# Turning on the Light: A New Assessment of Measurement Error in International Tax Data*

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**Abstract**

A central issue in international taxation is the extent to which multinational companies shift profits to low-tax jurisdictions. Policy analysis is obscured by difficulties in using existing datasets to measure profit shifting. This paper sheds new light on this issue by examining a key source of measurement error that can affect administrative international tax data: aggregation error that leads to double counting of foreign income. We link data from tax filings and public disclosures to construct a novel, firm-level proxy that uses book-tax differences to quantify the extent to which commonly-used aggregation techniques may result in double counting. A comparison of book and tax data reveals that aggregation error has been increasing over time, leading to overestimates of the extent of profit shifting. Applying a simple correction results in a 30% reduction in the magnitude of foreign earnings as measured in tax data in 2016, significantly harmonizing measures of foreign income and tax rates across firms' book and tax filings. This correction resolves a systematic relationship between book-tax differences and the size of MNCs' foreign affiliate networks that arises as a result of aggregation error. Finally, we revisit estimates from prior literature and reexamine their conclusions after correcting for aggregation error.

Keywords: international taxation, profit shifting, measurement error, double counting
JEL Codes: D22, H25, H26, H32

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# 1 Introduction

Tax competition and corporate tax avoidance have become central areas of focus for researchers and policymakers over the past several decades as the global economy has become increasingly integrated. Yet it is surprisingly difficult to reliably nail down even basic descriptive information regarding key elements of multinational corporate activity. For example, estimates of US tax revenue lost to profit shifting can differ by an order of magnitude. Clausing (2016) provides an upper bound estimated at $111 billion, whereas Blouin and Robinson (2020) estimate a figure of only $10 billion.

A key source of these discrepancies is the potential for significant measurement error in commonly-used datasets of multinational activity. While Altshuler and Grubert (2006) first highlighted this issue, recent work by Blouin and Robinson (2020, henceforth B&R) has underscored the extent of measurement error in international tax data. This paper focuses on the problem of aggregation error, which can occur when the same earnings appear on the books of multiple affiliates within a multinational corporation (MNC). Summing the earnings of all affiliates within an MNC will introduce double counting because dividends paid from one affiliate to another can appear in the data for both affiliates. Aggregation error can thus result in upwardly biased estimates of foreign earnings and profit shifting.

As MNCs have become increasingly complex, with potentially hundreds of affiliates distributed globally, the potential for measurement error has increased. The growth in measurement error over time undercuts the reliability of analyses that rely on temporal variation to measure changes in corporate activity. This paper takes a closer look at the potential for aggregation error when using data from tax filings by foreign affiliates of US MNCs.[1] By comparing aggregated income from tax filings against consolidated foreign income data as reported in public filings, we show that adjustments that correct for aggregation error in tax data appear to be quite promising. Our research suggests that a simple correction can yield more reliable information on average foreign tax rates and income earned by foreign affiliates of US MNCs, providing crucial information for the increasing number of researchers using IRS tax files to help evaluate and

[1] B&R provide several recommendations that researchers can use to guard against measurement error in accounting data from the US Bureau of Economic Analysis, but they provide only a brief discussion of the potential for measurement error in IRS business tax data based on publicly available aggregate statistics. While B&R suggest that it may not be possible to fully correct for such measurement error in tax data, our analyses based on IRS business tax micro data explore the potential to correct for aggregation error using tax data.

improve the US system for taxing international income.

When properly adjusted, tax data have a number of advantages over financial statements data in Compustat or survey data from the Bureau of Economic Analysis (BEA), as we discuss in Section 2. First, Compustat data and BEA surveys typically focus only on large US MNCs. Tax data, on the other hand, are comprehensive, and samples compiled by the IRS contain information about smaller US firms that are active abroad. Second, IRS data contain information regarding the entity types that US corporations elect for the tax treatment of their foreign affiliates, which in turn reveals information about tax planning structures that one cannot observe in other data sources. Finally, measurement of corporate income tax is more reliable in IRS data when compared with data from corporations' public filings. This is particularly true in certain industries, such as oil and gas, where firms have latitude in whether they categorize payments to foreign governments as income taxes on their books.

The insights gleaned from tax data, however, may be severely undercut by the inability of researchers to correctly measure foreign income and other outcomes. Aggregation error can introduce upward bias to estimates of foreign income and downward bias to estimates of foreign tax rates. In Section 3, we examine aggregate differences in foreign earnings and reported tax payments by matching a sample of publicly-traded firms to their IRS tax filings. We then construct a novel, firm-level proxy for this aggregation error by examining differences between aggregated tax filings and consolidated financial statements that should not be subject to such error. This proxy allows us to examine the performance of a simple correction for aggregation error suggested by B&R that removes related dividend payments.

We find that this correction significantly harmonizes measures of foreign income and tax rates across firms' book and tax filings. Adjusting for aggregation error leads to a 30% reduction in the magnitude of foreign earnings as measured in tax data in 2016. Moreover, the correction also resolves the systematic relationship we observe between book-tax differences and the size of an MNC's foreign affiliate network. The fact that we find no evidence of this relationship after correction, nor evidence of changes in post-correction residual book-tax differences over time, indicates that this adjustment can greatly help researchers take advantage of the benefits of tax data by mitigating aggregation error concerns.

With the knowledge that this correction appears to remove systematic aggregation error in tax data, we turn to reexamining results from prior literature in Section 4. Specifically, we

provide estimates of the tax semi-elasticity of foreign earnings, i.e., how the allocation of foreign earnings by US MNCs across countries correlates with average and statutory foreign tax rates. We first reproduce these semi-elasticities using the methodology of Dowd, Landefeld and Moore (2017, henceforth DLM) and then recompute them after correcting for aggregation error. Our correction-adjusted estimates yield elasticities with a similar magnitude. Furthermore, we find that DLM's general conclusion that foreign earnings are more sensitive to tax rate changes in haven jurisdictions is robust to aggregation error. We discuss this result in contrast to B&R, who find that MNCs in correction-adjusted BEA data do not demonstrate greater sensitivity to tax rate changes in haven jurisdictions.

This paper proceeds as follows. Section 2 discusses the advantages of tax data relative to other common data sources that are used to measure the activity of US MNCs. Section 3 describes how we construct a matched sample of MNCs that appear in both tax data as well as public filings compiled by Compustat. We use this sample to examine differences in how foreign earnings and income taxes are reported, to measure the extent of aggregation error that may be generated by naive aggregation of foreign affiliates' tax filings, and to assess the performance of a simple correction that aims to remove aggregation error from tax data. Section 4 presents our reproductions of tax semi-elasticity estimates from earlier studies. We also provide corrected estimates of average foreign effective tax rates by jurisdiction. Section 5 concludes.

## 2 Data Sources for Measuring Tax Outcomes of US Multinationals

This section provides an overview of several datasets that researchers have used to study US MNC activity. Much of the literature discusses measurement issues, with a focus on data compiled from surveys run by the BEA. We review the main issues encountered in this data. We then discuss the extent to which these measurement issues may translate to the sources used in this study, Compustat and IRS Statistics of Income (SOI). Table 1 briefly summarizes the main features and drawbacks of each data source.

## 2.1 Compustat

Compustat is a database that, among other things, compiles information about firms based on their consolidated public filings. While Compustat is a useful source of information for a large set of firms, it is not comprehensive—private firms are not covered by the database. Furthermore, information about MNCs' foreign operations is relatively limited in Compustat. It does, however, provide some information about the aggregate consolidated foreign income and foreign tax expense for a set of MNCs.

## 2.2 BEA Multinational Data

The BEA provides two different sources of data on US MNCs that are frequently used in the literature. The first is typically referred to as "Direct Investment Income." The second source, which provides two different foreign income measures, is published under "Activities of US Multinational Enterprises."

### Direct Investment Income

The BEA conducts quarterly surveys that collect information on investment positions and transactions with directly-owned foreign affiliates of US MNCs. Research that examines foreign earnings by US MNCs have used the "Direct Investment Income" (DII) measure contained in this data (e.g., Zucman, 2014, 2015). One advantage of DII is that it does not appear to suffer from issues related to double counting of equity income that are present in other data sources, as discussed below. On the other hand, on a country-by-country basis, DII may not reflect the true geographic distribution of where earnings are first realized—a type of measurement error known as misclassification error. This is due to the fact that income generated by indirectly-held foreign affiliates will only be observed at the level of a directly-owned affiliate. In addition, DII does not provide measures of foreign corporate income tax. As discussed in B&R, although researchers may attempt to combine DII with other data sources that provide information about tax payments, this can result in underestimation of average effective rates for tax havens to the extent that taxes on equity income do not match the jurisdiction in which they appear in DII data.

### Activities of US Multinational Enterprises

The BEA also conducts annual surveys that collect detailed information on the activity of foreign

affiliates directly or indirectly owned by US MNCs. These data are compiled into annual reports titled "Activities of US Multinationals" (AMNE). Much of the international tax literature focuses on statistics provided on the Income Statement (tables starting with "D"). AMNE data provide disaggregated information that separates income from directly- and indirectly-owned foreign affiliates, thereby avoiding the misclassification error present in the DII data. As discussed in B&R, however, simple aggregation of foreign net income may double count the so-called "equity income" included on the income statement of affiliates that are parents of other affiliates. B&R provide a simple adjustment to prevent such double counting by subtracting related dividend income, which is also reported by the BEA.

Another advantage of AMNE data is that, unlike DII data, measures of corporate income tax are also provided. This allows for more reliable estimates of taxes paid and average tax rates by jurisdiction.

## 2.3 Administrative Tax Data

The Statistics of Income division of the IRS produces two sets of corporate data that have been used by researchers to study US MNCs. These datasets provide information disclosed in tax returns for a large sample of US corporations, including not only the activity of US parent companies but also that of their foreign affiliates. The sample includes both public and private corporations, as well as relatively small firms that are not captured in BEA surveys.

**SOI Corporate Sample** The first dataset, the SOI Corporate Sample, is an annual stratified sample of US corporations that SOI uses to produce publicly available aggregated business income statistics.[2] The SOI Corporate Sample provides information from unaudited tax returns for approximately 100,000 US corporations annually, and has been used in the business tax literature to study domestic firms (Yagan, 2015; Zwick and Mahon, 2017). Our data focus on C corporations that were sampled between 1992 and 2016. This analysis uses Schedule M-3, an attachment to Form 1120 that is mandatory for corporations with total assets of at least $10 million.[3]

**SOI International Business Tax Statistics** The second dataset, which provides information related to foreign affiliates of US corporations, is used by SOI to publish aggregate statistics

[2]Statistics are available at IRS (2022*b*), and the sampling procedure is described in IRS (2011).
[3]See IRS (2019).

for international business taxes (IRS, 2022*a*). This dataset contains a subset of C corporations from the SOI Corporate Sample that file Form 5471 or Form 8858: Form 5471 provides financial information and activity of opaque foreign affiliates (Controlled Foreign Corporations, or CFCs), and Form 8858 provides similar information for pass-through foreign affiliates (Foreign Disregarded Entities, or FDEs).[4] Unlike the SOI Corporate Sample, which is provided annually, information about opaque foreign affiliates is only collected in even years (with the exception of 2014). Information about pass-through foreign affiliates is collected for four of the years in our sample period (2006, 2008, 2012, and 2016). Prior to 2004, SOI statistics only included information for foreign affiliates of large MNCs with greater than $500 million in assets. Starting in 2004, the sampling procedure became much broader.

Like the BEA AMNE data, this SOI dataset includes information about both directly- and indirectly-owned foreign affiliates. One key difference from BEA data is that the IRS reveals whether entities are CFCs or FDEs. The entity type of a foreign affiliate can reveal important information that can be used in tandem with well-known profit shifting and tax minimization strategies (Altshuler, Boller and Suárez Serrato, 2024). When a US parent company controls an affiliate indirectly (i.e., structures a CFC or FDE as the parent of another CFC or FDE), the affiliate "parent" reports consolidated information on Form 5471. This method of reporting can cause misclassification error similar to that observed in the BEA's DII series. To see how misclassification error can occur in the tax data, consider a US MNC with two foreign affiliates—affiliate A is a holding company located in a tax haven (e.g., Bermuda) and affiliate B is an affiliate that sells merchandise to customers (e.g., in Germany). If the US parent classifies affiliate B as a pass-through (FDE) and affiliate A as an opaque entity (CFC), then the information contained on affiliate A's Form 5471 will provide foreign income and tax data that include its German operations. As noted above, since information covering pass-through entities is available only for a handful of years, in general it is not possible to "undo" this misclassification error. Unlike DII data, however, the SOI also reports information about foreign tax payments.

The fact that the SOI contains misclassification error is not necessarily a "disadvantage" of the tax data. This instead depends on the researcher's goal. If researchers are attempting to accurately measure effective tax rates imposed by countries on businesses that operate in their

[4]Pass-through entities are often discussed in reference to a policy change known as "Check the Box." See Altshuler, Boller and Suárez Serrato (2024) for a detailed discussion of the policy.

**Table 1: Data Sources for US MNC Activity**

| | Features | Drawbacks |
|---|---|---|
| **Compustat** | • Large universe<br>• Public filings | • No small/private firms<br>• Limited foreign operations info. |
| **BEA DII** | • No aggregation error | • Misclassification error<br>• No foreign corp. tax data<br>• No smaller firms |
| **BEA AMNE** | • No misclassification error<br>• Foreign affiliate data<br>• Foreign corp. tax data | • Aggregation error<br>• No smaller firms<br>• Does not specify affiliate type (CFC vs. FDE) |
| **SOI Corporate Sample** | • Large universe<br>• Small/private firms<br>• Can combine with SOI Int'l Business data | • Aggregation error when combined with SOI Int'l Business data<br>• Misclassification error when combined with SOI Int'l Business data |
| **SOI Int'l Business Tax Statistics** | • Specifies foreign affiliate type (CFC vs. FDE)<br>• Foreign corp. tax data | • Aggregation error<br>• Misclassification error<br>• Small universe pre-2004 |

jurisdiction, SOI data will generally be unreliable when compared with BEA data. If researchers are instead interested in the effective tax rate faced by combined foreign structures (e.g., the consolidated operation of Bermudan-German affiliates), then the tax data may be preferable, as the BEA does not provide information about whether foreign affiliates are classified as pass-throughs or opaque entities for tax purposes. Thus, while misclassification error may be present in SOI data, this may not be problematic as long as researchers have the correct interpretation of the data.

SOI data may also suffer from aggregation error in a manner similar to the BEA's AMNE dataset. This may occur if there is indirect ownership of one opaque entity by another. In this case, foreign earnings that are distributed as dividends to the parent affiliate may appear as foreign earnings on each affiliate's Form 5471. However, the SOI also provides information that can be used to correct for this type of error. Schedule M of Form 5471 reports transactions between related foreign affiliates, including dividends. B&R suggest removing these dividends to accurately aggregate foreign income. Based on a comparison with BEA data, however, they question whether this adjustment is sufficient to fully correct for aggregation error. Aggregation

error potentially poses a much more serious problem for researchers: if SOI data overstates foreign earnings, estimates from research examining foreign earnings in tax data may not be reliable. Worse, to the extent this error is growing over time, as one might suspect if MNCs' ownership structures are also becoming more complex, standard economic approaches to control for such error (e.g., unit fixed effects) might only exacerbate the problem (Bound, Brown, Duncan and Rodgers, 1994; Bound and Krueger, 1991).

# 3 Assessing Aggregation Error in Foreign Earnings and Taxes

In this section, we use data from Compustat and SOI to measure the extent to which SOI data may suffer from aggregation error and examine whether the correction proposed by B&R appears to sufficiently correct for this error. First, we describe how we create a matched sample of US MNCs that appear both in SOI and Compustat. Compustat reports foreign income and foreign tax figures on a consolidated basis for a set of MNCs.[5] The consolidated nature of Compustat's reporting implies that it should not be contaminated by aggregation error. This provides a baseline comparison that can be used to measure aggregation error for a common set of firms, avoiding the possibility that aggregate differences may simply be due to differences in sample composition as in the analysis contained in B&R.[6]

## 3.1 Sample Construction

Figure 1 shows attrition associated with the sample construction process. The top line in the left panel shows the annual sample size for US MNCs contained in the SOI data, which ranges between 7,597 and 9,157. US MNCs are defined as US companies that file a corporate tax return and that own at least one opaque foreign affiliate (CFC) that files Form 5471. SOI includes a firm identifier (EIN) that can be used to link the firm's corresponding data from Compustat. The size of this linked sample, shown in the orange dashed line in the left panel of Figure 1, ranges between 1,845 and 2,334. The considerable attrition rate relative to the full SOI sample is not surprising given that Compustat does not include information about privately-held firms or smaller multinationals.

[5]The Compustat sample typically includes large, publicly-traded firms.

[6]This is not a criticism of that analysis. B&R only have access to highly aggregated data made public by SOI, and therefore the concern about differences in sample composition is unavoidable.

To ensure that the match is of high quality, we use information from Form 1120, Schedule M-3, which must be filed by large US MNCs to reconcile book and tax financial information. Firms must report book earnings on their M-3 that in theory should be the same as those disclosed in their public filings. These earnings should be directly comparable to the Net Income figure reported in Compustat; therefore, we drop firms from the matched sample that report M-3 Net Income with a different sign from Compustat Net Income, as well as firms that report M-3 Net Income not within 1% of the Compustat Net Income figure. The size of the final linked sample, which ranges from 1,680 to 2,023, is shown on the purple dotted line of the left panel of Figure 1. The figure demonstrates that only a small share of firms are dropped when using Schedule M-3 to match on net income, which is encouraging and indicative that the comparison is of high quality.

The right panel measures attrition by examining aggregate pretax income for each step of the sample construction. A much smaller proportion of foreign earnings are dropped relative to the attrition in sample size, confirming that Compustat does not provide coverage of relatively small US MNCs.

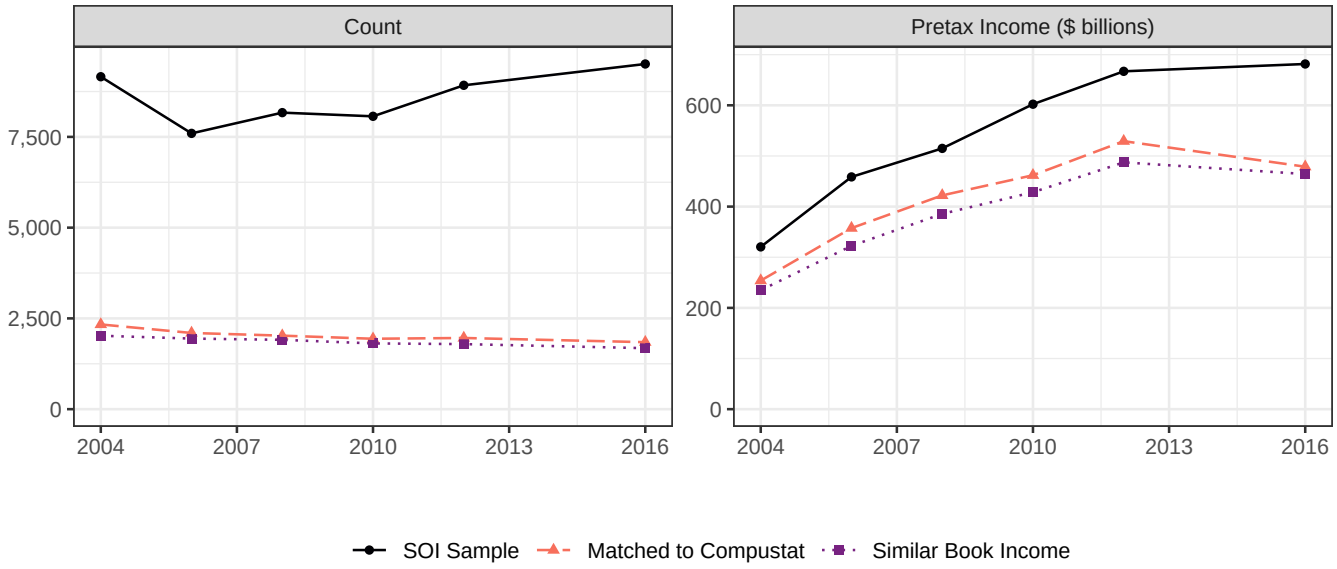
Figure A.1 provides an overview of attrition starting with the full Compustat sample. An additional filter is applied to remove Compustat observations that report missing pretax foreign income. As shown in the left panel, a much smaller portion of Compustat MNCs are dropped in the match, which is unsurprising given that SOI is the more comprehensive database. In 2016, for example, the matched sample includes 68.8% of Compustat MNCs. In the right panel, attrition is presented in terms of aggregate foreign earnings as reported in Compustat, with the matched sample including 84% of the aggregate foreign earnings reported in Compustat in 2016.

## 3.2 Comparison of Aggregate Foreign Income and Tax

Having constructed a sample of MNCs for which both public filings and tax filings are observed, we now examine aggregate foreign earnings and tax outcomes over time within the sample.

Figure 2 shows three aggregate measures of foreign income tax. The solid line plots aggregate foreign tax from Compustat. The dotted lines provide two different estimates from tax data: the series represented by purple dots are computed from Form 5471, Schedule C (Income Statement), and the series represented by orange dashes are computed from Form 5471, Schedule E (Income, War Profits, and Excess Profits Taxes Paid or Accrued). We use Schedule E as the preferred

**Figure 1: SOI MNCs vs. Matched Sample**



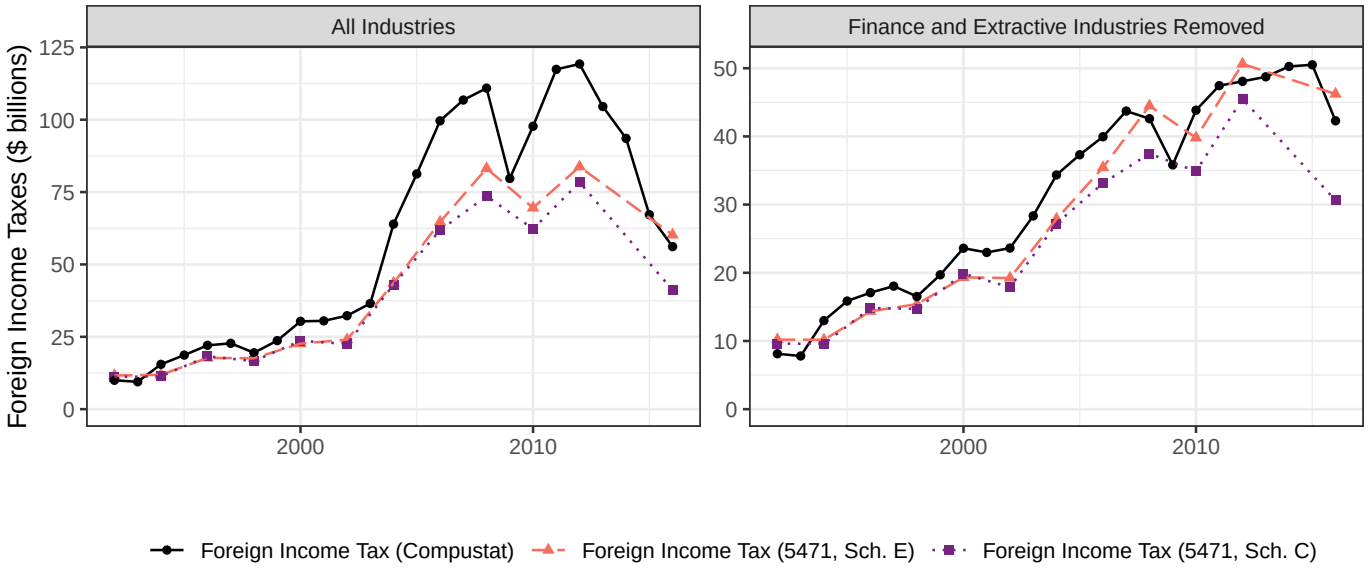

*Notes:* This figure demonstrates the attrition associated with the sample construction process. The "SOI Sample" contains all US MNCs from the SOI data sample. The "Matched to Compustat" sample contains SOI Sample MNCs matched to Compustat via unique firm identifier (EIN). The final linked sample, "Similar Book Income," was created by dropping Compustat-matched MNCs whose M-3 Net Income, as reported on IRS Form 1120, Schedule M-3, has a different sign than or is not within 1% of the firm's Compustat Net Income. The left panel displays sample sizes in terms of number of MNCs, while the right panel shows sample sizes in terms of pretax income. These panels showcase Compustat's lack of coverage for small and/or private MNCs, but underscore that the match quality of MNCs that are able to be linked is high.

measure. The left panel contains aggregates computed from MNCs in all industries. The right panel excludes MNCs classified as operating in Financial, Utilities, Mining, Agriculture, or Oil & Gas.

Examining the full sample, it appears that Compustat tends to report much larger estimates of foreign income tax than what is contained in tax filings. This difference is markedly lower when excluding the industries selected above. One key reason for this discrepancy appears to be related to how extractive industries operate foreign concessions. These projects are often structured so that the foreign state receives a share of revenue or profits, and firms have discretion over whether to report these profit-sharing arrangements as income tax in their books. It does not appear that they have the same amount of discretion when they disclose information about foreign taxes in their returns.

Even after removing this set of industries, Compustat tends to report larger estimates of corporate income tax than what firms disclose in their tax returns. This suggests that aggregation error is likely not a significant problem when computing a US MNC's foreign tax bill from its

**Figure 2: Comparison of Aggregate Foreign Tax Measures**



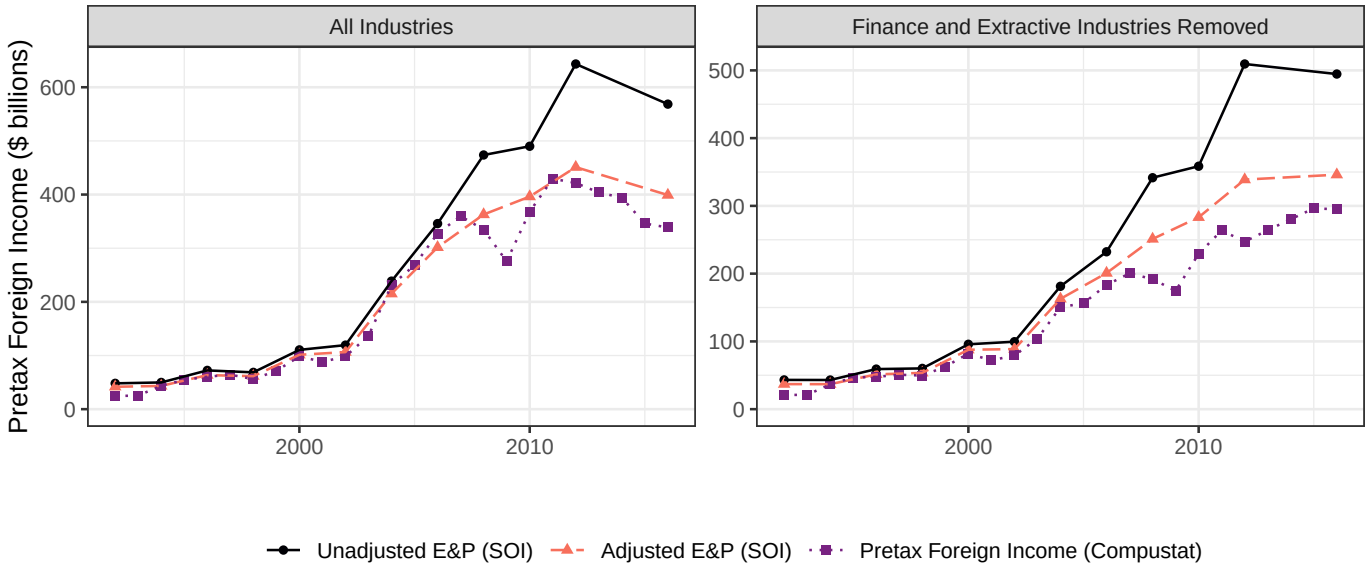

*Notes:* This figure shows three measures of aggregate foreign income tax as respectively reported by Compustat; IRS Form 5471, Schedule E; and IRS Form 5471, Schedule C. The left panel contains aggregates computed from MNCs in all industries, while the right panel excludes MNCs operating in Financial, Utilities, Mining, Agriculture, or Oil & Gas. The panels show that Compustat tends to report larger estimates of foreign income tax than is contained in tax filings; however, this difference is lessened when excluding the industries mentioned above. We use Schedule E as the preferred measure.

Form 5471 filings.

Figure 3 shows three aggregate measures of foreign pretax earnings for the matched sample. In this figure, the solid line plots represents unadjusted SOI earnings and profits (E&P) computed from Form 5471, Schedule H; the orange dashed line plots this data after adjusting to remove dividends received from related affiliates, as reported on Schedule M; and the purple dotted line plots aggregate foreign pretax income from Compustat. For the SOI data, we add back foreign taxes as reported on Schedule E so that both series represent pretax earnings. The left and right panels are inclusive and exclusive of the finance and extractive industries described above, respectively.

Notably, unadjusted E&P appear to diverge from the other measures over time. The Compustat and adjusted SOI foreign income measures are more closely aligned, although SOI seems to report a slightly higher figure on average. This provides suggestive evidence that B&R's proposed correction for aggregation error is at least partially effective, removing the bulk of disagreement between data sources. Figure A.2 provides a similar figure, but with aggregate post-tax earnings (instead of pretax), demonstrating a similar pattern.

**Figure 3: Comparison of Aggregate Foreign Income (Pretax)**

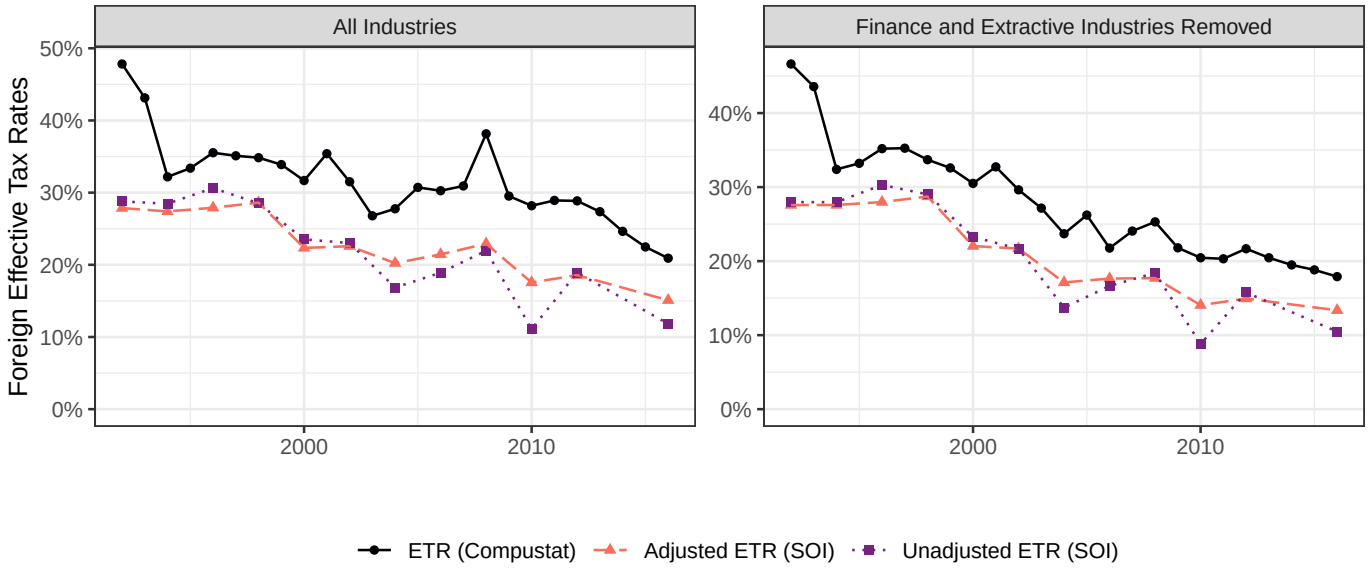



*Notes:* This figure shows three respective measures of aggregate foreign income tax: unadjusted E&P computed from IRS Form 5471, Schedule H; Schedule H E&P, adjusted to remove dividends received from related affiliates as reported on Schedule M; and aggregate foreign pretax income as reported by Compustat. Both SOI measures include foreign taxes, as reported in Schedule E, added back to represent pretax earnings. As in Figure 2, the left panel contains aggregates computed from MNCs in all industries and the right panel excludes MNCs operating in Financial, Utilities, Mining, Agriculture, or Oil & Gas. The panels indicate that the E&P adjustment proposed by B&R is at least partially effective.

Finally, Figure 4 presents a comparison of average annual foreign effective tax rates from Compustat and SOI (one adjusted for aggregation error, one unadjusted). Compared to the adjusted series, the average effective tax rate (ETR) computed from the unadjusted time series is downward-biased, as would be expected given that it overestimates the denominator. There is still considerable residual disagreement, however, when comparing adjusted ETRs from SOI with those computed from Compustat data. Compustat estimates are much higher throughout the sample period. This is a result of its higher tax estimates (Figure 2) and lower foreign earnings estimates (Figure 3).

Which source is more reliable? We do not have a full explanation for the remaining aggregate differences, but the Compustat series appear to be much noisier than aggregate series computed from tax data. Finance and extractive industries distort aggregate rates upward in both Compustat and SOI data, but the distortion is much more evident in Compustat data, generating what seem to be unrealistically high average rates in certain periods. This suggests that reporting of foreign taxes and income in public filings may be less consistent and comparable over time relative to tax data.

**Figure 4: Comparison of Aggregate Foreign Effective Tax Rates**



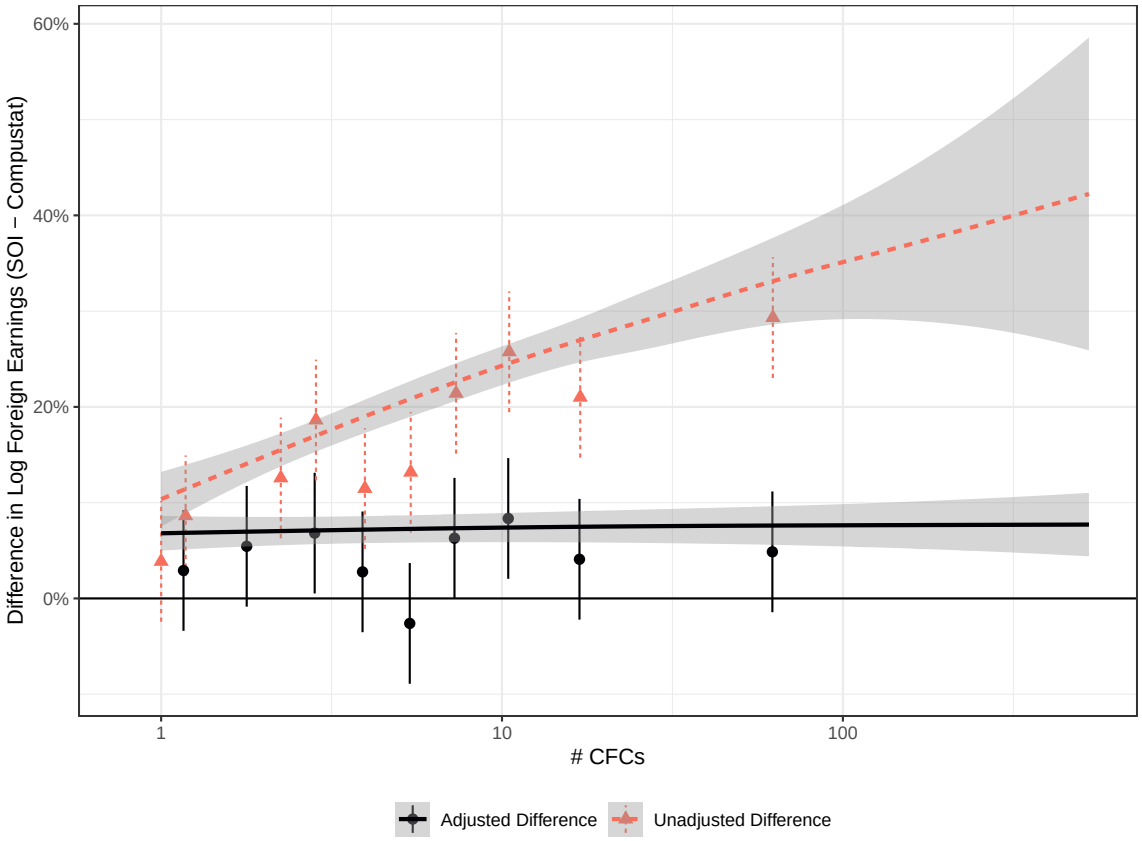

*Notes:* This figure presents a comparison of average foreign effective tax rates from Compustat, SOI (adjusted for aggregation error), and SOI (unadjusted). These tax rates are based on pretax income as reported in Figure 3 and foreign tax as reported in Figure 2. The left panel contains aggregates computed from MNCs in all industries and the right panel excludes MNCs operating in Financial, Utilities, Mining, Agriculture, or Oil & Gas. The panels demonstrate that lack of adjustment to the SOI data creates downward bias in the tax rate estimates. Alternately, they also show that comparatively higher taxes and lower foreign income in the Compustat data lead to larger Compustat ETR estimates than adjusted or unadjusted SOI.

## 3.3 Measurement Error and MNC Corporate Complexity

In this section, we show that aggregation error is closely related to the size of MNCs' foreign networks. More complex foreign networks create more potential for double counting, as dividends may be reported on the books of a potentially large number of foreign affiliates. Once foreign earnings are adjusted to remove related dividends, however, there is no evidence that residual measurement error is systematically related to the complexity of an MNC's affiliate structure. Furthermore, we show that these adjustments result in residual measurement error that appears to be roughly constant over time. These results are encouraging for researchers, as they suggest that standard techniques to control for time-invariant heterogeneity and measurement error may be valid.

The aggregate trends shown above suggest that aggregation error primarily distorts estimates of foreign earnings, not foreign taxes. Given that the primary mechanism behind aggregation error relates to the double counting of foreign earnings that are distributed up through an MNC's foreign ownership network, we would expect aggregation error to increase with the size of an

**Figure 5: SOI/Compustat Foreign Earnings Differential**

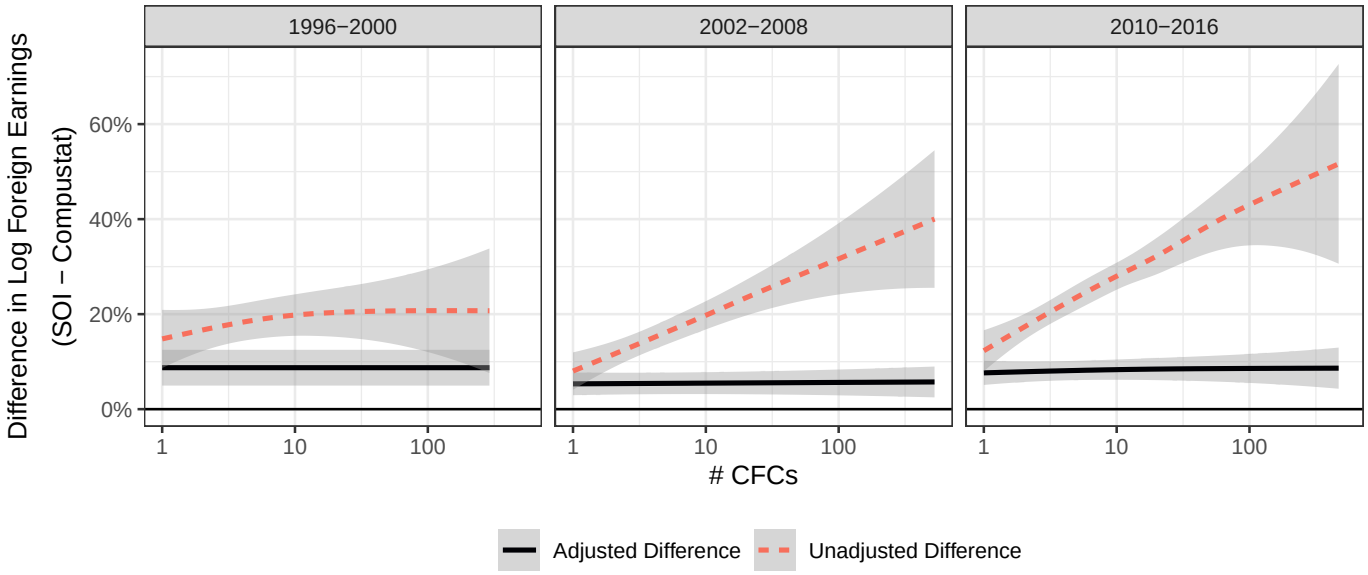



*Notes:* This figure presents the results of two cubic spline regressions where the dependent variable is the difference between log SOI foreign E&P and log Compustat foreign income. The orange line represents the estimates of a regression using unadjusted SOI E&P, while the black line uses adjusted SOI E&P. The orange triangles and black circles represent respective binscatter estimates produced for MNCs in 10 quantiles of foreign affiliate network size, as measured by the number of CFCs in the SOI data. The upward trend in the orange line and binscatter estimates indicates that aggregation error increases with the size of an MNC's foreign affiliate network. Alternately, the flat spline of the adjusted E&P regression indicates that residual differences between Compustat estimates are unrelated to a firm's foreign affiliate network size.

MNC's foreign affiliate network. Figure 5 confirms that this is the case. The orange line and surrounding ribbon plot the estimates of a cubic spline regression. The dependent variable is the difference between log unadjusted foreign E&P as reported in SOI and log foreign income as reported in Compustat. The orange triangles are binscatter estimates produced for MNCs in 10 quantiles of foreign affiliate network size, as measured by the number of opaque foreign entities (CFCs) in the tax data. Note that there is a clear upward trend, indicating that aggregation error is closely related to MNCs' foreign network size.

The black line and circles plot the same statistics computed for a dependent variable that uses adjusted SOI E&P. The spline is flat, suggesting that the residual differences between Compustat estimates are unrelated to the complexity of a firm's foreign network. If this adjustment were

**Figure 6: SOI/Compustat Foreign Earnings Differential by Period**




*Notes:* This figure plots the same spline estimates as Figure 5 above, split into three time periods. The increase in the slope of the orange line over the three periods further confirms that aggregation error in the unadjusted SOI data has been increasing over time. However, the roughly constant black line indicates that residual measurement error has not been increasing.

imperfect, and missed a portion of double-counted profits, we would expect this slope to perhaps be attenuated but not flat.

Even though the slope is flat, the black line does appear to be significantly positive, indicating that SOI foreign earnings are on average about 8% larger than the figures reported in Compustat. One reason for this may be that tax data include earnings by foreign affiliates that are associated with sales to US-based customers. These sales would be accounted for on the books of foreign affiliates, but might not be reported as foreign income on a firm's consolidated public filings.

Figure 6 plots spline estimates for the same sample, but split into three distinct periods. This confirms that aggregation error has been increasing over time, as reflected by the increasing slope of the orange splines. Adjusted E&P, however, remains flat and roughly constant at the same level. This again suggests that residual measurement error has not been increasing over time, and instead might be due to other reporting differences between tax and public filings.

Table 2 provides a regression formulation of the graphical analysis shown above that estimates the following specification,

$$\log(\Pi_{it}^{f,\text{SOI}}) - \log(\Pi_{it}^{f,\text{Compustat}}) = \beta \log(N_{it}^{\text{CFC}}) + \mu_t + u_i. \tag{1}$$

**Table 2: Measurement Error and MNC Foreign Affiliate Network Size**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| (Intercept) | 0.095*** | 0.082** | | | 0.081*** | 0.079*** | | |
| | (0.027) | (0.027) | | | (0.016) | (0.016) | | |
| Log # CFCs | 0.043*** | −0.001 | 0.043*** | −0.012 | 0.047*** | 0.005 | 0.050*** | 0.000 |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.005) | (0.005) | (0.006) | (0.005) |
| Num. Obs. | 9993 | 9993 | 9993 | 9993 | 9040 | 9040 | 9040 | 9040 |
| FE: year | | | X | X | | | X | X |
| Remove Outliers: | - | - | - | - | Yes | Yes | Yes | Yes |
| Adjusted Earnings | - | Yes | - | Yes | - | Yes | - | Yes |

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

*Notes:* This table displays coefficients from regressions of the form 1. The dependent variable is the difference between log SOI foreign E&P and log Compustat foreign income. Odd columns use unadjusted SOI E&P and even columns use adjusted SOI E&P. Columns (3), (4), (7), and (8) add year fixed effects, and Columns (5) through (8) remove MNCs operating in Financial, Utilities, Mining, Agriculture, or Oil & Gas. *, **, and *** denote statistical significance at the 10, 5, and 1% level.

Again, the dependent variable is the difference between log foreign E&P as reported in SOI and log foreign income as reported in Compustat. Odd columns use unadjusted E&P and even columns introduce the double counting adjustment. The independent variable is the log of the number of CFCs in a firm-year. For the unadjusted difference, the coefficients on this variable are positive, with large t-statistics. The adjusted coefficients, however, are close to zero with narrow confidence intervals. Columns (3), (4), (7), and (8) include the year fixed effects $\mu_t$, and Columns (5) through (8) remove the industries excluded in the aggregate plots shown in the previous section.

# 4 Measurement Error and Tax Elasticities of Foreign Income

In the previous section, we show that introducing a simple correction to remove related dividends appears to remove systematic aggregation error in the measurement of foreign earnings in tax data. In this section, we recompute tax semi-elasticities of foreign earnings following the methodology in Dowd, Landefeld and Moore (2017, henceforth DLM). DLM use unadjusted earnings and a simple regression framework to examine how sensitive the allocation of MNC earnings are to average and statutory tax rates by country. First, we attempt to reproduce their results without any alterations using unadjusted earnings. DLM show that foreign earnings are more sensitive to tax rates in jurisdictions typically classified as tax havens. We construct a

sample that is nearly identical to theirs, and obtain similar regression results with their aggregation process. We then modify their approach to utilize adjusted foreign earnings that remove aggregation error. Although this adjustment does result in noticeably different estimates, their general findings are robust to this measurement error.

Notably, our finding that DLM's results are robust to measurement error is different than the takeaway from B&R, who use BEA data to demonstrate that, once aggregation error is taken into account, multinationals do not appear to be more sensitive to rate changes in haven jurisdictions. One reason for this could be specification error—B&R run country-level regressions. We examine a similar specification that continues to show larger elasticities in tax haven jurisdictions. We discuss why this might be the case: the apparent contradiction can be resolved by understanding how foreign earnings are geographically classified in BEA vs. tax data.

## 4.1 Sample Construction

DLM provide a clear description of how they construct their sample. This allows us to nearly replicate their analysis sample with data from Form 5471. They start with a sample of opaque foreign affiliates (CFCs) with positive foreign earnings for MNCs that do not operate in extractive industries, finance, insurance, or utilities. As shown in Section 3, this appears to be a reasonable selection criterion given that tax reporting can be quite different for these industries. DLM require that at least 10 CFCs operate in countries that are included in the analysis.[7] They also require that CFCs report positive amounts for wages and tangible assets.[8]

Table A.1 contains three iterations of relevant sample statistics from DLM, Table 1. First, we show the unadjusted DLM sample statistics. Second, we reproduce these statistics. There are some small differences between the samples—ours is slightly smaller (90,746 vs. 96,959 in their sample), which may be due to differences in how they classify industries.[9] Overall, however, the summary statistics are very close.

[7] This meets standard criteria for disclosure rules from the SOI.

[8] Assets are reported on the balance sheet disclosed on Form 5471, Schedule F. Tangible assets are calculated as the sum of end-year figures for buildings and other depreciable assets, depletable assets, and land (Sch. F, lines 8a, 9a, and 10 on the 12-2007 revision of the form). Although DLM indicate that depreciation is removed, we obtain similar summary statistics only when computing tangible assets before removing accumulated depreciation and depletion and proceed with the analysis accordingly. Wages are computed from the income statement disclosed in Schedule C (line 10 on the 12-2007 revision, "Compensation not deducted elsewhere").

[9] DLM do not provide the exact industry codes that they exclude in their analysis.

Finally, we produce a similar sample using adjusted foreign earnings.[10] Unsurprisingly, average profits are lower. The sample size is also somewhat smaller due to the fact that foreign earnings for a small part of the sample become negative once the adjustment is introduced.

## 4.2 Corrected Measurements of Tax Semi-Elasticities of Foreign Earnings

### Adjusted Estimates from DLM

We use the samples described above to estimate the regression,

$$\log \pi_{ict} = \alpha + \beta_1 \log K_{ict} + \beta_2 \log L_{ict} + \beta_3(1 - \tau_{ct}) + \beta_4 X_{ct} + \mu_t + \psi_g + \epsilon_{it}, \tag{2}$$

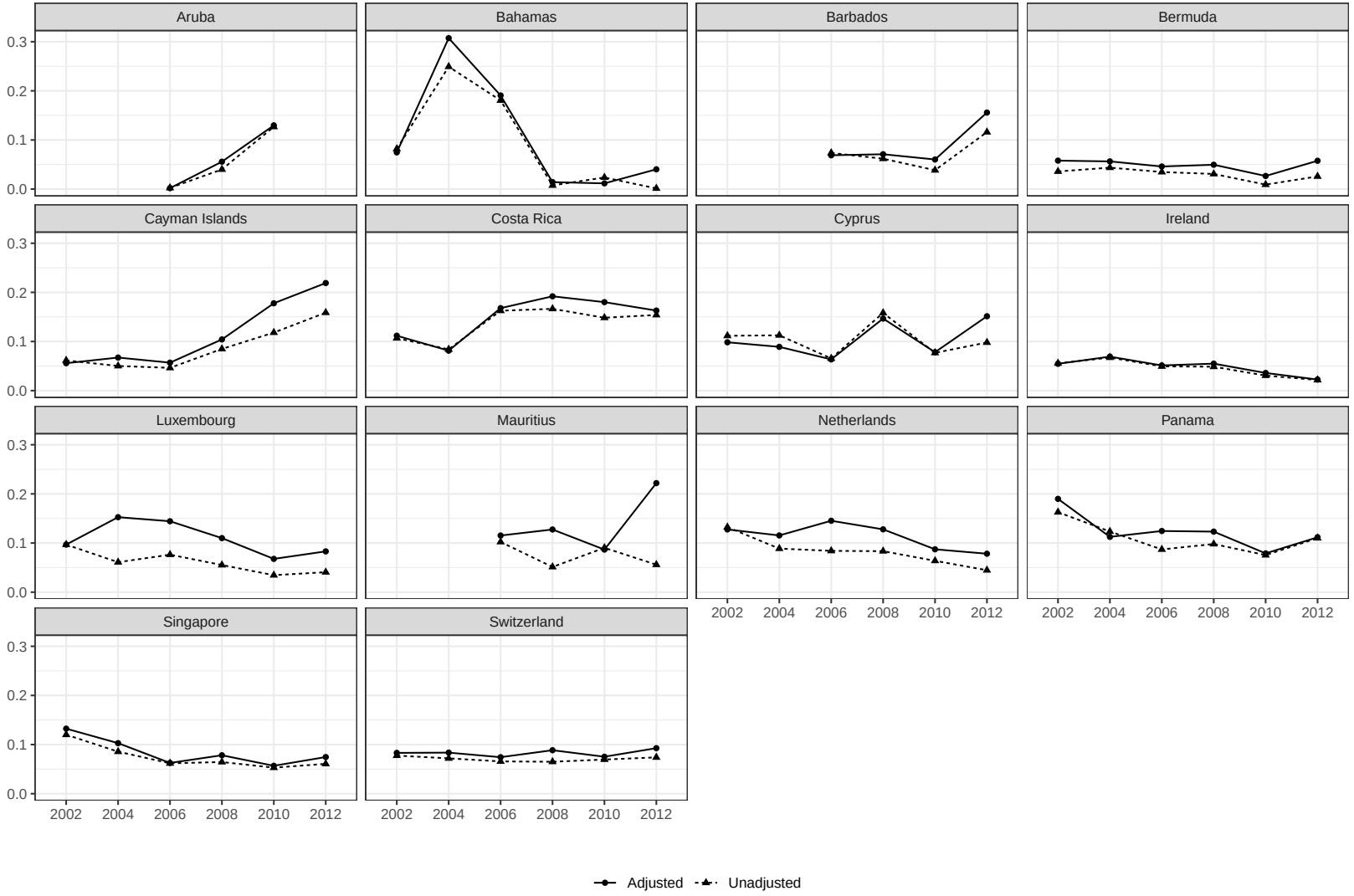
where $\pi_{it}$ are profits, $K_{it}$ are tangible assets, $L_{it}$ is the wage bill, and $\tau_{ct}$ is either the average tax rate faced by CFCs incorporated in jurisdiction $c$ or the statutory rate for country $c$ in period $t$. $X_{ct}$ is a vector of country-level controls that includes a second-order polynomial of GDP per capita and population. $\mu_t$ is a year fixed effect and $\psi_g$ is a multinational fixed effect. As in DLM, $\beta_3$ is the parameter of interest. This parameter captures how sensitive MNC profit allocations are to tax rates. In practice, when using average tax rates, $\tau_{ct}$ is computed using a jackknife procedure to remove the effect of firm $i$ on its own average rate.

Figure 7 shows average tax rates for the set of tax havens considered in DLM. After implementing the correction for aggregation error, these estimates generally increase. This is expected, given that aggregation error increases the denominator of ETR estimates, while leaving the numerator unchanged, creating downward bias.[11]

[10] We make two adjustments to DLM's measurement of foreign earnings. They use pretax income disclosed in the income statement (Schedule C). We instead use foreign earnings and profits (E&P), disclosed on Schedule H, and remove related dividends disclosed on Schedule M. B&R suggest that E&P is reported in a more consistent manner than the earnings figure reported on Schedule C.

[11] We also include Netherlands in this figure given its importance as a domicile for the hybrid tax planning structures, although it is not classified as a tax haven for the DLM-style regressions for comparability.

## Figure 7: Adjusted and Unadjusted Average Tax Rates for Selected Haven Jurisdictions




*Notes:* This figure presents adjusted and unadjusted average tax rates over time for the set of tax haven countries we consider in our DLM-style regression analysis (Equation 2), as well as the Netherlands.

We also run two modified specifications that are also presented by DLM. The first allows the intercept and $\beta_3$ to vary according to whether country $c$ is classified as a tax haven,

$$\log \pi_{ict} = \alpha_h + \beta_1 \log K_{ict} + \beta_2 \log L_{ict} + \beta_{3,h}(1 - \tau_{ct}) + \beta_4 X_{ct} + \mu_t + \psi_g + \epsilon_{it}. \tag{3}$$

Note that the only difference between equation Equation 2 and Equation 3 is the addition of $h$ subscripts on $\alpha$ and $\beta_3$. The second allows for a second-order polynomial in the keep rate,

$$\log \pi_{ict} = \alpha_h + \beta_1 \log K_{ict} + \beta_2 \log L_{ict} + \beta_3(1 - \tau_{ct}) + \gamma_3(1 - \tau_{ct})^2 + \beta_4 X_{ct} + \mu_t + \psi_g + \epsilon_{it}. \tag{4}$$

Existing literature interprets $\beta_3$ as a semi-elasticity. Here, we do not emphasize a causal interpretation, which would require conditional exogeneity of $\tau_{ct}$.[12] Instead, we focus on whether these parameter estimates are sensitive to measurement error.

Table 3 shows estimates for specification Equation 2 using both unadjusted and adjusted earnings. Columns (1) and (3) present estimates using statutory rates, and Columns (2) and (4) present estimates using average rates. The coefficient for the keep rate in the adjusted regression is slightly larger, but close in magnitude to the unadjusted estimates.

Table 4 presents unadjusted and adjusted results for specification Equation 3, following the haven classification of Gravelle (2013). This classification includes Aruba, the Bahamas, Barbados, Bermuda, the Cayman Islands, Costa Rica, Cyprus, Ireland, Luxembourg, Mauritius, Panama, Singapore, and Switzerland. The coefficients on the interaction term are large and significant, which replicates the general findings of DLM. This suggests that foreign earnings are more sensitive to changes in tax rates within havens. Table A.2 contains an alternate specification that uses Equation 3 but defines havens as countries in the smallest decile of the tax rate distribution by year. Both definitions are used by DLM.

Finally, Table 5 presents unadjusted and adjusted results for specification Equation 4. As in DLM, the second-order keep rate coefficient is significant, and actually increases in magnitude for the adjusted results.

[12] One can imagine that countries who lower effective tax rates on foreign investment may also change other policy levers to attract capital, which would violate this assumption.

**Table 3: Dowd, Landefeld and Moore (2017), Table 2**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| 1-Rate | 1.293*** | 0.740*** | 1.308*** | 0.836*** |
| | (0.150) | (0.086) | (0.155) | (0.102) |
| Log capital | 0.321*** | 0.320*** | 0.317*** | 0.317*** |
| | (0.009) | (0.009) | (0.009) | (0.009) |
| Log wages | 0.394*** | 0.393*** | 0.391*** | 0.390*** |
| | (0.012) | (0.012) | (0.013) | (0.013) |
| GDP per capita | 4.866*** | 2.432+ | 4.159** | 2.291+ |
| | (1.329) | (1.313) | (1.384) | (1.388) |
| GDP per capita sq. | 53.218*** | 72.183*** | 46.753** | 61.697*** |
| | (15.239) | (15.468) | (15.108) | (15.662) |
| Population | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Population sq. | 0.000*** | 0.000** | 0.000*** | 0.000** |
| | (0.000) | (0.000) | 0.000*** | 0.000** |
| Sample | Unadjusted | Unadjusted | Adjusted | Adjusted |
| Num.Obs. | 90,746 | 90,746 | 88,801 | 88,801 |
| R2 Within | 0.463 | 0.463 | 0.457 | 0.457 |
| ETR | Statutory | Average | Statutory | Average |

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

*Notes:* This table displays coefficients from regressions under Equation 2. The dependent variable is log profits for MNC $i$ in country $c$ in period $t$, using unadjusted (Columns (1) - (2)) or adjusted (Columns (3) - (4)) SOI foreign E&P. The parameter of interest, 1-Rate, captures the sensitivity of MNC profit allocation to changes in tax rates. Odd columns present estimates using statutory tax rates and even columns present estimates using average rates. *, **, and *** denote statistical significance at the 10, 5, and 1% level.

### Country-Level Regressions

B&R also estimate DLM-style regressions using corrected data from the BEA, and show that there is no evidence for heterogeneity once estimates of net income are corrected to adjust for aggregation error. One reason for this may be differences in specification. B&R estimate country-level regressions of the form,

$$\log \pi_{ct} = \alpha + \beta_1 \log K_{ct} + \beta_2 \log L_{ct} + \beta_3(1 - \tau_{ct}) + \beta_4 X_{ct} + \mu_t + \gamma_c + \epsilon_{ct}, \tag{5}$$

where the dependent variable is aggregate foreign earnings for foreign affiliate located in country $c$ in year $t$. They present results inclusive and exclusive of country fixed effects $\gamma_c$.

We aggregate the sample described in the previous section to the country level, and estimate

**Table 4: Dowd, Landefeld and Moore (2017) Table 4**
**Using Gravelle (2013) Haven Definition**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Haven | −1.997*** | −2.631** | −2.361*** | −1.543* |
| | (0.410) | (0.971) | (0.397) | (0.728) |
| 1-Rate | 0.539** | 0.578*** | 0.418* | 0.605*** |
| | (0.182) | (0.089) | (0.182) | (0.112) |
| Haven × 1 - Rate | 2.657*** | 3.020** | 3.144*** | 1.872* |
| | (0.519) | (1.054) | (0.502) | (0.804) |
| Log capital | 0.319*** | 0.320*** | 0.316*** | 0.316*** |
| | (0.009) | (0.009) | (0.009) | (0.009) |
| Log wages | 0.395*** | 0.393*** | 0.392*** | 0.391*** |
| | (0.012) | (0.012) | (0.013) | (0.013) |
| GDP per capita | 3.566** | 3.233* | 2.626+ | 2.559+ |
| | (1.318) | (1.318) | (1.361) | (1.382) |
| GDP per capita sq. | 50.850*** | 48.653** | 44.019** | 47.561** |
| | (15.208) | (15.383) | (14.896) | (15.555) |
| Population | 0.001*** | 0.001*** | 0.001** | 0.001*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Population sq. | 0.000** | 0.000*** | 0.000** | 0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Sample | Unadjusted | Unadjusted | Adjusted | Adjusted |
| Num.Obs. | 90,746 | 90,746 | 88,801 | 88,801 |
| R2 Within | 0.464 | 0.463 | 0.458 | 0.457 |
| ETR | Statutory | Average | Statutory | Average |

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

*Notes:* This table displays coefficients from regressions under Equation 3. The dependent variable is log profits for MNC $i$ in country $c$ in period $t$, using unadjusted (Columns (1) - (2)) or adjusted (Columns (3) - (4)) SOI foreign E&P. The parameter of interest is an interaction term between 1-Rate, which captures the sensitivity of MNC profit allocation to changes in tax rates, and a dummy variable equal to one if country c is classified as a tax haven. Tax havens are classified as defined in Gravelle (2013), the same methodology used by DLM (Figure 7). Odd columns present estimates using statutory tax rates and even columns present estimates using average rates. *, **, and *** denote statistical significance at the 10, 5, and 1% level.

similar regressions, presented in Tables 6 and 7 below. Even columns in Table 6 include the haven interaction term analogous to the specification Equation 3, and the same columns in Table 7 include second-order polynomials in the tax rate analogous to specification Equation 4.[13] B&R present results with respect to the tax rate (as opposed to the keep rate in prior regressions). We do the same to facilitate comparison with their results.

[13]We include the same tax havens used by B&R—Bermuda, the Cayman Islands, Ireland, Luxembourg, the Netherlands, Singapore, and Switzerland.

**Table 5: Dowd, Landefeld and Moore (2017), Table 5**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| 1-Rate | −8.847*** | −0.542+ | −9.963*** | −3.666** |
| | (1.944) | (0.291) | (1.943) | (1.150) |
| 1-Rate sq. | 6.764*** | 0.885*** | 7.521*** | 2.916*** |
| | (1.320) | (0.211) | (1.316) | (0.751) |
| Log capital | 0.320*** | 0.320*** | 0.317*** | 0.317*** |
| | (0.009) | (0.009) | (0.009) | (0.009) |
| Log wages | 0.394*** | 0.393*** | 0.391*** | 0.391*** |
| | (0.012) | (0.012) | (0.013) | (0.013) |
| GDP per capita | 4.512*** | 2.514+ | 3.755** | 2.365+ |
| | (1.336) | (1.311) | (1.388) | (1.389) |
| GDP per capita sq. | 47.706** | 67.960*** | 40.917** | 57.132*** |
| | (15.173) | (15.392) | (14.880) | (15.498) |
| Population | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Population sq. | 0.000** | 0.000** | 0.000** | 0.000** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Sample | Unadjusted | Unadjusted | Adjusted | Adjusted |
| Num.Obs. | 90,746 | 90,746 | 88,801 | 88,801 |
| R2 Within | 0.464 | 0.463 | 0.458 | 0.457 |
| ETR | Statutory | Average | Statutory | Average |

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

*Notes:* This table displays coefficients from regressions under Equation 4. The dependent variable is log profits for MNC $i$ in country $c$ in period $t$,using unadjusted (Columns (1) - (2)) or adjusted (Columns (3) - (4)) SOI foreign E&P. The parameter of interest, 1-Rate, is the semi-elasticity of sensitivity of MNC profit allocation to changes in tax rates. Odd columns present estimates using statutory tax rates and even columns present estimates using average rates. *, **, and *** denote statistical significance at the 10, 5, and 1% level.

In both tables, Columns (1) through (4) present estimates using unadjusted foreign earnings, and Columns (5) through (8) present estimates using adjusted foreign earnings. As in B&R, estimates are computed with and without country fixed effects. Table 6 demonstrates that, unlike B&R, the coefficient on the haven interaction remains large and significant, although slightly attenuated. Results in Table 7 are mixed—the adjusted estimates appear to weaken the non-linear term.

**Table 6: Replication of Blouin and Robinson (2020) Table 2, Panel A**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| ETR | −2.833** | −1.173+ | −2.706* | −2.644** | −2.313*** | −1.581* | −2.445* | −2.414* |
| | (0.480) | (0.575) | (0.678) | (0.631) | (0.286) | (0.408) | (0.641) | (0.675) |
| Haven × ETR | | −12.099* | | −11.802+ | | −9.054** | | −8.290* |
| | | (3.020) | | (4.872) | | (1.948) | | (2.420) |
| Log capital | 0.480*** | 0.437** | 0.370* | 0.341* | 0.426*** | 0.390*** | 0.160 | 0.123 |
| | (0.067) | (0.084) | (0.128) | (0.129) | (0.044) | (0.043) | (0.171) | (0.165) |
| Log wages | 0.549** | 0.554** | 0.358 | 0.294 | 0.604*** | 0.606*** | 0.358 | 0.360 |
| | (0.098) | (0.110) | (0.258) | (0.268) | (0.056) | (0.068) | (0.234) | (0.248) |
| GDP per capita | −0.177+ | −0.167+ | −0.009 | 0.010 | −0.158+ | −0.135+ | −0.179 | −0.128 |
| | (0.085) | (0.070) | (0.069) | (0.085) | (0.068) | (0.053) | (0.130) | (0.104) |
| GDP per capita sq. | 0.024* | 0.014 | 0.008 | 0.003 | 0.025** | 0.012* | 0.021* | 0.012+ |
| | (0.009) | (0.008) | (0.006) | (0.007) | (0.006) | (0.004) | (0.008) | (0.005) |
| Population | 0.137 | 0.105 | −0.277 | 0.227 | 0.169 | 0.199 | −3.250 | −2.974 |
| | (0.104) | (0.071) | (2.183) | (1.919) | (0.153) | (0.138) | (1.623) | (1.546) |
| Population sq. | −0.012 | −0.008 | 0.016 | 0.001 | −0.014 | −0.016 | 0.131 | 0.122 |
| | (0.007) | (0.005) | (0.100) | (0.091) | (0.011) | (0.010) | (0.070) | (0.068) |
| Sample | Unadjusted | Unadjusted | Unadjusted | Unadjusted | Adjusted | Adjusted | Adjusted | Adjusted |
| Num. Obs. | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 |
| Year FEs | X | X | X | X | X | X | X | X |
| Country FEs | | | X | X | | | X | X |

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

*Notes:* This table displays coefficients from regressions under Equation 5. The dependent variable is aggregate foreign earnings for a foreign affiliate located in country $c$ in year $t$. The parameter of interest is effective foreign tax rate. Even columns include the same tax haven interaction term as presented in Equation 3 (Tables 4 and A.2). Columns (1) through (4) use unadjusted SOI foreign E&P; Columns (5) through (8) use adjusted E&P. Columns (3), (4), (7), and (8) also include country fixed effects.

**Table 7: Replication of Blouin and Robinson (2020) Table 2, Panel B**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| ETR | −2.833** | −12.001** | −2.706* | −9.359+ | −2.313*** | −3.832* | −2.445* | −3.200+ |
| | (0.480) | (2.781) | (0.678) | (4.519) | (0.286) | (1.360) | (0.641) | (1.470) |
| ETR Sq. | | 18.742* | | 12.321 | | 1.760 | | 0.759 |
| | | (4.817) | | (7.329) | | (1.689) | | (1.159) |
| Log capital | 0.480*** | 0.508*** | 0.370* | 0.392* | 0.426*** | 0.442*** | 0.160 | 0.153 |
| | (0.067) | (0.071) | (0.128) | (0.136) | (0.044) | (0.041) | (0.171) | (0.175) |
| Log wages | 0.549** | 0.522** | 0.358 | 0.278 | 0.604*** | 0.594*** | 0.358 | 0.368 |
| | (0.098) | (0.096) | (0.258) | (0.271) | (0.056) | (0.054) | (0.234) | (0.245) |
| GDP per capita | −0.177+ | −0.164+ | −0.009 | −0.084 | −0.158+ | −0.153+ | −0.179 | −0.188 |
| | (0.085) | (0.079) | (0.069) | (0.069) | (0.068) | (0.067) | (0.130) | (0.119) |
| GDP per capita sq. | 0.024* | 0.019 | 0.008 | 0.009 | 0.025** | 0.023* | 0.021* | 0.020* |
| | (0.009) | (0.010) | (0.006) | (0.005) | (0.006) | (0.006) | (0.008) | (0.007) |
| Population | 0.137 | 0.079 | −0.277 | −0.278 | 0.169 | 0.194 | −3.250 | −3.442 |
| | (0.104) | (0.094) | (2.183) | (1.913) | (0.153) | (0.151) | (1.623) | (1.767) |
| Population sq. | −0.012 | −0.007 | 0.016 | 0.022 | −0.014 | −0.016 | 0.131 | 0.141 |
| | (0.007) | (0.007) | (0.100) | (0.090) | (0.011) | (0.011) | (0.070) | (0.076) |
| Sample | Unadjusted | Unadjusted | Unadjusted | Unadjusted | Adjusted | Adjusted | Adjusted | Adjusted |
| Num. Obs. | 269 | 269 | 269 | 269 | 269 | 269 | 269 | 269 |
| Year FEs | X | X | X | X | X | X | X | X |
| Country FEs | | | X | X | | | X | X |

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

*Notes:* This table displays coefficients from regressions under Equation 5. The dependent variable is aggregate foreign earnings for a foreign affiliate located in country $c$ in year $t$. The parameter of interest is effective foreign tax rate. Even columns include the same tax haven interaction term as presented in Equation 4 (Table 5). Columns (1) through (4) use unadjusted SOI foreign E&P; Columns (5) through (8) use adjusted E&P. Columns (3), (4), (7), and (8) also include country fixed effects.

# 5 Conclusion

Measurement error should be a primary concern for researchers who use accounting and tax data to study the activity of multinational firms. IRS tax data provide a wealth of information for researchers, but may generate significant measurement error if foreign earnings are improperly aggregated. This paper aims to improve the general understanding of these benefits and measurement challenges, and in particular to evaluate one potential solution for tax data aggregation error. Using a novel proxy based on a comparison with consolidated measures from public filings, we show that a simple adjustment proposed by Blouin and Robinson (2020) significantly harmonizes book and tax measures of foreign income and tax rates. After applying this correction, we find no relationship between residual book-tax differences and MNC foreign affiliate network complexity, and no increase in residual book-tax differences over time. Finally, by reproducing existing literature estimates of tax semi-elasticities across haven and non-haven jurisdictions, we show that these prior conclusions are generally robust to aggregation error.

The performance of this adjustment is encouraging for the use of IRS tax data in analyzing MNC activity. Ultimately, however, whether this is the most "correct" data source depends on the goal and estimand of the research. By shedding new light on the performance of this correction in tax data, our results can help researchers and policymakers more precisely estimate tax data outcomes and more accurately interpret different measures of MNC activity across data sources.

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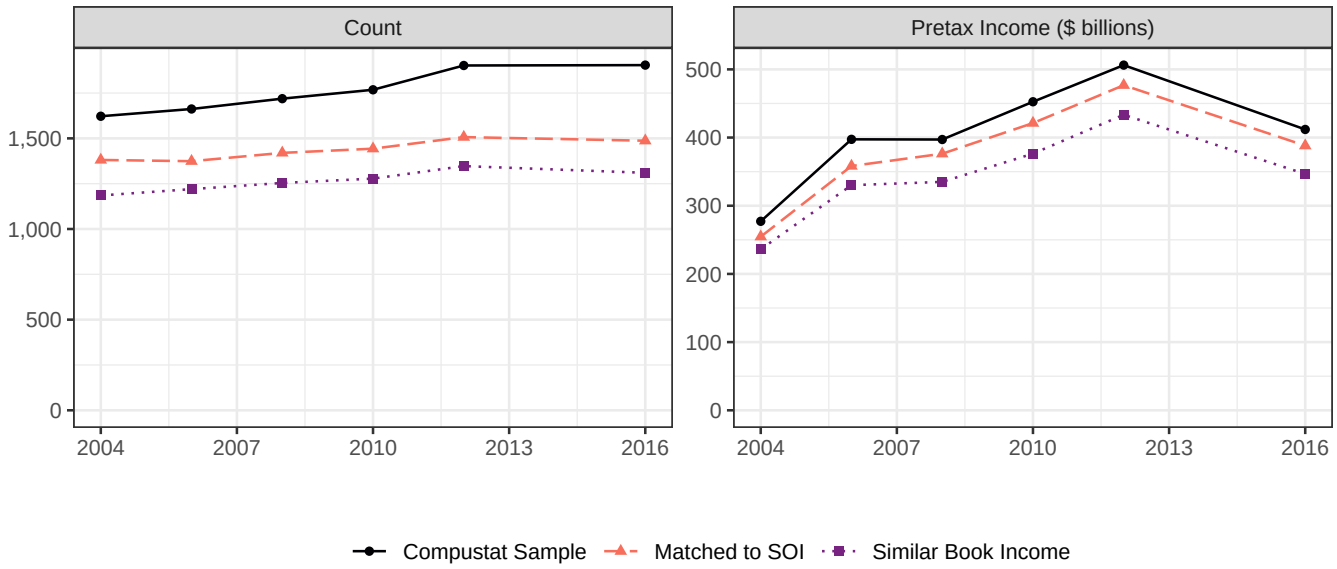
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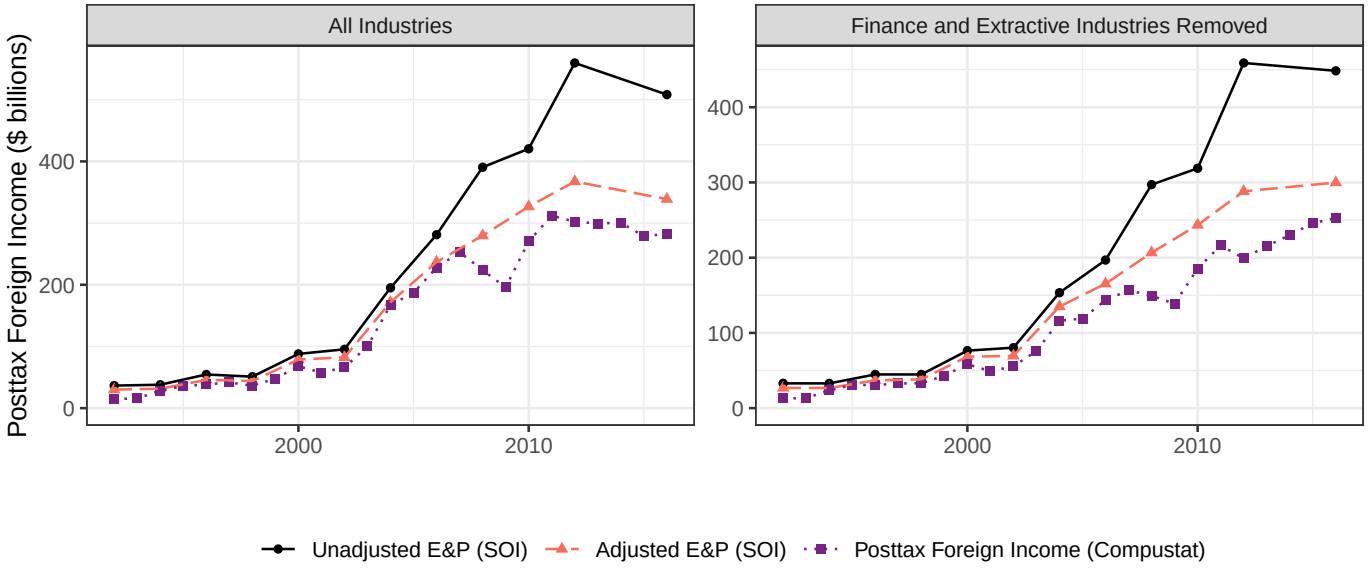
# A Additional Tables and Figures

**Figure A.1: Compustat MNCs vs. Matched Sample**




*Notes:* This figure demonstrates the attrition associated with the sample construction process, following the same methodology as described in Figure 1 but starting with the Compustat sample rather than the SOI sample. Observations reporting missing pretax foreign income are removed from the initial Compustat sample. The left panel shows sample sizes in terms of number of MNCs, while the right panel shows sample sizes in terms of pretax income. These panels show that the majority of Compustat MNCs were able to be linked to an SOI MNC, and that the match quality of linked MNCs is high.

**Figure A.2: Comparison of Aggregate Foreign Income (Post-Tax)**




*Notes:* This figure displays the same three aggregate foreign income measures as Figure 3 on a post-tax, rather than pretax, basis. It similarly underscores the effectiveness of B&R's adjustment for aggregation error in the SOI E&P data.

**Table A.1: Sample Statistics from Dowd, Landefeld and Moore (2017), Table 1**

| *Sample* | Unadjusted | | | Unadjusted (Reproduction) | | | Adjusted | | |
|---|---|---|---|---|---|---|---|---|---|
| | All | Nonhavens | Havens | All | Nonhavens | Havens | All | Nonhavens | Havens |
| Profits | 14.41 | 9.01 | 57.19 | 15.25 | 9.42 | 76.31 | 13.33 | 7.99 | 69.60 |
| Average Tax Rate | 0.17 | 0.18 | 0.08 | 0.17 | 0.18 | 0.07 | 0.20 | 0.21 | 0.08 |
| Statutory Tax Rate | 0.29 | 0.30 | 0.18 | 0.29 | 0.30 | 0.18 | 0.29 | 0.30 | 0.18 |
| Capital | 27.37 | 24.40 | 50.91 | 27.15 | 23.25 | 68.05 | 26.82 | 22.83 | 68.93 |
| Wages | 7.75 | 7.18 | 12.32 | 8.08 | 7.37 | 15.49 | 8.01 | 7.25 | 16.05 |
| GDP per capita | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.05 | 0.03 | 0.03 | 0.05 |
| Population | 150.24 | 168.54 | 5.14 | 154.50 | 168.82 | 4.60 | 156.43 | 170.83 | 4.58 |
| 2002 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.11 | 0.10 |
| 2004 | 0.16 | 0.16 | 0.15 | 0.16 | 0.16 | 0.15 | 0.16 | 0.16 | 0.15 |
| 2006 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| 2008 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.19 | 0.18 | 0.18 | 0.19 |
| 2010 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 | 0.19 |
| 2012 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Num obs. | 96,959 | 86,099 | 10,860 | 90,746 | 82,831 | 7,915 | 88,801 | 81,112 | 7,689 |

*Notes:* This table contains relevant sample statistics from DLM Table 1. DLM use a sample of CFCs with positive foreign earnings for MNCs that report positive amounts for wages and tangible assets and do not operate in extractive industries, finance, insurance, or utilities. Statistics are shown for the entire sample, for CFCs located in non-haven countries, and for CFCs located in tax havens. Columns (1) - (3) show unadjusted sample statistics. Columns (4) - (6) show our reproduction of the unadjusted sample statistics: while our sample is slightly smaller, the summary statistics are very similar between DLM's original and our reproduction. Finally, Columns (7) - (9) show sample statistics using adjusted foreign earnings data: whereas DLM use pretax income disclosed in IRS Form 5471, Schedule C, we instead use foreign E&P disclosed in Schedule H and remove related dividends disclosed in Schedule M. This results in lower average profits and a slightly smaller sample size post-adjustment.

**Table A.2: Dowd, Landefeld and Moore (2017) Table 4**
**Using Lowest Decile Haven Definition**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Haven | −1.871*** | −6.361*** | −2.706*** | −6.844*** |
| | (0.400) | (1.849) | (0.416) | (1.801) |
| 1-Rate | 0.759*** | 0.597*** | 0.735*** | 0.644*** |
| | (0.154) | (0.087) | (0.155) | (0.104) |
| Haven × 1 - Rate | 2.582*** | 6.932*** | 3.518*** | 7.499*** |
| | (0.517) | (1.961) | (0.523) | (1.933) |
| Log capital | 0.319*** | 0.319*** | 0.316*** | 0.316*** |
| | (0.009) | (0.009) | (0.009) | (0.009) |
| Log wages | 0.395*** | 0.393*** | 0.392*** | 0.391*** |
| | (0.012) | (0.012) | (0.013) | (0.013) |
| GDP per capita | 4.185** | 3.158* | 3.700** | 2.124 |
| | (1.318) | (1.319) | (1.377) | (1.387) |
| GDP per capita sq. | 49.668*** | 56.189*** | 39.629** | 60.933*** |
| | (15.077) | (15.161) | (14.897) | (15.460) |
| Population | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Population sq. | 0.000*** | 0.000** | 0.000** | 0.000** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Sample | Unadjusted | Unadjusted | Adjusted | Adjusted |
| Num.Obs. | 90,746 | 90,746 | 88,801 | 88,801 |
| R2 Within | 0.464 | 0.463 | 0.458 | 0.457 |
| ETR | Statutory | Average | Statutory | Average |

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

*Notes:* This table displays coefficients from regressions under Equation 3. The dependent variable is log profits for MNC $i$ in country $c$ in period $t$, using unadjusted (Columns (1) - (2)) or adjusted (Columns (3) - (4)) SOI foreign E&P. The parameter of interest is an interaction term between 1-Rate, which captures the sensitivity of MNC profit allocation to changes in tax rates, and a dummy variable equal to one if country c is classified as a tax haven. Tax havens are defined as the countries in the smallest decile of tax rate distribution by year. Odd columns present estimates using statutory tax rates and even columns present estimates using average rates. *, **, and *** denote statistical significance at the 10, 5, and 1% level.