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OFFSHORE PROFIT SHIFTING AND DOMESTIC PRODUCTIVITY MEASUREMENT

Fatih Guvenen
Raymond J. Mataloni, Jr.
Dylan G. Rassier
Kim J. Ruhl

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ABSTRACT

Official statistics display a significant slowdown in U.S. aggregate productivity growth that begins in 2004. We show how offshore profit shifting by U.S. multinational enterprises affects GDP and, thus, productivity measurement. Under international statistical guidelines, profit shifting causes part of U.S. production generated by multinationals to be excluded from official measures of U.S. production. Profit shifting has increased significantly since the mid-1990s, resulting in lower measures of U.S. aggregate productivity growth. We construct an alternative measure of value added that adjusts for profit shifting. The adjustments raise aggregate productivity growth rates by 0.09 percent annually for 1994-2004, 0.24 percent annually for 2004-2008, and lowers annual aggregate productivity growth rates by 0.09 percent after 2008. Our adjustments mitigate, but do not eliminate, the measured productivity slowdown. The adjustments are especially large in R&D-intensive industries, which most likely produce intangible assets that facilitate profit shifting. The adjustments boost value added in these industries by as much as 8 percent in the mid-2000s.

Fatih Guvenen
Department of Economics
University of Minnesota
4-101 Hanson Hall
1925 Fourth Street South
Minneapolis, MN, 55455
and NBER
guvenen@umn.edu

Raymond J. Mataloni, Jr.
Bureau of Economic Analysis
4600 Silver Hill Road
Washington, DC 20233
raymond.mataloni@bea.gov

Dylan G. Rassier
Bureau of Economic Analysis
4600 Silver Hill Road
Washington, DC 20233
dylan.rassier@bea.gov

Kim J. Ruhl
Department of Economics
Pennsylvania State University
615 Kern Building
University Park, PA 16802
and NBER
kjr42@psu.edu

1 Introduction

Economists have long understood the pivotal role of productivity growth as the engine of long-run economic growth. A wide range of economic 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 (as measured in official statistics) that started around 2004 generated widespread concern about the growth prospects of the U.S. economy. Perhaps more surprisingly, this slowdown took place 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 slowdown might be the result—at least partially—of the way output is measured in official economic statistics.[1] Several recent papers have focused on official price indexes as a source of the productivity slowdown measured in official statistics. While the jury is still out, these studies generally find price-related measurement to have modest effects on productivity growth.[2]

In this paper, we study another potential source of the productivity slowdown, one often acknowledged but not investigated thoroughly in the existing literature: the offshore profit shifting by domestic and foreign multinational enterprises (MNEs) operating in the United States. Offshore profit shifting (for brevity, "profit shifting") occurs when an MNE structures itself so that profit that would have accrued in the United States accrues instead in its foreign affiliate. These shifted profits are recorded in the primary income account as a return on U.S. assets held abroad, which does not affect U.S. GDP.[3] Using firm-level data, we show that profit shifting has reduced U.S. GDP as measured in official statistics. Further, as profit shifting has increased significantly in the last two decades, the reduction accelerated, giving the impression of a larger slowdown in the GDP growth rate and, consequently, the aggregate productivity growth rate. To explain the contribution of profit shifting to the productivity slowdown and why it has worsened over time, we begin with two important facts.

[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 the role of measurement in accounting for the dynamics of productivity. Syverson (2016) and Byrne, Fernald, and Reinsdorf (2016) argue that measurement is unlikely to explain most of the productivity slowdown.

[3]This is the appropriate accounting under the international statistical guidelines that the Bureau of Economic Analysis follows.

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 with Japan and trailing only the United States, the European Union, and China. In the same year, their domestic value added was \$3.25 trillion, accounting for 26.9 percent of U.S. business-sector value added. Furthermore, in the last 20 years, U.S. MNEs have substantially increased their global operations: earnings on U.S. direct investment abroad (USDIA) averaged 12.4 percent of corporate profits from 1973 to 1993 but grew to 28.1 percent (\$450 billion) of corporate profits in 2012.

Second, MNEs own significant stocks of intangible capital (e.g., intellectual property, brands, blueprints) and have a presence in countries that vary widely in corporate tax rates. These characteristics allow MNEs to legally 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.[4] 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.[5] These tax strategies have generated discussion among both the compilers and users of official statistics regarding the treatment of transactions within MNEs and their effect on national statistics.[6]

The effects of profit shifting on value added 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

[4]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 them in the latter.

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

[6]See, for example, Lipsey (2009; 2010), Rassier (2017), United Nations, Eurostat, and Organisation for Economic Co-operation and Development (2011), United Nations (2015), and the proceedings of a March 2018 meeting of the NBER Conference on Research in Income and Wealth (conference.nber.org/confer/2018/CRIWs18/summary.html). 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 intangible assets are developed in the United States but used in foreign subsidiaries? These intangibles are not traded in organized markets, so it is very difficult to judge whether the assigned values are correct.

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.

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 under charges for the use of intellectual property 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. Suppose that 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 will accrue in Ireland rather than in the United States, 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 "income on USDIA," which is included in U.S. gross national product,

$$GNP_t = GDP_t + \text{income on USDIA}_t - \text{income on FDIUS}_t + / - \cdots \tag{1}$$

Thus, relative to the conceptual measure, U.S. net exports and GDP are understated and earnings on USDIA are overstated.[7]

Profit shifting results in retained profits and other assets accumulating in foreign affiliates, particularly in affiliates located in low-tax jurisdictions (Foley, Hartzell, Titman,

[7]Income on FDIUS is income earned on foreign direct investment in the United States, the foreign counterpart to income on U.S. direct investment abroad.

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.

and Twitec, 2007). To illustrate the prevalence of this situation, Table I reports, by host country, the total assets (cash, receivables, plant, property, equipment [PPE], 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, whereas 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.[8]

The goal of this paper is to provide an alternative measure of U.S. domestic productivity growth by adjusting for the effects of MNE profit shifting on value added. For this purpose, we use confidential MNE survey data, collected by the Bureau of Economic Analysis (BEA)

[8]These cross-border strategies can wreak havoc on the official statistics of even relatively large economies 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 the unexpected movement of legal ownership of MNE assets to the country (Eurostat, 2016).

for the period 1982–2014.[9] 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 (ITAs), also available for 1982–2014.

Profit shifting distorts the relationship between the location of economic activity and the location of reported profit. To realign reported profit and economic activity, we use the firm-level data to 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 location 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. It should be noted, however, that formulary apportionment assumes away real factors that can create differences in the returns to productive factors in different locations. Primarily for this reason, the results of formulary apportionment presented here should be interpreted as rough estimates; it is our intention to emphasize the direction of adjustments rather than the level of the adjustments.

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. We use the results of formulary apportionment to compute an adjusted measure of domestic business-sector value added and consequent labor productivity growth for the United States, for 1973–2014.[10]

For comparability with earlier work (Fernald, 2015), we use domestic business-sector value added as our measure of output. From 1973 to 1999, our adjusted value added series is never more than 0.6 percent larger than the official series. Starting in the late 1990s, profit shifting, and the resulting adjustments, grow rapidly. By 2012, our adjusted value added series is 2.5 percent larger than its official counterpart. The adjustments raise aggregate productivity growth rates by 0.09 percent annually from 1994 to 2004, by 0.24 percent annually from 2004 to 2008, and decrease aggregate productivity growth rates by

[9]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.

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

0.09 percent annually 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 eliminate the slowdown in aggregate productivity growth after 2004.

That said, our adjustment to productivity growth is quite large in some important industries. When we group industries by R&D intensity, the adjustments to the value added of R&D-intensive industries are as large as 8 percent of the group's value added in some years (Figure 7a). Furthermore, these adjustments raise productivity growth rates significantly during some periods: the annual growth rate of productivity from 2000 to 2008 increases by 0.53 percentage points in R&D-intensive industries after the adjustments.

Finally, 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, pushing measured U.S. GDP further downward. The 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 Section 5 we construct a data set of the largest 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 admittedly incomplete analysis, we find the magnitudes of the biases for foreign MNEs to be smaller than those for U.S. MNEs.

1.1 Related Literature

Most of the evidence of MNE profit shifting comes from cross-country regressions of MNE profits (or income) on tax rates (Clausing, 2016; Dowd, Landefeld, and Moore, 2016; Hines and Rice, 1994). Dharmapala (2014) provides a comprehensive survey. These studies find a strong relationship between differential tax rates and income attribution. In contrast, we do not use tax rate data in our methodology, yet, consistent with the previous literature, we find the largest effects of profit shifting in the well-known "tax havens." In Section 3.5, we estimate the semi-elasticity of profits to tax rates in ways consistent with the literature and arrive at very similar results.

Of the literature on profit shifting, Clausing (2016) is closest to our work. Using estimates of the elasticity of MNE income to tax rates, she computes the cross-country distribution of MNE income under the counterfactual that all countries tax profits at 30 percent. The difference between the counterfactual income levels and the observed income levels is attributed to profit shifting. Her estimates using direct investment earnings data are conceptually the closest to ours. Quantitatively, our measurements are similar. For 2012, she finds profit shifting to be $258 billion, compared to our measured $280 billion. Clausing (2016) uses her estimates to compute forgone tax revenues, while our focus is on measurement in the real economy.

Our focus is on the reduction in measured domestic productivity. In related work, Maffini and Mokkas (2011) study the increase in measured affiliate productivity that is the result of profit shifting. Using a panel of European manufacturing firms, the authors regress affiliate total factor productivity on changes in statutory tax rates and find that affiliates in lower-taxed countries are more productive. Their results are consistent with our measurement of domestic aggregate productivity.

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.[11] 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.[12] Formulary apportionment applied to economic accounting faces fewer challenges compared to its use in international taxation because it is descriptive rather than fiscal.

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 the effects created by excess profits attributed to tax haven countries, as presented in 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.

In Section 2, we present a simple model of an MNE to highlight the source of the measured slowdown and discuss our empirical methodology. In Section 3 we report the

[11]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).

[12]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).

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 measurement of the foreign MNEs operating in the United States, Section 6 considers other measures that might be affected by profit shifting, and Section 7 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).[13] We assume that physical capital and labor can be freely adjusted and are obtained from perfectly competitive factor markets. Intangible capital is nonrivalrous but subject to ownership.

The final-good production function for the parent is

$$y_m = f(z_m, k_m, \ell_{sm}, \ell_{um}, h), \tag{2}$$

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

$$y_a = f(z_a, k_a, \ell_{sa}, \ell_{ua}, h). \tag{3}$$

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.

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

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

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 provenance of the intangible capital, 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

$$\pi_a = py_a - w_s\ell_{sa} - w_u\ell_{ua} - r^k k_a - r^h(1-\lambda)h - r^h\lambda h + r^h(1-\lambda)h = r^h(1-\lambda)h, \quad (4)$$

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 depreciation 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 (4) follows from the assumption that inputs are paid their marginal products and that the production function has constant returns to scale.

Parent earnings are

$$\pi_m = py_m - w_s\ell_{sm} - w_u\ell_{um} - r^k k_m - r^h\lambda h - r^h(1-\lambda)h + r^h\lambda h = r^h\lambda h, \quad (5)$$

where the term $-r^h\lambda h$ is the depreciation of the parent intangible assets; the term $-r^h(1-\lambda)h$ is the payment from the parent to the affiliate for the use of $(1-\lambda)h$; and the term $r^h\lambda h$ is the payment from the affiliate to the parent for the use of λh. Again, the second equality in (5) 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

$$Y^E = py_m + r^h\lambda h - r^h(1-\lambda)h, \quad (6)$$

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

$$Y^I = w_s\ell_{sm} + w_u\ell_{um} + r^k k_m + 2r^h\lambda h = py_m - r^h h + 2r^h\lambda h, \tag{7}$$

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 the BEA surveys on transactions in services as "payments by foreign affiliates to U.S. reporters [parents] for the use of intellectual property." In the aggregate accounting, these payments reduce earnings on U.S. direct investment abroad. In our framework, earnings on USDIA is simply

$$Y^{\text{USDIA}} = \pi_a = r^h(1-\lambda)h. \tag{8}$$

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

$$A = \frac{Y^E}{\ell_m} = \frac{py_m + 2r^h\lambda h - rh}{\ell_m}, \tag{9}$$

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 (9) would be smaller. This reduction 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 the measured slowdown. In this section, we present 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

$$\omega_n = \frac{1}{2} \times \frac{w_s \ell_{sn} + w_u \ell_{un}}{w_s \ell_{sm} + w_u \ell_{um} + w_s \ell_{sa} + w_u \ell_{ua}} + \frac{1}{2} \times \frac{py_n}{py_m + py_a} \qquad n \in \{a, m\}. \tag{10}$$

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

$$\pi_n^\omega = \omega_n(\pi_a + \pi_m) \qquad n \in \{a, m\}, \tag{11}$$

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

$$\epsilon_n = \pi_n^\omega - \pi_n. \tag{12}$$

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,

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

The adjusted GDP in (13) is the numerator in *adjusted aggregate labor productivity*,

$$\widetilde{A} = \frac{\widetilde{Y}^E}{\ell_m} = \frac{py_m + r^h \lambda h - r^h(1-\lambda)h + \epsilon_m}{\ell_m}. \tag{14}$$

While standard in the multijurisdictional tax literature, the formulary adjustment will not generally provide an exact measure of the counterfactual 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 (NIPAs) 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 nonprofit 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 data 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 (9).

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 (12). 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.[14]

Apportionment factors

We use compensation of employees and sales to unaffiliated parties as apportionment factors to construct the apportionment weights in (10) 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.[15] For example, unaffiliated sales may reflect intangible capital actually employed by a foreign affiliate. In addition, sales is a measure of local output that results from production, whereas compensation is a measure of local inputs employed in production.

[14]Transactions in income on USDIA include earnings and net interest receivable. Earnings include a U.S. parent's share of its foreign affiliate's net income less capital gains, less income from equity investments, and plus 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.

[15]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 nonfinancial 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 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).

Economic profits

Our measure of profits reflects current production that is consistent with the after-tax 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 voting interest in the foreign affiliate. In the data appendix (Figure A.1), we report the adjustment using a measure of operating surplus. The two adjustments are very similar.

Adjusted output

We compute the entity-level adjustments according to (12) 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, $\widetilde{Y}^{\mathrm{VA}}$, is

$$\widetilde{Y}^{\mathrm{VA}} = Y^{\mathrm{VA}} + \sum_{m \in M} \epsilon_m. \tag{15}$$

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. In the data appendix (Figure A.2), we show that our results are robust to other price indexes. We divide our adjusted real value added measure by total hours worked to yield the adjusted labor productivity defined in (14).

3.2 Results

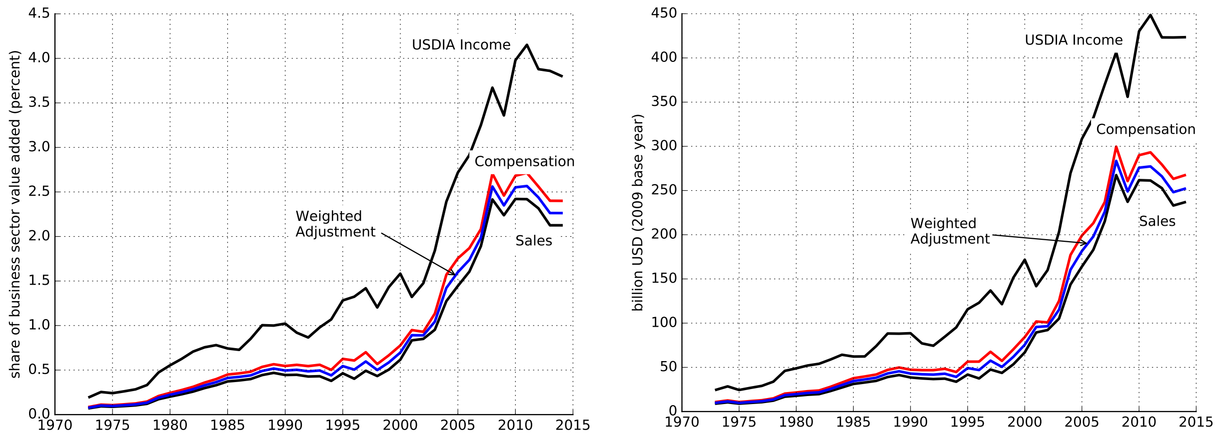
Figure 1 presents the aggregate formulary adjustments as a share of business-sector value added—the sum of the ϵ_m from (15). Our baseline formulary adjustment, when the apportionment weights in (10) are based on sales and employee compensation, is labeled "weighted adjustment." We also plot the formulary 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 adjustment. We plot total income on USDIA for reference.

From 1973 to 2000, the adjustments grow, but very slowly, and never exceed 0.6 percent

Figure 1 – Aggregate formulary adjustments

(a) As share of business-sector value added

(b) Inflation-adjusted level



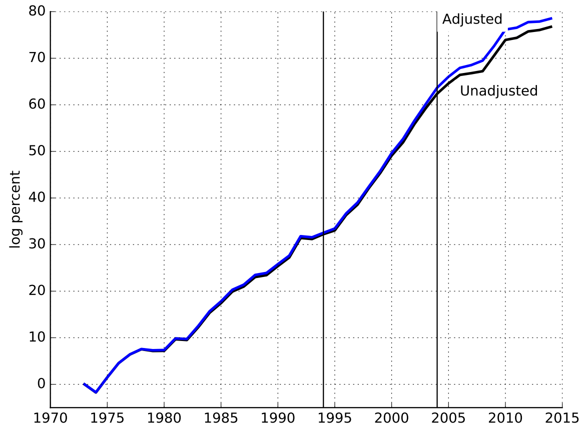
of value added in any year. This picture changes quickly in the early 2000s as income on USDIA surges, and the weighted formulary adjustments grow to about 2.5 percent of value added. The cumulative increase in U.S. GDP from the adjustment is substantial. From 2004 to 2014, the weighted formulary adjustment adds \$2.98 trillion to GDP, the compensation-based adjustment adds \$3.16 trillion, and the sales-based adjustment adds \$2.79 trillion.

Next we turn to labor productivity. Figure 2a shows the cumulative growth in labor productivity for the entire period (1973–2014), normalizing 1973 to zero. Unless otherwise noted, in this paper we compute growth rates using (natural) log changes. That is, the growth in variable X between years t and $t+k$ is computed as $s = \log(X_{t+1}) - \log(X_t)$, and we refer to $100 \times s$ as "s log percent" for ease of interpretation (and drop the log designation—s percent—when it does not cause confusion). So, for example, the cumulative growth rate in unadjusted labor productivity (solid black line) from 1973 to 2014 is 79 (log) percent, which translates to a 120 percentage points increase.

Overall, the unadjusted labor productivity series we plot here is consistent with Fernald (2015), except for 2012–2014, where we have incorporated revised NIPA data. The unadjusted labor productivity growth rate over the entire period averages 1.9 percent per year. This period is often broken into three subperiods that displayed distinct growth patterns: 1973–1994, 1994–2004, and 2004–2014. The unadjusted labor productivity growth rate averaged 1.5 percent per year from 1973 to 1994, 3.0 percent per year from 1994 to 2004, and reverted back to a lower growth rate of 1.4 percent per year in the last period (2004–2014). We report cumulative and average annual productivity growth rates in Table II.

Figure 2 – Aggregate cumulative labor productivity growth

(a) 1973–2014



(b) 1994–2014

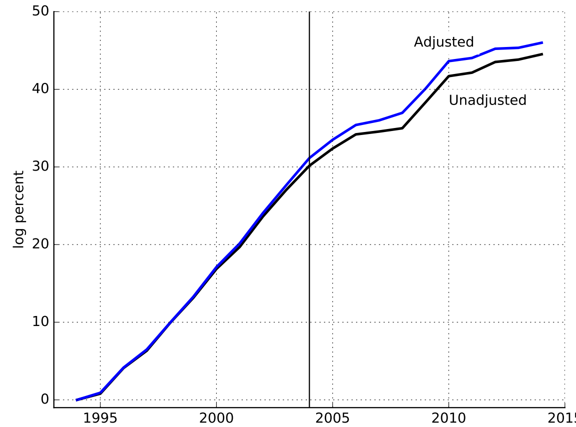
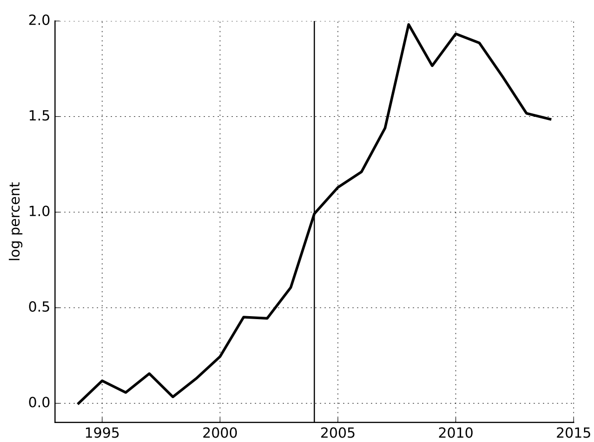


Figure 3 – Increase in aggregate cumulative labor productivity due to formulary adjustment

(a) 1994–2014



(b) 2004–2014

In Figure 2a, we plot the cumulative growth of labor productivity unadjusted and adjusted by the weighted formulary adjustment shown in Figure 1, and in Figure 3, we plot the difference between the two series. By the end of the period, labor productivity is higher in the adjusted series. Adjusted cumulative labor productivity growth for 1973–2014 is 1.8 log percent 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

Table II – Labor productivity growth rates (log percent)

	Cumulative growth rate		Average annual growth rate	
	Unadjusted	Adjusted	Unadjusted	Adjusted
1973–2014	76.7	78.5	1.87	1.92
1973–1994	32.2	32.5	1.53	1.55
1994–2014	44.5	46.0	2.23	2.30
1994–2004	30.2	31.1	3.02	3.11
2004–2014	14.4	14.8	1.44	1.48

growth slowdown (2004–2014). From 1994 to 2014, the formulary adjustment adds 1.5 log percent to cumulative labor productivity growth. The adjustment increases the productivity 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. For example, from 2006 to 2008 adjusted productivity grew by 1.6 percent, while unadjusted productivity grew only by 0.8 percent.

3.3 The Dynamics of Aggregate Profit Shifting

In this section, we examine the factors that shaped the evolution of the aggregate adjustment, and in particular its rapid growth from the mid-1990s to late 2000s and its tapering off thereafter.

I. Tax laws and regulations

The rapid rise in profit shifting in the 1990s spurred enormous research interest in academics (e.g., tax scholars in accounting, economics, and law) as well as in government agencies (e.g., the Department of the Treasury and Congress). The voluminous body of research resulting from this effort strongly points to three major changes in tax regulations as important drivers of the rise in profit shifting in the 1990s as well as its tapering off in the last decade. Here, we briefly summarize the most relevant parts of these tax regulations and provide a more extensive discussion of each in Appendix C.

The rise in profit shifting seems to have been driven by two major changes in tax regulation in the 1990s. The first one is the 1995 revision of IRS regulations on cost sharing agreements (CSAs). In a CSA, one geographic unit of an MNE—typically a foreign affiliate in a tax haven country—shares the cost of developing a new technology with its U.S. parent and, in return, is granted rights to royalties on a portion of the sales of products or services using that technology. The 1995 change made it much easier for MNEs to use CSAs to transfer their intellectual property at advantageous prices to their foreign affiliates, which then collect the royalties and profits accruing to those intellectual properties.

A second important change happened in 1997 when the IRS introduced what would become known as the "check-the-box" regulation, which aimed to simplify how U.S. corporations classified their various subsidiaries. Check-the-box allowed a U.S. MNE to *disregard* a foreign affiliate by "checking the box" on Form 8832. When a disregarded entity receives a payment from another entity in the enterprise, this transaction is not considered taxable by the IRS, as the payment is viewed as occurring within a consolidated entity. This change made it easier for U.S. MNEs to set up chains of foreign affiliates whose payments to each other were not taxed by the IRS. This arrangement made profit shifting an even more effective tax reduction strategy because now a U.S. MNE could also shift its profits from its foreign subsidiaries in higher-tax jurisdictions to the one(s) in tax havens, without making those transfers a taxable event from the perspective of the IRS.

The pivotal role played by CSAs and check-the-box regulation for driving profit shifting was well understood by tax authorities, tax scholars, and MNEs.[16] Starting in the mid-2000s, the IRS increased its efforts to reduce the tax base erosion caused by profit shifting and tightened the rules governing CSAs, issuing Temporary Regulations in 2008 and Final Regulations in 2011. In testimony to the U.S. Senate in 2013, Harvard law professor Stephen Shay described the pre-2011 regulations as "much more relaxed" than the post-2011 regulations (Senate Committee on Homeland Security and Government Affairs, 2013). This comment suggests that the combined IRS guidance on "buy-in payments" and "platform contributions" gradually made it much more difficult for MNEs to use CSAs to transfer intangible assets. The timing of these tighter new rules (as well as stricter enforcement) lines up very well with the tapering off and subsequent decline in profit shifting—and hence in our adjustments—shown in Figures 1 to 3.[17]

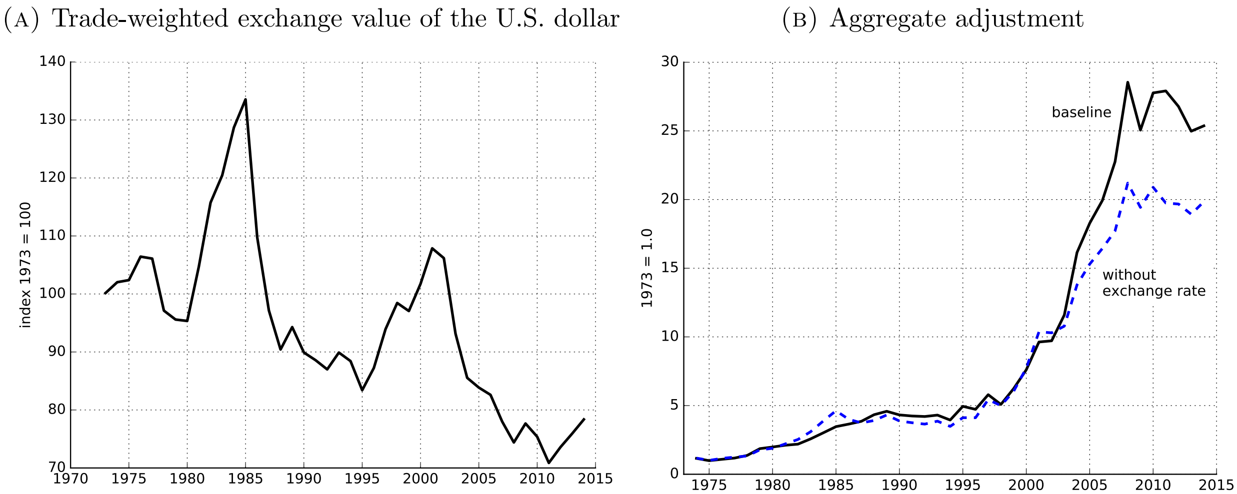
II. Exchange rates

The data reported by MNEs to BEA are denominated in U.S. dollars. If foreign affiliates keep their books in a currency other than the dollar, the data are converted at the nominal exchange rate. In Figure 4a, we plot the trade-weighted exchange value of the U.S. dollar.

[16] For example, in a 2007 report to the U.S. Congress, the Treasury Department wrote that "[t]he Treasury Department believes that CSAs under the current regulations pose significant risk of income shifting from non-arm's length transfer pricing (U.S. Department of the Treasury 2007)." For detailed summaries of how these regulations have affected profit shifting, see Sullivan and Cromwell, LLP (2011) and Senate Committee on Homeland Security and Government Affairs (2013).

[17] Sullivan and Cromwell, LLP (2011) discuss various pieces of evidence on how profit shifting and transfer pricing became a key focus for the IRS, especially after the mid-2000s. They also mention the creation of a new director-level position as evidence of a "heightened focus on transfer pricing issues" within the IRS.

FIGURE 4 – Exchange rate effects



In Figure 4b, we plot the cumulative growth of our baseline aggregate adjustment (solid black line) along with an alternative version where the nominal exchange rate is held fixed at its base value in 1973 (dashed blue line).[18]

Comparing the two series, we see that the appreciation in the U.S. dollar in the early 1980s and late 1990s depressed the baseline adjustment—the dashed line is slightly above the solid line. The strong depreciation during 1985–1995 and during the 2000s boosted the baseline adjustment relative to what it would have been without exchange rate effects.[19] Aggregating over the entire period, exchange rate movements contributed about 24 percent of the cumulative aggregate adjustment (the ratio in Figure 4b of the 25-fold increase under the baseline case to the 20-fold increase with fixed exchange rates). This suggests that the weaker dollar in the last 15 years has made U.S. MNEs' foreign earnings and sales more valuable in dollar terms, and shifting these profits abroad led to a larger slowdown in measured productivity growth.

III. Petroleum

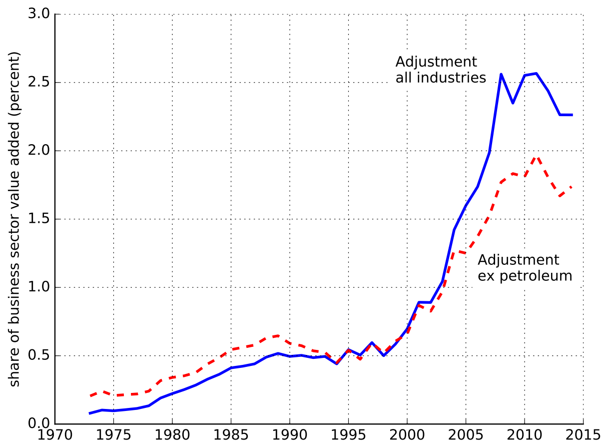
As we discuss in more detail in Sections 3.6 and 4, the oil and gas industry accounts for a large share of our adjustments to U.S. GDP. Given the large swings in oil prices during our sample period, we examine how they have contributed to variation in our adjustments over time.

[18]Specifically, letting X_t be the aggregate adjustment in dollars and e_t be the trade-weighted U.S. dollar exchange rate, the aggregate adjustment fixing the exchange rate is simply $X_t^F = X_t/e_t$, with $e_{1973} = 1$.

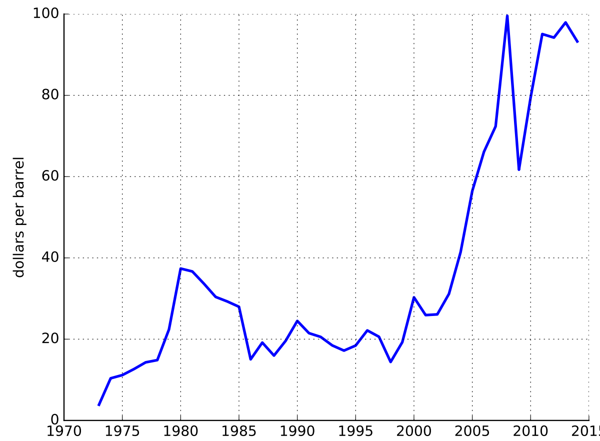
[19]A caveat to keep in mind is that we are holding the USDIA values denominated in foreign currency unchanged from the baseline as we counterfactually fix the exchange rates. Depending on what drives the exchange rate fluctuations in the first place, this assumption may not hold.

FIGURE 5 – The petroleum industry

(A) The aggregate adjustment



(B) The price of West Texas Intermediate Crude



Companies in the petroleum industry often face resource taxes and royalties (in addition to corporate income taxes) that create strong incentives to manage tax liabilities. Perhaps in response to these incentives, the structure of firms in the petroleum industry lends itself to an array of profit shifting strategies. Exploration and production affiliates may be thinly capitalized, and transportation, insurance, hedging operations, and intercompany loans create transfer pricing opportunities. A U.S. multinational petroleum company, for example, agreed in 2017 to pay 340 million AUD in extra taxes to the Australian government in regard to intercompany loans that were made at above-market rates (Smyth, 2017).

In Figure 5a, we plot the aggregate adjustment that excludes the petroleum sector (dashed red line) against the baseline adjustment (solid blue line) reproduced from Figure 1. Notice that, up until 2008, excluding the petroleum sector yields slower *growth* in the adjustment, which is especially evident during the 2004–2008 period. The adjustment after 2008 is flat or declining regardless of whether we exclude petroleum. The right panel (Figure 5b) plots the price of crude oil per barrel during the same time period, which was relatively stable around $25 from about 1985 to 1999 but had a very strong run-up from 2000 to 2008, during which time it quadrupled to $100 per barrel. This rise in oil prices, coupled with the relatively inelastic demand for oil, boosted both domestic and foreign income earned by MNEs in this sector relative to the rest of the U.S. economy. If we assume that the propensity of U.S. MNEs in this sector to shift profits was unchanged, the sector's contribution to the low measured growth of U.S. GDP and productivity increased along with the rise in oil prices in the last decade.

Table III – Cumulative labor productivity growth (log changes)

	Petroleum industry		Non-petroleum industries	
	Unadjusted	Adjusted	Unadjusted	Adjusted
1973–2014	329.0	342.8	66.6	68.1
1973–1994	247.2	251.8	29.4	29.7
1994–2014	81.8	91.0	37.1	38.4
1994–2004	112.1	120.3	26.4	27.2
2004–2014	–30.3	–29.3	10.7	11.2

In Table III, we report cumulative labor productivity growth for the petroleum industry and the non-petroleum industries. The non-petroleum industries behave much like the aggregate: from 1973 to 2014, the adjustment adds 1.6 percentage points to non-petroleum productivity growth compared to 1.8 percentage points for aggregate productivity (Table II). While the petroleum industry has a modest effect on aggregate productivity, the adjustment to productivity in the petroleum industry is considerable: the adjustment adds 9.2 percentage points to productivity in the petroleum industry during 1994–2014.

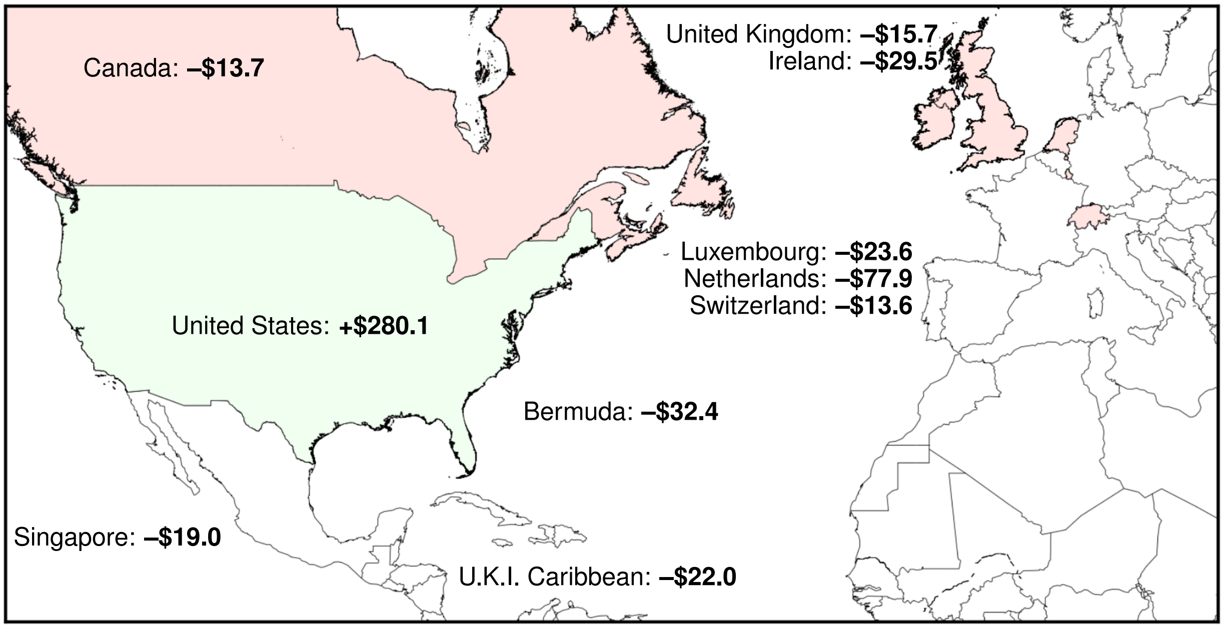
3.4 Adjustments for Other Countries

Our adjustments are reattributions of earnings among the parent and foreign affiliates of each U.S. MNE. As evident in Figure 1, in 2012, 63 percent of earnings on USDIA are reattributed to the United States.[20] 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 low-tax destinations for MNE profit shifting (Table IV and Figure 6). 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.[21]

[20]One might note that this share is identical to the share of total FDI earnings that were reinvested in 2012 ($284 b./$449 b. = 63%). We do not mean to suggest by our estimates that all reinvested earnings on U.S. direct investment abroad are associated with profit shifting. Although the equality of these two shares is notable, there are undoubtedly times when profits temporarily held abroad for tax reasons must be remitted to the parent, such as in cases of domestic liquidity needs. We are grateful to Aneta Markowska of Cornerstone Macro LLC for bringing this comparison to our attention.

[21]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 accounting statistics. Lipsey (2009) provides a sense of scale: in 1999, the

Figure 6 – 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.

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 negative adjustments for some countries do not necessarily imply that the GDP of those countries is overstated. Some of the larger countries are home to 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

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.

Table IV – Adjustments in other countries, 2012

Country	Adjustment (share of total)	Adjustment (share of 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
Canada	0.05	0.01
Switzerland	0.05	0.02
Remaining 176 countries	0.12	

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 9 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.

profit shifting affects measurement as a result of income on USDIA being shifted to affiliates in countries with relatively low tax rates.

3.5 Relationship to Tax Rates

Our formulary apportionment method does not use tax rate differences across countries; our method relies only on measures of economic activity. It is evident, however, that our measures of shifted profit are correlated with tax rate differentials. Much of the literature on profit shifting has looked for evidence of tax-motivated profit shifting by running cross-country regressions of the form

$$\log(\pi_i) = \beta_0 + \beta_1\tau_i + \beta_2\ell_i + \beta_3 k_i + u_i, \tag{16}$$

where π_i is a measure of reported affiliate profit in country i, τ_i is a measure of the effective tax rate in country i, ℓ_i is a measure of labor used by affiliates in country i, k_i is a measure of the physical capital stock used by affiliates in country i, and u_i is a classical error term. This particular specification is from the seminal work in Hines and Rice (1994), which is estimated using data on the foreign affiliates of U.S. multinationals for 1982, drawn from the same data that we use.

In column 1 of Table V, we report an estimate of (16) using the 1982 data. We find a coefficient (a semi-elasticity) of –3.96 compared to –2.83 in Hines and Rice (1994). The different values reflect differences in our measure of profits and a slightly different sample of countries. In Hines and Rice (1994), the theoretical relationship between profits and taxes is

$$\log(\pi_i) = \log(\rho_i) + c_1\tau_i + c_2, \tag{17}$$

where π_i is the reported affiliate profit, ρ_i is the profit derived from real economic activity, and c_1 and c_2 are constants. Hines and Rice (1994) model ρ_i as derived from capital and labor, which leads to the ℓ_i and k_i terms in (16). In contrast, we have directly computed ρ_i, so our theoretically consistent version of (16) is

$$\log(\pi_i) - \log(\rho_i) = \beta_0 + \beta_1\tau_i + u_i, \tag{18}$$

the estimates of which we report in the second column of Table V. We find a semi-elasticity with respect to tax rates of –4.89. We view the similarity of our tax semi-elasticity—derived using no data on tax rates—to that from specifications that explicitly model profit shifting as a function of the tax rates to be an important consistency check on our results.

Since we have computed ρ_i directly, we can further study the relationship between tax rates and profit derived from real economic activity. In column 3 in Table V, we regress ρ_i on tax rates and measures of labor and capital inputs. Once we have removed the shifted profit from the reported profit, the tax rate is no longer significant. Our methodology appears to have removed the tax-motivated profit from the reported profit.

3.6 Industry Composition

How is our adjustment distributed across industries? In the next section, we group industries according to some relevant characteristics and analyze their productivity growth. In this section, we discuss the general composition of the adjustment. In Table VI, we report the adjustments by two-digit NAICS industry of the U.S. parent in 2012.[22] We report an industry's adjustment as its share of the total adjustment and as its share of the industry's unadjusted value added. The industrial composition of the adjustment is consistent with the idea that firms use intangible assets to shift profits to low-tax jurisdictions.

Industry group 32—a subset of manufacturing—makes up 42 percent of the total adjustment. This industry is dominated by pharmaceuticals (a part of chemicals) and petroleum,

[22]The industry of the affiliate closest to the parent is often NAICS 55—holding companies—which is not very informative about the industrial composition of the sub-affiliates held by the affiliate holding company.

Table V – Shifted profits and tax rates

	(1) log(unadj. profit)	(2) $\log(\frac{\text{unadj profit}}{\text{adj. profit}})$	(3) log(adj. profit)
Tax rate	–3.96	–4.89	0.03
	(0.49)	(0.71)	(0.38)
Labor compensation	0.40		0.90
	(0.12)		(0.09)
Physical capital	0.49		0.02
	(0.11)		(0.08)
Constant	1.68	2.41	-0.61
	(0.36)	(0.27)	(0.27)
Adj. R-squared	0.94	0.46	0.97
Observations	56	56	56

Notes: Standard errors are reported in parentheses.

which we have discussed above. (To avoid disclosure of confidential data, we cannot report the exact adjustments for these industries.) The pharmaceutical industry's profits are largely derived from its intellectual property, which provides ample opportunities for profit shifting. A major U.S. pharmaceutical company, for example, has licensed the manufacturing rights to some best-selling drugs to its Irish subsidiary (Bergin and Drawbaugh, 2015). Industries 51 and 54—which include software publishing, data processing and hosting, and computer system design—make up 12 percent of the aggregate adjustment. As in the pharmaceutical industry, the "information" industry derives much of its profit from intangible assets and low marginal production costs.

Industry group 52 is responsible for 14 percent of the total adjustment. The foreign operations of the insurance industry, for example, are concentrated in Bermuda—a country whose corporate tax rate is zero (Lipsey, 2010).

The industries that are not significant contributors to the aggregate adjustment tend to be those in which it is difficult to uncouple the physical location of production from the point of sale. These industries include construction, transportation, education, health care, and other services.

Table VI – Adjustment by industry of U.S. parent

Key industries	Adjustment (percent)	
	Share of total adjustment	Share of ind. value added
32 Petroleum, chemicals, plastics, wood, paper	42.04	15.99
52 Finance, insurance	14.32	3.51
33 Computers, electrical equip., motor vehicles	11.95	3.38
51 Publishing, information, data processing	7.14	2.71
54 Legal, computer sys. design, scientific R&D	5.34	1.33
31 Food, textiles, apparel	4.91	5.37
21 Mining	4.16	2.83
44 Retail trade	2.81	0.84
42 Wholesale trade	2.33	0.68
55 Management of companies and enterprises	1.75	1.61
53 Real estate and leasing	1.00	0.48
22 Utilities	0.72	0.47
48 Transportation and warehousing	0.61	0.37

Notes: The adjustment in construction, agriculture, education, health care, arts and entertainment, and others that are not listed here are very small and hence omitted.

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 U.S. Industry Economic Accounts (IEAs) 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 B.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 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 IEAs include nominal and real measures as well as the related price indexes (base year 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 (10) and the formulary adjustments as in (12).

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

$$\widetilde{Y}^{RD} = \sum_{i \in I^{RD}} Y_i + \sum_{m \in M^{RD}} \epsilon_m, \tag{19}$$

where Y_i is nominal value added in industry i and ϵ_m is the formulary adjustment of enterprise m defined in (12). 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 R&D-Intensive Industries

In Figure 7a, 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 grow rapidly during the 1990s and early 2000s before flattening out post-2008. The formulary adjustments for R&D-intensive enterprises as a share of value added are substantially larger than those for non-R&D-intensive enterprises, with the adjustment for R&D-intensive enterprises peaking in 2008 at 8 percent of nominal value added.

The impact of our adjustments on productivity growth by R&D intensity is evident in Figure 8, 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. From 1994 to 2014, adjusting for offshore profit shifting in the R&D-intensive industries adds 4.4 log points to cumulative growth, but only a little less 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 2008 is 0.53 log points higher in the R&D-intensive industries after the adjustments (Table VII).

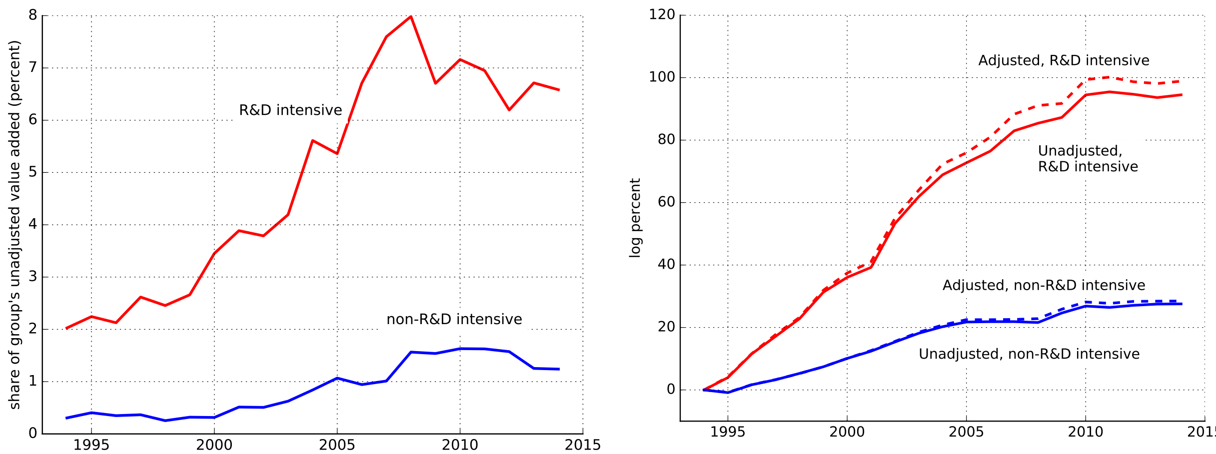
4.4 IT-Producing Industries

In Figure 9a, 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, the adjustment for IT-producing industries is similar to that in R&D-intensive industries.

Figure 7 – Formulary Adjustment and Cumulative Labor Productivity Growth, by R&D Intensity, 1994–2014

(A) Formulary Adjustment

(B) Levels: Adjusted vs. Unadjusted



The adjustments grow strongly during the 2000s. The IT-producing industries are almost all R&D-intensive industries, so this is not surprising. From 1994 to 2014, adjusting for offshore profit shifting adds 4.3 log points to cumulative labor productivity growth in IT-producing industries (Figure 9b, Table VII). Our adjustments add 1.7 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 9c, Table VII). 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 9d, we plot the cumulative labor productivity growth in the industries grouped by IT usage. Since 1994, adjusting productivity for offshore profit shifting adds about 1.4 log points to productivity in the industries that use IT intensively and 1.5 log points to industries that do not use IT intensively.

Figure 8 – Cumulative Labor Productivity Growth, by R&D Intensity, 1973–2014

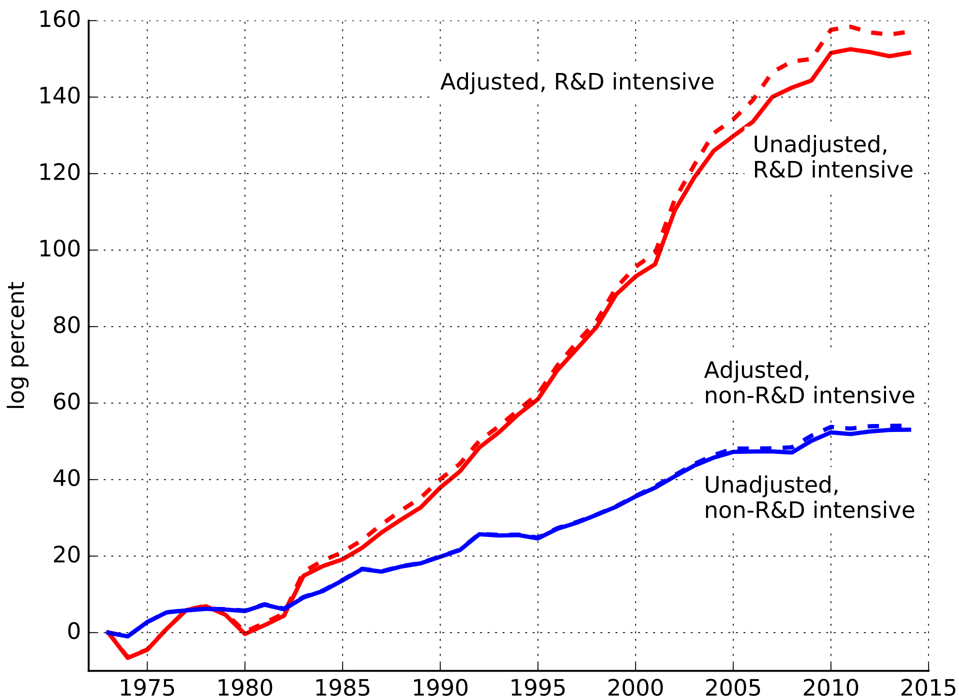
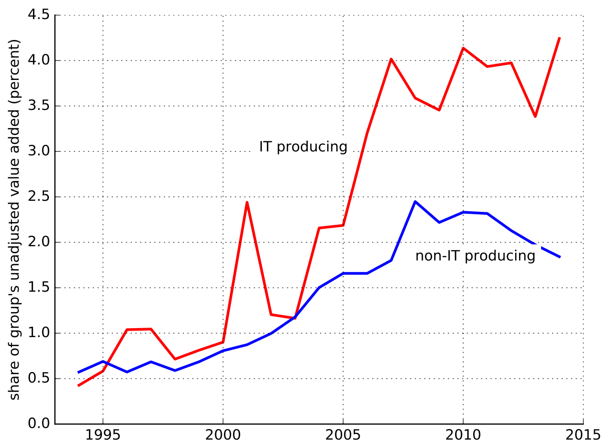


Table VII – Cumulative Labor Productivity Growth, by R&D and IT Intensity, 1994–2014

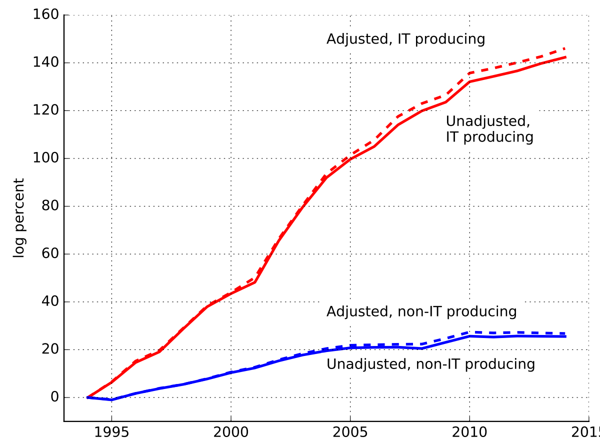
	1994–2014	1994–2004	2004–2014
R&D intensive			
Adjusted	98.9	72.3	26.5
Unadjusted	94.5	68.9	25.6
Non-R&D intensive			
Adjusted	28.5	20.8	7.7
Unadjusted	27.6	20.3	7.3
IT producing			
Adjusted	146.0	93.7	52.4
Unadjusted	142.3	92.0	50.4
Non-IT producing			
Adjusted	26.8	20.5	6.3
Unadjusted	25.5	19.6	6.0
IT using			
Adjusted	73.9	51.0	22.9
Unadjusted	72.5	50.6	21.9
Non-IT using			
Adjusted	29.0	22.5	6.6
Unadjusted	27.5	21.2	6.3

Figure 9 – Industries by IT producing and using intensity

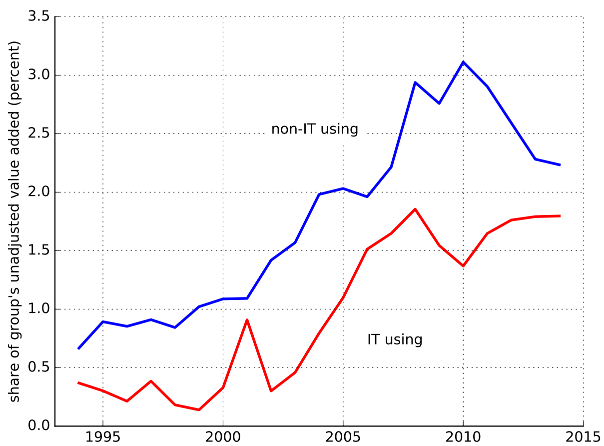
(a) Formulary adjustments, IT producing



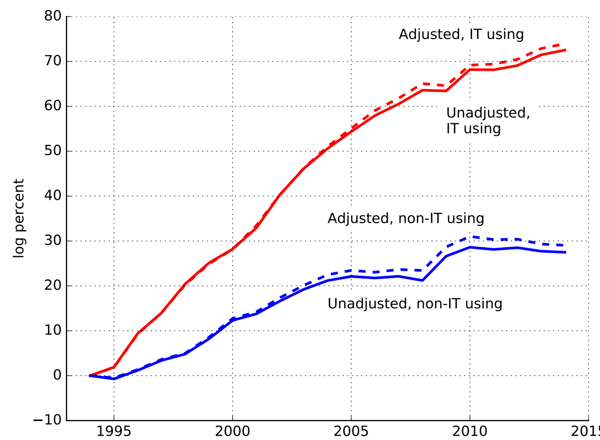
(b) Productivity growth, IT producing



(c) Formulary adjustment, by IT using



(d) Productivity growth, by IT using



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 foreign-owned MNEs that operate affiliates in the United States can also affect measures of U.S. production and labor productivity. If foreign-owned MNEs shift profit out of the United States, this will reduce U.S. GDP and income on FDIUS. The relationship between GDP, income on USDIA, and income on FDIUS can be seen in (1).

Ideally, we could apply the formulary apportionment method used for U.S.-owned MNEs to foreign-owned MNEs operating in the United States and arrive at a measure of the profit shifting by foreign MNEs. Data availability, however, poses difficulties. Whereas the BEA direct investment surveys cover the worldwide operations of U.S.-owned MNEs, BEA does not have legal authority to collect data on the worldwide operations of foreign-owned MNEs that own U.S. affiliates. Creating a data set comparable to the one we use to study U.S. MNEs requires combining BEA data on the U.S. operations of foreign MNEs with data on the foreign MNEs' worldwide operations from a commercial data set such as Bureau van Dijk's *Orbis*. 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 imperfect and time consuming.

Nevertheless, to give a sense of the potential significance of profit shifting by foreign-owned U.S. businesses, we develop a partial link between the BEA and Orbis data sets for 2008, 2012, and 2015. Given our finding that R&D-intensive firms are most affected by profit shifting, we construct a data set of large technology-intensive foreign-owned U.S. businesses containing the data needed to conduct an apportionment exercise. These businesses account for about 40 percent of R&D spending by foreign-owned U.S. businesses and about 13 percent of employment in all foreign-owned U.S. businesses. The scope of our data set is summarized in Table VIII.

In the data set we have been able to construct, we find evidence that foreign-owned MNEs operating in the United States are shifting profits out of the United States. This is evident in Figure 10a. On the vertical axis, we plot the reported U.S. share of worldwide profits for each foreign-owned MNE in our sample. On the horizontal axis, we plot the apportionment weight, (10), for the U.S. operations of each foreign-owned MNE.[23] In our methodology, if there was no profit shifting, the two measures would fall on the

[23]We use employee compensation and net plant, property, and equipment—equally weighted—as apportionment factors.

Table VIII – Profit shifting

	FDIUS				USDIA
	Number of firms	Share of R&D spending	Share of employment	Est. shifted profit (bil.)	Est. shifted profit (bil.)
2008	137	0.45	0.13	2.1	282.9
2012	136	0.43	0.13	12.3	280.1
2015	127	0.32	0.11	3.5	—

Notes: The column labeled "Share of R&D spending" is the share of R&D spending by foreign-owned U.S. businesses, and the column labeled "Share of employment" is the share of total U.S. employment in foreign-owned U.S. businesses.

45-degree line. In 2012 and 2008 (not reported), we find the U.S. share of profits is significantly below the 45-degree line—particularly for MNEs with operations concentrated in the United States. The locally weighted scatterplot (Lowess smoothed values) suggests that, for foreign-owned businesses with less than 20 percent of their worldwide production attributed to their U.S. operations, their U.S. profits are roughly proportional to their attributed U.S. production. However, the U.S. profits of foreign-owned businesses with 20 percent or more of their worldwide production attributed to the United States are significantly understated relative to their attributed production in the United States.

Altogether, if the profits of these foreign-owned businesses were reattributed according to the weighted apportionment factors, their U.S. profits would have been $12.3 billion higher in 2012 and $2.1 billion higher in 2008. It is difficult to judge the magnitude of these figures given the size of our data set, but it does suggest that foreign-owned MNEs are shifting profit out of the United States.

In the 2015 data, we find less evidence of foreign-MNEs shifting profit out of the United States (Figure 10b). In this case, the firms in our sample have U.S. profit shares that are roughly proportional to their attributed production shares. This result is consistent with the increased efforts by revenue authorities in the United States to deter profit shifting, but given the incomplete nature of our data, it is difficult to know the extent to which this reflects a reduction in profit shifting by foreign MNEs or an implication of our sample. Despite the tighter relationship between U.S. profit shares and U.S. apportionment weights, our reapportionment adds about $3.5 billion to U.S. GDP in 2015.

Overall, our analysis, incomplete as it is, suggests that profits of foreign-owned MNEs are being shifted out of the United States. This implies that our findings from the U.S. MNE data (Section 3) are the lower bounds of the measured slowdown of U.S. productivity growth caused by offshore profit shifting.

Figure 10 – Foreign-owned MNEs operating in the United States

(a) 2012 (b) 2015

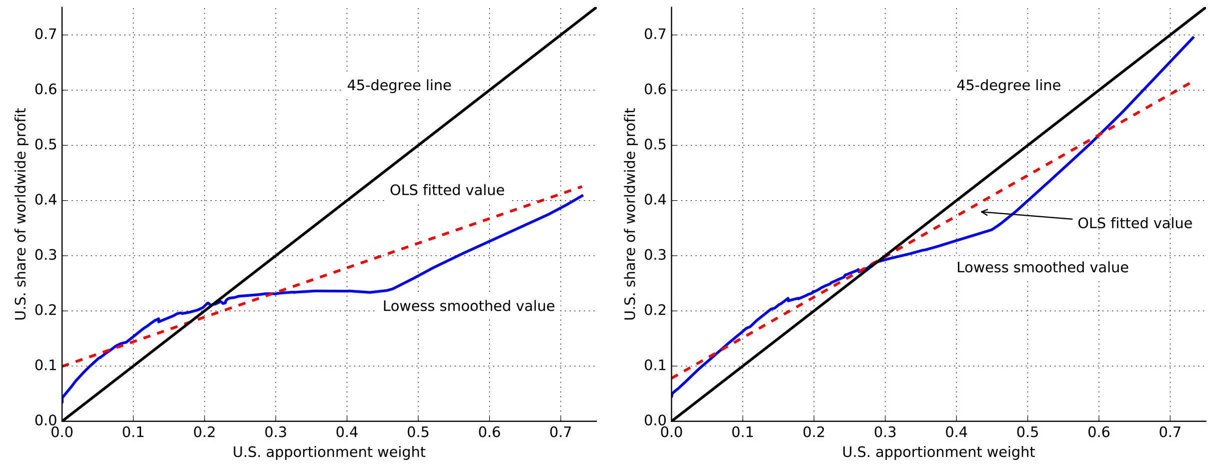
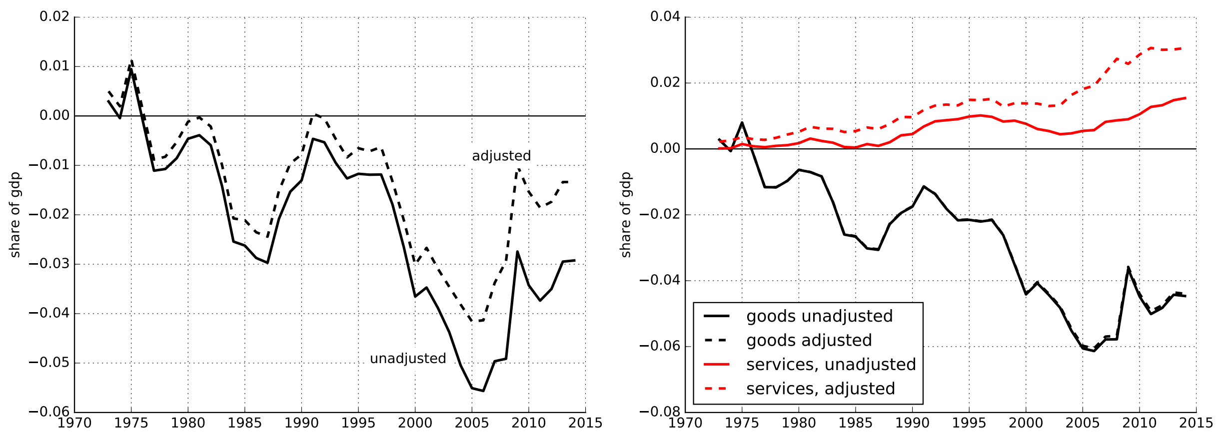


Figure 11 – Trade balances

(a) Total trade balance (b) Goods and services trade balances



6 Implications for Other Measurements

We have focused on the effects of profit shifting on U.S. productivity measurement, but the adjustments we have computed will affect other measures as well. Here, we briefly discuss some of these other measurements, which present interesting avenues for future research.

6.1 External Balances

In Section 2.2, we assumed that the income we reattribute to the United States is matched with a flow of exports from the United States to the rest of the world. In the aggregate, the effect of our adjustment on the U.S. trade balance relative to GDP can be seen in Figure 11a. The implied increase in exports makes the trade balance less negative. The effect of the adjustment (the gap between the solid and dashed lines in Figure 11a) is very small in the 1970s and stays small in the 1980s and 1990s (less than 0.5 percent of GDP), but then grows rapidly after the turn of the 21st century. In 2014, the unadjusted trade balance is –2.9 percent of GDP, and the adjusted trade balance is –1.3 percent of GDP.

Our assumption is that the reattributed income is the result of intangible assets created in the United States, so the exports would be classified as "charges for the use of intellectual property" and counted as a service export from the United States. In Figure 11b, we plot the trade balance for goods and services separately. Our adjustment does not change the goods trade balance, so the only differences between the adjusted and unadjusted goods trade-balance-to-GDP ratios are from changes to GDP in the adjusted measure. Our adjustment makes the services trade balance more positive, and, as before, the effect grows over time and especially rapidly in the 2000s. In 2014, the unadjusted services trade balance is 1.5 percent of GDP, and the adjusted services trade balance is 3.1 percent of GDP.

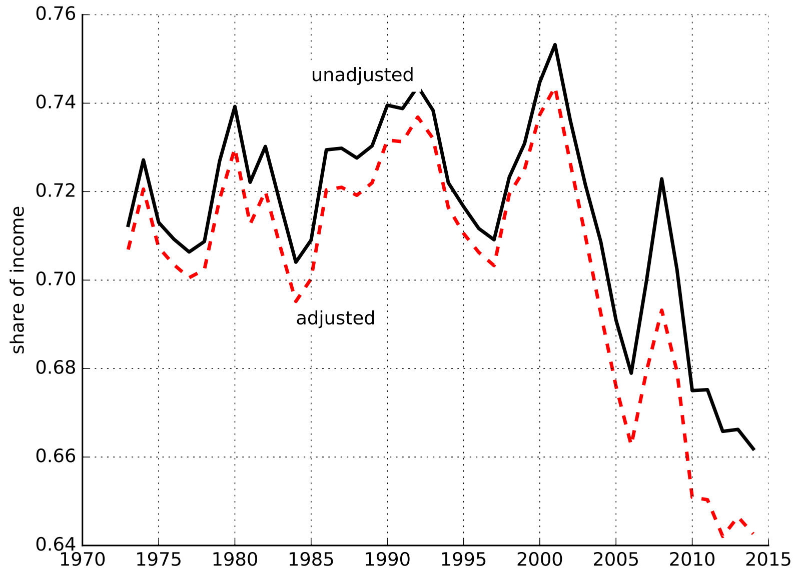
These large effects of our adjustment on the trade balance raise a natural question: What is the effect on the current account? As is evident from equation (1), our adjustment decreases income on USDIA and increases exports of services by the same amount, leaving the current account unchanged. One assumption behind this exact offsetting result that leaves the current account intact is the treatment of interest payments between the parent and affiliates, which are assumed to be unaffected by the adjustment in this calculation. Bruner, Rassier, and Ruhl (2018) consider additional adjustments for these payments and find a small, negative adjustment to the current account.[24]

6.2 Labor's Share of Aggregate Income

A well-established empirical regularity during much of the 20th century is the lack of a time trend in labor's share of aggregate income. This relationship appeared so robust that it became one of Kaldor's balanced growth facts and a key feature that macroeconomic models aimed to match. A number of recent studies, however, find that the labor share has been declining in recent decades—especially since the early 2000s (Autor, Dorn, Katz, Patterson, and Van Reenen, 2017; Elsby, Hobijn, and Sahin, 2013; Karabarbounis and Neiman, 2014). The decline in the labor share has led to a surge in interest in the measurement of the

[24] Bruner, Rassier, and Ruhl (2018) examine the effects of profit shifting on other parts of the U.S. national accounts and balance of payments accounts. Their analysis is limited to a single year however, whereas here we examine the entire path of adjustments going back to 1978.

Figure 12 – Labor share in the United States



labor (and capital) share. Our adjustment to GDP has implications for this measurement issue as well. It is worth noting that the income we reattribute to the United States is part of domestic capital income (corporate profits), which has the effect of reducing the labor share and raising the capital share.

To quantify the magnitude of this effect, in Figure 12, we plot the unadjusted *net labor share* of income for corporate business: employee compensation divided by net value added.[25] We also plot the adjusted net labor share: employee compensation divided by the sum of net value added and our aggregate adjustment. As can be anticipated from our previous findings, the adjustment grows over time and accelerates in the 2000s. The unadjusted net labor share fell from 0.753 in 2001 to 0.662 in 2014, for a decline of 9.1 percentage points, whereas the adjusted labor share fell from 0.743 to 0.643 during the same time, for a decline of 10.0 percentage points. Our adjustment also changes the shorter-run dynamics of the labor share. For example, in 2008, the unadjusted series increases sharply, suggesting that the preceding dip in 2006 was cyclical. The adjusted labor share tells a different story: while there is an upward movement in 2008, the adjusted labor share displays a strong downward trend.

[25] This is one of the measures used by Bridgman (2017), who also demonstrates that the treatment of depreciation and taxes affects the measured labor share. Our adjustment yields similar results regardless of the measure considered.

6.3 Other Measures

Our reattribution of income also implies that the return on U.S. foreign direct investment abroad is lower than current measures suggest and—to the extent that foreign MNEs are shifting profits out of the United States—the return on direct investment in the United States is greater than current measures suggest.

Lastly, a line of research has taken up the decline in the share of C corporations in total net business income (Cooper, McClelland, Pearce, Prisinzano, Sullivan, Yagan, Zidar, and Zwick, 2016; DeBacker and Prisinzano, 2015). To the extent that profit shifting is occurring largely in C corporations, our adjustment may offset some of the decline in the prevalence of C corporations.

7 Concluding Remarks

Using firm-level data on U.S. MNEs, we find increasing profit shifting activity by U.S. MNEs, leading to low measured growth in GDP. Our adjustments mitigate the productivity slowdown reflected in official statistics. The adjustments raise aggregate productivity growth rates by 0.09 percent annually from 1994 to 2004, by 0.24 percent annually from 2004 to 2008, and decrease productivity growth rates by 0.09 percent annually after 2008.[26] While the effects on the measured slowdown seem to have subsided after 2008, the challenge itself still persists: from 2008 to 2014, official domestic business-sector value added in the United States was, on average, more than 2 percent—about $260 billion—lower than our adjusted measure. The measured slowdown is most pronounced 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 four to five times their annual GDP. Even for some relatively large economies, such as Ireland and the Netherlands, the adjustments are as large as 9–13 percent of their annual GDP.

We also examine the other international component of the measured slowdown: profit shifting by the U.S. subsidiaries of foreign MNEs. The data used to analyze these companies are 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 10—suggest a similar pattern. Further work on this topic is warranted.

[26] It is not clear whether the apparent plateauing in profit shifting activity is related to corporate inversions, which cause some firms to exit the BEA survey sample used in this paper.

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A Data 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 (NIPAs) and value added by industry in the Industry Economic Accounts (IEAs) 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 (ITAs), 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 IEA data are current as of the annual revision of the NIPAs 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 ITAs 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 IEA 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 NIPAs and the IEAs 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 NIPAs 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 (12). 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 (12). 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 IEAs 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 (12) 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 Price index adjustments

In our analysis above, we deflate the sum of nominal value added and the nominal adjustment by the value added price deflator. If the industrial composition of the nominal adjustment varied significantly from the composition of value added, the value added price deflator may not be appropriate. To address this concern, we construct a Törnqvist price index using the domestic value added data and a Törnqvist price index using the sum of domestic value added and our adjustment. We report the difference between the two indexes in Figure A.2.

The two price indexes are very similar. In absolute value, the two indexes do not differ by more than five basis points. While the industrial composition of the adjustment is different from the composition of aggregate value added, the difference does not change the industry weights in the price index enough to have an appreciable impact.

Figure A.1 – Aggregate adjustment under alternative profit definition

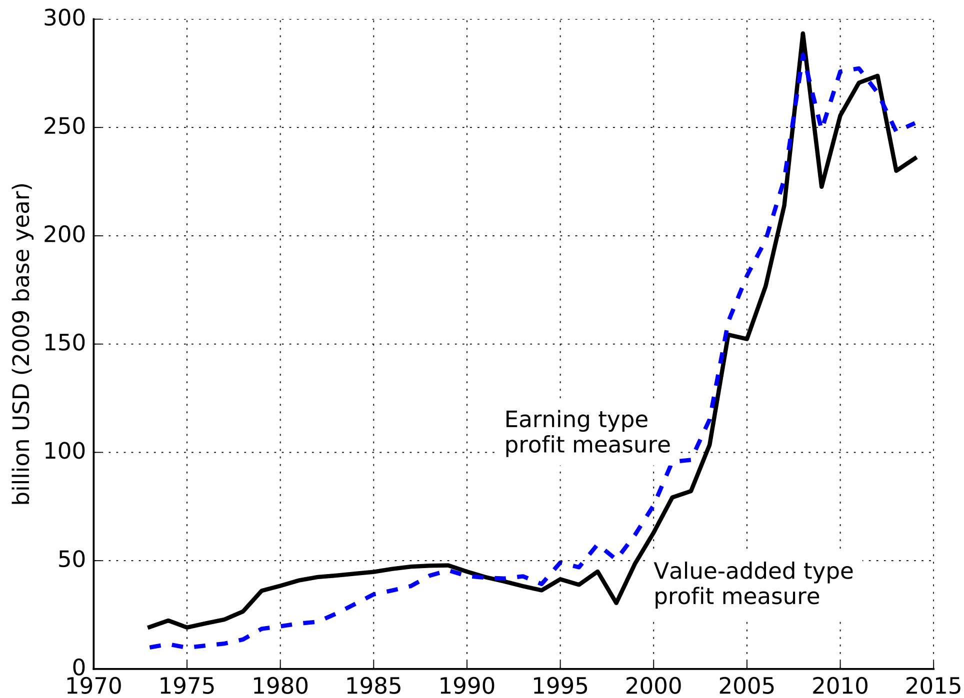
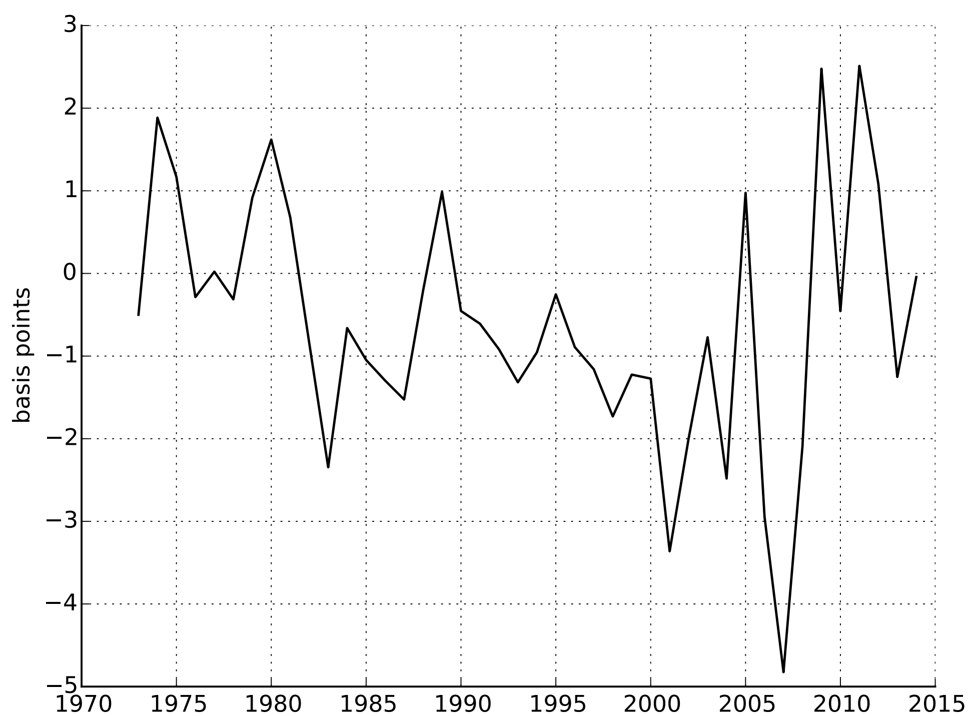


Figure A.2 – Deflator for value added minus the deflator for adjusted value added



B Figures and tables

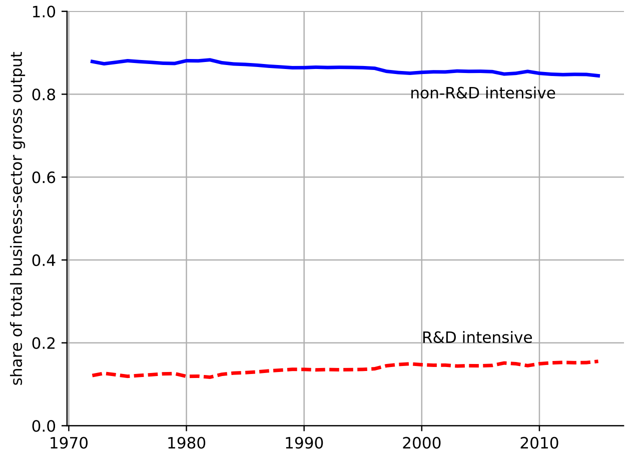
Table B.1 – Industry groupings

	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 R&D Services

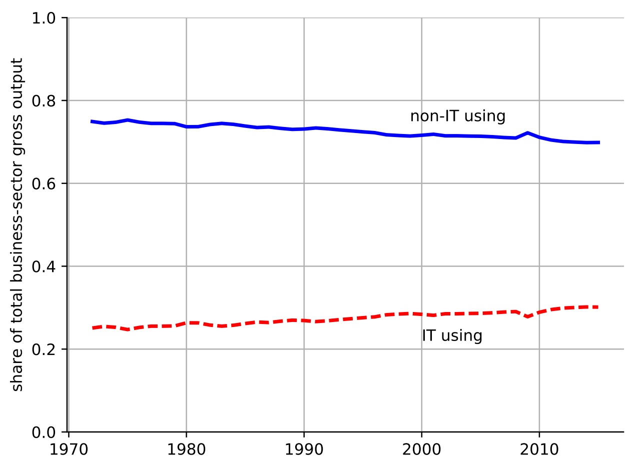
Notes: The IT-producing classification is from Fernald (2015). The IT-using classification is from Bloom, Sadun, and Van Reenen (2012). The R&D classification is from Moylan and Robbins (2007). ISIC or SIC codes have been converted to the NAICS-based ISI classification used by BEA in its surveys of MNEs.

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

(a) By R&D intensity



(b) By IT-using intensity



(c) By IT-producing intensity

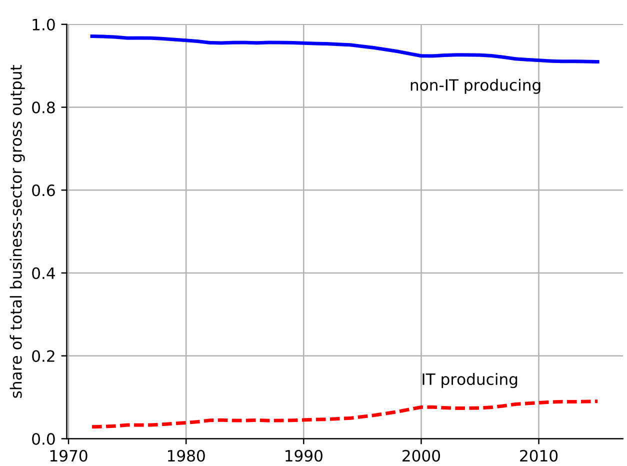
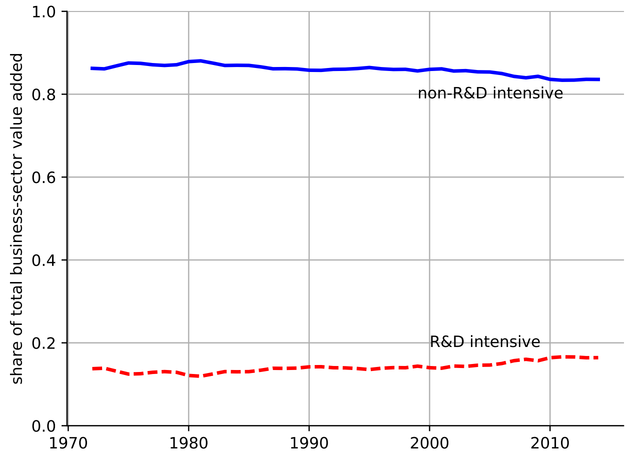
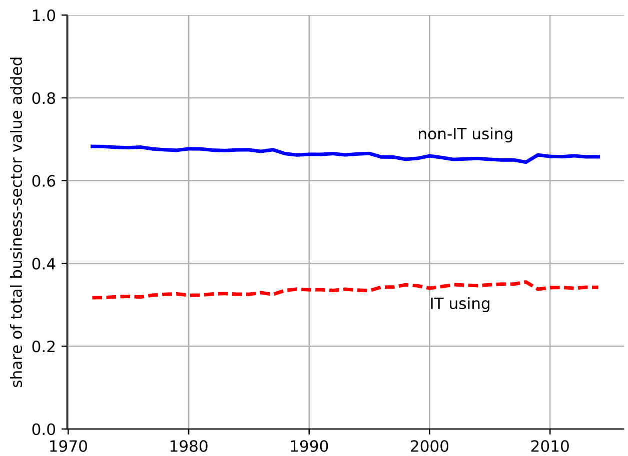


Figure B.2 – Industry group shares of total value added

(a) By R&D intensity



(b) By IT-using intensity



(c) By IT-producing intensity

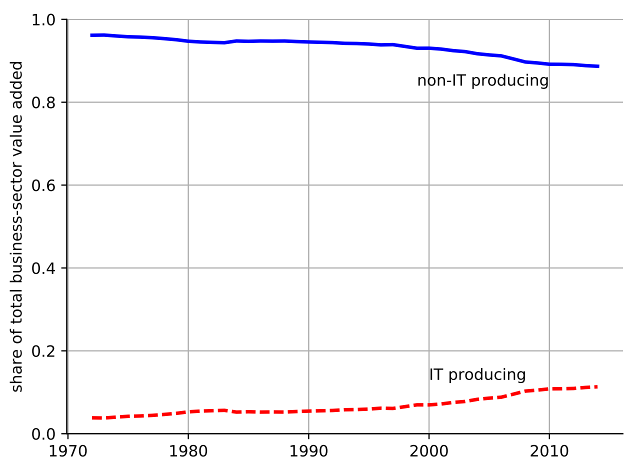
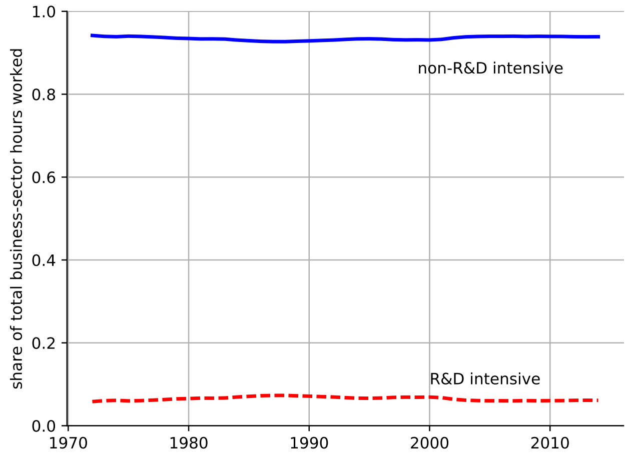
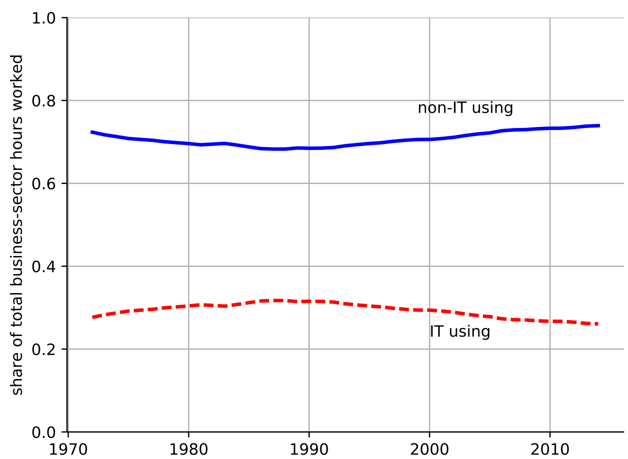


Figure B.3 – Industry group shares of total hours worked

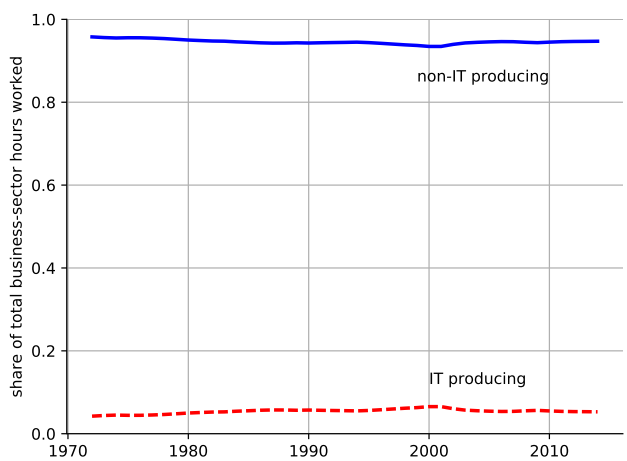
(a) By R&D intensity



(b) By IT-using intensity



(c) By IT-producing intensity



C Profit shifting strategies of MNEs

Intangible assets have long been a defining feature of multinational enterprises (MNEs). Hymer (1976, pp. 42–43) is widely acknowledged as the first scholar to recognize that domestic firms venture abroad to exploit their proprietary intangible assets (such as patents and brand recognition) and that it is the market power from those assets that allows these firms to overcome the liability of foreignness and to operate abroad successfully. What is unique about the last few decades is that the importance of intangible assets in firms' balance sheets has been growing at an accelerating rate. Data in Lev and Gu (2016, p. 82) show that the contribution of investment in intangible assets to production grew at roughly a 1.1 percent annual rate in 1977–1994 compared with a 1.4 percent annual rate in 1994–2011. This rise in the importance of intangible assets has created an extra incentive for U.S. MNEs to shift the ownership of their intangible assets to foreign affiliates in tax haven countries to reduce their global tax liability.

U.S. tax laws regarding the intrafirm transfer of intangible assets are long-standing, but the codification and enforcement of those laws have become a major focus of both the IRS and the corporate sector in the last few decades. Current guidelines covering the intrafirm transfer of intangible assets are covered by Section 482 of the U.S. tax code. Bose (2002) notes that these guidelines have existed in some form ever since the creation of the IRS in 1917 but that, in the last few decades, firms have tried to develop tax strategies that exploit ambiguities in those guidelines and the IRS has, in turn, tried to tighten its guidelines to eliminate ambiguity. The original guiding principle for U.S. tax treatment of the transfer of intangible assets came out of the Tax Reform Act of 1986. That Act amended Section 482 to require that when intangible assets are transferred between units of an MNE, the receiving unit must pay a price to the providing unit that is commensurate with the expected income from that asset.

C.1 Cost sharing agreements

Firms can structure an intrafirm transfer of intangible assets in different ways, but one of the most common legal structures is a cost sharing agreement (CSA). In a CSA, one geographic unit of an MNE—typically a foreign affiliate in a tax haven country—shares the cost of developing a new technology with its U.S. parent and, in return, is granted rights to royalties on a portion of the sales of products or services using that technology. Under IRS guidelines, the foreign affiliate cannot be granted royalties on sales in the United States, so the affiliate is typically granted rights to royalties on sales in the rest of the world.

IRS guidelines on CSAs have been updated several times since the 1986 Act. In 1995, the idea of a "buy-in payment" was introduced to account for the value of preexisting technology that could be embedded in a new technology governed by a CSA. In 2005, the idea of a "platform contribution" was introduced to account for the value of other U.S. headquarters services that could be embedded in a product or service whose technology was governed by a CSA. These contributions could include services such as "resources, capabilities, or rights, such as expertise in decision-making concerning research and product development, manufacturing or marketing intangibles or services, and management oversight and direction." The IRS codified the 2005 guidance on CSAs in its 2008 Temporary Regulations and its 2011 Final Regulations. In testimony to the Senate in 2013, Harvard law professor Stephen Shay described the pre-2011 regulations as "much more relaxed" than the post-2011 regulations (Senate Committee on Homeland Security and Government Affairs, 2013). This comment suggests that the combined IRS guidance on "buy-in payments" and "platform contributions" gradually made it much more difficult for MNEs to use CSAs to transfer intangible assets over the 2005–2011 period.

C.2 Deferral and hybrid entities

Prior to the December 2017 tax reform, U.S.-based businesses were subject to a worldwide tax system rather than a territorial tax system so that their worldwide profits were essentially taxed at the U.S. statutory rate. On the face of it, this principle would seem to eliminate the advantage of moving intangible assets (and their associated income) to tax havens. However, there were exceptions to the general principle. One exception was that foreign-sourced income was generally not taxed until it was repatriated to the United States, as long as it was actively invested abroad. One way for MNEs to indefinitely defer U.S. taxation was to declare foreign earnings as "permanently reinvested" abroad.

The difference between the pre-reform 35 percent corporate statutory federal income tax rate in the United States and the 12.5 percent rate in Ireland, for example, should have been incentive enough for U.S. MNEs to seek to shift profits offshore, but there could be even further inducements, such as hybrid entities. A hybrid entity is a unit of an MNE that is recognized by the tax authority of its home or host country but not recognized by the tax authority of the other country. Through the creation of complex holding structures, MNEs have, at times, been able to exploit differences in the pre-reform tax rules to create foreign entities that were essentially stateless and therefore free from tax. One of these structures, spanning an ownership chain that crosses the United States, Bermuda, Ireland, and the Netherlands, is known as the "double Irish with a Dutch sandwich" strategy. In October of 2014, however, Ireland changed its tax laws to eliminate this loophole.