

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

Steven Rosenthal, Matthew Russell, Jon D. Samuels, Erich H. Strassner, Lisa Usher¹

May 15, 2014

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 We thank Matt Calby, Thomas F. Howells III, and Amanda Lyndaker of BEA and Mark Dumas and Randy Kinoshita of BLS for their work on the data. We also thank Carol Moylan of BEA and John Ruser of BLS for their support on this project. The views expressed in this paper are solely those of the authors and not necessarily those of the Bureau of Economic Analysis, U.S. Department of Commerce, and the Bureau of Labor Statistics, U.S. Department of Labor.

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 1995-2000, 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. 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 financial crisis that led to the Great Recession did not impact all industries equally. For example, according to data released by the Bureau of Economic Analysis (BEA), between 2007 and 2012, real value added declined in construction and nondurable 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.³

² (Jorgenson, Ho, & Samuels, Forthcoming)

³ (Jorgenson, Ho, & Samuels, 2014)

The unique episodes of growth 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. The dataset combines industry-level output and intermediate inputs from the Bureau of Economic Analysis' Gross Domestic Product by Industry (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 and the January 2014 comprehensive revision of the Industry Economic Accounts.⁴

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.

⁴ 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.

- Including R&D reduces estimated MFP growth from about 0.51% per year to 0.44% per year over the 1998-2012 period.
- 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 gross output using primary capital and labor inputs and intermediate input using 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.⁵

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 research and development 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.

Figure 1 shows that the contribution of MFP growth to industry output varies 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 industries and transportation. 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 outputs and inputs, including but not limited to quality adjustment issues or changes in unmeasured inputs.

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 portrays the heterogeneity in industry growth and its sources for that period. For example, Support activities for mining 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 Apparel industry shrank by about 10% per year over the period (which is in line 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 industry-level production account is useful for analyzing the economic changes that occurred during the time of the Great Recession and the ongoing recovery. Tables 2 presents the decomposition of industry output growth preceding the onset of the Great Recession, while Table 3 gives the changes to the sources of growth that occurred during the recession period.

⁵ Employee, or self-employed.

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 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.

Table 4 shows that the ongoing recovery is not as widespread as the declines that occurred during the Great Recession. To analyze the ongoing recovery in comparison to 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.⁶ Of the 63 industries that we analyze, 34 grew faster between 2009 and 2012 than they did over the 1998-2007 period. For these industries, 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.

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 capital equipment, Software capital, Research and development 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 5 indicates that the contribution of IT and software capital was broad 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.

⁶ The unemployment rate peaked in October 2009.

Table 6 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.

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.⁷

Table 7 shows that between 1998 and 2012 the majority of aggregate value added growth was due to accumulation of inputs. Of the 1.98% average annual growth in value added, 1.20 percentage points were accounted for by capital, 0.35 percentage point by labor, and 0.44 percentage point by MFP growth. Within capital, about 40 percent of the capital contribution was due to IT equipment and software, and 0.09 percentage points from R&D capital. The contribution of R&D capital to aggregate value added growth of 0.09 percentage points per year provides a measure of the bias of previously published estimates. If this capital was excluded from the measure of capital input, estimated MFP growth would have been higher by about 0.09 percentage points per year; that is, aggregate MFP growth would have been 0.51% per year instead of 0.44% per year. Within labor input, the contribution from workers without a college degree actually fell over the period as a whole.

Table 7 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, aggregate 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. This was split between IT-capital which accounted for 0.30 percentage point, Software capital accounted for 0.17 percentage point, and other capital accounted for 0.67 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.

⁷ 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.

The direct aggregation across industry approach yields insights into the underlying structural changes that have occurred over the 1998-2012 period. Tables 8 and 9 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 0.30 percentage point of the 1.98 average annual growth, or about 15% of the growth in aggregate value added. IT-using industries accounted for 0.97 percentage point, Non-IT 0.44 percentage point, and Government 0.28 percentage point. The decomposition suggests that both IT-using and Non-IT industries were hard hit during the recession and are recovering at about the same rate.

In terms of aggregate productivity growth, IT-producing industries accounted for the majority of productivity growth over the 1998-2012 period. The contribution of IT-producing industries to aggregate productivity growth has fallen slightly from 0.33 percentage point per year before the recession to 0.14 percentage point per year during the recession and recovery. Not surprisingly, 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 and Non-IT industries.

Table 10 shows that relatively R&D intensive industries made a disproportionate contribution to aggregate MFP growth. Between 1998 and 2012, of the 0.44% per year in aggregate MFP growth, 0.33 percentage point was due to industries that were relatively R&D intensive. Importantly, of this 0.33 percentage point contribution, about 0.26 percentage point was due to productivity growth of the Computer and electronic products industry.⁸

5 Changes in classifications

This account was prepared using the 2007 North American Industry Classification System (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,

⁸ 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.

incorporates a number of reclassifications within the sector.⁹ Internet publishing and 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, Preview of the 2013 Comprehensive Revision of the Industry Economic Accounts, 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 U.S. National Accounts 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 research and development 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.¹⁰

⁹ Table 2 of Strassner and Wasshausen (2013) provides the pertinent details for the information sector.

¹⁰ 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.

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 (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.¹¹

Overall, the changes in definition for the U.S. National Accounts resulted in an upward revision of 488 billion dollars in value added and of 318.4 billion dollars in gross output for the year 2007.¹² 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." The value of these capital services are now accounted for in value added, specifically in capital income.

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.¹³

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 categories are equipment, structures, inventories, and land. 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

¹² 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.

¹³ 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

purpose of discovering or developing new products or improving existing ones. Entertainment, artistic, and literary originals include theatrical movies, long-lived television programs, books, music, and other forms of entertainment.

Table 11 shows that except for the 1995-2000 period when information processing equipment (mainly computers and related equipment and communication equipment) contributed twice as much to the growth rate of output per hour as other types of capital, the three broad categories of capital in table 11: information processing equipment, intellectual property products, and all other capital services, have contributed similar amounts to output per hour over time.

The "implicit rental price" of capital is based on the neoclassical principle that inputs should be aggregated using weights that reflect their marginal products.¹⁴ 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 previous 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,

¹⁴ See (Fleck, Rosenthal, Russell, Strassner, & Usher, 2013) for details.

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 Current Employment Statistics SIC-to-NAICS employment bridge at the micro-record level, 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 Current Population Survey 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. Thus, incorporating R&D lowered MFP growth estimates from about 0.53% per year to about 0.44% 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.

8 Bibliography

- Bureau of Economic Analysis. (2013, March). Preview of the 2013 Comprehensive Revision of the National Income and Product Accounts: Changes in Definitions and Presentation. *Survey of Current Business*.
- Byrne, D., Oliner, S., & Sichel, D. (2013). *Is the Information Technology Revolution Over?* FRB Working Paper.
- Fleck, S., Rosenthal, S., Russell, M., Strassner, E., & Usher, L. (2013). *A Prototype BEA/BLS Industry-Level Production Account for the United States*. National Bureau of Economic Research Conference on Research in Income and Wealth.
- Gordon, R. (2014). *The Demise of U.S. Economic Growth: Restatement, Rebuttal, and Reflections*. NBER Working Paper.
- Griliches, Z. (1979). Issues in assessing the contribution of research and development to productivity growth. *Bell Journal of economics*, 92-116.
- Jorgenson, D., Ho, M., & Samuels, J. (2011). Information Technology and U.S. Productivity Growth Evidence from a Prototype Industry Production Account.
- Jorgenson, D., Ho, M., & Samuels, J. (2014). *Long-Term Estimates of U.S. Productivity and Growth*.
- Jorgenson, D., Ho, M., & Samuels, J. (Forthcoming). What Will Revive U.S. Economic Growth? Lessons from a Prototype Industry-Level. *Journal of Policy Modeling* .
- Jorgenson, D., Ho, M., Samuels, J., & Stiroh, K. (2007). The Industry Origins of the American Productivity Resurgence. *Economic System Research*, 19(3), 229-252.
- Kornfeld, R. (2013, August). Initial Results of the Comprehensive Revision of the National Income and Product Accounts. *Survey of Current Business*.
- McCulla, S. H., Holdren, A. E., & Smith, S. (2013, September). Improved Estimates of the National Income and Product Accounts: Results of the 2013 Comprehensive Revision. *Survey of Current Business*.
- Office of Management and Budget. (1997). *The North American Industry Classification System*. Washington, District of Columbia.
- Romer, P. (1994). The origins of endogenous growth. *The journal of economic perspectives*, 3-22.
- Strassner, E. H., & Wasshausen, D. B. (2013, June). Preview of the 2013 Comprehensive Revision of the Industry Economic Accounts. *Survey of Current Business*.
- Strassner, E. H., & Wasshausen, D. B. (2014, February). Industry Economic Accounts: Results of the Comprehensive Revision. *Survey of Current Business*.
- United Nations. (2008). *System of National Accounts*.

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	1.91	0.54	0.00	1.36	0.00
State and local	1.69	0.75	0.55	0.39	0.00

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

Table 2: Sources of Industry Output Growth 1998-2007

	Output Growth	Capital Contribution	Labor Contribution	Intermediate Contribution	MFP Growth
Farms	1.02	0.12	0.07	-0.06	0.88
Forestry, fishing, and related activities	-0.09	0.34	0.95	-2.16	0.78
Oil and gas extraction	-0.12	-0.30	-0.02	0.90	-0.70
Mining, except oil and gas	0.55	-0.07	-0.22	0.54	0.30
Support activities for mining	9.28	-0.24	2.19	2.40	4.92
Utilities	1.09	0.51	-0.09	0.45	0.21
Construction	1.05	0.59	1.03	0.98	-1.55
Wood products	0.19	0.06	-0.41	-0.08	0.62
Nonmetallic mineral products	0.83	0.30	-0.18	0.79	-0.08
Primary metals	-0.47	-0.14	-0.79	-0.14	0.60
Fabricated metal products	0.81	0.07	-0.34	0.44	0.64
Machinery	0.69	0.11	-0.69	0.40	0.87
Computer and electronic products	6.53	0.50	-1.00	-0.87	7.91
Electrical equipment, appliances, and components	-0.99	-0.02	-0.79	-1.83	1.65
Motor vehicles, bodies and trailers, and parts	1.45	0.18	-0.32	0.44	1.15
Other transportation equipment	1.44	0.03	-0.17	0.32	1.26
Furniture and related products	0.14	0.25	-0.68	0.24	0.33
Miscellaneous manufacturing	2.59	0.53	-0.48	1.33	1.22
Food and beverage and tobacco products	0.53	0.14	-0.03	-0.16	0.58
Textile mills and textile product mills	-4.57	-0.17	-1.51	-3.38	0.49
Apparel and leather and allied products	-11.72	-0.06	-2.82	-9.42	0.58
Paper products	-1.04	-0.16	-0.62	-0.48	0.22
Printing and related support activities	-0.95	0.11	-1.06	-1.84	1.84
Petroleum and coal products	1.90	-0.04	-0.02	0.96	1.00
Chemical products	2.28	1.07	-0.15	0.90	0.45
Plastics and rubber products	0.19	0.23	-0.38	0.23	0.10
Wholesale trade	4.34	1.43	0.32	1.63	0.97
Retail trade	2.88	1.35	0.26	1.25	0.02
Air transportation	-1.29	0.17	-0.60	-1.13	0.28
Rail transportation	1.61	0.07	-0.69	0.86	1.38
Water transportation	3.43	-0.23	0.22	0.64	2.80
Truck transportation	2.06	0.57	0.13	1.24	0.13
Transit and ground passenger transportation	2.62	0.77	0.47	1.11	0.27
Pipeline transportation	-2.48	0.82	-0.51	-5.08	2.29
Other transportation and support activities	3.53	0.18	0.07	2.99	0.29
Warehousing and storage	8.03	0.62	1.65	5.10	0.66
Publishing industries, except internet (includes software)	2.44	1.67	-0.07	-0.23	1.08
Motion picture and sound recording industries	1.73	1.16	0.15	0.43	-0.01
Broadcasting and telecommunications	5.18	1.90	-0.05	1.34	2.00
Data processing, internet publishing, and other information services	8.85	3.65	-0.83	4.92	1.11
Federal Reserve banks, credit intermediation, and related activities	3.41	1.88	0.61	1.28	-0.36
Securities, commodity contracts, and investments	8.62	0.22	0.90	5.85	1.65
Insurance carriers and related activities	4.82	1.57	0.28	2.65	0.32
Funds, trusts, and other financial vehicles	4.31	1.47	0.23	2.21	0.40
Real estate	3.86	2.09	0.12	1.52	0.13
Rental and leasing services and lessors of intangible assets	2.70	3.95	0.09	1.50	-2.84
Legal services	1.33	1.58	0.35	0.33	-0.92
Computer systems design and related services	4.72	0.21	1.75	0.47	2.29
Miscellaneous professional, scientific, and technical services	3.47	1.13	1.27	1.73	-0.66
Management of companies and enterprises	2.79	1.06	1.11	2.40	-1.79
Administrative and support services	2.98	1.00	1.04	0.27	0.67
Waste management and remediation services	1.99	0.19	0.47	1.20	0.14
Educational services	3.09	0.25	2.07	1.43	-0.66
Ambulatory health care services	3.74	0.22	1.61	1.51	0.38
Hospitals and Nursing and residential care	3.05	0.27	1.25	1.89	-0.36
Social assistance	4.49	0.16	1.71	2.47	0.16
Performing arts, spectator sports, museums, and related activities	3.61	0.18	0.65	2.04	0.74
Amusements, gambling, and recreation industries	2.90	0.85	0.75	1.85	-0.56
Accommodation	1.93	1.13	-0.02	0.60	0.22
Food services and drinking places	2.30	-0.02	0.61	1.01	0.69
Other services, except government	0.46	0.62	0.29	1.02	-1.47
Federal	1.93	0.47	-0.09	1.54	0.00
State and local	2.27	0.84	0.80	0.63	0.00

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

Table 3: Sources of Industry Output Growth Change in Output Growth 2007-2009 less 1998-2007

	Output Growth	Capital Contribution	Labor Contribution	Intermediate Contribution	MFP Growth
Farms	0.51	-0.45	-0.87	-2.78	4.61
Forestry, fishing, and related activities	-4.51	-0.37	-3.03	-1.17	0.05
Oil and gas extraction	3.10	0.35	0.32	-8.38	10.81
Mining, except oil and gas	-7.58	1.48	-0.51	-4.96	-3.60
Support activities for mining	-24.76	1.92	-4.53	-11.61	-10.54
Utilities	-7.46	0.33	0.26	-5.44	-2.61
Construction	-12.06	-0.71	-6.03	-6.03	0.71
Wood products	-20.08	-0.13	-4.05	-16.00	0.10
Nonmetallic mineral products	-20.49	-0.17	-2.96	-14.13	-3.23
Primary metals	-14.15	0.15	-0.69	-14.58	0.98
Fabricated metal products	-14.28	-0.01	-1.96	-7.43	-4.88
Machinery	-13.64	0.12	-1.12	-8.91	-3.73
Computer and electronic products	-13.30	-0.04	-0.70	-9.03	-3.53
Electrical equipment, appliances, and components	-12.48	-0.22	-1.05	-8.67	-2.54
Motor vehicles, bodies and trailers, and parts	-26.77	-0.34	-2.22	-15.73	-8.48
Other transportation equipment	-5.78	0.43	-0.18	-2.89	-3.13
Furniture and related products	-19.52	-0.30	-3.89	-10.99	-4.34
Miscellaneous manufacturing	-5.22	-0.27	-0.44	-5.83	1.32
Food and beverage and tobacco products	-0.30	0.07	0.00	0.86	-1.23
Textile mills and textile product mills	-13.20	-0.05	-1.59	-9.20	-2.36
Apparel and leather and allied products	-9.49	-0.04	-2.67	-7.05	0.27
Paper products	-6.47	-0.14	-0.53	-5.67	-0.13
Printing and related support activities	-10.45	-0.21	-2.11	-5.60	-2.53
Petroleum and coal products	-4.31	0.80	-0.02	-3.79	-1.30
Chemical products	-13.06	0.28	-0.41	-9.91	-3.01
Plastics and rubber products	-13.76	-0.31	-1.59	-11.62	-0.25
Wholesale trade	-15.86	-1.85	-1.57	-7.91	-4.53
Retail trade	-8.11	-1.31	-1.40	-4.14	-1.26
Air transportation	-6.06	-0.21	-0.09	-3.02	-2.74
Rail transportation	-10.06	0.04	-0.40	-6.66	-3.04
Water transportation	0.77	0.15	-0.23	-1.96	2.81
Truck transportation	-12.64	-0.74	-2.64	-8.10	-1.16
Transit and ground passenger transportation	-6.79	-0.86	-0.22	-2.00	-3.70
Pipeline transportation	-3.59	1.84	0.49	1.38	-7.29
Other transportation and support activities	-10.50	-0.47	-1.35	-8.48	-0.20
Warehousing and storage	-8.81	0.50	-2.61	-7.47	0.77
Publishing industries, except internet (includes software)	-6.63	-0.73	-1.71	-0.47	-3.73
Motion picture and sound recording industries	-6.41	-0.35	-0.55	-10.17	4.65
Broadcasting and telecommunications	-4.01	-0.20	-0.75	-0.96	-2.10
Data processing, internet publishing, and other information services	-4.43	-2.49	-0.23	-1.17	-0.54
Federal Reserve banks, credit intermediation, and related activities	-1.95	-1.96	-1.82	-3.22	5.04
Securities, commodity contracts, and investments	-19.34	0.00	-2.16	-16.51	-0.68
Insurance carriers and related activities	-8.53	-1.10	-0.62	-3.72	-3.09
Funds, trusts, and other financial vehicles	-8.74	-0.49	-0.44	-8.12	0.31
Real estate	-6.27	-1.49	-0.29	-4.28	-0.21
Rental and leasing services and lessors of intangible assets	-8.56	-4.42	-0.84	-4.83	1.53
Legal services	-5.66	-0.66	0.27	-2.39	-2.89
Computer systems design and related services	-1.73	-0.02	-0.49	-0.07	-1.15
Miscellaneous professional, scientific, and technical services	-4.56	-0.45	-2.05	-3.12	1.06
Management of companies and enterprises	-6.35	0.43	-0.47	-3.26	-3.06
Administrative and support services	-6.63	-0.70	-4.67	-1.76	0.50
Waste management and remediation services	-5.63	-0.10	-1.03	-4.78	0.29
Educational services	0.70	-0.03	-0.75	-0.38	1.86
Ambulatory health care services	-1.44	0.08	-0.87	-1.42	0.77
Hospitals and Nursing and residential care	0.22	0.01	-0.36	-0.92	1.49
Social assistance	-1.07	-0.14	-0.53	-0.63	0.23
Performing arts, spectator sports, museums, and related activities	-3.72	-0.03	-2.13	-1.78	0.22
Amusements, gambling, and recreation industries	-5.17	-0.22	-1.40	-2.17	-1.38
Accommodation	-7.52	0.36	-1.13	-1.56	-5.18
Food services and drinking places	-5.55	0.08	-0.90	-1.85	-2.87
Other services, except government	-4.23	-0.32	-1.04	-2.04	-0.83
Federal	2.01	0.40	0.48	1.13	0.00
State and local	-0.58	-0.09	-0.42	-0.07	0.00

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

Table 4: Sources of Industry Output Growth Change in Output Growth 2009-2012 less 1998-2007

	Output Growth	Capital Contribution	Labor Contribution	Intermediate Contribution	MFP Growth
Farms	-2.72	0.55	-0.13	-0.96	-2.18
Forestry, fishing, and related activities	2.48	0.32	-0.11	1.88	0.39
Oil and gas extraction	6.92	0.41	0.65	3.87	2.00
Mining, except oil and gas	1.70	1.00	0.76	-2.36	2.30
Support activities for mining	6.71	1.57	3.70	1.01	0.44
Utilities	-1.81	0.04	-0.17	-4.07	2.38
Construction	-3.58	-0.86	-1.33	-3.33	1.94
Wood products	2.71	-0.21	0.41	1.60	0.91
Nonmetallic mineral products	0.69	-0.51	0.44	0.18	0.58
Primary metals	13.46	0.15	1.42	11.50	0.39
Fabricated metal products	4.30	-0.05	1.42	2.58	0.36
Machinery	8.53	0.14	1.76	5.63	1.00
Computer and electronic products	-2.71	-0.39	1.32	0.74	-4.37
Electrical equipment, appliances, and components	4.38	-0.06	1.47	4.76	-1.79
Motor vehicles, bodies and trailers, and parts	14.20	-0.35	0.91	8.44	5.21
Other transportation equipment	3.03	0.10	0.16	3.21	-0.44
Furniture and related products	0.24	-0.43	0.10	-0.51	1.09
Miscellaneous manufacturing	-1.03	-0.27	1.01	-0.75	-1.02
Food and beverage and tobacco products	-1.48	0.05	0.19	-0.18	-1.54
Textile mills and textile product mills	5.66	-0.11	0.87	4.67	0.22
Apparel and leather and allied products	14.40	-0.09	1.89	10.84	1.76
Paper products	1.08	-0.02	0.46	1.94	-1.29
Printing and related support activities	-0.24	-0.46	-0.16	0.26	0.12
Petroleum and coal products	-2.38	0.07	0.03	0.81	-3.29
Chemical products	0.20	0.02	0.26	0.66	-0.74
Plastics and rubber products	3.86	-0.28	0.81	3.12	0.20
Wholesale trade	1.64	-0.92	0.16	2.71	-0.30
Retail trade	1.77	-1.06	0.31	2.39	0.13
Air transportation	1.95	-0.52	1.11	1.83	-0.46
Rail transportation	4.82	0.27	1.65	5.09	-2.19
Water transportation	-1.72	0.00	0.10	1.26	-3.08
Truck transportation	2.74	-0.45	0.66	1.02	1.50
Transit and ground passenger transportation	-2.37	-1.16	0.35	-1.21	-0.36
Pipeline transportation	4.04	0.38	1.34	-2.73	5.05
Other transportation and support activities	-1.65	-0.45	0.97	-2.46	0.30
Warehousing and storage	-0.92	-0.95	-0.13	-1.62	1.78
Publishing industries, except internet (includes software)	-0.68	-1.31	0.23	-0.04	0.44
Motion picture and sound recording industries	1.41	0.18	0.72	-3.47	3.99
Broadcasting and telecommunications	-1.04	-0.82	-0.38	2.03	-1.86
Data processing, internet publishing, and other information services	0.69	-0.62	1.83	1.02	-1.54
Federal Reserve banks, credit intermediation, and related activities	-7.79	-2.29	-0.07	-5.08	-0.35
Securities, commodity contracts, and investments	-8.14	-0.18	-0.64	-4.97	-2.35
Insurance carriers and related activities	-0.92	-1.53	0.31	-0.19	0.49
Funds, trusts, and other financial vehicles	-2.34	-2.02	0.09	0.32	-0.74
Real estate	-2.10	-2.13	-0.11	-1.43	1.57
Rental and leasing services and lessors of intangible assets	2.70	-4.42	-0.33	2.40	5.05
Legal services	-2.55	-2.23	-0.40	0.16	-0.08
Computer systems design and related services	2.36	-0.08	0.85	0.49	1.10
Miscellaneous professional, scientific, and technical services	-1.09	-0.93	-0.47	-1.11	1.42
Management of companies and enterprises	4.44	-0.25	0.31	0.89	3.50
Administrative and support services	0.91	-0.69	0.99	0.91	-0.30
Waste management and remediation services	1.34	0.08	0.54	-0.50	1.22
Educational services	0.47	-0.08	-1.05	1.75	-0.15
Ambulatory health care services	-1.57	-0.05	0.24	-0.95	-0.81
Hospitals and Nursing and residential care	-0.27	-0.04	-0.33	0.46	-0.35
Social assistance	-3.85	-0.15	-0.64	-1.81	-1.24
Performing arts, spectator sports, museums, and related activities	-2.06	-0.15	-0.16	-1.90	0.16
Amusements, gambling, and recreation industries	-0.14	-0.62	0.06	-1.95	2.36
Accommodation	-0.15	-1.06	0.37	-1.26	1.80
Food services and drinking places	1.04	0.03	0.32	0.61	0.09
Other services, except government	0.67	-0.52	-0.14	0.23	1.11
Federal	-1.44	0.07	0.11	-1.61	0.00
State and local	-2.33	-0.37	-0.89	-1.07	0.00

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

Table 5: 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	0.54	0.24	0.28	0.00	0.02
State and local	0.75	0.08	0.03	0.00	0.64

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

Table 6: 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	0.00	0.09	-0.09
State and local	0.55	0.57	-0.01

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

**Table 7: 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	1.98	2.72	0.67	-1.40	2.04
Capital Input	1.20	1.56	0.54	0.74	0.41
IT Capital	0.30	0.39	0.13	0.19	0.09
R&D Capital	0.09	0.09	0.09	0.10	0.08
Software Capital	0.17	0.23	0.07	0.10	0.06
Artistic Originals Capital	0.03	0.03	0.02	0.02	0.02
Other Capital	0.61	0.83	0.23	0.32	0.16
Labor Input	0.35	0.59	-0.08	-1.27	0.71
College Labor	0.51	0.61	0.33	-0.10	0.61
Non-college Labor	-0.16	-0.02	-0.41	-1.17	0.10
MFP	0.44	0.57	0.21	-0.86	0.92

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

Table 8: Sector Sources of Value-Added Growth

	1998-2012	1998-2007	2007-2012	2007-2009	2009-2012
	Contributions				
Value-Added	1.98	2.72	0.67	-1.40	2.04
IT-Producing Industries	0.30	0.36	0.19	0.13	0.23
IT-Using Industries	0.97	1.39	0.22	-0.87	0.94
Non-IT Industries	0.44	0.65	0.05	-0.98	0.74
Government	0.28	0.32	0.20	0.33	0.12
Shares in Nominal Value-Added	100.0	100.0	100.0	100.0	100.0
IT-Producing Industries	3.1	3.0	3.1	3.0	3.2
IT-Using Industries	45.6	46.0	44.8	44.9	44.8
Non-IT Industries	31.8	31.9	31.6	31.5	31.6
Government	19.6	19.2	20.5	20.6	20.4

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 9: Sector Sources of Aggregate MFP Growth

	1998-2012	1998-2007	2007-2012	2007-2009	2009-2012
	Contributions				
MFP Growth	0.44	0.57	0.21	-0.86	0.92
IT-Producing Industries	0.26	0.33	0.14	0.14	0.14
IT-Using Industries	0.06	0.13	-0.06	-0.53	0.26
Non-IT Industries	0.11	0.11	0.12	-0.47	0.52
Government	0.00	0.00	0.00	0.00	0.00
Shares in Nominal Value-Added	100.0	100.0	100.0	100.0	100.0
IT-Producing Industries	3.1	3.0	3.1	3.0	3.2
IT-Using Industries	45.6	46.0	44.8	44.9	44.8
Non-IT Industries	31.8	31.9	31.6	31.5	31.6
Government	19.6	19.2	20.5	20.6	20.4

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 10: Sector Sources of Aggregate MFP Growth

	1998-2012	1998-2007	2007-2012	2007-2009	2009-2012
	Contributions				
MFP Growth	0.44	0.57	0.21	-0.86	0.92
R&D Intensive Industries	0.33	0.49	0.06	-0.37	0.34
IT-Producing Industries	0.26	0.33	0.14	0.14	0.14
Other R&D Intensive	0.07	0.15	-0.08	-0.50	0.20
Non R&D Intensive	0.10	0.08	0.15	-0.50	0.58
Government	0.00	0.00	0.00	0.00	0.00
Shares in Nominal Value-Added	100.0	100.0	100.0	100.0	100.0
R&D Intensive Industries	16.0	16.2	15.6	15.4	15.8
Non R&D Intensive	64.4	64.6	63.9	64.0	63.8
Government	19.6	19.2	20.5	20.6	20.4

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 below 1% have been dropped.

Figure 1: Industry TFP Growth 1998-2012

