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ABSTRACT

Official statistics display a significant slowdown in U.S. aggregate productivity growth that begins in 2004. In this paper, we investigate a source of mismeasurement in official statistics, which arises from offshore profit shifting by multinational enterprises operating in the United States. This profit shifting causes part of the economic activity generated by these multinationals to be attributed to their foreign affiliates, leading to an understatement of measured U.S. gross domestic product. Profit-shifting activity has increased significantly since the mid-1990s, resulting in an understatement of measured U.S. aggregate productivity growth. We construct adjustments to correct for the effects of profit shifting on measured gross domestic product. The adjustments raise aggregate productivity growth rates by 0.1 percent annually for 1994–2004, 0.25 percent annually for 2004–2008, and leave productivity unchanged after 2008; Our adjustments mitigate, but do not overturn, the productivity slowdown in the official statistics. The adjustments are especially large in R&D-intensive industries, which are most likely to produce intangible assets that are easy to move across borders. The adjustments boost value added in these industries by as much as 8.0 percent annually in the mid-2000s.

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1 Introduction

Economists have long understood the pivotal role of aggregate productivity growth as the engine of long-run economic growth. A wide range of macroeconomic policy questions hinge on the forecasts of future productivity growth, making the future path of productivity a crucial input into policy analysis. Thus, it is not surprising that the news of a significant slowdown in U.S. productivity growth, starting around 2004, generated widespread concern about the growth prospects of the U.S. economy. Perhaps more surprisingly, this productivity slowdown took place (according to official statistics) primarily in sectors that either produce or use information technology (IT) services intensively. This finding has raised skepticism among some economists, who point to the major innovative products and technologies introduced in the last decades, and conjecture that the appearance of a slowdown might be caused by mismeasurement in official statistics.[1] For the growth rate of productivity to be biased, however, mismeasurement alone (no matter how large) is not sufficient; the problem must be worsening over time, which is a harder fact to establish. A recent literature addressing productivity measurement has focused mainly on official price indexes as a source of mismeasurement. While the jury is still out, many of these studies find this type of mismeasurement to have modest effects on productivity growth.[2]

In this paper, we study another potential source of mismeasurement, one often acknowledged but not investigated thoroughly in the existing literature. This mismeasurement arises from the offshore profit shifting by domestic and foreign multinational enterprises (MNEs) operating in the United States. As we will show, this profit shifting understates measured U.S. gross domestic product in official statistics. Further, as this profit shifting has increased significantly in the last two decades, the mismeasurement has worsened, giving the impression of a larger slowdown in the GDP growth rate and, consequently, the aggregate productivity growth rate. To explain the source of mismeasurement and why it has worsened over time, we begin with two important facts.

First, the total economic activity generated by U.S. MNEs is very large and has grown significantly in the past 20 years. The total *global* value added of U.S. MNEs was \$4.66 trillion in 2012, making them equivalent to the fourth largest economy in the world, tied

[1]Some important examples include the widespread availability of broadband Internet; the rise of innovative business models and products in companies such as Apple, Google, Facebook, Amazon, Uber, and AirBnB; and new products and technologies such as smartphones, electric cars, cloud computing, and software-as-a-service.

[2]Aeppel (2015), Alloway (2015), Brynjolfsson and McAfee (2011), Byrne, Oliner, and Sichel (2015), Feldstein (2015), Hatzius and Dawsey (2015), Mokyr (2014), and Smith (2015) have explored measurement error in productivity. Syverson (2016) and Byrne, Fernald, and Reinsdorf (2016) argue that it is unlikely that measurement error is large enough to account for the productivity slowdown.

with Japan and trailing only the United States, the European Union, and China. In the same year, their domestic value added was \$3.26 trillion, accounting for 26.9 percent of U.S. business-sector value added. Furthermore, in the last 20 years, U.S. MNEs have increased their global operations substantially: Earnings on U.S. direct investment abroad (USDIA) averaged less than 1 percent of U.S. business-sector value added from 1973 to 1993 but grew to 3.7 percent (\$450 billion) of business-sector value added by 2012.

Second, MNEs own significant stocks of intangible capital (intellectual property, blueprints, brands) and have a presence in countries that vary widely in corporate tax rates. These characteristics allow MNEs to take advantage of differences in national tax regimes to shift profits from high-tax jurisdictions — such as the United States — to low-tax jurisdictions — such as Bermuda. Increasingly common profit-shifting practices include transfer pricing and complex global structuring related to intangible capital, in which an MNE effectively underprices intangible capital when "sold" from one of its entities in a high-tax jurisdiction to another of its entities in a low-tax jurisdiction or engages in a series of transactions among subsidiaries that are strategically located in order to reduce the MNE's effective global tax rate.[3] For U.S. MNEs, these strategies allow them to book earnings in low-tax foreign affiliates in ways that are disproportionate to the economic activity carried out in those affiliates.[4] These tax strategies have generated discussion among official statistics compilers and users of official statistics regarding the treatment of transactions within MNEs and their effect on national statistics.[5]

The measurement problem can be illustrated through a concrete example. Consider the iPhone, which is developed and designed in California but assembled by an unrelated company in China with components manufactured in various (mostly Asian) countries. Taking some hypothetical ballpark figures, suppose the bill of materials and labor costs of assembly amount to \$250 per iPhone and the average selling price is \$750, for a gross profit of \$500 per phone. For simplicity, assume that there are no further costs of retailing and that all iPhones are sold to customers outside of the United States.

[3]Another common strategy is to have subsidiaries in high-tax jurisdictions borrow funds from the subsidiaries in low-tax ones, thereby reducing the profits in the former and raising in the latter.

[4]See, for example, Bartelsman and Beetsma (2003), Bernard, Jensen, and Schott (2006), Clausing (2003), Grubert and Mutti (1991), and Hines and Rice (1994).

[5]See, for example, Lipsey (2009; 2010), Rassier (forthcoming), United Nations, Eurostat, and Organisation for Economic Co-operation and Development (2011), and United Nations (2015). Although the OECD's transfer pricing guidelines call for an "arm's-length principle," which requires firms to apply market prices to related-party transactions, this is difficult to do in practice because many intrafirm transactions do not have market values. For example, how should Apple value the intellectual property, marketing, and brand associated with the iPhone, when these are developed in the United States but used in foreign subsidiaries? These intangibles are not traded in organized markets, so it is very hard to judge whether the assigned values are correct.

Two important questions arise from this simple scenario: First, defining GDP as total domestic value added, how much *should* each iPhone contribute to U.S. GDP? Second, given the profit-shifting practices described above, how much of each iPhone's gross profit *is actually* included in U.S. GDP?

To answer the first question, note that the $250 paid to contract manufacturers and suppliers in Asia is not part of U.S. GDP, whereas how much of the $500 gross profit should be attributed to U.S. GDP depends on where that value is created. If consumers are willing to pay a $500 premium over the production cost for an iPhone, it is because they value the design, software, brand name, and customer service embedded in the product. If we assume these intangibles were developed by managers, engineers, and designers at Apple headquarters in California (Apple, U.S.), then the entire $500 should be included in U.S. GDP. In the national accounts, the $500 would be a net export in expenditure-based GDP, matched by an increase in Apple's earnings in income-based GDP. To the extent that some intangible assets were created outside of the United States, only the appropriate share of the gross profit and related net export would accrue to the United States.

As to the second question, the gross profit actually included in U.S. GDP may be very small. If Apple generates intangible assets in the United States and legally transfers them to a foreign affiliate (e.g., one in Ireland), payments for the use of intellectual property should accrue to Apple U.S. as a net export in U.S. expenditure-based GDP, which are matched by an increase in Apple U.S.'s earnings in U.S. income-based GDP. As a result of profit shifting, however, payments for the use of intellectual property may be underpriced or not made at all, which means that the returns to Apple U.S.'s intangible assets are attributed to an Apple affiliate outside the United States and not included in U.S. GDP. In this case, the returns are captured in "earnings on USDIA," which is included in U.S. gross national product. Thus, relative to the conceptual measure, U.S. net exports and GDP are understated and earnings on USDIA are overstated.

To illustrate the magnitude of this problem, Table I reports, by host country, the total assets (cash, receivables, plant, property, equipment, etc.) owned by the foreign affiliates of U.S. MNEs relative to several production-related measures. The ratio of total assets to physical capital (plant, property, and equipment) for U.S.-owned foreign affiliates in Canada is 6.4. This ratio averages almost 300 for European tax havens Ireland, Luxembourg, the Netherlands, and Switzerland, and more than 90 for Barbados, Bermuda, and the U.K. Caribbean Islands. Measuring assets relative to employment (number of employees) or compensation yields similar patterns.[6]

[6]These cross-border strategies can wreak havoc in the official statistics of even relatively large economies

Table I – Assets in U.S.-owned foreign affiliates, 2012

	Ratio of U.S.-owned foreign affiliate total assets to		
	PPE	Compensation	Employment (mil. USD)
World	16.8	39.0	1.8
Canada	6.4	21.2	1.2
Ireland	20.0	142.7	10.9
Luxembourg	1,109.6	1,380.0	121.6
Netherlands	97.7	115.3	8.7
Switzerland	59.9	60.0	7.7
Barbados	41.8	1,444.7	43.3
Bermuda	130.8	1,475.5	155.8
U.K.I., Caribbean	101.2	3,330.2	199.8
Hong Kong	40.3	39.3	2.7
Singapore	18.6	50.3	3.1

Notes: Total assets are the sum of all financial (e.g., cash, receivables) and non-financial (e.g., property, plant, and equipment, inventories) assets on a historic cost basis — that is, amounts reported on firms' financial statements under U.S. generally accepted accounting principles (GAAP). United Kingdom Islands (U.K.I.), Caribbean, consist of the British Virgin Islands, Cayman Islands, Montserrat, and Turks and Caicos Islands.

The goal of this paper is to obtain a more accurate measurement of U.S. domestic productivity growth by correcting for the mismeasurement in value added introduced by MNE offshore profit shifting. For this purpose, we use confidential MNE survey data, collected by the Bureau of Economic Analysis (BEA) for the period 1982–2014.[7] The survey data cover the worldwide operations of U.S. MNEs and contain, among other key measures, information on their employment, sales, and R&D expenditures. We also use annual data for transactions in income on direct investment published by BEA in the International Transactions Accounts (ITA), also available for 1982–2014.

Using these data, we reattribute earnings on USDIA among a U.S. parent and its foreign affiliates, based on factors that reflect economic activity, under a method of *formulary apportionment*. Under this method, the total worldwide earnings of an MNE are attributed to locations based on apportionment factors that aim to capture the true loca-

like Ireland and the Netherlands. As one example, annual Irish GDP growth in 2015 was 26 percent, compared to a consensus forecast by economists of 7.8 percent. This large discrepancy was almost entirely due to foreign affiliates in Ireland booking larger than expected earnings in the country (Eurostat, 2016).

[7]The firm-level survey data, which by law are confidential, are collected for the purpose of producing publicly available aggregate statistics on the activities of multinational enterprises.

tion of economic activity. As apportionment factors, we use, in each geographical location, a combination of (i) labor compensation and (ii) sales to unaffiliated parties, as they are likely to be good proxies for the actual economic activity taking place in each location.

We use the results of formulary apportionment to compute a corrected measure of domestic business-sector value added and consequent labor productivity growth for the United States, for 1973–2014.[8] Since the aggregate earnings of U.S. MNEs are disproportionately booked to low-tax jurisdictions with little true economic activity, our adjustment reattributes their earnings toward the United States and other higher-tax jurisdictions, thereby increasing measured U.S. GDP and labor productivity growth.

For comparability with earlier work (Fernald, 2015), we use domestic business-sector value added as our measure of output. Our adjustments increase value added by less than 0.5 percent per year from 1973 to the late 1990s, but, starting in the late 1990s, the mismeasurement problem, and therefore the resulting adjustments, grow rapidly. By 2010, the adjustment increases value added by 2.5 percent per year. The adjustments raise aggregate productivity growth rates by 0.1 percent annually from 1994 to 2004, by 0.25 percent annually from 2004 to 2008, and leave productivity unchanged after 2008. The adjustments mitigate the slowdown found in official statistics; however, because the post-2004 slowdown is quite large, and our adjustments raise productivity growth not only after 2004 but also before it (although to a lesser extent), our analysis does not overturn the slowdown in aggregate productivity growth after 2004.

That said, the understatement of productivity growth is quite large in some important industries. When we group industries by R&D intensity, the adjustments to the aggregate value added of R&D-intensive industries is as large as 8.0 percent of the group's value added in some years (Figure 5a). The effects on growth can be substantial: the annual productivity growth rate from 2000 to 2008 is 0.6 percent higher in R&D-intensive industries after the adjustments.

While our focus is on the profit shifting of U.S. MNEs, for some of the same reasons, foreign MNEs are also likely to be shifting profits out of the United States, biasing measured U.S. GDP further downward. BEA surveys cover the U.S. affiliates of foreign MNEs but unfortunately do not cover (most of) their foreign operations, including their foreign parent operations. Without this latter piece of data, constructing apportionment factors for foreign MNEs with the BEA survey data alone is not feasible. It is possible, however, to combine data from commercial databases to make progress on this question, and in

[8]Because the BEA surveys start in 1982, the analysis for the 1973–1981 period relies on some extrapolations discussed below.

Section 5 we take a first look at this issue using a preliminary data set on the largest 98 technology-intensive foreign MNEs that have operations in the United States. Our results indicate a similar profit-shifting behavior by these corporations, further biasing U.S. GDP and labor productivity measures. In our preliminary analysis, we find the magnitudes of the biases for foreign MNEs to be smaller than those for U.S. MNEs.

1.1 Related literature

The formulary apportionment approach we use to reattribute earnings within the MNE has been primarily applied in multijurisdictional tax practice. The treatment of global income under formulary apportionment is widely explored in multidisciplinary research, and formulary apportionment has been proposed as an alternative to the complexity and subjectivity of transfer pricing for the allocation of international tax obligations within MNEs.[9] From a tax policy perspective, a potential problem with formulary apportionment is the endogenous response of firms to the formulary rules of the tax system.[10] To the extent that MNEs do not make operating or investment decisions based on surveys intended solely for statistical purposes, formulary apportionment applied to economic accounting faces fewer challenges compared to its use in international taxation.

Our approach follows Rassier and Koncz-Bruner (2015), which proposes formulary apportionment as an alternative method for attributing the profits component of income-based value added to foreign affiliates of U.S. MNEs. The formulary adjustment reduces distortions created by excess profits attributed to tax haven countries (Lipsey, 2010). Rassier (2014) treats the reduction in earnings on USDIA under formulary apportionment as an implied increase in U.S. GDP, which is a necessary counterpart to the related increase in domestic income. The author, however, does not construct a time series of adjusted domestic business-sector value added and does not consider the consequences for productivity measures or the differential impacts on R&D- and IT-intensive industries.

McGrattan and Prescott (2010) and Bridgman (2014) seek to explain the higher rate of return earned by U.S. MNEs on their direct investments abroad compared with the rate of return earned by foreign-owned MNEs on their investments in the United States. Their explanations for the rate of return differential focus on the use of intangible capital by MNEs in their foreign affiliates. These studies use general equilibrium models and estimates of intangible assets to account for the rate of return differentials. The aggregate

[9] See, for example, Avi-Yonah (2010), Avi-Yonah and Benshalom (2011), Avi-Yonah and Clausing (2007), Fuest, Hemmelgarn, and Ramb (2007), and Runkel and Schjelderup (2011).

[10] See, for example, Altshuler and Grubert (2010), Anand and Sansing (2000), Goolsbee and Maydew (2000), Gordon and Wilson (1986), Gresik (2001), Hines (2010), Martens-Weiner (2006), and Röder (2012).

analyses in these papers are complementary to our estimates derived from the firm-level data.

In Section 2, we present a simple model of an MNE to highlight the source of mismeasurement and discuss our empirical methodology. In Section 3 we report the impact of our adjustments on aggregate productivity, and in Section 4, we show how our adjustments matter more for R&D- and IT-intensive industries. Section 5 takes a first look at mismeasurement due to foreign MNEs operating in the United States, and Section 6 concludes.

2 Conceptual framework

In this section we provide a conceptual framework to demonstrate how the ownership of intangible assets — regardless of where they are used — affects the measurement of aggregate output and productivity. Our data cover U.S. parents and their foreign affiliates, so our focus here is on the measurement of U.S. aggregate output and productivity.

The MNE consists of a parent (m) located in the United States and one wholly owned foreign affiliate (a). The parent and affiliate produce nontraded final goods (y) using physical capital (k), skilled and unskilled labor (ℓ_s, ℓ_u), and intangible capital (h).[11] We assume that physical capital and labor can be freely adjusted and are obtained from perfectly competitive factor markets. Intangible capital is non-rivalrous but subject to ownership.

The final-good production function for the parent is

$$y_m = f(z_m, k_m, \ell_{sm}, \ell_{um}, h), \tag{1}$$

where z is total factor productivity. The final-good production function for the affiliate is

$$y_a = f(z_a, k_a, \ell_{sa}, \ell_{ua}, h). \tag{2}$$

We assume that both production functions are homogeneous of degree one. Note that intangible capital does not have a subscript that denotes its physical location. This is an advantageous characteristic of intangible capital: It can be used to produce in each location, regardless of its location of ownership.

[11] In the data, firms produce both goods and services. For simplicity, we refer to the output of firms as goods.

2.1 Accounting

We map the production framework specified above into the economic accounting framework used by BEA, which is based on international statistical guidelines. To do so, we need to assign economic ownership of the firm's intangible capital. We assume that the MNE assigns ownership share λ of the stock of intangible capital to the parent and $1-\lambda$ to the foreign affiliate. This decision does not affect production but determines the location in which the returns to intangible capital are booked. The firm may assign ownership of its intangible capital to the affiliate for several reasons, including taxation, regulation, confidentiality, property rights protection, and exchange rate management (Organisation for Economic Co-operation and Development, 2008a). For our purposes, we do not need to model the firm's choice of λ.

Given our assumptions, affiliate earnings are

$$\pi_a = py_a - w_s\ell_{sa} - w_u\ell_{ua} - r^k k_a - r^h(1-\lambda)h - r^h\lambda h + r^h(1-\lambda)h = r^h(1-\lambda)h, \quad (3)$$

where p is the price of the final good, w_s and w_u are the wage rates, r^k is the return on physical capital, and r^h is the return on intangible capital. We assume that factor and goods prices are the same in the parent and affiliate. The term $-r^h(1-\lambda)h$ is the impairment of affiliate intangible assets; the term$-r^h\lambda h$ is the payment from the affiliate to the parent for the use of λh; and the term $r^h(1-\lambda)h$ is the payment from the parent to the affiliate for the use of $(1-\lambda)h$. The second equality in (3) follows from the assumption that inputs are paid their marginal products and that the production function has constant returns to scale.

Parent earnings are

$$\pi_m = py_m - w_s\ell_{sm} - w_u\ell_{um} - r^k k_m - r^h\lambda h - r^h(1-\lambda)h + r^h\lambda h = r^h\lambda h, \quad (4)$$

where the term $-r^h\lambda h$ is the impairment of the parent intangible assets; the term $-r^h(1-\lambda)h$ is the payment from the parent to the affiliate for use of $(1-\lambda)h$; and the term $r^h\lambda h$ is the payment from the affiliate to the parent for use of λh. Again, the second equality in (4) follows from the assumption that inputs are paid their marginal products and that the production function has constant returns to scale.

2.2 Accounting with multinational enterprises

How do the ownership shares of intangible capital affect aggregate output measures? In the United States, expenditure-based GDP is

$$Y^E = py_m + r^h\lambda h - r^h(1-\lambda)h, \tag{5}$$

where the last two terms are the exports and imports of intangible capital services. Income-based GDP is

$$Y^I = w_s\ell_{sm} + w_u\ell_{um} + r^k k_m + 2r^h\lambda h = py_m - r^h h + 2r^h\lambda h, \tag{6}$$

where the second equality follows from $py_m = w_s\ell_{sm} + w_u\ell_{um} + r^k k_m + r^h h$. The payment from the affiliate to the parent ($r^h\lambda h$) is reported in BEA surveys on transactions in services as "receipts by U.S. reporters [parents] on the use of intellectual property by foreign persons." In the aggregate accounting, these receipts are a part of earnings on U.S. direct investment abroad. In our framework, earnings on USDIA is simply

$$Y^{\text{USDIA}} = \pi_a = r^h(1-\lambda)h. \tag{7}$$

Note that $r^h(1-\lambda)h$ is counted as earnings on USDIA, whether or not the earnings are paid as cash dividends to the parent. Earnings not paid as dividends are treated in economic accounts as paid and immediately reinvested in the foreign affiliate. The earnings are not included in GDP.

Unadjusted aggregate labor productivity is

$$A = \frac{Y^E}{\ell_m} = \frac{py_m + 2r^h\lambda h - rh}{\ell_m}, \tag{8}$$

where $\ell_m = \ell_{sm} + \ell_{um}$ is total employment in the United States. Suppose that all of the intangible capital was created in the United States. When the parent retains all of the firm's intangible capital ($\lambda = 1$), the entire return to intangible capital would be counted in GDP. When $\lambda < 1$, some of the return to intangible capital gets attributed to earnings on USDIA rather than GDP, and the productivity measure in (8) would be smaller. This mismeasurement grows larger as λ decreases or intangible capital becomes more important.

2.3 Formulary apportionment method

The simple framework presented in the previous section made it easy to see the source of mismeasurement and a practical solution: Attribute MNE earnings to the entities of the firm in a way that reflects the location of production. We use a formulary apportionment approach for this attribution.

Formulary apportionment begins by constructing, for each entity in the firm, an apportionment weight, ω_n, that reflects the entity's share of the total apportionment factors. We use sales to unaffiliated parties and labor compensation as our apportionment factors. The market presence of the entity is captured by the sales measure, and restricting sales to unaffiliated parties mitigates problems with transfer pricing and global structuring. Compensation reflects labor's contribution to production in the entity. To account for differences in labor quality across entities, we use compensation rather than employment. Weighting the two factors equally, the apportionment weights in our framework are

$$\omega_n = \frac{1}{2} \times \frac{w_s \ell_{sn} + w_u \ell_{un}}{w_s \ell_{sm} + w_u \ell_{um} + w_s \ell_{sa} + w_u \ell_{ua}} + \frac{1}{2} \times \frac{py_n}{py_m + py_a} \qquad n = a, m. \tag{9}$$

We use these weights to allocate the MNE's consolidated earnings across the entities,

$$\pi_n^{\omega} = \omega_n(\pi_a + \pi_m) \qquad n = a, m, \tag{10}$$

which yields π_n^{ω}, the earnings attributed to entity n under formulary apportionment. The *formulary adjustment* to each entity is simply

$$\epsilon_n = \pi_n^{\omega} - \pi_n. \tag{11}$$

The formulary adjustment reflects the additional earnings (which could be negative) due to the entity. We use the formulary adjustment for the parent to adjust GDP,

$$\widetilde{Y}^E = Y^E + \epsilon_m = py_m + r^h \lambda h - r^h(1-\lambda)h + \epsilon_m. \tag{12}$$

The adjusted GDP in (12) is the numerator in *adjusted aggregate labor productivity*,

$$\widetilde{A} = \frac{\widetilde{Y}^E}{\ell_m} = \frac{py_m + r^h \lambda h - r^h(1-\lambda)h + \epsilon_m}{\ell_m}. \tag{13}$$

While standard in the multijurisdictional tax literature, the formulary adjustment will not generally provide an exact measure of the missing payment to the parent. The accuracy of our adjustment depends upon the extent to which inputs are substitutable: With fixed-proportions production functions, the adjustment exactly reattributes profits in proportion to output. We experiment with different apportionment factors to generate a range of adjustments.

3 Aggregate productivity

We begin with an analysis of U.S. aggregate productivity. In Section 4, we study productivity in industries grouped by their R&D expenditure and their use and production of information technology.

3.1 Data and variable construction

We construct unadjusted labor productivity for 1973–2014 using annual domestic business-sector value added from the national income and product accounts (NIPA) published by BEA and annual total hours worked from the Labor Productivity and Costs series published by the U.S. Bureau of Labor Statistics (BLS). In Section 2, for clarity, we used GDP as our measure of output. In our empirical implementation, we use the more appropriate business-sector value added measure, which abstracts from the household, government, and non-profit sectors of the economy. In addition, we use the annual survey data collected by BEA on U.S. MNEs to construct productivity measures adjusted for transactions in earnings on USDIA based on the formulary framework outlined in Section 2.3.

While the productivity series span 1973–2014, the survey-level data are only available for 1982–2014. Furthermore, some requisite survey-level data on U.S. parents were not collected for 1983–1988 and 1990–1993. However, aggregate statistics on transactions in income (direct investment income and portfolio income) are available for all years. Thus, we extrapolate backward the nominal adjustment prior to 1982 using the aggregate statistics as an indicator. In addition, we linearly interpolate the nominal adjustment for 1983–1988 and 1990–1993.

Before turning to our results, we briefly discuss the construction of our productivity series. More details are available in the appendix.

3.1.1 Unadjusted productivity measures

To construct unadjusted labor productivity, we follow Fernald (2015) and take the geometric average of the income-based and expenditure-based measures of business-sector value added, which we deflate with an implicit price deflator derived from business-sector value added. We divide our real value added measure by total hours worked to yield the unadjusted labor productivity defined in (8).

3.1.2 Adjusted productivity measures

To construct adjusted labor productivity, we need the apportionment factors and profits for each entity in each MNE. These data are collected in the BEA MNE surveys and used to generate the formulary adjustment in (11). The survey data include financial and operating activities based on income statement and balance sheet information reported under U.S. GAAP for U.S. parents and their foreign affiliates. These surveys are required to be completed for all U.S. parents, and surveys are required to be completed for all foreign affiliates based on thresholds for assets, sales, and net income. These surveys report, for each parent and affiliate, compensation and sales to unaffiliated parties, which we use to construct the apportionment factors. The surveys are also the source of earnings reported on U.S. parents and foreign affiliates, as well as the U.S. parent's reported voting interest in a foreign affiliate.[12]

Apportionment factors

We use compensation of employees and sales to unaffiliated parties as apportionment factors to construct the apportionment weights in (9) for each MNE. Each apportionment factor has advantages and disadvantages. Compensation reflects both the number of employees and their wages. If workers are paid their value marginal product, compensation reflects variation in economic activity across industries and countries. As an apportionment factor, compensation yields relatively more production attributable to high-margin industries and high-wage countries and relatively less production attributable to low-margin industries and low-wage countries. In addition, compensation is based on market transactions rather than financial accounting conventions, which may affect our other apportionment factor, unaffiliated sales. Thus, apportionment weights constructed using only compensation may provide the most objective measure of economic activity. Compensation, however, may not reflect the actual economic owner of intangible capital and may not reflect the provision of services through means such as digital technology, which do not require a physical presence.

While unaffiliated sales may be affected by revenue recognition rules under financial accounting conventions, an advantage of using sales as an apportionment factor is that it reflects activity at a location regardless of physical presence, which may be a better indicator of economic activity for some products.[13] For example, unaffiliated sales may reflect intangible capital actually employed by a foreign affiliate. In addition, sales is a

[12]Transactions in income on USDIA include earnings and net interest. Earnings include a U.S. parent's share of its foreign affiliate's net income adjusted for capital gains and depletion. Earnings are either distributed as dividends or reinvested as further direct investment. Net interest is very small relative to earnings, so we do not include it in our adjustments.

[13]The OECD's work on base erosion and profit shifting recommends that the taxable presence of an entity be determined primarily by the location of "significant people functions" in the case of non-financial enterprises or by the location of "key entrepreneurial risk takers" in the case of financial enterprises. In the case of electronic commerce, the commentary to the OECD model tax convention clarifies that computer equipment at a location may constitute a taxable presence even if no personnel are required to operate

measure of local output that results from production, whereas compensation is a measure of local inputs employed in production.

Economic profits

Our measure of profits reflects current production that is consistent with the profits component of GDP calculated by the factor income approach. Profits of U.S. parents are calculated as net income minus capital gains and losses, minus profits of their foreign affiliates on which the U.S. parent has a claim, plus charges for depletion of natural resources. Profits of foreign affiliates on which the U.S. parent has a claim — our measure of foreign profits — are calculated as foreign affiliate net income minus capital gains and losses, minus profits of other foreign affiliates on which they have a claim, plus charges for depletion of natural resources, the result of which is multiplied by the parent's direct and indirect voting interest in the foreign affiliate.

We compute the entity-level adjustments according to (11) and aggregate the parents' adjustments for all U.S. MNEs. We add this aggregate adjustment to nominal expenditure-based business-sector value added and to nominal income-based business-sector value added. Let M be the set of all U.S. MNEs and Y^{VA} be either income- or expenditure-based nominal value added. Adjusted value added, $\widetilde{Y}^{\text{VA}}$, is

$$\widetilde{Y}^{\text{VA}} = Y^{\text{VA}} + \sum_{m \in M} \epsilon_m. \tag{14}$$

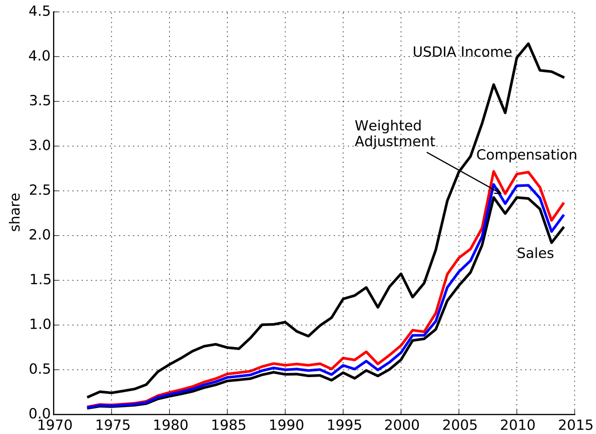
As in the construction of unadjusted labor productivity, we take the geometric average of the two adjusted value added series and deflate them using the implicit deflator for business-sector value added. We divide our adjusted real value added measure by total hours worked to yield the adjusted labor productivity defined in (13).

3.2 Results

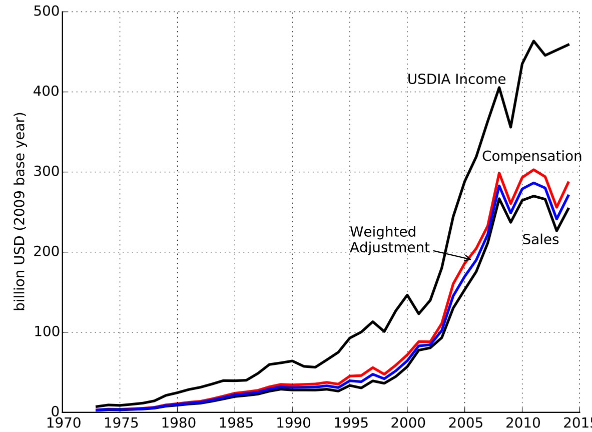
Figure 1 presents, as a share of business-sector value added, the aggregate formulary adjustments: the sum of the ϵ_m from (11). Our baseline formulary adjustment, when the apportionment weights in (9) are based on sales and employee compensation, is labeled "weighted adjustment." We also plot the formulary adjustment when either compensation or sales is the only factor used to compute the apportionment weights. The adjustments based on only compensation or sales are similar to each other and, thus, to the weighted

the equipment. However, the attribution of profits to the location would still depend on the performance of "significant people functions," which implies little or no profit would be attributed to the location (Organisation for Economic Co-operation and Development, 2008b, paragraph 95).

Figure 1 – Aggregate formulary adjustments



(a) As share of business-sector value added



(b) Inflation-adjusted level

adjustment. We plot total income on USDIA for reference. The apportionment factors are stable over time, so the adjustment series generally follow the pattern of total income on USDIA.

Although the adjustments grow, from 1973 to 2000 they are less than 1 percent of value added per year. In the early 2000s, income on USDIA explodes, and the sales-compensation weighted formulary adjustments grow to about 2.5 percent of value added per year. The cumulative increase in U.S. GDP from the adjustment is substantial. From 2004 to 2014, the sales-compensation weighted formulary adjustment adds \$2.6 trillion to GDP, the compensation-based adjustment adds \$2.8 trillion, and the sales-based adjustment adds \$2.5 trillion.

We plot cumulative labor productivity growth for 1973–2014 (normalizing 1973 to zero) in Figure 2a. In what follows, we compute growth rates using natural logarithms. The unadjusted cumulative labor productivity series is consistent with Fernald (2015), except for 2012–2014, where we have incorporated revised NIPA data. The average annual unadjusted labor productivity growth rate for 1973–2014 is 1.9 percent. The productivity data are often broken into three periods: 1973–1994, 1994–2004, and 2004–2014. The average annual unadjusted labor productivity growth rates for 1973–1994 and 2004–2014 are roughly equivalent at 1.5 percent and 1.4 percent, respectively. The average annual unadjusted productivity growth rate for 1994–2004 increases to 3.0 percent. We report cumulative and average annual productivity growth rates in Table II.

In Figure 2a, we plot the cumulative growth of labor productivity adjusted by the weighted formulary adjustment shown in Figure 1, and in Figure 3, we plot the difference

Figure 2 – Aggregate cumulative labor productivity growth

(a) 1973–2014 (b) 1994–2014

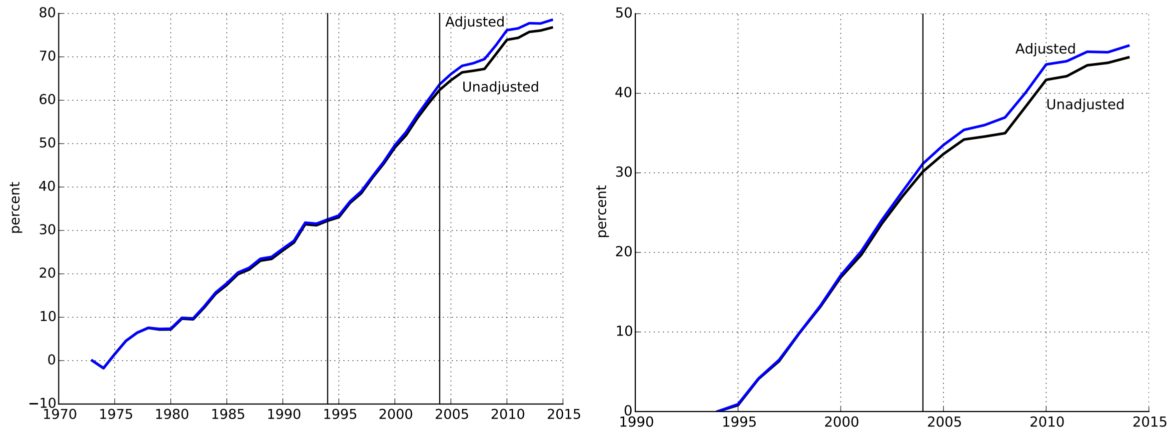


Figure 3 – Increase in aggregate cumulative labor productivity growth

(a) 1994–2014 (b) 2004–2014

between the two series. By the end of the period, cumulative labor productivity is higher in the adjusted series. Adjusted cumulative labor productivity growth for 1973–2014 is 1.8 log points higher than the unadjusted cumulative labor productivity growth.

From Figure 2a, it is clear that the formulary adjustment does not affect aggregate productivity in a substantial way until the 1990s, with most of the adjustment occurring after 2000. In Figure 2b, we plot aggregate cumulative productivity growth since 1994 to highlight the period of increased productivity growth (1994–2004) and the productivity growth slowdown (2004–2014). From 1994 to 2014, the formulary adjustment adds 1.6 log points to cumulative labor productivity growth. The adjustment increases the productivity

Table II – Labor productivity growth rates (percent)

	Cumulative growth rate		Average annual growth rate	
	Unadjusted	Adjusted	Unadjusted	Adjusted
1973–2014	76.7	78.5	1.87	1.91
1973–1994	32.2	32.5	1.53	1.55
1994–2014	44.5	46.0	2.23	2.30
2002–2014	20.9	21.9	1.74	1.83

growth rate during the period of increased productivity growth, but the adjustment has its largest effects during the productivity growth slowdown. In some years, this effect is dramatic. From 2006 to 2008, for example, adjusted productivity grew 1.5 percent, while unadjusted productivity grew only 0.6 percent.

3.3 Adjustment for other countries

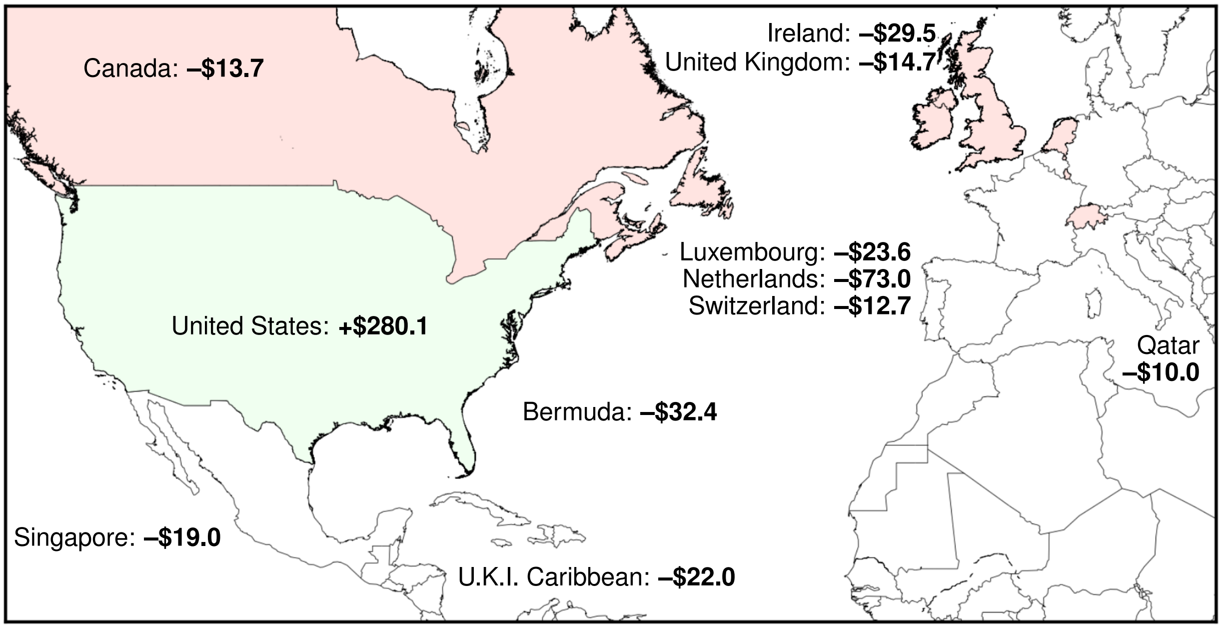
Our adjustments are reattributions of earnings among the parent and foreign affiliates of each U.S. MNE. As evident in Figure 1, almost 65 percent of earnings on USDIA are reattributed to the United States. From which countries did this income originate? Almost 92 percent of the reattribution to the United States is concentrated in ten countries, and the largest reattributions were away from countries that are considered to be havens for MNE profit shifting (Table III and Figure 4). Consistent with the popularity of the "double Irish with a Dutch sandwich" tax reduction strategy (Sanchirico, 2015), the Netherlands is the largest source (27.8 percent) and Ireland is the third largest source (10.5 percent) of income reattributed to the United States. The top ten also includes tax havens Bermuda, Luxembourg, Singapore, Switzerland, and the U.K. Caribbean Islands.[14]

Canada and the United Kingdom are also in the top ten sources of reattributed income; however, these countries are major hosts of U.S.-owned affiliate employment. In 2012, Canada accounted for 8.4 percent of all employment in the foreign affiliates of U.S. parents, and the United Kingdom accounted for 10.3 percent.

The fact that adjustments are negative for some countries does not necessarily suggest that the GDP of those countries is overstated. Some of the larger countries are home to

[14]The adjustments may be larger than GDP due to national accounting practices in some host countries that exclude the income from certain foreign-owned companies from GDP. Bermuda, for example, does not include exempted companies — companies that are located in Bermuda but do not do business in Bermuda — in its national account statistics. Lipsey (2009) provides a sense of scale: In 1999, the foreign affiliates of U.S. MNEs in Bermuda reported sales of services to parties outside of Bermuda of $13,908 million; however, total service exports as reported in Bermudian official statistics are only $1,163 million.

Figure 4 – Geographical reattribution of earnings of U.S. MNEs, 2012 (bil. USD)



Notes: The United Kingdom Islands (U.K.I.), Caribbean,are made up of the British Virgin Islands, Cayman Islands, Montserrat, and Turks and Caicos Islands.

indigenous MNEs, and reattribution of those companies' global profits may very well raise the GDP of those countries.

Our adjustments are positive for some countries (besides the United States) as well, although the increases are small. The adjustments, in fact, are too small to be reported given the confidentiality of the BEA survey data. The ten countries with the largest positive reattribution of income on USDIA are, in order from highest to lowest: Japan, France, Italy, Russia, Argentina, Greece, Turkey, Libya, Germany, and Kenya. Among this set of countries, Japan, France, Italy, Greece, and Germany have tax rates that generally exceed the OECD average. Overall, the reattribution pattern supports the concern that measurement error arises as a result of income on USDIA being shifted to affiliates in countries with relatively low tax rates.

Table III – Adjustments in other countries, 2012

Country	Adjustment (share of total)	Adjustment (share GDP)
Decrease in GDP	1.00	
Netherlands	0.28	0.10
Bermuda	0.12	5.91
Ireland	0.11	0.14
Luxembourg	0.08	0.43
U.K.I., Caribbean	0.08	4.76
Singapore	0.07	0.07
United Kingdom	0.06	0.01
Switzerland	0.05	0.02
Canada	0.05	0.01
Qatar	0.04	0.06
Remaining 178 countries	0.08	

Notes: The adjustment to U.S. GDP in 2012 is an increase of $280.1 billion. This table reports the offsetting adjustments (decreases in GDP) to the top 10 counterpart countries by size of adjustment. The United Kingdom Islands (U.K.I.), Caribbean, include the British Virgin Islands, Cayman Islands, Montserrat, and Turks and Caicos Islands. They are members of CARICOM, which publishes a comprehensive set of national accounts data.

4 Productivity in R&D- and IT-intensive industries

Attributing the return to intangible capital correctly is likely to make a bigger difference in industries in which intangible capital is more important. To investigate this hypothesis, we construct adjusted productivity measures for industries grouped by their R&D and IT intensities.

We use data on value added by industry from the Annual Industry Accounts (AIA) published by BEA and hours worked by industry from the Labor Productivity and Costs database published by BLS. As before, we use the BEA survey of MNEs to construct value added adjusted for transactions in earnings on USDIA based on the formulary framework outlined in Section 2.3.

We use the survey data to calculate R&D and IT intensity at the *enterprise level* — the U.S. parent and all of its foreign affiliates. We calculate R&D intensity by dividing enterprise-level R&D expenditures, aggregated across all available years, by enterprise-level sales to unaffiliated parties, aggregated across all available years. We consider an enterprise to be *R&D intensive* if its R&D intensity is at or above the 75th percentile. In most cases, R&D-intensive enterprises include U.S. parents and foreign affiliates classified into industries that are considered to be R&D intensive as defined in Moylan and Robbins (2007).

We calculate IT intensity separately for IT usage and IT production. We first categorize industries as IT using, as defined in Bloom, Sadun, and Van Reenen (2012), or as IT producing, as defined in Fernald (2015). We consider an enterprise to be *IT-using intensive* if the share of its total unaffiliated sales generated by entities classified into IT-using industries is greater than 50 percent. We consider an enterprise to be *IT-producing intensive* if the share of its total unaffiliated sales generated by entities classified into IT-producing industries is greater than 50 percent.

A complete list of industry groups is reported in appendix Table A.1. Note that a number of industries are included in more than one group. Information industries (NAICS 51) are included in both IT-using and IT-producing groups, and computer and electronic product manufacturing industries (NAICS 334) and computer systems design industries (NAICS 5415) are grouped with both IT-producing industries and R&D-intensive industries. Likewise, transportation and equipment manufacturing industries (NAICS 336) and scientific research and development industries (NAICS 5417) are grouped with both IT-using industries and R&D-intensive industries. IT-producing and R&D-intensive industries overlap the most — IT-producing industries are almost a subset of R&D-intensive industries. In contrast, IT-using industries include a number of industries that are not included in either the IT-producing industries or the R&D-intensive industries, including well-measured industries such as wholesale trade (NAICS 42) and retail trade (NAICS 44–45).

4.1 Unadjusted productivity measures

The value added by industry data published in the AIA include nominal and real measures as well as the related price indexes (base year is 2009). We group industries according to their R&D or IT intensities and compute each group's real value added using the relevant Törnqvist price index. We divide the group's real value added by the group's hours worked to yield unadjusted labor productivity.

4.2 Adjusted productivity measures

We adjust nominal value added for industries grouped by R&D intensity and IT intensity. To compute, for example, adjusted value added for the R&D-intensive industries, we begin with the MNEs that are identified as R&D intensive. For each of these enterprises, we use the survey data collected by BEA to compute the apportionment weights as in (9) and the formulary adjustments as in (11).

We sum the formulary adjustments and add them to the nominal value added of the R&D-intensive industries. If I^{RD} is the set of R&D-intensive industries and M^{RD} is the set of R&D-intensive enterprises, then the adjusted nominal value added of the R&D-intensive industries is

$$\widetilde{Y}^{RD} = \sum_{i \in I^{RD}} Y_i + \sum_{m \in M^{RD}} \epsilon_m, \tag{15}$$

where Y_i is nominal value added in industry i and ϵ_m is the formulary adjustment of enterprise m defined in (11). We deflate nominal adjusted value added by a Törnqvist index of the price indexes from the industries in I^{RD}. We divide the industry group's real value added by the group's hours worked to yield adjusted labor productivity.

Proceeding in this way, we compute adjusted labor productivity for R&D-intensive industries, non-R&D-intensive industries, IT-using industries, non-IT-using industries, IT-producing industries, and non-IT-producing industries.

4.3 Industries that engage in R&D

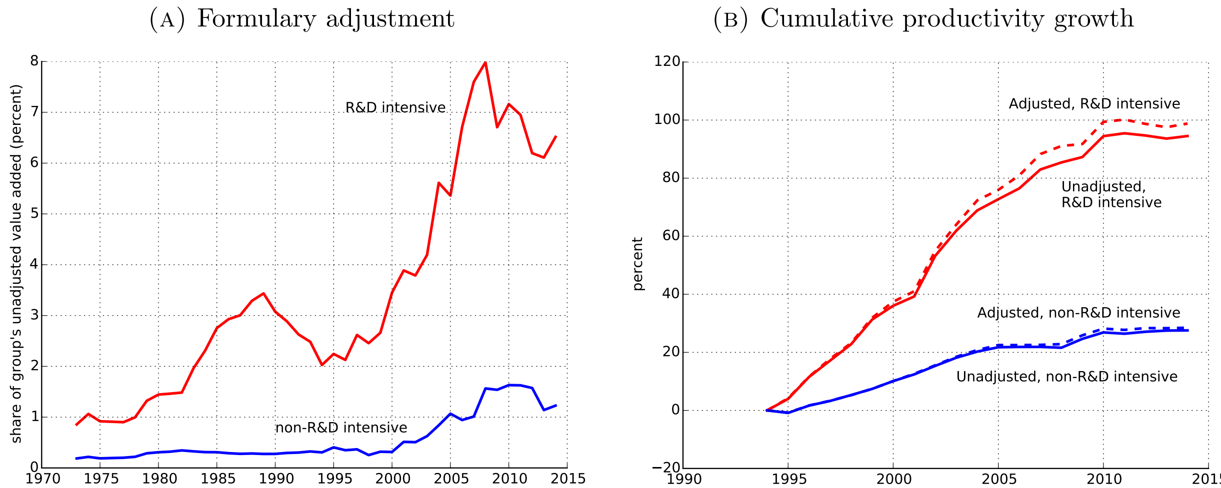
In Figure 5a, we plot, as a share of unadjusted value added, the formulary adjustment for R&D-intensive and non-R&D-intensive industries. The formulary adjustments for R&D-intensive industries are hump shaped in the 1980s and then grow strongly in the 2000s. The formulary adjustments for R&D-intensive enterprises are substantially larger than those for non-R&D-intensive enterprises, with the adjustment for R&D-intensive enterprises peaking in 2008 at 8.0 percent of nominal value added.

The impact of our adjustments on productivity growth by R&D intensity is evident in Figure 5b, in which we plot cumulative labor productivity growth. From 1973 to 2014, productivity growth in the R&D-intensive industries is about three times that in the non-R&D-intensive industries. Adjusting for offshore profit shifting in the R&D-intensive industries adds about 5.4 log points to cumulative growth, but only a little more than 1 log point in non-R&D-intensive industries. As we observed in the aggregate data, the largest effects on productivity growth occurred in the 2000s. The annual growth rate from 2000 to 2007 is 0.6 log points higher in the R&D-intensive industries after the adjustments (Table IV).

4.4 IT-producing industries

In Figure 6a, we plot the formulary adjustments as a share of value added for those industries that produce IT and those industries that do not. While quantitatively smaller,

FIGURE 5 – Industries by R&D intensity



the adjustment for IT-producing industries is similar to that in R&D-intensive industries. The adjustments are hump shaped in the 1980s and grow strongly during the 2000s. The IT-producing industries are almost all R&D-intensive industries, so this is not surprising. Adjusting for offshore profit shifting adds 3.6 log points to cumulative labor productivity growth in IT-producing industries over the sample period, with all of the added growth coming after 1994 (Figure 6b, Table IV). Our adjustments add 1.6 log points to cumulative labor productivity growth in the industries that do not produce IT.

4.5 IT-using industries

When we classify industries by their use of IT, we find that the formulary adjustments in industries that use IT intensively are smaller than, but quantitatively similar to, those in the industries that do not use IT intensively (Figure 6c, Table IV). Offshore profit shifting is often achieved through the location of intangible assets; if industries that use IT intensively — which include wholesale and retail trade — also have fewer intangible assets, we would expect to see a smaller adjustment in these industries.

In Figure 6d, we plot the cumulative labor productivity growth in the industries grouped by IT usage. Since 1994, adjusting productivity for offshore profit shifting adds about 1.7 log points to productivity in the industries that use IT intensively and 1.8 log points to industries that do not use IT intensively.

Table IV – Cumulative labor productivity growth

	1973–2014	1973–1994	1994–2014	2002–2014
R&D intensive				
Adjusted	157.0	58.2	98.8	43.9
Unadjusted	151.6	57.1	94.5	41.3
Non-R&D intensive				
Adjusted	54.1	25.6	28.5	12.9
Unadjusted	53.0	25.5	27.6	12.2
IT producing				
Adjusted	242.1	96.1	146.0	79.6
Unadjusted	238.5	96.2	142.3	76.7
Non-IT producing				
Adjusted	51.0	24.2	26.8	11.0
Unadjusted	49.4	23.9	25.5	10.2
IT using				
Adjusted	126.6	52.7	73.9	33.6
Unadjusted	124.9	52.4	72.5	32.1
Non-IT using				
Adjusted	58.2	29.2	29.0	11.6
Unadjusted	56.4	28.9	27.5	10.8

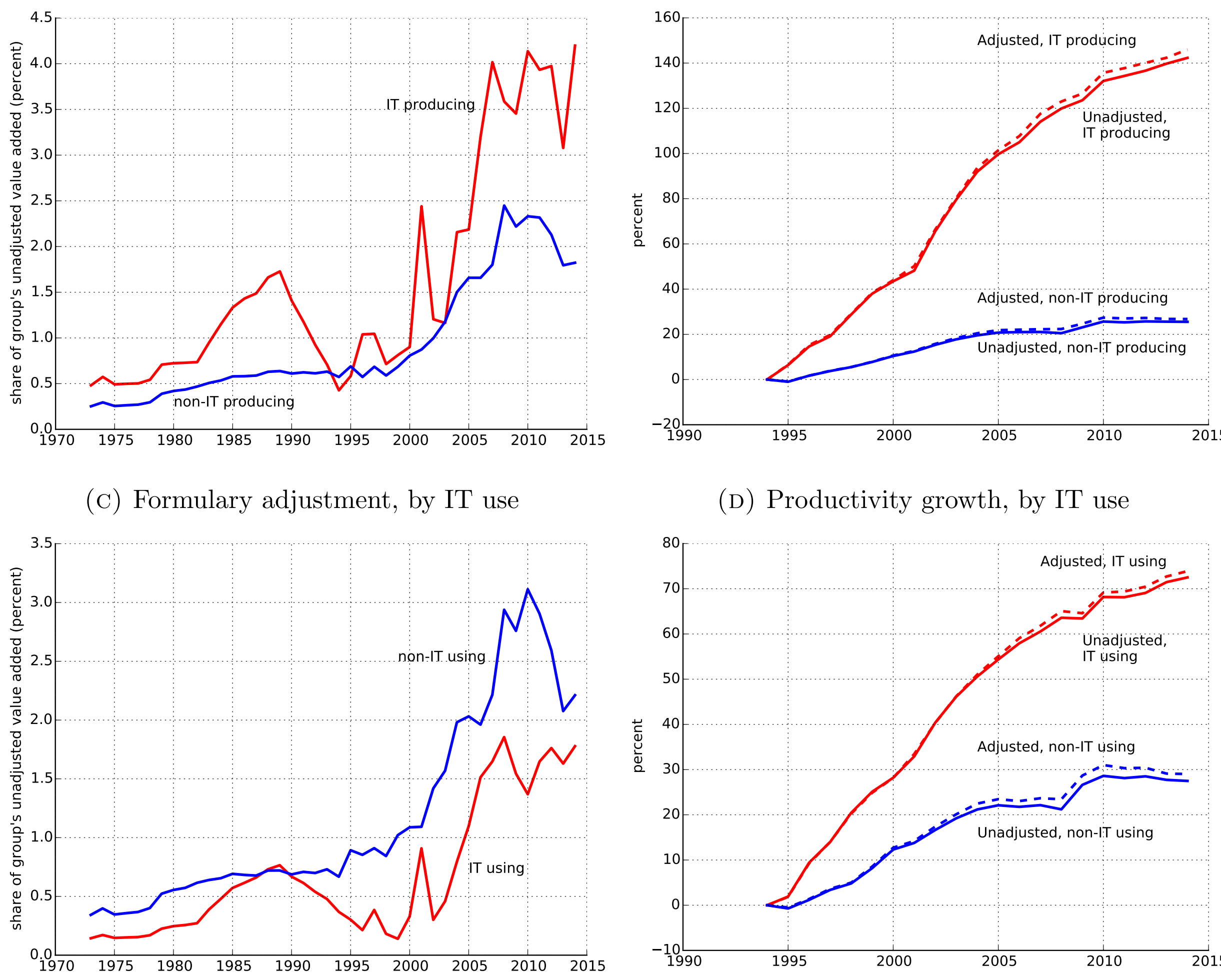
FIGURE 6 – Industries by IT producing and using intensity

(A) Formulary adjustments, IT producing

(B) Productivity growth, IT producing

(C) Formulary adjustment, by IT use

(D) Productivity growth, by IT use



5 Foreign MNEs in the United States

Although the primary focus of this paper is the apportionment of the worldwide profits of U.S.-owned MNEs, profit shifting by the U.S. affiliates of foreign-owned MNEs can also affect measures of U.S. production and labor productivity.

The fact that the United States continues to earn net positive investment income vis-à-vis the rest of the world, even though its international investment position has been negative since 1989 has been interpreted as evidence of profit shifting by foreign-owned U.S. businesses. Likewise, the rate of return on foreign-owned U.S. businesses is lower than that of other U.S. businesses and is lower still than U.S.-owned businesses abroad. In 2012, for example, foreign-owned U.S. businesses earned an average return on sales of 3.1 percent, compared with 6.5 percent for domestic-owned U.S. businesses and 17.9 percent for U.S.-owned businesses abroad. Most of the literature on the relatively low rate of return of foreign-owned businesses acknowledges that part of this rate-of-return gap reflects economic factors, such as a maturation effect reflecting the time required for foreign investors to realize efficiencies in their operations as they engage in learning-by-doing (Grubert, Goodspeed, and Swenson, 1993, and Grubert, 1998), and a market-power effect reflecting the fact that foreign investors do not tend to acquire market leaders in the U.S. industries in which they invest (Mataloni, 2000). Nevertheless, these studies also recognize that a significant portion of the rate-of-return gap cannot be explained by economic factors.

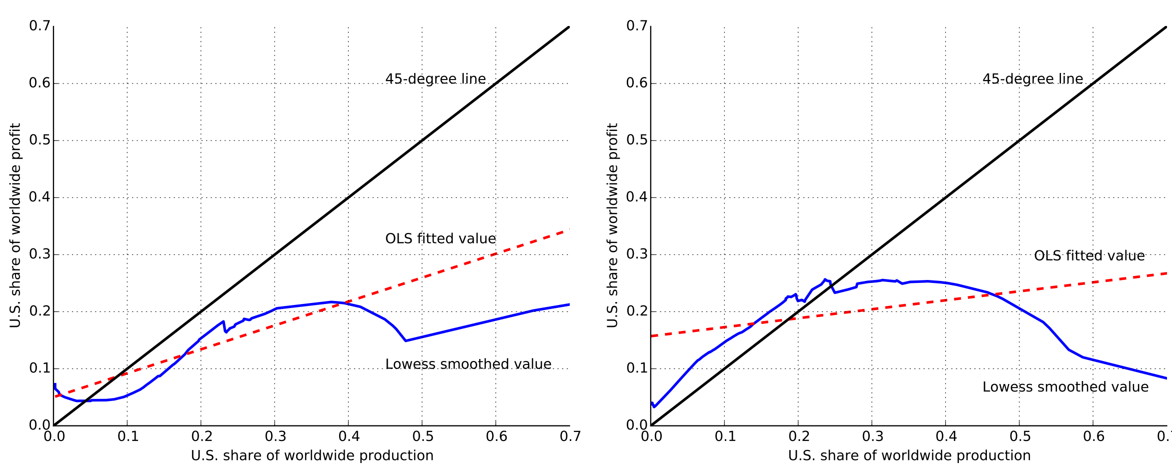
Another possible explanation for the rate-of-return gap is that some foreign direct investors use accounting devices to artificially reduce the profitability of their U.S. affiliates. Some foreign-owned MNEs have an incentive to reduce the reported profits of their U.S. operations because the statutory U.S. federal corporate tax rate (35 percent) is significantly higher than the domestic tax rates in major investing countries, such as the United Kingdom (20 percent), the Netherlands (20–25 percent), and Ireland (12.5 percent). Moreover, most other countries employ a territorial tax regime in which a resident corporation's tax liability is limited to income earned within the country's borders, whereas the United States employs a global tax regime in which the global profits of U.S. resident corporations are taxed at the statutory U.S. rate. Each year, the U.S. Internal Revenue Service prosecutes foreign-owned U.S. companies, under Section 482 of the U.S. Treasury Regulations, for overcharging their U.S. affiliates for goods and services provided by the foreign parent group. Testimony before the U.S. Congress has documented some of the types of charges used for profit shifting, including overpricing of goods, interest charges, and head office charges, such as marketing and accounting (House Committee on Ways and Means, 1990).

Studies that have tried to quantify the significance of profit shifting have focused on measuring the share of the rate-of-return gap that can be explained by quantifiable economic factors, so the remainder might be considered an upper bound on the effects of profit shifting. Grubert, Goodspeed, and Swenson (1993) control for the effects of maturation, exchange rates, and asset valuation, and find them to account for about half of the rate-of-return gap in a cross section of firms covering 1987. Grubert (1998) controls for these effects and more, and finds that economic factors account for more than half of the gap, perhaps as much as 75 percent. Nevertheless, even 25 percent of the rate-of-return gap can represent tens of billions of dollars in profits that could be escaping official measures of value added in the United States.

We hope to eventually apply the methods used in this paper for U.S.-owned MNEs to U.S. affiliates of foreign-owned MNEs, but have not yet been able to do so because of data challenges. Whereas the BEA direct investment surveys cover the worldwide operations of U.S.-owned MNEs, for U.S. affiliates of foreign-owned MNEs, BEA does not have legal authority to collect data on their worldwide operations. Collecting the data would require combining BEA data on their U.S. operations with data on their worldwide operations from a commercial data set such as Bureau van Dijk's Orbis data set. A particularly challenging aspect of this work is creating a match between companies in the two data sets. A common numeric identifier does not exist in the two data sets, so the linking must be done by name matching, which, because of inconsistencies and ambiguities in company names, is time consuming.

FIGURE 7 – Foreign-owned MNEs

(A) 2007 (B) 2012



Nevertheless, to give a sense of the potential significance of profit shifting by foreign-owned U.S. businesses, we develop a link between the BEA and Orbis data sets for 98 large technology-intensive foreign-owned U.S. businesses and collected the data needed to conduct an apportionment exercise. In 2012, these 98 businesses accounted for 58 percent of the R&D performed by, and 11 percent of the employment of, all foreign-owned U.S. businesses. As reported in Figure 7b, the U.S. share of the worldwide profits of those businesses tended to be less than proportional to the U.S. share of their worldwide production, as measured by employee compensation and net property, plant, and equipment. That is, if U.S. profits were proportional to U.S. production, the two measures would fall on the 45-degree line. For the most part, however, the U.S. share of profits is significantly below the 45-degree line. The locally weighted scatterplot (Lowess smoothed values) suggests that, for foreign-owned businesses with less than 20 percent of their worldwide production in the United States, their U.S. profits are roughly proportional to their U.S. production. However, the U.S. profits of foreign-owned businesses with 40 percent or more of their worldwide production in the United States are significantly understated relative to their production in the United States. Of the 98 businesses, 16 have a U.S. share of worldwide production greater than 30 percent. Altogether, if the profits of these 98 foreign-owned businesses were reattributed using employee compensation and net property, plant, and equipment as equally weighted apportionment factors, their U.S. profits would have been $20.7 billion higher.

We repeat this exercise for 68 large technology-intensive foreign-owned U.S. businesses in 2007 and find similar results. In 2007, the 68 businesses accounted for 52 percent of the R&D performed by, and 10 percent of the employment of, all foreign-owned U.S. businesses. The patterns in the graph for 2007 (Figure 7a) are similar to those in the graph for 2012, suggesting that foreign-owned businesses with a large share of their global production in the United States are particularly prone to understate their U.S. profits. Of the 68 businesses, 12 have a U.S. share of worldwide production greater than 30 percent. Altogether, if the profits of these 68 foreign-owned businesses were reattributed using employee compensation and net property, plant, and equipment as equally weighted apportionment factors, their U.S. profits would have been $13.3 billion higher.

These patterns suggest that profits of foreign-owned MNEs are being shifted out of the United States. If this is true, our findings from the U.S. MNE data (Section 3) are the lower bounds of the mismeasurement of U.S. GDP caused by offshore profit shifting. We leave for future work the quantification of foreign-owned MNE profit shifting and the extent to which this profit shifting has changed over time.

6 Concluding remarks

Using firm-level data on U.S. MNEs, we find increasing profit shifting activity by U.S. MNEs, leading to an understatement of measured gross domestic product. Our adjustments mitigate the productivity slowdown found in official statistics. The adjustments raise aggregate productivity growth rates by 0.1 percent annually from 1994 to 2004, by 0.25 percent annually from 2004 to 2008, and leave productivity unchanged after 2008.[15] While the worsening of the mismeasurement seems to have subsided after 2008, the problem itself still persists: From 2008 to 2014, domestic business-sector value added in the United States, on average, is understated by slightly more than 2 percent — or about $280 billion — per year. The worst mismeasurement is found in industries that are R&D intensive or that produce information technology; the very industries that have been singled out for being the most responsible for the aggregate productivity slowdown.

The upward adjustments to U.S. value added imply downward adjustments to value added in some other countries. For small countries with very low tax rates, such as Bermuda and U.K.I, Caribbean, the adjustment is 5 to 6 times their annual GDP. Even for some relatively large economies, such as Ireland and the Netherlands, the adjustments are as large as 10–14 percent of their annual GDP.

We also examine the other component of mismeasurement — profit shifting by the U.S. subsidiaries of foreign MNEs. The data used to analyze these companies is not as complete as the BEA survey data that we use for U.S. MNEs, so we are not able to provide a definitive assessment. That said, our preliminary findings — especially Figure 7 — suggest a similar pattern. Further work on this topic is warranted.

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A Appendix

A.1 Data and variable construction details

Data sources and productivity series

We construct annual and cumulative series of labor productivity growth for 1973–2014. We use annual domestic business sector data published by the U.S. Bureau of Economic Analysis (BEA) and by the U.S. Bureau of Labor Statistics (BLS) to construct unadjusted series. The BEA data include aggregate value added in the national income and product accounts (NIPA) and value added by industry in the Annual Industry Accounts (AIA) for the entire period 1973–2014. The BLS data include, from the Labor Productivity and Costs (LPC) database, aggregate number of hours worked for 1973–2014 and number of hours worked by industry for 1987–2014. We also use annual data for transactions in income on direct investment published by BEA in the International Transactions Accounts (ITA), which are available for 1982–2014. In addition, we use annual survey-level data collected by BEA on MNEs for 1982–2014 to construct an adjustment series based on the formulary framework outlined in Section 2.3. We construct aggregate adjusted and unadjusted productivity growth series that are consistent with Fernald (2015), and we also construct adjusted and unadjusted productivity growth series grouped by R&D-intensive industries and IT-intensive industries in order to more clearly observe the effects of our adjustments for transactions in direct investment income attributable to intangible capital.

The NIPA data and the AIA data are current as of the annual revision of the NIPA released on July 30, 2015. The LPC data we use were released on June 4, 2015. The ITA data are current as of the annual revision of the ITA released on June 18, 2015. The MNE survey data we use include surveys conducted for 1982, 1989, and 1994–2014.

The NIPA data and the AIA data that we use include real and nominal measures. We use real measures to construct growth rates for the unadjusted series, and we use nominal measures deflated to real measures to construct growth rates for the adjusted series. Real measures from both the NIPA and the AIA are based on a chained Fisher formula with a base year of 2009. We deflate nominal measures using either an actual or implicit deflator in cases of business-sector aggregates or industry groups for which actual or implicit deflators are available. In cases of industry groups for which actual or implicit deflators are not published, we calculate growth rates using a Törnqvist formula.

While the productivity series span 1973–2014, the survey-level data are only available for 1982–2014. Furthermore, some requisite survey-level data on U.S. parents were not collected for 1983–1988 and 1990–1993. However, aggregate statistics on transactions in income (i.e., direct investment income and portfolio income) are available for all years. Thus, we extrapolate backward the nominal adjustment prior to 1982 using the aggregate statistics as an indicator. In addition, we linearly interpolate the nominal adjustment for 1983–1988 and 1990–1993.

Aggregate unadjusted series with business sector data

Aggregate business-sector value added published in the NIPA includes nominal value added published in NIPA table 1.3.5 and real value added published in NIPA table 1.3.6, which yield an implicit deflator for business-sector value added. We derive an implied aggregate nominal income-based measure of business-sector value added by subtracting nominal expenditure-based value added for the non-business sector published in NIPA table 1.3.5 from aggregate nominal income-based GDP published in NIPA table 1.10. We deflate the implied aggregate nominal income-based measure using the implicit deflator for business-sector value added. Thus, aggregate business-sector value added includes a real expenditure-based measure and a real income-based measure from which we generate separate growth rates and then average across the expenditure- and income-based measures. We then subtract the growth in the number of hours worked from the growth in value added to construct annual and cumulative unadjusted series of aggregate labor productivity growth.

Aggregate adjusted series with business sector data

We apply survey-level data collected by BEA on MNEs to (11). The survey-level data include financial and operating activities based on income statement information and balance sheet information reported for U.S. parents and their foreign affiliates on U.S. direct investment abroad (USDIA). Depending on the year, the data are reported on either the Annual Survey of U.S. Direct Investment Abroad (form BE-11) or the Benchmark Survey of U.S. Direct Investment Abroad (form BE-10).

The survey-level data provide a source for apportionment factors on U.S. parents and foreign affiliates. The apportionment factors include compensation and unaffiliated sales. In addition, the survey-level data provide a source for earnings reported on U.S. parents and foreign affiliates and provide a source for the U.S. parent's reported voting interest in a foreign affiliate. We infer a parent's share of a foreign affiliate's earnings under separate accounting by multiplying earnings reported for the foreign affiliate by the U.S. parent's reported voting interest.

We generate an adjustment for aggregate nominal expenditure-based business-sector value added and for our implied aggregate nominal income-based business-sector value added by aggregating the survey-level adjustments obtained from (11). We then deflate the adjusted nominal measures using the implicit deflator for business-sector value added and construct annual and cumulative adjusted series of aggregate labor productivity growth by averaging across the adjusted expenditure- and income-based measures and then subtracting the same growth in the number of hours worked that we used in the unadjusted aggregate series.

R&D intensity and IT intensity

The survey-level data allow us to calculate R&D intensity and IT intensity at the firm level (i.e., U.S. parents and foreign affiliates for a given U.S. MNE). We calculate R&D intensity by dividing firm-level R&D expenditures aggregated across all available years by firm-level unaffiliated sales aggregated across all available years. We consider R&D-intensive firms and industries to be those with R&D intensity at or above the 75th percentile. We calculate IT intensity separately based on IT usage and IT production. IT-using firms are determined by the proportion of unaffiliated sales generated by entities within a firm that are classified to industries characterized as IT using in Bloom, Sadun, and Van Reenen (2012). IT-producing firms are determined by the proportion of unaffiliated sales generated by entities within a firm that are classified to industries characterized as IT producing in Fernald (2015). In each case, IT-using firms and IT-producing firms include firms with an unaffiliated sales proportion greater than 50 percent. Using the survey-level data, we apply adjustments for R&D-intensive firms and IT-intensive firms to the industry-level data to construct the adjusted labor productivity growth series for comparison with the unadjusted series.

Unadjusted series

Value added by industry published in the AIA includes nominal and real measures as well as the related chained Fisher price indexes. We generate the growth in unadjusted real value added separately for industries grouped by R&D intensity and IT intensity using the Törnqvist formula. We also generate the growth in the number of hours worked for each group of industries. We then subtract the growth in the number of hours worked from the Törnqvist growth in unadjusted real value added to construct separate annual and cumulative unadjusted series of labor productivity growth for R&D industries, non-R&D industries, IT-using industries, non-IT-using industries, IT-producing industries, and non-IT-producing industries.

Adjusted series

We adjust nominal value added for industries grouped by R&D intensity and IT intensity. We generate separate adjustments for R&D-intensive industries and IT-intensive industries by first applying the survey-level data collected by BEA on MNEs to (11) and then aggregating the survey-level adjustments for R&D-intensive firms, IT-using firms, IT-producing firms, and the respective residual firms. We then generate the growth in adjusted nominal value added for each group of industries, and we also generate the growth in prices for each group using the Törnqvist formula. We subtract the growth in prices from the growth in adjusted nominal value added to derive the growth in adjusted real value added. Finally, we subtract the same growth in number of hours worked that we used in the unadjusted series from the growth in adjusted real value added to construct separate annual and cumulative adjusted series of labor productivity growth for R&D industries, non-R&D industries, IT-using industries, non-IT-using industries, IT-producing industries, and non-IT-producing industries.

A.2 Figures and tables

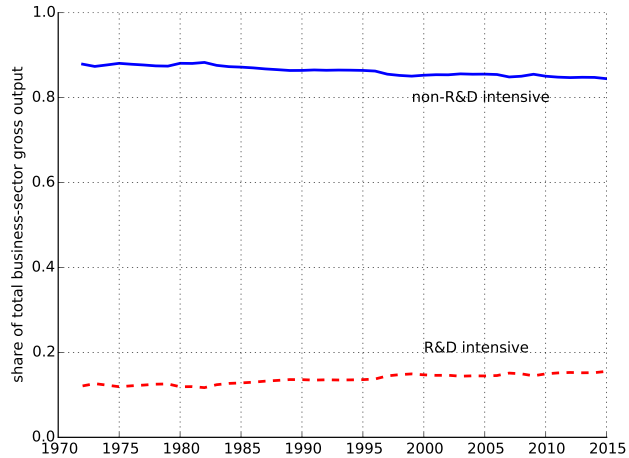
Table A.1 – Industry groupings

	NAICS Codes	Description
R&D Intensive	325	Chemical Manufacturing
	334	Computer and Electronic Product Manufacturing
	336	Transportation and Equipment Manufacturing
	511	Publishers
	5415	Computer Systems Design
	5417	Scientific R&D Services
IT Producing	334	Computer and Electronic Product Manufacturing
	51	Information
	5415	Computer Systems Design
IT Using	315	Apparel Manufacturing
	333	Machinery Manufacturing
	335	Electrical Equipment, Appliance, and Component Man.
	336	Transportation and Equipment Manufacturing
	337	Furniture and Related Product Manufacturing
	339	Miscellaneous Manufacturing
	42	Wholesale Trade
	44-45	Retail Trade
	51	Information
	532	Rental and Leasing Services
	5417	Scientific Research and Development Services

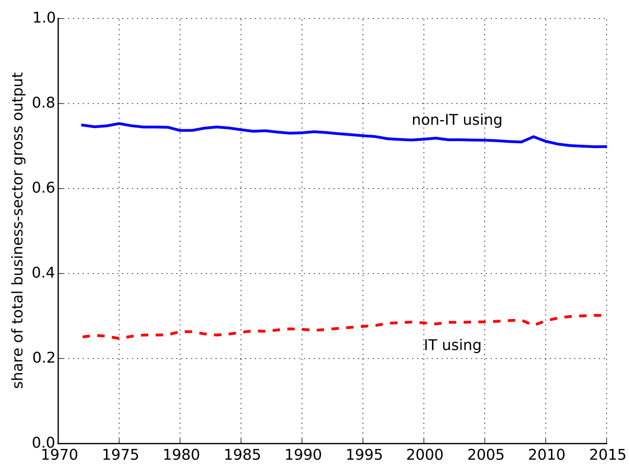
Notes: The IT-producing classification is from Fernald (2015). The IT-using classification is from Bloom, Sadun, and Van Reenen (2012). The R&D classification is from Moylan and Robbins (2007). ISIC or SIC codes have been converted to the NAICS-based ISI classification used by BEA in its surveys of MNEs.

Figure A.1 – Industry group shares of total gross output

(a) By R&D intensity



(b) By IT-using intensity



(c) By IT-producing intensity

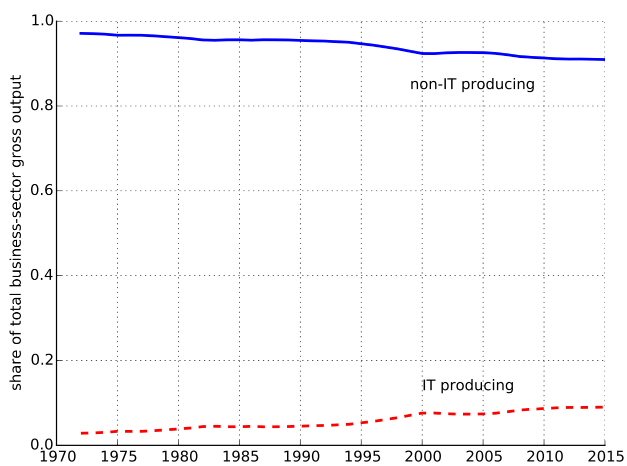
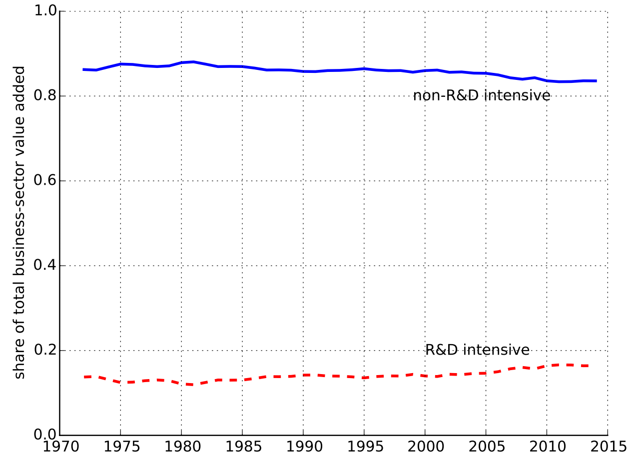
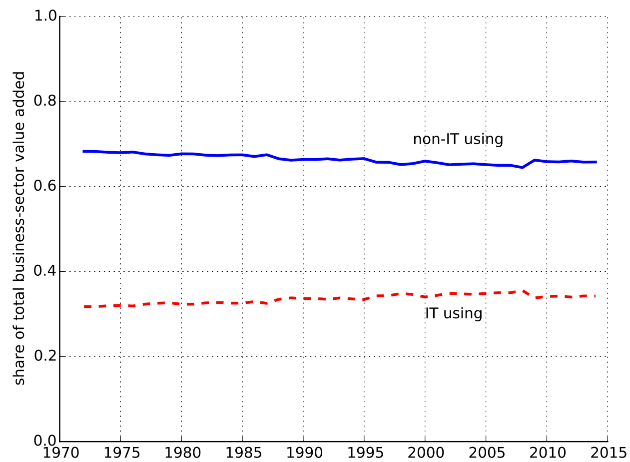


Figure A.2 – Industry group shares of total value added

(a) By R&D intensity



(b) By IT-using intensity



(c) By IT-producing intensity

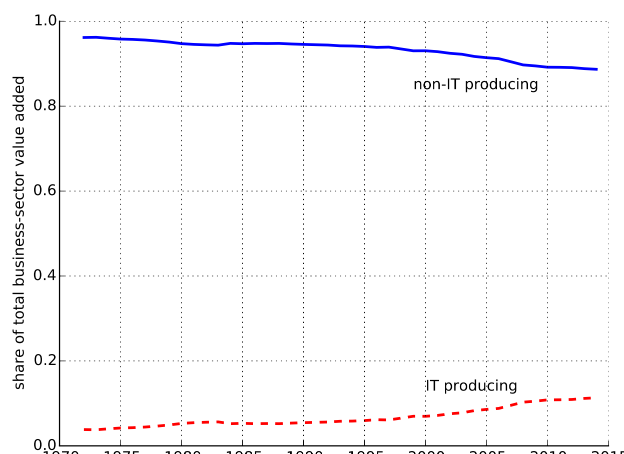
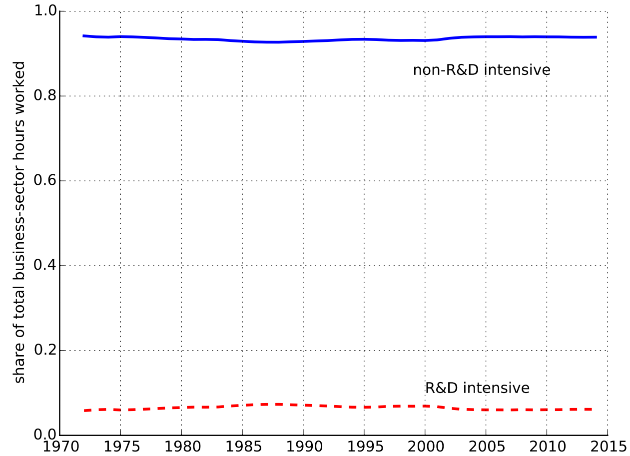
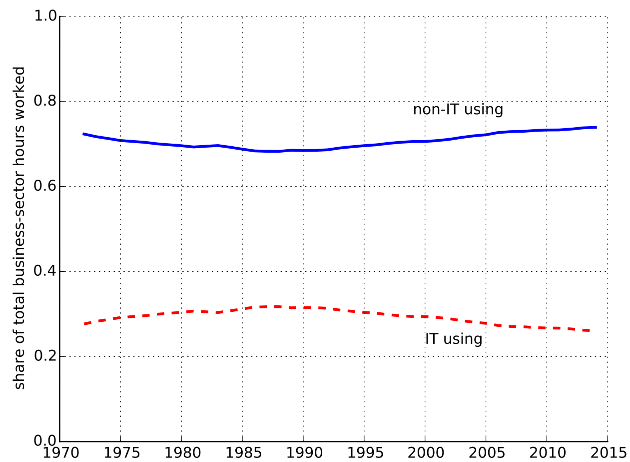


Figure A.3 – Industry group shares of total hours worked

(a) By R&D intensity



(b) By IT-using intensity



(c) By IT-producing intensity