete analysis of trends leading up to and after the period of the Great Recession.

To summarize our results, we find that:
- R&D capital input contributed about 0.09 percentage point to aggregate value added growth between 1998 and 2012, about half as much as software.
- Including R&D reduces estimated MFP growth from about 0.56% per year to 0.47% per year over the 1998-2012 period.

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[5] The complete dataset is available on BEA's website at https://www.bea.gov/industry/index.htm#integrated.
[6] This industry-level production account is somewhat broader in scope. It treats government capital symmetrically with private sector capital input. In particular, in addition to the depreciation cost, there is also a rate of return on government capital assets.

- The smaller contribution of capital input relative to the pre-crisis period more than accounts for the slower growth during the recovery.

The remainder of the paper proceeds as follows: section 2 gives an overview of the framework, section 3 presents estimates of the industry sources of growth over the period that we analyze, and section 4 presents results on the industry sources of aggregate growth and productivity. Sections 5 and 6 present information on the changes in methodology in this version of the data, and section 7 presents the conclusions and next steps.

2   Overview of the framework

We use a growth accounting framework to analyze the sources of growth across industries. The implementation of this framework requires data on outputs produced by industry, the prices received by the producer for these outputs, and the prices and quantities of intermediate and value added inputs used in production, by industry. Because an objective of our analysis is to produce estimates that are consistent with the NIPAs and the GDP by Industry accounts, the industry-level production account that we construct maintains the definitional and conceptual framework of the BEA economic accounts. In fact, a complementary view of the industry-level production account that we present, and employ for analysis, in this paper is that the accounts that we construct simply impose another layer of internal consistency. Specifically, the additional level of internal consistency that we apply is that like intermediate inputs, primary inputs capital and labor have heterogeneous types, and assembled together, the price and quantities of capital and labor inputs along with existing data on industry intermediate inputs and output yields the industry-level production account that we describe below.

The industry-level production account and MFP measures presented here reflect output consistent with GDP for the total economy, but differ in concepts and coverage from the official BLS measures of multifactor productivity. For example, the use of a gross output concept for measuring multifactor productivity in this project contrasts with the sectoral industry output approach used in the BLS multifactor productivity measures for major sectors and industries. For more details, see "Conceptual and Measurement Challenges" in (Fleck, Rosenthal, Russell, Strassner, & Usher, 2013).

3   Sources of industry growth

The fundamental economic entity in our analysis is the industry, and the aggregate economy is divided into 63 industries. Each of these industries produces output using primary capital and labor inputs, intermediate input, and the available level of production technology. It is noteworthy that each of these major input groupings at the industry level is, in fact, made up of many heterogeneous inputs, each with its own price and quantity index. For example, under intermediate input, there are all of the commodities that are published in the benchmark input-output accounts. Capital input includes estimates for approximately 90 assets within the

categories of fixed business equipment, structures, inventories, land, and intellectual property products. Intermediate inputs include items such as energy, materials, and purchased business services. Labor input is cross classified by gender, age, education, and class of worker.[7]

Since productivity is a measure of how efficiently inputs are converted to output, it is important that outputs and inputs are measured in constant units exclusive of inflation, i.e. hours adjusted for labor composition and constant dollar quantity indexes of capital input and intermediates that measure the services provided by that input.

Using the growth accounting framework, industry output growth is expressed as the sum of the share weighted growth rate of industry inputs and the change in MFP. Within this framework, MFP growth measures embed underlying changes in the true economic technology, innovation, changes in production management, but also include the effects of inputs that are not properly measured or are unmeasured. For example, prior to the July 2013 comprehensive revision of the NIPAs, spending on R&D did not produce future capital services, so that R&D was missing as a capital input. The set of accounts presented in this paper includes R&D spending as a capital input.

Table 1 presents the comprehensive results from the industry-level production account: industry output growth and the sources of industry output growth for the 1998-2012 period. This table demonstrates the heterogeneity in industry growth and its sources for that period. For example, the Support activities for mining industry grew by about 7.2% per year over the period (consistent with the expansion of fracking), due mostly to an expansion of labor input and MFP growth. The Data processing, internet publishing, and other information services industry grew by a little over 8% per year as a result of capital investments and purchases of intermediate inputs, consistent with anecdotal evidence of shifts to cloud computing. At the bottom end of the spectrum, the Apparel industry shrank by about 10% per year over the period (which is consistent with increased apparel purchases produced abroad), but became slightly more productive in terms of MFP growth. Textile mills had a similar growth experience to Apparel. The Motor vehicle industry grew by about 0.7% over the period, driven mostly by MFP growth, as declines in labor input dampened growth by about 0.4% per year.

Figure 1 shows that the contribution of MFP growth to industry output varied considerably by industry. Over the 1998-2012 period, the largest growth in MFP occurred in Computer and electronic products, Support activities for mining, Water transportation, Computer systems design and related services, and Pipeline transportation. These productivity gains reflect ongoing innovation in information technology, and innovative practices in the mining and transportation industries. In contrast, Rental and leasing, Management of companies, Legal services, and Other services, experienced negative productivity growth over the same period. Negative measured MFP growth reflects decreased capability to manage resources, decisions to hoard inputs in uncertain times, but also indicates potential issues in the measurement of

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[7] Employee, or self-employed.

outputs and inputs, including but not limited to quality adjustment issues or changes in unmeasured inputs.

As noted above, the contribution of each broad input (capital, labor, intermediate) incorporates heterogeneous components. For the purpose of exposition, we have divided the measures of capital input into components, specifically, Information Technology (IT) capital equipment, Software capital, R&D capital, and Other capital. Other capital includes about 90 types of other capital equipment and structures, inventories and land. Intermediates include energy, materials, and purchased services. For labor input, we have divided the estimates into those with a college degree and those without. Underlying each of these components of labor is detail on labor input by gender, class, age, and level of educational attainment.

Table 2 indicates that the contribution of IT and software capital was spread broadly across industries over the 1998-2012 period, and that R&D capital was important for the growth of a few select industries. IT and software capital played particularly important roles in Data processing, Broadcasting and telecom, Publishing (including software), and Management of companies. R&D capital was particularly important for Chemical products, Computer and electronic products, and Miscellaneous manufacturing.

Table 3 shows that the declining contribution of noncollege workers was spread broadly across industries over the 1998-2012 period. In contrast to the large majority of industries, labor input for noncollege workers increased in select Transportation and warehousing and storage-related industries, and for some Education, health and social assistance-related industries.

This integrated production account is useful for analyzing the economic changes at the industry level that occurred during the time of the Great Recession and that are taking place during the ongoing recovery. To analyze the ongoing recovery within the 1998-2012 period, we split the sample into three periods: 1998-2007, 2007-2009, and 2009-2012. According to the National Bureau of Economic Research Business Cycle Dating Committee, the official recession began in December 2007, but annual GDP was relatively strong in 2007, so we group 2007 in the pre-Recession period. We group 2008 and 2009 as the recessionary period, and 2010-2012 as the Recovery period.[8] We also include the 2007-2012 period as a sub period of comparison.

Figure 2 gives the changes to the sources of growth that occurred during the recession period. During the 2007-2009 period, industry output growth fell relative to the earlier period in the large majority of industries, by large percentages. The output of the Support activities for mining, Wood products, Nonmetallic mineral, Motor vehicles, Furniture, and Securities industries all fell by about 20 percentage points versus the 1998-2007 period on average. In general, the largest source of the decline was a decrease in intermediate purchases, followed by declines in labor and MFP growth, and lastly declines in the contribution of capital by industry. It is worth noting that these measures of input use during cyclical adjustments do not

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[8] The unemployment rate peaked in October 2009. However, the National Bureau of Economic Research Business Cycle Dating Committee, recorded the end the recession in the United States as June, 2009. See http://www.nber.org/cycles/recessions_faq.html

capture effects such as worker effort, changes in capital utilization, or unmeasured labor effort that average out over the business cycle, but can be important over the course of the business cycle.

Figure 3 compares industry output growth and its sources over the 2007 to 2012 period to the 1998-2007 period. Output growth was slower in all but seven industries, two of which were government sectors. Relative to growth during the 1998-2007 period, the industries with the steepest declines were Securities, commodity contracts, and investments, Nonmetallic mineral products, Furniture, Construction, and Computer and electronic products. The sources of these relative declines was broad based; for each of these sectors all inputs declined relative to the earlier period except labor input in the Computer and electronic products industry and MFP growth in Construction. There are a subset of industries with significant counterbalancing growth of inputs. For example, in Motion pictures and sound recording, and Rental and leasing, large declines in inputs relative to the 1998-2007 period were counterbalanced by large increases in MFP. In the Pipeline transportation industry, intermediate inputs fell, while the contributions of capital and labor increased. In Educational services, declines in labor were offset by increases in intermediate purchases and MFP.

To analyze how the ongoing recovery compares to the pre-crisis expansion, figure 4 compares industry output growth and its sources between 2009 and 2012 with the 1998-2007 period. Of the 63 industries we analyze, 34 industries grew faster during the ongoing recovery period than during the period immediately preceding the crisis, even though aggregate GDP growth was slower during the latter period. The largest relative differences occurred in Apparel and leather products, Motor vehicles, Primary metals, Machinery, Oil and gas extraction, and Support activities for mining. For each of these industries the sources of growth was mostly attributable to labor input, intermediate input, and MFP growth, with contribution of capital not showing much difference compared to the earlier period. The industries with slowest output growth relative to the early period were Securities, Credit intermediation, Social assistance, Construction, and Farms. This slower growth was due to slower accumulation of inputs and MFP growth in each of these industries, except for relatively higher MFP in Construction and a small increase in the contribution of capital in Farms. Overall, for the industries that grew faster during the recovery period compared to the 1998-2007 period, the largest source of increased output growth was increased intermediate growth, followed by MFP growth, labor input growth, and then capital input growth, on average. For those industries that declined relative to the 1998-2007 period, the largest source, on average, was the decline in intermediate input, followed by capital input, MFP growth, and labor input. This figure shows that ongoing recovery has not reverted the depth and breadth of the recession.

4   Decomposition of aggregate GDP growth

The main purpose of this paper is to decompose aggregate GDP growth to its sources across industries and factors of production. We do this by means of the direct aggregation of industry approach (Jorgenson, Ho, Samuels, & Stiroh, 2007). With this approach aggregate value added

growth is the share weighted growth of industry value added growth. The contribution of primary, or value added, input growth by industry to aggregate value added growth is the Domar-weighted input contribution, and the contribution of industry MFP to aggregate MFP is the Domar-weighted industry MFP growth rate.[9]

Table 4 shows that between 1998 and 2012 the majority of aggregate value added growth was due to accumulation of inputs. Of the 2.01% average annual growth in value added, 1.18 percentage points were accounted for by capital (about 60 percent of growth), 0.36 percentage point by labor (18 pecent), and 0.47 percentage point by MFP growth (22 percent). Within capital, about 40 percent of the capital contribution was due to IT equipment and software (0.48 percentage point), and 0.09 percentage points (about 8 percent) from R&D capital. The contribution of R&D capital to aggregate value added growth of 0.09 percentage point per year provides a measure of the bias of previously published estimates. If this contribution of capital was excluded, estimated MFP growth would have been higher by about 0.09 percentage points per year; that is, aggregate MFP growth would have been 0.56% per year instead of 0.47% per year. Within labor input, the contribution from workers without a college degree actually fell over the period as a whole.

Table 4 demonstrates that the majority of the difference in GDP growth from 2009 to 2012 relative to the 1998-2007 period was due to the difference in the contribution of capital. Comparing the recovery during the 2009-2012 period with the 1998-2007 period, GDP grew slower, by 0.67 percentage point per year. The slower growth was more than accounted for by the smaller contribution of capital input, which contributed 1.16 percentage point less to growth during this period than during the 1998-2007 period. This was split between IT-capital which accounted for 0.31 percentage point, Software capital accounted for 0.17 percentage point, and Other capital accounted for 0.66 percentage point.

Interestingly, all of the increase of the contribution of labor input during the Recovery period was due to the increased contribution of workers without a college degree, reversing the decline in the contribution of non-college workers that took place beginning in the late 1990s.

The direct aggregation across industry approach yields insights into the underlying structural changes that occurred over the 1998-2012 period. Tables 5 and 6 divide the aggregate value added and productivity growth into contributions from IT-producing industries, industries that use IT relatively intensively, and other industries. Between 1998-2012, IT-producing industries accounted for 3.1 percent of nominal value added, but 0.31 percentage point of the 2.01 average annual growth, or about 15% of the growth in aggregate valued added. IT-using industries accounted for 0.99 percentage point, or almost 50% of growth which is slightly larger than its 46.8 percent share of nominal value added. Non-IT accounted for 0.45 percentage

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[9] Each industry's Domar weight is the ratio of the industry's current-dollar gross output to aggregate current-dollar value added. The industry's contribution to aggregate MFP growth is the industry's MFP growth multiplied by its Domar weight. The contribution of industry intermediate input use drops out in the calculation of aggregate value added and its decomposition.

point and Government accounted for 0.26 percentage point. The decomposition suggests that both IT-using (-0.90 percentage point contribution) and Non-IT industries (-1.01 percentage point contribution) were hard hit during the recession period of 2007-2009, while IT-producing industries (0.13 percentage point contribution) added to growth. During the recovery period, Non-IT industries have contributed a larger share of growth relative to its share during the pre-crisis period, while IT-producing, IT-using, and Government all contributed smaller shares of growth.

In terms of aggregate productivity growth in Table 6, IT-producing industries accounted for the majority of productivity growth over the 1998-2012 period, when MFP averaged 0.47 percent per year. The contribution of IT-producing industries to aggregate productivity growth has fallen slightly from 0.34 percentage point per year before the recession to 0.14 percentage point per year during the recession and recovery. Not surprisingly, measured aggregate MFP growth fell significantly during the Great Recession, and recovered during the subsequent period. There does not appear to be a major difference in the decline and recovery between the IT-using and Non-IT industries.

Table 7 shows that relatively R&D intensive industries made a disproportionate contribution to aggregate MFP growth. Between 1998 and 2012, of the 0.47% per year in aggregate MFP growth, 0.34 percentage point was due to industries that were relatively R&D intensive. Importantly, of this 0.34 percentage point contribution, about 0.27 percentage point was due to productivity growth in the IT-producing industries.[10]

Table 8 provides an examination of structural changes at the industry level for 22 major industry groups at roughly the 2-digit North American Industry Classification System (NAICS) level of detail, consistent with industry groupings publishing in BEA's Industry economic accounts. Finance and insurance accounted for about 42 percent (0.28 percentage point) of the slower U.S. economic growth during the 2009-2012 period, with capital input accounting for the majority of its slowdown. State and local government accounted for about 29 percent (0.19 percentage point) of the slower growth, due mainly to labor input, and nondurable goods manufacturing accounted for about 27 percent (0.18 percentage point) due to MFP.

In contrast, Mining, Management of companies, and Durable goods manufacturing exhibited stronger growth during the recovery period relative to the pre-crisis period. Mining contributes 0.12 percentage more to growth during the 2009-2012 period relative to the 1998-2007 period, due mainly to gains in MFP but also from stronger contributions of labor and capital input. Management of companies was also led by stronger relative growth in MFP, while Durable goods stronger relative growth was more than accounted for by stronger relative growth in labor input.

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[10] The IT classification is taken from (Jorgenson, Ho, & Samuels, 2014). The classification of industries into R&D intensive and non-R&D intensive is based on an R&D intensity index defined as the average share of R&D capital income in capital over the 1998-2012 period. First industries with a share less than 1% are allocated to non R&D. Then industries with shares above the median share of 0.08 are allocated to R&D intensive.

The framework and data permits an analysis of the industry sources of the aggregate sources of growth. Figure 5 shows the difference in industry contributions to aggregate value added growth during the recovery relative to the 1998-2007 pre-recession period, and extends the more-aggregate analysis from Table 8. As noted, aggregate value added growth has been slower during the recovery period compared to the 1998-2007 period, but this is not the case for all industries. For example, Motor vehicles, Management of companies, Machinery, Utilities, Oil and Gas, and Computer systems design are all growing more rapidly in the recovery than during the period preceding the recession, as would be expected of most industries during the recovery from a cyclical downturn. Yet all industries are not recovering relative to the 1998-2007 period. State and local governments, Computers and electronic products, Broadcasting and telecom, and Credit intermediation are all growing significantly less rapidly than during the pre-crisis period that we consider.

To understand the sources of slower aggregate value added growth during the recovery period, figures 6-8 show the differences in industry contributions to aggregate capital, labor, and MFP between 2009-2012 and 1998-2007. With respect to industry contribution to aggregate capital input, figure 6 indicates that relative to the precrisis period, there was a significantly lower contribution of capital input in Real estate, Credit intermediation, Retail trade, Rental and leasing, Wholesale trade, and Construction. Figure 7 shows that small increase in the aggregate contribution of labor input during the 2009-2012 period compared to the 1998-2007 period was spread broadly across a subset of industries including Computer and electronic products, Machinery, Administrative support services, Fabricated metal, and Motor vehicles. In each of these industries, the contribution of non-college workers outpaced that from the 1998-2007 period.

5   Changes in classifications

This account was prepared using the 2007 NAICS, which updates the industrial classification from the 2002 NAICS. The NAICS was introduced in 1997 as a new classification system with the organizing principal of unique production processes to classify and aggregate outputs and inputs consistently (Office of Management and Budget, 1997).

Changes stemming from the incorporation of the 2007 NAICS were limited for the presentation of Industry statistics in this account. Specifically, the description of NAICS industries used in this account have been updated for NAICS 511 as Publishing industries, except Internet (includes software) and NAICS 514 Data processing, Internet publishing, and other information services.

Importantly, this account now reflects the heterogeneous mix of outputs and inputs of the more-detailed NAICS changes introduced for 2007. The information sector, NAICS 51, incorporates a number of reclassifications within the sector.[11] Internet publishing and

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[11] Table 2 of (Strassner & Wasshausen, 2013)provides the pertinent details for the information sector.

broadcasting has been reclassified into other information services. Internet services providers, web search portals, and data processing has been renamed: data processing, hosting, and related services. Internet services providers have been reclassified to telecommunications and web search portals has been reclassified to other information services. In addition, two changes for the 2007 NAICS results in reclassifications across sectors. Real Estate Investment trusts (REITs) have been split between equity REITs, now classified in the Real Estate industry (NAICS 531) with mortgage REITs remaining in Funds, Trusts, and other financial vehicles (NAICS 525). Executive Search Services are now classified in Administrative and Support Services (NAICS 561), from Miscellaneous professional, scientific, and technical services (NAICS 5412OP).

6   Changes in definitions and statistical methods

Several major definitional changes were incorporated into the BEA NIPAs, Industry Economic Accounts, and Fixed Assets Accounts, as well as measures of BLS capital in this integrated account. These changes are covered in detail in (Strassner & Wasshausen, 2013), (Strassner & Wasshausen, 2014); (Bureau of Economic Analysis, 2013), (Kornfeld, 2013), and (McCulla, Holdren, & Smith, 2013). In particular the boundary for business investment was expanded to include investments in intangible capital in the calculation of GDP. This expanded scope of business investment was incorporated to update the NIPAs to more accurately portray the evolving nature of the economy. These changes were recommended in the updated international guidelines of *The System of National Accounts 2008* (United Nations, 2008).

A new category of intangible investment was created—intellectual property products— that is, expenditures on R&D and on entertainment, artistic, and literary originals were added as new intangible-capital formation. Software development expenditures were reclassified from the category of private equipment and software investments to the new intellectual property products category. In addition, the scope of capitalized ownership transfer costs of residential fixed investment was expanded to include additional nonfinancial costs of acquisition and expected disposal to be included with the already-capitalized brokers' commissions.

The BEA also adopted an accrual basis for the accounting of defined benefit pension plans and now recognizes the costs of unfunded liabilities. This change more accurately matches incomes earned in production with the productive activity. It affects both labor income measured through compensation of employees and as well as capital income measured through gross operating surplus.[12]

6.1   BEA Gross Output, Intermediate Inputs, and Value Added
The effects of the changes in definition, as well as changes in statistical methods and source data, on BEA's gross output, intermediate inputs, and value added are documented in

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[12] The gross output of nonprofit institutions serving households and of federal and state and local governments are also impacted by the definitional changes that affect capital and labor income because these industries are measured by the sum of their expenses.

(Strassner & Wasshausen, 2014). (Strassner & Wasshausen, 2013) provides a complete description of the motivation behind these changes to the U.S. Industry Accounts and also details the changes to the national economic accounting of the Input-Output and GDP by industry Accounts.

Overall, the changes in definition for the NIPAs resulted in an upward revision of 488 billion dollars in value added and of 318.4 billion dollars in gross output for the year 2007.[13] The value added of industries that were affected most by the changes in definition from the introduction of intellectual property products are illustrated in the data found in NIPA table 5.6.5 "Private Fixed Investment in Intellectual Property Products by Type." Specifically, the value created by the capital service flows due to these intangible investments are now accounted for in the capital income component of value added.

Statistical revisions for 2007 were -36.4 billion for value added and 19.2 billion for gross output. A summary of the major statistical revisions now reflected in the industry-level production account include the incorporation of the 2007 economic census data, which affected gross output, intermediate inputs and value added in various ways; improved measures of financial services provided by commercial banks, which provides a more accurate picture of banking gross output and value added; and improved measurement of the construction industry and of the insurance industry, which affected gross output and value added.[14]

6.2   Capital Input

Principal changes in capital input due to the 2013 comprehensive revision of the U.S. NIPAs include the introduction of R&D and entertainment, artistic, and literary originals as fixed investment, the capitalization of ownership transfer costs of residential fixed assets, and revisions to the capital income estimates derived from the annual industry accounts.

Intellectual property accounts are now a fifth category of major asset types that include the 90 individual assets. The other major categories are equipment, structures, inventories, and land.[15] Intellectual property products are composed of three broad classes of assets: software (originally in a category called fixed business equipment and software), research and development, and artistic originals. Software is comprised of pre-packaged, custom, and own-account software. R&D is creative work undertaken to increase the stock of knowledge for the purpose of discovering or developing new products or improving existing ones. Entertainment,

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[13] The year 2007 is presented because this is a year for which economic census data is reflected in the estimates. Economic census data, which cover years that end in 2 and 7 are used to benchmark the U.S. NIPAs and Industry Accounts. These data are the most comprehensive and consistent data available in the U.S. federal economic statistical system.

[14] The most complete picture of the impact on gross output, intermediate inputs and value added can be seen in the benchmark input-output account for 2007. These data are available at
http://www.bea.gov/industry/io_annual.htm

[15] This update also includes an estimate of the service flow from government land following (Jorgenson & Landefeld, 2007).

artistic, and literary originals include theatrical movies, long-lived television programs, books, music, and other forms of entertainment.[16]

The "implicit rental price" of capital is based on the principle that inputs should be aggregated using weights that reflect their marginal products.[17] The assumption used to formulate the rental price expression is that the purchase price of a capital asset equals the discounted value of the stream of services (and, hence, implicitly the rents) that the asset will provide.

Rental prices for R&D assets are treated somewhat differently than other assets. For R&D assets, businesses receive credits for increasing research activities. Unlike all other assets where the effective rate of the investment tax credit is zero, R&D assets do have tax credits factored into the rental price. Given that qualified R&D capital expenses are immediately deductible, the present value of $1 of tax depreciation allowances is given the value of one. Also, given the fact that there is a certain amount of risk to R&D expenditure that is not incurred by other assets, a risk premium of .04 is added to the rates of return of R&D assets.

6.3   Labor Input

6.3.1   Labor hours
As in the previous set of accounts, the labor hours reflect annual hours worked. Payroll employment and hours from the Current Employment Statistics (CES) survey are supplemented with data for the self-employed (partners and proprietors) from the Current Population Survey (CPS). This year, improved ratios of hours worked to hours paid were calculated and applied at a more detailed industry level than previously before summing to the industry levels presented here. In addition, hours were controlled by aggregate group to NIPA hours worked by full-time and part-time workers by industry to ensure consistency within the national accounts framework.

6.3.2   Labor composition
This set of accounts modifies the previously published set of accounts for the labor composition adjustment to labor input. Previously, a labor input index was generated using hours measures from BLS and labor matrices of demographic characteristics from the work of (Jorgenson, Ho, & Samuels, 2011) (JHS). The 192 unique demographic categories were divided by gender, class of worker, age (eight categories), and education (six categories). For this update, the complete time series of labor matrices was re-estimated to avoid relying on estimates produced outside of the statistical system. Furthermore, the time series was updated to include estimates through 2012, but differs from the JHS approach in the period 1998-2002 with respect to converting micro-level Standard Industrial Classification (SIC)-based CPS records to NAICS. The current approach uses the CES SIC-to-NAICS employment bridge at the micro-record level,

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[16] The split of IPP capital held by nonprofits into software, R&D, and entertainment originals is based on capital income shares in the private business sector. Furthermore, the growth rate is assumed to be the same in the private business and the nonprofit sectors.

[17] See (Fleck, Rosenthal, Russell, Strassner, & Usher, 2013) for details.

rather than converting SIC-based labor matrices as done by JHS. The basic source data is the same: data from the March Supplement of the CPS provides the marginal, while the U.S. Census 2000 1-Percent Public Use Microdata Sample Files provides the 2000 benchmark matrix.

7   Conclusions and next steps

During the ongoing recovery from the financial crisis, U.S. growth continues to be sluggish compared to the period immediately before the crisis. At the aggregate level, our analysis attributes the majority of this sluggishness to a decrease in the contribution of capital services. At the industry level, stronger growth in Motor vehicles, Management of companies, Machinery and Utilities is counterbalanced by slower growth in State and local government, Computer and electronic products, Broadcasting, Credit intermediation, and Real estate. The large decline in capital services relative to the 1998-2007 period was driven mainly by Real estate, Credit intermediation, Retail trade and Wholesale trade.

The purpose of this paper is to lay the framework for a set of industry-level production accounts that are consistent with aggregate GDP and provide industry detail to analyze the sources of growth. The current update includes an expansion of the scope of the accounts to include investments in R&D and entertainment originals as an investment good. For the period that we consider, R&D capital input accounted for about 0.09 percentage points of aggregate growth, about half as much as software capital. Entertainment originals capital input accounted for about 0.03%. Thus, incorporating R&D lowered MFP growth estimates from about 0.58% per year to about 0.47% per year.

Our analysis is limited by the time series availability of our industry-level production account. Future work includes investigating approaches to extend the industry-level production account backwards in time following (Jorgenson, Ho, & Samuels, 2014) and improving estimates of labor composition by incorporating results from the American Community survey. In any case, the groundwork for future updates to the industry-level production accounts is now in place, and work is underway to plan for these future updates.

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Table 1: Sources of Industry Output Growth 1998-2012

	Output Growth	Capital Contribution	Labor Contribution	Intermediate Contribution	MFP Growth
Farms	0.51	0.18	-0.08	-0.66	1.07
Forestry, fishing, and related activities	-0.20	0.36	0.49	-1.92	0.87
Oil and gas extraction	1.81	-0.16	0.16	0.53	1.28
Mining, except oil and gas	-0.17	0.35	-0.13	-0.68	0.28
Support activities for mining	7.18	0.37	2.34	0.96	3.51
Utilities	-0.36	0.57	-0.09	-1.19	0.35
Construction	-1.44	0.30	-0.11	-0.60	-1.03
Wood products	-2.10	0.00	-0.90	-2.02	0.83
Nonmetallic mineral products	-1.94	0.17	-0.51	-1.19	-0.41
Primary metals	0.39	-0.09	-0.58	0.24	0.82
Fabricated metal products	-0.31	0.06	-0.31	-0.07	0.02
Machinery	0.57	0.16	-0.47	0.33	0.56
Computer and electronic products	4.05	0.41	-0.82	-2.01	6.47
Electrical equipment, appliances, and components	-1.83	-0.06	-0.62	-2.05	0.90
Motor vehicles, bodies and trailers, and parts	0.67	0.06	-0.44	0.00	1.06
Other transportation equipment	1.26	0.11	-0.16	0.60	0.72
Furniture and related products	-2.60	0.12	-1.21	-1.44	-0.06
Miscellaneous manufacturing	1.62	0.43	-0.33	0.34	1.19
Food and beverage and tobacco products	0.17	0.16	0.01	-0.07	0.07
Textile mills and textile product mills	-5.25	-0.20	-1.55	-3.70	0.20
Apparel and leather and allied products	-9.99	-0.09	-2.80	-8.10	0.99
Paper products	-1.73	-0.18	-0.60	-0.87	-0.08
Printing and related support activities	-2.49	-0.02	-1.40	-2.58	1.50
Petroleum and coal products	0.77	0.09	-0.02	0.59	0.11
Chemical products	0.45	1.12	-0.15	-0.38	-0.14
Plastics and rubber products	-0.95	0.13	-0.43	-0.76	0.11
Wholesale trade	2.43	0.96	0.13	1.08	0.26
Retail trade	2.10	0.94	0.13	1.17	-0.14
Air transportation	-1.74	0.03	-0.38	-1.18	-0.22
Rail transportation	1.21	0.13	-0.40	1.00	0.48
Water transportation	3.17	-0.21	0.21	0.63	2.54
Truck transportation	0.85	0.36	-0.10	0.30	0.29
Transit and ground passenger transportation	1.15	0.39	0.52	0.57	-0.34
Pipeline transportation	-2.13	1.17	-0.16	-5.46	2.33
Other transportation and support activities	1.67	0.01	0.08	1.25	0.33
Warehousing and storage	6.58	0.49	1.25	3.69	1.15
Publishing industries, except internet (includes software)	1.35	1.28	-0.27	-0.30	0.64
Motion picture and sound recording industries	1.12	1.15	0.22	-1.77	1.51
Broadcasting and telecommunications	4.38	1.69	-0.24	1.64	1.30
Data processing, internet publishing, and other information services	8.36	3.16	-0.48	4.97	0.70
Federal Reserve banks, credit intermediation, and related activities	1.46	1.11	0.34	-0.27	0.29
Securities, commodity contracts, and investments	4.11	0.18	0.45	2.43	1.05
Insurance carriers and related activities	3.40	1.08	0.26	2.08	-0.02
Funds, trusts, and other financial vehicles	2.56	0.96	0.19	1.12	0.29
Real estate	2.52	1.42	0.05	0.60	0.44
Rental and leasing services and lessors of intangible assets	2.06	2.37	-0.10	1.32	-1.54
Legal services	-0.02	1.00	0.30	0.02	-1.35
Computer systems design and related services	4.98	0.19	1.86	0.57	2.36
Miscellaneous professional, scientific, and technical services	2.58	0.87	0.88	1.04	-0.21
Management of companies and enterprises	2.83	1.07	1.11	2.13	-1.47
Administrative and support services	2.23	0.75	0.59	0.21	0.68
Waste management and remediation services	1.47	0.19	0.44	0.41	0.44
Educational services	3.29	0.22	1.74	1.75	-0.43
Ambulatory health care services	3.19	0.22	1.54	1.11	0.32
Hospitals and Nursing and residential care	3.02	0.27	1.13	1.85	-0.23
Social assistance	3.52	0.11	1.49	1.99	-0.08
Performing arts, spectator sports, museums, and related activities	2.63	0.14	0.31	1.38	0.80
Amusements, gambling, and recreation industries	2.13	0.69	0.56	1.12	-0.25
Accommodation	0.82	0.95	-0.10	0.11	-0.14
Food services and drinking places	1.73	0.00	0.55	0.88	0.30
Other services, except government	0.00	0.46	0.11	0.78	-1.35
Federal	2.28	0.71	0.01	1.44	0.12
State and local	1.65	0.52	0.62	0.43	0.08

Notes: Average annual percentage growth. A contribution is a share-weighted growth rate.

Table 2: Sources of Capital Contribution 1998-2012

	Capital Contribution	IT Capital and Software Contribution	R&D Capital Contribution	Artistic Originals Capital Contribution	Other Capital Contribution
Farms	0.18	0.01	0.00	0.00	0.16
Forestry, fishing, and related activities	0.36	0.00	0.00	0.00	0.36
Oil and gas extraction	-0.16	0.03	0.02	0.00	-0.20
Mining, except oil and gas	0.35	-0.07	0.01	0.00	0.42
Support activities for mining	0.37	0.12	0.03	0.00	0.23
Utilities	0.57	0.10	-0.01	0.00	0.48
Construction	0.30	0.03	0.00	0.00	0.27
Wood products	0.00	0.01	0.02	0.00	-0.04
Nonmetallic mineral products	0.17	0.00	0.01	0.00	0.16
Primary metals	-0.09	-0.01	-0.01	0.00	-0.07
Fabricated metal products	0.06	0.03	-0.01	0.00	0.04
Machinery	0.16	0.02	0.10	0.00	0.04
Computer and electronic products	0.41	0.15	0.28	0.00	-0.02
Electrical equipment, appliances, and components	-0.06	0.03	-0.06	0.00	-0.03
Motor vehicles, bodies and trailers, and parts	0.06	0.00	-0.02	0.00	0.07
Other transportation equipment	0.11	0.01	-0.03	0.00	0.14
Furniture and related products	0.12	0.05	0.02	0.00	0.05
Miscellaneous manufacturing	0.43	0.19	0.19	0.00	0.05
Food and beverage and tobacco products	0.16	0.03	0.04	0.00	0.09
Textile mills and textile product mills	-0.20	-0.01	0.00	0.00	-0.19
Apparel and leather and allied products	-0.09	0.00	0.00	0.00	-0.09
Paper products	-0.18	0.00	0.03	0.00	-0.21
Printing and related support activities	-0.02	0.01	0.03	0.00	-0.06
Petroleum and coal products	0.09	0.05	-0.12	0.00	0.17
Chemical products	1.12	0.12	0.94	0.00	0.06
Plastics and rubber products	0.13	0.05	0.03	0.00	0.05
Wholesale trade	0.96	0.55	0.00	0.00	0.41
Retail trade	0.94	0.37	0.01	0.00	0.56
Air transportation	0.03	-0.02	0.00	0.00	0.05
Rail transportation	0.13	0.00	0.00	0.00	0.13
Water transportation	-0.21	-0.03	0.00	0.00	-0.17
Truck transportation	0.36	0.16	0.00	0.00	0.20
Transit and ground passenger transportation	0.39	0.02	0.00	0.00	0.38
Pipeline transportation	1.17	0.00	0.00	0.00	1.17
Other transportation and support activities	0.01	0.16	0.00	0.00	-0.15
Warehousing and storage	0.49	0.07	0.00	0.00	0.42
Publishing industries, except internet (includes software)	1.28	1.10	0.06	0.08	0.04
Motion picture and sound recording industries	1.15	0.05	0.02	1.12	-0.04
Broadcasting and telecommunications	1.69	1.45	-0.14	0.31	0.07
Data processing, internet publishing, and other information services	3.16	2.79	0.18	0.00	0.19
Federal Reserve banks, credit intermediation, and related activities	1.11	0.50	0.01	0.00	0.60
Securities, commodity contracts, and investments	0.18	0.16	0.00	0.00	0.02
Insurance carriers and related activities	1.08	1.01	0.01	0.00	0.06
Funds, trusts, and other financial vehicles	0.96	0.06	0.00	0.00	0.91
Real estate	1.42	0.04	0.00	0.00	1.38
Rental and leasing services and lessors of intangible assets	2.37	0.69	0.00	0.00	1.68
Legal services	1.00	0.72	0.00	0.00	0.28
Computer systems design and related services	0.19	0.16	0.04	0.00	-0.01
Miscellaneous professional, scientific, and technical services	0.87	0.49	0.12	0.00	0.25
Management of companies and enterprises	1.07	1.05	-0.01	0.00	0.03
Administrative and support services	0.75	0.62	0.00	0.00	0.13
Waste management and remediation services	0.19	-0.02	0.00	0.00	0.21
Educational services	0.22	0.10	0.00	0.00	0.12
Ambulatory health care services	0.22	0.19	0.00	0.00	0.04
Hospitals and Nursing and residential care	0.27	0.17	0.01	0.00	0.09
Social assistance	0.11	0.03	0.00	0.00	0.07
Performing arts, spectator sports, museums, and related activities	0.14	0.03	0.00	0.01	0.10
Amusements, gambling, and recreation industries	0.69	0.15	0.00	0.00	0.53
Accommodation	0.95	0.07	0.00	0.00	0.88
Food services and drinking places	0.00	0.02	0.00	0.00	-0.01
Other services, except government	0.46	0.31	0.00	0.00	0.15
Federal	0.71	0.25	0.30	0.00	0.16
State and local	0.52	0.09	0.03	0.00	0.40

Notes: Average annual percentage growth. A contribution is a share-weighted growth rate.

Table 3: Sources of Labor Contribution 1998-2012

	Labor Contribution	College Contribution	Non-college Contribution
Farms	-0.08	0.10	-0.18
Forestry, fishing, and related activities	0.49	0.43	0.06
Oil and gas extraction	0.16	0.14	0.02
Mining, except oil and gas	-0.13	0.08	-0.21
Support activities for mining	2.34	1.03	1.30
Utilities	-0.09	0.05	-0.14
Construction	-0.11	0.15	-0.27
Wood products	-0.90	-0.03	-0.87
Nonmetallic mineral products	-0.51	0.06	-0.57
Primary metals	-0.58	-0.04	-0.54
Fabricated metal products	-0.31	0.11	-0.43
Machinery	-0.47	0.02	-0.49
Computer and electronic products	-0.82	-0.16	-0.66
Electrical equipment, appliances, and components	-0.62	0.09	-0.71
Motor vehicles, bodies and trailers, and parts	-0.44	-0.07	-0.37
Other transportation equipment	-0.16	0.11	-0.27
Furniture and related products	-1.21	-0.08	-1.13
Miscellaneous manufacturing	-0.33	0.12	-0.45
Food and beverage and tobacco products	0.01	0.03	-0.02
Textile mills and textile product mills	-1.55	-0.32	-1.23
Apparel and leather and allied products	-2.80	-0.76	-2.04
Paper products	-0.60	-0.15	-0.45
Printing and related support activities	-1.40	-0.36	-1.04
Petroleum and coal products	-0.02	0.00	-0.02
Chemical products	-0.15	-0.06	-0.09
Plastics and rubber products	-0.43	-0.05	-0.38
Wholesale trade	0.13	0.23	-0.10
Retail trade	0.13	0.21	-0.09
Air transportation	-0.38	-0.21	-0.16
Rail transportation	-0.40	-0.09	-0.31
Water transportation	0.21	0.06	0.15
Truck transportation	-0.10	-0.02	-0.08
Transit and ground passenger transportation	0.52	0.15	0.37
Pipeline transportation	-0.16	-0.05	-0.11
Other transportation and support activities	0.08	0.02	0.06
Warehousing and storage	1.25	0.21	1.03
Publishing industries, except internet (includes software)	-0.27	0.10	-0.36
Motion picture and sound recording industries	0.22	0.34	-0.12
Broadcasting and telecommunications	-0.24	0.02	-0.26
Data processing, internet publishing, and other information services	-0.48	-0.13	-0.34
Federal Reserve banks, credit intermediation, and related activities	0.34	0.50	-0.16
Securities, commodity contracts, and investments	0.45	0.61	-0.16
Insurance carriers and related activities	0.26	0.36	-0.10
Funds, trusts, and other financial vehicles	0.19	0.24	-0.06
Real estate	0.05	0.06	0.00
Rental and leasing services and lessors of intangible assets	-0.10	0.05	-0.14
Legal services	0.30	0.41	-0.11
Computer systems design and related services	1.86	1.74	0.12
Miscellaneous professional, scientific, and technical services	0.88	0.84	0.04
Management of companies and enterprises	1.11	1.09	0.03
Administrative and support services	0.59	0.50	0.08
Waste management and remediation services	0.44	0.18	0.26
Educational services	1.74	1.51	0.23
Ambulatory health care services	1.54	1.08	0.46
Hospitals and Nursing and residential care	1.13	0.81	0.31
Social assistance	1.49	1.11	0.38
Performing arts, spectator sports, museums, and related activities	0.31	0.44	-0.13
Amusements, gambling, and recreation industries	0.56	0.34	0.22
Accommodation	-0.10	0.12	-0.22
Food services and drinking places	0.55	0.24	0.31
Other services, except government	0.11	0.38	-0.26
Federal	0.01	0.09	-0.09
State and local	0.62	0.64	-0.02

Notes: Average annual percentage growth. A contribution is a share-weighted growth rate.

Table 4: Growth in Aggregate Value-Added and the Sources of Growth
Direct Aggregation across Industries

	1998-2012	1998-2007	2007-2012	2007-2009	2009-2012
Contributions					
Value-Added	2.01	2.78	0.62	-1.62	2.11
Capital Input	1.18	1.55	0.52	0.71	0.40
IT Capital	0.31	0.40	0.14	0.20	0.10
R&D Capital	0.09	0.09	0.09	0.10	0.08
Software Capital	0.18	0.23	0.08	0.10	0.06
Entertainment Originals Capital	0.03	0.03	0.02	0.02	0.02
Other Capital	0.59	0.80	0.19	0.28	0.14
Labor Input	0.36	0.60	-0.09	-1.31	0.73
College Labor	0.52	0.63	0.34	-0.11	0.63
Non-college Labor	-0.16	-0.02	-0.42	-1.21	0.10
MFP	0.47	0.62	0.18	-1.02	0.99

Notes: Average annual percentages. Aggregate value added growth is the aggregate of share weighed industry value added growth. The contribution is the domar-weighted industry contributions. IT Capital is Computer, Communications and Other IT capital.

Table 5: Sector Sources of Value-Added Growth

	1998-2012	1998-2007	2007-2012	2007-2009	2009-2012
Contributions					
Value-Added	2.01	2.78	0.62	-1.62	2.11
IT-Producing Industries	0.31	0.37	0.20	0.13	0.24
IT-Using Industries	0.99	1.42	0.22	-0.90	0.97
Non-IT Industries	0.45	0.66	0.05	-1.01	0.76
Government	0.26	0.33	0.15	0.16	0.14
Shares in Nominal Value-Added	100.0	100.0	100.0	100.0	100.0
IT-Producing Industries	3.1	3.1	3.2	3.1	3.2
IT-Using Industries	46.8	47.2	46.1	46.2	46.1
Non-IT Industries	32.6	32.7	32.5	32.4	32.5
Government	17.5	17.1	18.2	18.3	18.1

Notes: Average annual percentages. Aggregate value added growth is the aggregate of share weighed industry value added growth. IT-Producing industries are Computers and electronic products, Data processing, and Computer systems design and related services. IT-using industries are those with an IT intensity share above the median share in 2005. Non-IT are the remaining private sector industries. Government includes government enterprise.

Table 6: Sector Sources of Aggregate MFP Growth

	1998-2012	1998-2007	2007-2012	2007-2009	2009-2012
Contributions					
MFP Growth	0.47	0.62	0.18	-1.02	0.99
IT-Producing Industries	0.27	0.34	0.14	0.14	0.14
IT-Using Industries	0.06	0.13	-0.06	-0.55	0.27
Non-IT Industries	0.12	0.11	0.13	-0.49	0.53
Government	0.02	0.05	-0.03	-0.13	0.04
Shares in Nominal Value-Added	100.0	100.0	100.0	100.0	100.0
IT-Producing Industries	3.1	3.1	3.2	3.1	3.2
IT-Using Industries	46.8	47.2	46.1	46.2	46.1
Non-IT Industries	32.6	32.7	32.5	32.4	32.5
Government	17.5	17.1	18.2	18.3	18.1

Notes: Average annual percentages. Aggregate value added growth is the aggregate of share weighed industry value added growth. IT-Producing industries are Computers and electronic products, Data processing, and Computer systems design and related services. IT-using industries are those with an IT intensity share above the median share in 2005. Non-IT are the remaining private sector industries. Government includes government enterprise.

Table 7: Sector Sources of Aggregate MFP Growth

	1998-2012	1998-2007	2007-2012	2007-2009	2009-2012
Contributions					
MFP Growth	0.47	0.62	0.18	-1.02	0.99
R&D Intensive Industries	0.34	0.50	0.06	-0.38	0.35
IT-Producing Industries	0.27	0.34	0.14	0.14	0.14
Other R&D Intensive	0.07	0.16	-0.08	-0.52	0.21
Non R&D Intenstive	0.11	0.08	0.15	-0.51	0.59
Government	0.02	0.05	-0.03	-0.13	0.04
Shares in Nominal Value-Added	100.0	100.0	100.0	100.0	100.0
R&D Intensive Industries	16.4	16.6	16.1	15.8	16.3
Non R&D Intenstive	66.1	66.3	65.7	65.9	65.6
Government	17.5	17.1	18.2	18.3	18.1

Notes: Average annual percentages. Aggregate value added growth is the aggregate of share weighed industry value added growth. R&D intensive industries are those with an R&D capital income share above the median share, once industries with a share belwo 1% have been dropped.

	1998-2012				1998-2007				2009-2012				2009-2012 less 1998-2007			
	Value Added	Capital	Labor	MFP	Value Added	Capital	Labor	MFP	Value Added	Capital	Labor	MFP	Value Added	Capital	Labor	MFP
Total Economy	2.01	1.18	0.36	0.47	2.78	1.55	0.60	0.63	2.11	0.40	0.73	0.98	-0.67	-1.16	0.13	0.36
Agriculture, forestry, fishing, and hunting	0.03	0.00	0.00	0.02	0.03	0.00	0.01	0.02	-0.01	0.02	0.00	-0.03	-0.04	0.01	0.00	-0.05
Mining	0.07	0.00	0.01	0.05	0.02	0.00	0.01	0.01	0.14	0.02	0.04	0.08	0.12	0.02	0.03	0.07
Utilities	0.02	0.02	0.00	0.00	0.01	0.02	0.00	0.00	0.07	0.01	-0.01	0.07	0.06	0.00	0.00	0.07
Construction	-0.07	0.03	0.00	-0.09	0.00	0.05	0.09	-0.14	-0.02	-0.02	-0.02	0.02	-0.02	-0.07	-0.11	0.16
Durable goods	0.25	0.03	-0.10	0.31	0.36	0.05	-0.11	0.43	0.44	0.01	0.09	0.35	0.08	-0.04	0.20	-0.08
Nondurable goods	0.01	0.06	-0.05	0.00	0.09	0.06	-0.05	0.09	-0.09	0.05	0.01	-0.15	-0.18	0.00	0.06	-0.24
Wholesale trade	0.11	0.08	0.01	0.02	0.22	0.12	0.03	0.08	0.13	0.04	0.04	0.05	-0.09	-0.07	0.01	-0.03
Retail Trade	0.09	0.09	0.01	-0.01	0.15	0.12	0.02	0.00	0.08	0.02	0.05	0.01	-0.07	-0.10	0.02	0.01
Transportation and warehousing	0.03	0.01	0.00	0.02	0.05	0.02	0.00	0.02	0.09	0.00	0.05	0.05	0.04	-0.02	0.04	0.02
Information	0.21	0.14	-0.02	0.09	0.28	0.17	-0.01	0.12	0.16	0.09	0.00	0.06	-0.12	-0.07	0.01	-0.06
Finance and insurance	0.20	0.12	0.04	0.04	0.31	0.18	0.07	0.05	0.03	-0.02	0.06	-0.01	-0.28	-0.20	-0.02	-0.07
Real estate and rental and leasing	0.30	0.26	0.01	0.04	0.37	0.39	0.02	-0.03	0.28	-0.01	0.00	0.29	-0.10	-0.40	-0.02	0.33
Professional, scientific, and technical services	0.17	0.08	0.09	0.00	0.20	0.10	0.11	-0.02	0.20	0.00	0.10	0.10	0.00	-0.10	-0.01	0.12
Management of companies and enterprises	0.02	0.03	0.03	-0.04	0.01	0.03	0.03	-0.04	0.11	0.02	0.04	0.05	0.11	0.00	0.01	0.09
Administrative and waste management services	0.08	0.03	0.02	0.03	0.11	0.04	0.04	0.03	0.12	0.01	0.08	0.02	0.01	-0.03	0.04	0.00
Educational services	0.02	0.00	0.03	-0.01	0.02	0.00	0.03	-0.01	0.01	0.00	0.02	-0.01	-0.02	0.00	-0.01	-0.01
Health care and social assistance	0.16	0.02	0.14	0.00	0.17	0.02	0.14	0.00	0.10	0.02	0.15	-0.07	-0.06	0.00	0.01	-0.07
Arts, entertainment, and recreation	0.02	0.01	0.01	0.00	0.02	0.01	0.01	0.00	0.03	0.00	0.01	0.02	0.01	-0.01	0.00	0.02
Accommodation and food services	0.04	0.01	0.02	0.01	0.06	0.01	0.02	0.03	0.09	0.00	0.04	0.05	0.03	-0.01	0.02	0.02
Other services, except government	-0.03	0.02	0.00	-0.05	-0.02	0.02	0.01	-0.06	0.00	0.00	0.01	-0.01	0.02	-0.02	-0.01	0.04
Federal government	0.07	0.06	0.00	0.01	0.06	0.05	-0.01	0.02	0.07	0.06	0.00	0.01	0.01	0.01	0.01	-0.01
State and local government	0.20	0.09	0.10	0.01	0.26	0.10	0.14	0.03	0.07	0.06	-0.02	0.03	-0.19	-0.04	-0.16	0.01

Notes: Average annual percentange growth. A contribution is a share-weighted growth rate.

Figure 1: Industry MFP Growth 1998-2012

Computer and electronic products
Support activities for mining
Water transportation
Computer systems design and related services
Pipeline transportation
Motion picture and sound recording industries
Printing and related support activities
Broadcasting and telecommunications
Oil and gas extraction
Miscellaneous manufacturing
Warehousing and storage
Farms
Motor vehicles, bodies and trailers, and parts
Securities, commodity contracts, and investments
Apparel and leather and allied products
Electrical equipment, appliances, and components
Forestry, fishing, and related activities
Wood products
Primary metals
Performing arts, spectator sports, museums, and related...
Other transportation equipment
Data processing, internet publishing, and other information...
Administrative and support services
Publishing industries, except internet (includes software)
Machinery
Rail transportation
Real estate
Waste management and remediation services
Utilities
Other transportation and support activities
Ambulatory health care services
Food services and drinking places
Funds, trusts, and other financial vehicles
Truck transportation
Federal Reserve banks, credit intermediation, and related...
Mining, except oil and gas
Wholesale trade
Textile mills and textile product mills
Plastics and rubber products
Petroleum and coal products
Food and beverage and tobacco products
Fabricated metal products
State and local
Federal
Insurance carriers and related activities
Furniture and related products
Social assistance
Paper products
Retail trade
Chemical products
Accommodation
Miscellaneous professional, scientific, and technical services
Air transportation
Hospitals and Nursing and residential care
Amusements, gambling, and recreation industries
Transit and ground passenger transportation
Nonmetallic mineral products
Educational services
Construction
Other services, except government
Legal services
Management of companies and enterprises
Rental and leasing services and lessors of intangible assets

-2.0   -1.0   0.0   1.0   2.0   3.0   4.0   5.0   6.0   7.0

Average Annual Percent Change

Figure 2: Output Growth Differences 2007-2009 less 1998-2007

Oil and gas extraction
Federal
Water transportation
Educational services
Farms
Hospitals and Nursing and residential care
Food and beverage and tobacco products
Social assistance
State and local
Ambulatory health care services
Computer systems design and related services
Federal Reserve banks, credit intermediation, and…
Pipeline transportation
Performing arts, spectator sports, museums, and…
Broadcasting and telecommunications
Other services, except government
Petroleum and coal products
Data processing, internet publishing, and other…
Forestry, fishing, and related activities
Miscellaneous professional, scientific, and technical…
Amusements, gambling, and recreation industries
Miscellaneous manufacturing
Food services and drinking places
Waste management and remediation services
Legal services
Other transportation equipment
Air transportation
Real estate
Management of companies and enterprises
Motion picture and sound recording industries
Paper products
Publishing industries, except internet (includes software)
Administrative and support services
Transit and ground passenger transportation
Utilities
Accommodation
Mining, except oil and gas
Retail trade
Insurance carriers and related activities
Rental and leasing services and lessors of intangible…
Funds, trusts, and other financial vehicles
Warehousing and storage
Apparel and leather and allied products
Rail transportation
Printing and related support activities
Other transportation and support activities
Construction
Electrical equipment, appliances, and components
Truck transportation
Chemical products
Textile mills and textile product mills
Computer and electronic products
Machinery
Plastics and rubber products
Primary metals
Fabricated metal products
Wholesale trade
Securities, commodity contracts, and investments
Furniture and related products
Wood products
Nonmetallic mineral products
Support activities for mining
Motor vehicles, bodies and trailers, and parts

-30.0   -25.0   -20.0   -15.0   -10.0   -5.0   0.0   5.0   10.0   15.0

Average Annual Percent

■ Capital   ■ Labor   ■ Intermediate   ■ MFP

Figure 3: Output Growth Differences 2007-2012 less 1998-2007

Oil and gas extraction
Apparel and leather and allied products
Primary metals
Pipeline transportation
Computer systems design and related services
Educational services
Management of companies and enterprises
Hospitals and Nursing and residential care
Forestry, fishing, and related activities
Machinery
Other transportation equipment
Federal
Water transportation
Food and beverage and tobacco products
Rail transportation
Air transportation
Other services, except government
Data processing, internet publishing, and other...
Farms
Waste management and remediation services
Ambulatory health care services
Food services and drinking places
Motion picture and sound recording industries
Rental and leasing services and lessors of intangible assets
Textile mills and textile product mills
Paper products
State and local
Mining, except oil and gas
Administrative and support services
Amusements, gambling, and recreation industries
Retail trade
Motor vehicles, bodies and trailers, and parts
Broadcasting and telecommunications
Electrical equipment, appliances, and components
Miscellaneous professional, scientific, and technical...
Miscellaneous manufacturing
Performing arts, spectator sports, museums, and related...
Social assistance
Publishing industries, except internet (includes software)
Accommodation
Fabricated metal products
Petroleum and coal products
Plastics and rubber products
Truck transportation
Real estate
Legal services
Insurance carriers and related activities
Utilities
Warehousing and storage
Transit and ground passenger transportation
Printing and related support activities
Funds, trusts, and other financial vehicles
Chemical products
Other transportation and support activities
Wholesale trade
Federal Reserve banks, credit intermediation, and...
Support activities for mining
Wood products
Computer and electronic products
Construction
Furniture and related products
Nonmetallic mineral products
Securities, commodity contracts, and investments

-15   -10   -5   0   5   10

Average Annual Percent

■ Capital   ■ Labor   ■ Intermediate   ■ MFP

Figure 4: Output Growth Differences 2009-2012 less 1998-2007

Apparel and leather and allied products
Motor vehicles, bodies and trailers, and parts
Primary metals
Machinery
Oil and gas extraction
Support activities for mining
Textile mills and textile product mills
Rail transportation
Management of companies and enterprises
Electrical equipment, appliances, and components
Fabricated metal products
Pipeline transportation
Plastics and rubber products
Other transportation equipment
Truck transportation
Wood products
Rental and leasing services and lessors of intangible assets
Forestry, fishing, and related activities
Computer systems design and related services
Air transportation
Retail trade
Mining, except oil and gas
Wholesale trade
Motion picture and sound recording industries
Waste management and remediation services
Paper products
Food services and drinking places
Administrative and support services
Data processing, internet publishing, and other…
Nonmetallic mineral products
Other services, except government
Educational services
Furniture and related products
Chemical products
Amusements, gambling, and recreation industries
Accommodation
Printing and related support activities
Hospitals and Nursing and residential care
Publishing industries, except internet (includes software)
Insurance carriers and related activities
Warehousing and storage
Miscellaneous manufacturing
Broadcasting and telecommunications
Miscellaneous professional, scientific, and technical…
Food and beverage and tobacco products
Ambulatory health care services
Other transportation and support activities
Federal
Water transportation
Utilities
Performing arts, spectator sports, museums, and related…
Real estate
Funds, trusts, and other financial vehicles
Transit and ground passenger transportation
Petroleum and coal products
State and local
Legal services
Computer and electronic products
Farms
Construction
Social assistance
Federal Reserve banks, credit intermediation, and…
Securities, commodity contracts, and investments

-10   -5   0   5   10   15   20

■ Capital   ■ Labor   ■ Intermediate   ■ MFP   **Average Annual Percent**

Figure 5: Contribution to Aggregate Value Added Growth: 2009-2012 less 1998-2007

Motor vehicles, bodies and trailers, and parts
Management of companies and enterprises
Machinery
Utilities
Oil and gas extraction
Computer systems design and related services
Motion picture and sound recording industries
Support activities for mining
Primary metals
Fabricated metal products
Mining, except oil and gas
Truck transportation
Other services, except government
Food services and drinking places
Amusements, gambling, and recreation industries
Apparel and leather and allied products
Accommodation
Pipeline transportation
Waste management and remediation services
Other transportation and support activities
Plastics and rubber products
Miscellaneous professional, scientific, and technical services
Federal
Textile mills and textile product mills
Warehousing and storage
Data processing, internet publishing, and other information services
Wood products
Air transportation
Rental and leasing services and lessors of intangible assets
Nonmetallic mineral products
Furniture and related products
Administrative and support services
Performing arts, spectator sports, museums, and related activities
Forestry, fishing, and related activities
Other transportation equipment
Rail transportation
Transit and ground passenger transportation
Miscellaneous manufacturing
Electrical equipment, appliances, and components
Printing and related support activities
Paper products
Water transportation
Educational services
Social assistance
Funds, trusts, and other financial vehicles
Ambulatory health care services
Publishing industries, except internet (includes software)
Chemical products
Construction
Hospitals and Nursing and residential care
Insurance carriers and related activities
Farms
Legal services
Food and beverage and tobacco products
Retail trade
Wholesale trade
Securities, commodity contracts, and investments
Real estate
Petroleum and coal products
Federal Reserve banks, credit intermediation, and related activities
Broadcasting and telecommunications
Computer and electronic products
State and local

Average annual percentage point

-0.25   -0.2   -0.15   -0.1   -0.05   0   0.05   0.1   0.15

Figure 6: Contribution to Aggregate Capital Contribution: 2009-2012 less 1998-2007

Farms
Mining, except oil and gas
Federal
Oil and gas extraction
Support activities for mining
Chemical products
Data processing, internet publishing, and other information services
Food and beverage and tobacco products
Primary metals
Machinery
Other transportation equipment
Rail transportation
Food services and drinking places
Forestry, fishing, and related activities
Waste management and remediation services
Pipeline transportation
Textile mills and textile product mills
Hospitals and Nursing and residential care
Apparel and leather and allied products
Water transportation
Paper products
Motion picture and sound recording industries
Educational services
Electrical equipment, appliances, and components
Performing arts, spectator sports, museums, and related activities
Petroleum and coal products
Computer systems design and related services
Social assistance
Wood products
Fabricated metal products
Utilities
Ambulatory health care services
Management of companies and enterprises
Furniture and related products
Printing and related support activities
Transit and ground passenger transportation
Miscellaneous manufacturing
Warehousing and storage
Nonmetallic mineral products
Amusements, gambling, and recreation industries
Plastics and rubber products
Other transportation and support activities
Securities, commodity contracts, and investments
Air transportation
Truck transportation
Motor vehicles, bodies and trailers, and parts
Funds, trusts, and other financial vehicles
Accommodation
Computer and electronic products
Other services, except government
Administrative and support services
Publishing industries, except internet (includes software)
State and local
Legal services
Broadcasting and telecommunications
Miscellaneous professional, scientific, and technical services
Insurance carriers and related activities
Construction
Wholesale trade
Rental and leasing services and lessors of intangible assets
Retail trade
Federal Reserve banks, credit intermediation, and related activities
Real estate

■ IT Equip. and Software ■ Other

-0.35   -0.3   -0.25   -0.2   -0.15   -0.1   -0.05   0   0.05

Average annual percentage point

Figure 7: Contribution to Aggregate Labor Contribution: 2009-2012 less 1998-2007

Categories (top to bottom):
Computer and electronic products
Machinery
Administrative and support services
Fabricated metal products
Motor vehicles, bodies and trailers, and parts
Retail trade
Computer systems design and related services
Ambulatory health care services
Primary metals
Support activities for mining
Data processing, internet publishing, and other information services
Insurance carriers and related activities
Management of companies and enterprises
Wholesale trade
Apparel and leather and allied products
Electrical equipment, appliances, and components
Food services and drinking places
Truck transportation
Chemical products
Oil and gas extraction
Plastics and rubber products
Other transportation and support activities
Miscellaneous manufacturing
Air transportation
Food and beverage and tobacco products
Federal
Textile mills and textile product mills
Rail transportation
Paper products
Motion picture and sound recording industries
Mining, except oil and gas
Accommodation
Publishing industries, except internet (includes software)
Other transportation equipment
Printing and related support activities
Wood products
Waste management and remediation services
Nonmetallic mineral products
Pipeline transportation
Furniture and related products
Warehousing and storage
Transit and ground passenger transportation
Funds, trusts, and other financial vehicles
Amusements, gambling, and recreation industries
Water transportation
Petroleum and coal products
Forestry, fishing, and related activities
Performing arts, spectator sports, museums, and related activities
Farms
Utilities
Social assistance
Rental and leasing services and lessors of intangible assets
Other services, except government
Hospitals and Nursing and residential care
Legal services
Educational services
Federal Reserve banks, credit intermediation, and related activities
Real estate
Broadcasting and telecommunications
Securities, commodity contracts, and investments
Miscellaneous professional, scientific, and technical services
Construction
State and local

Legend: ■ College Labor ■ Non-College Labor

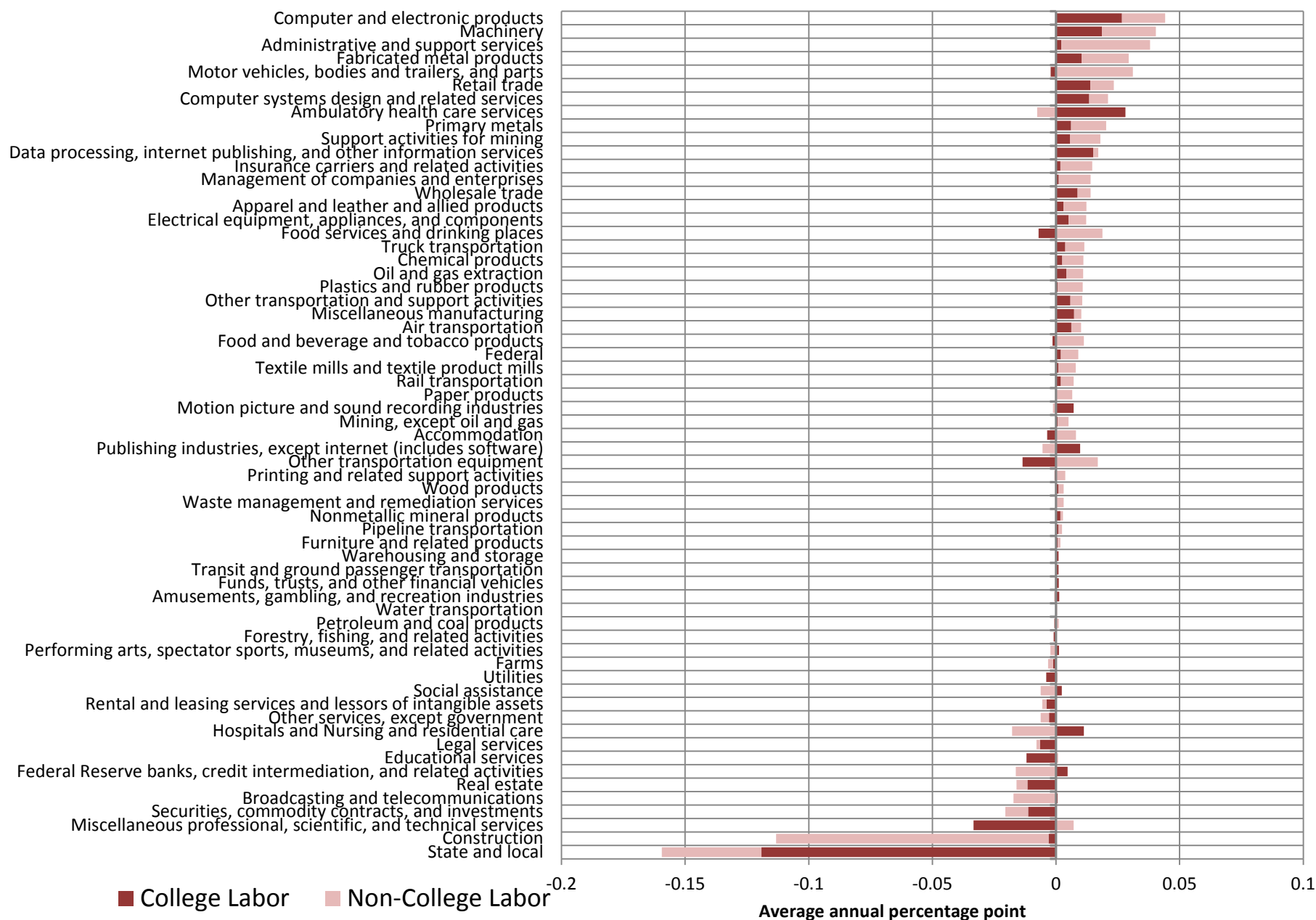X-axis: Average annual percentage point (-0.2, -0.15, -0.1, -0.05, 0, 0.05, 0.1)

Figure 8: Contribution to Aggregate MFP Growth: 2009-2012 less 1998-2007

Average annual percentage point