AN ASSESSMENT OF GLOBAL FORMULA APPORTIONMENT

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Global formula apportionment as a way to attribute taxable profits of multinationals across jurisdictions is receiving increased attention in recent debates on the future of the international tax framework. This paper exploits different data sets to assess the direct revenue implications of formula apportionment, both globally and for individual countries, under alternative formulas. The aggregate tax base is estimated to fall by approximately 10 percent due to cross-border loss consolidation. The associated loss in global corporate income tax revenue is smaller, though, between 5 and 8 percent depending on the formula, as profit shifting is mitigated. The distributional effects across countries are found to be large, reflecting major discrepancies between where profits are currently attributed and where factors of production are located or sales take place. The largest losses appear in low-tax jurisdictions and investment hubs (i.e., countries with a disproportionate ratio of foreign direct investment to gross domestic product), while several large advanced countries are likely to gain. Developing countries most likely gain if employment receives a large weight in the formula; they also tend to benefit, on average, from a formula based on sales by destination. The paper also reviews the literature on dynamic effects of formula apportionment, which may significantly alter the results based on static analysis.

Keywords: international corporate taxation, multinationals, formula apportionment

JEL Codes: F23, H25

I. INTRODUCTION

The taxation of multinational enterprises (MNEs) has traditionally been based on separate accounting (SA), under which the accounts of an MNE group are separated...
between the entities operating in different countries. Over time, to minimize their global
tax liabilities MNEs have exploited this system to engage in aggressive profit shift-
ing from entities in high-tax countries to entities in low-tax countries. Formula ap-
portionment (FA) is a prominent alternative tax regime that would reduce such tax
avoidance. This paper assesses the changes in corporate income tax (CIT) revenues
and the distribution of these revenues across countries from replacing current tax
rules with an FA-based system.

Under the current international tax framework, taxing rights of a country over
business profits depend on identifying the source of the profits and the residence
of the corporate taxpayer. Source refers to where investment is made and produc-
tion takes place. Residence means the place where the MNE is deemed to have its
primary location. By international convention, source countries have primary tax-
ing rights over active business income within their borders, subject to firms having
a sufficient physical presence (nexus). Residence countries retain the right to tax
passive income (such as interest and royalties) and may also tax foreign active in-
comes under a worldwide system. Income allocation between countries under SA
depends on the valuation of transactions among the related parties within an MNE.
Most countries rely on income allocation based on the arm’s length principle
(ALP), which stipulates that transfer prices should resemble prices that would pre-
vail between independent parties.

The SA concept implemented through the ALP has come under significant stress
in recent years (Collier and Andrus, 2017). The application of SA has become in-
creasingly complex as hard-to-value intangible assets have grown in importance.
Furthermore, allocating the returns to risk-taking under SA lacks a clear economic
rationale and leads to tax arbitrage opportunities. Internationally agreed guidelines
on how to calculate ALPs are inevitably to some extent subjective, leading to pro-
tracted disputes. The current international tax framework has also been criticized
by countries for its unfairness in light of the digitalization of the economy. Some
highly digitalized firms operate in many countries with little or no physical pres-
ence, leaving governments in such countries with no taxing rights on the profits
of these companies. One remedy for this problem would be to allocate taxing rights
of the digitalized economy differently, such as taxing based on consumption. How-
ever, the ALP is ill-suited to establish such attribution to destination countries.

The conceptual and practical difficulties associated with SA have sparked interest
in proposals for FA, under which accounts of all company’s affiliates are first con-
solidated to generate a common tax base. This is subsequently apportioned across
jurisdictions on a formulaic basis, for example, based on the share of payroll, em-
ployment, assets, and/or sales. Under FA, jurisdictions thus will need to agree on
a common base and formula but can then apply their own tax rate (and possible
tax credits) to their apportioned base.1 Subnational CITs commonly work by FA,

1 Some formulaic elements already exist under the ALP, such as the profit split method and profit at-
tribution based on functions, assets, and risk. Hence, the distinction between SA and FA might be less
for instance in countries such as Canada, China, Germany, Japan, and the United States. This may indicate that, as economic and political integration proceeds, FA may present itself as better suited than ALP for dividing profits of related companies across jurisdictions. In this spirit, the European Commission has proposed a “Common Consolidated Corporate Tax Base” (CCCTB) for the EU (European Commission, 2016). Worldwide FA has been proposed by, for example, the Independent Commission for the Reform of International Corporate Taxation (ICRICT, 2018). Several scholars have also advocated such an approach; see, for example, the contributions in Picciotto (2016).³

Introduction of FA at the international level would mean a significant departure from current practice. To inform the public debate on such a fundamental reform, careful consideration and analysis of its implications are needed. A small but growing economic literature has assessed the distributional implications of FA. Section II of this paper discusses the key findings. Section III then presents the main contribution of this paper: an assessment of the direct effect on countries’ tax revenue of replacing the current system by global FA. Compared with previous studies, we provide a more comprehensive assessment by exploiting three different data sets, each with its own merits and demerits. The analysis yields several important insights. For instance, revenue effects tend to be more positive and larger for countries with high tax rates. Low-tax countries can lose up to 80 or 90 percent of their revenue from MNEs. Developing countries are more likely to benefit from FA if the number of employees has a large weight in the formula, while the opposite holds for advanced economies. We also find that the global tax base under FA could be reduced by up to 10 percent due to cross-border loss consolidation. The associated loss in global CIT revenue is smaller, though, between 5 and 8 percent depending on the formula, as profit shifting is mitigated. While the quantitative analysis is static, dynamic effects of FA can be important. These are discussed in Section IV, based on a brief literature review.

II. EXISTING LITERATURE ON THE REVENUE IMPACT OF FA

While the principal idea of FA is straightforward, it requires numerous design choices to make it operational. First, it requires agreement across countries on the worldwide definition of taxable income of an MNE, that is, a common tax base. This could follow a common set of agreed rules, for example building on the International

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² See Matheson et al. (2021) for an overview. Mintz and Smart (2004) provide an assessment of the FA system in Canada, and Clausing (2016) of that in the United States.

³ Avi-Yonah and Clausing (2008) propose unilateral adoption of FA by the United States, i.e., the US tax base would be a fraction of the worldwide income of each MNE operating in the United States, based on the share of worldwide sales. The focus in this paper is on international adoption.
Accounting Standards. Also, a unitary group needs to be defined to determine which entities fall under FA. The unitary base could be separated between different types of income or different types of activities undertaken by the MNE. In the US FA system, for instance, a distinction is made between business income (which is consolidated) and nonbusiness income (which is directly assigned to a state). Some flexibility in the tax base definition could be achieved by allowing countries to modify their apportioned share of the unitary base, for instance by offering additional investment deductions or credits.

Once the consolidated base of MNEs is determined, a formula will allocate the base across jurisdictions using proxies for substantial economic activities. FA thus can align tax payments more closely with some observable fundamentals. Commonly used apportionment factors are production-based factors, such as payroll, employment, and assets. Another commonly used factor is sales. These can be measured either on an origin basis (where the seller resides) or on a destination basis (where the consumer resides).

For global FA, the common assumption is that countries would agree on a single apportionment formula to allocate the consolidated profit across countries. However, securing agreement on a common apportionment scheme would be extremely difficult. Some kind of equalization scheme might thus be necessary, as is adopted in Canada. Flexibility can also be created if countries can choose their own apportionment formula, as is practiced at state level in the United States. However, this can lead to either more or less than 100 percent of total profits being allocated somewhere. Divergent weights also evidently complicate implementation.

Moving from SA to FA can have three effects on global CIT revenue, namely through (1) the common tax base, (2) loss consolidation, and (3) reallocation of the tax base between countries. Regarding the first, the agreed common tax base under FA might differ from most existing tax bases of countries, which can change aggregate CIT revenue. However, the common base can be calibrated such that it

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4 FA can also allocate profit based on the residence of the company group, which is the case in, e.g., China. Intangible assets are usually excluded because they are hard to value and relatively easy to relocate. To the extent that intangible assets derive from employment (R & D workers) or tangible investments (such as laboratories), they are already captured by those other factors.

5 Risks of tax planning may arise by not selling directly to consumers in high-tax countries but by channeling sales through unrelated firms based in low-tax countries. Note that any form of destination-based profit taxation requires amendment of the nexus definition in tax treaties. In the United States, many states use throwback rules that attribute taxable income back to the source state if a company has no nexus in the state where the goods are sold.

6 In existing FA systems, there are often special formulas applied to particular sectors. For instance, the formula factors applied to the financial sector are generally modified, as fixed assets comprise only a small fraction of total assets of financial companies (most of their assets are based on loans and deposits) while sales are of a different nature than for other companies (receipts come mainly from margins on interest, money market instruments, or credit cards). For extractive industries, the formula is often adjusted to reflect that natural resources generate location-specific rents for the source jurisdiction.
yields the same aggregate profit tax base as under current rules, which is what is assumed in our analysis (and is also the implicit assumption in previous papers).

Regarding the second effect, CIT systems usually do not grant an immediate tax refund if a corporation suffers a loss. Instead, they generally offer limited loss carryforward, without indexation for interest. Under SA, this limitation to loss offset applies separately to each subsidiary or, if there is domestic group taxation, to the group of subsidiaries within a country. Under FA, however, profits and losses within a group are immediately offset into the consolidated account, reducing the overall tax base of the MNE under FA. Fuest, Hemmelgarn, and Ramb (2007) assess the base effect of loss consolidation in the EU, using data for German MNEs. They find a reduction in the EU-wide CIT base of more than 20 percent. Model simulations with a computable general equilibrium (CGE) model for Europe by Bettendorf et al. (2010) yield a smaller reduction of close to 7.5 percent in the long term, that is, when the stock of loss carryforward from past years has stabilized. Cobham and Loretz (2014) use a larger set of unconsolidated firm-level data from Orbis to assess the effect of global FA and report a loss of around 10 percent.

The third direct effect on CIT revenue is due to the reallocation of the tax base between countries. This can (partly) offset the impact of a narrower tax base if the base is shifted from low- to high-tax countries, because this will boost aggregate CIT revenue. Such an effect would be plausible if profit shifting is important under SA. However, if profit shifting is less important, a reallocation may also occur from high- to low-tax countries and thus magnify the revenue loss from a narrower tax base. For the EU, Devereux and Loretz (2008) find that the reallocation effect goes from low- to high-tax countries. In fact, this relocation effect more than offsets the effect of loss consolidation, and EU-wide tax revenues will rise by 2 percent due to FA. For global FA, Cobham and Loretz (2014) also report a net increase in total tax revenue of between 2 and 4 percent.

Several studies have analyzed the distributional implications of FA, especially for regional implementation in Europe. They generally ignore behavioral responses and focus mostly on allocations based on production factors. Fuest, Hemmelgarn, and Ramb (2007) find that small European countries such as Ireland and the Netherlands would lose part of their tax base under FA, while large countries such as Germany, Italy, France, and the United Kingdom would benefit. Devereux and Loretz (2008) show that, irrespective of the apportionment factors used, Belgium, Denmark, Finland, Germany, Greece, Italy, and Luxembourg would see a reduction in tax revenues, while Spain, Sweden, the United Kingdom, and some countries in central and eastern Europe would experience an increase. The International Monetary

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7 The impact of loss consolidation depends on the extent of profit shifting under SA, as losses may already be more concentrated in high-tax countries. Other nonlinearities in the system (e.g., differential rates) might also influence profit allocation under SA and FA in different ways.

8 Mardan and Stimmelmayr (2018) show that the revenue loss from loss consolidation might be more than offset in the longer term as MNEs reoptimize their strategies and governments their policies.
Fund (IMF, 2014) and Cobham and Loretz (2014) report gains associated with changes in the tax base mostly in large economies with relatively high tax rates and losses in small countries with relatively low tax rates. Faccio and Fitzgerald (2018) find significant gains for Germany and the United Kingdom and losses for Luxembourg and Malta, exploiting country-by-country reports of Vodafone.

This paper builds on these earlier studies by simulating the revenue effects of global FA, both in the aggregate and for individual countries. Instead of relying on one single data set for a selection of multinationals, we exploit three independent data sets. Thus, we aim to infer the systematic factors determining the revenue effects of FA when using alternative sources of information, while also identifying differences. Compared with prior studies using some of these data sets, we also improve upon some methodological aspects.

III. A QUANTITATIVE REVENUE ASSESSMENT OF GLOBAL FA

This section explores the effects of FA on tax revenue, both of individual countries and globally. The analysis is static in that it ignores behavioral responses. The analysis also assumes, for simplification, that there is no additional taxation of multinational profits in the home country, that is, it assumes that all countries use the territorial approach to taxing foreign earnings.

A. Data

We exploit three data sets to analyze the revenue impact of FA: (1) firm-level data from Orbis, which captures the global activities of a large group of MNEs, mainly from Europe; (2) aggregate data from the Bureau of Economic Analysis (BEA), which provides country-level information on the key financial activities of all majority-owned affiliates of US MNEs worldwide; and (3) aggregate data from the Internal Revenue Service (IRS) based on country-by-country reports by US MNEs with revenue greater than US$850 million. While none of these data sets provide a comprehensive coverage of the worldwide population of MNEs, they complement each other by allowing for analysis of different aspects of FA. For instance, the firm-level data in Orbis can be used for an assessment of loss consolidation; the BEA data is the only data set that provides information about sales by destination; and the IRS data set is based on tax returns and has the widest coverage of countries. Both the Orbis data and the BEA data use the pretax income reported in companies’ financial statements as a proxy for their taxable income. Pretax income may deviate from the true CIT tax base due to the divergent reporting in financial and tax accounts (book-tax differences). While the book-tax difference adds noise to the measurement of true taxable income, we expect it to have a much smaller impact on the revenue implication of our analysis as we express the change in the CIT

* The three data sets together still do not provide universal coverage.
revenue from moving to FA as a percentage of current CIT revenue. Hence, the extent of book-tax difference is in relative terms and in general should be much smaller than the absolute level. Blouin and Robinson (2019) caution for the use of net income from BEA data to calculate the extent of profit shifting due to double (or more) counting of profits from equity investment in affiliates. The revenue estimates presented here are based on the profit-type return series from the BEA, which is not subject to the same critique; neither is the country-by-country reporting data from the IRS.10

1. Orbis

We use a large sample of all MNE subsidiaries in the Orbis database, provided by Bureau van Dijk (BVD).11 We match the unconsolidated financial report in each subsidiary-year with the corresponding consolidated accounts of their parent company, using the BVD identifier of the parent company, whenever available. We then restrict the sample to include only subsidiaries for which the sum of employment within each MNE group represents at least 70 percent of total employment reported in the consolidated account. While this restricts the size of the sample for analysis, it overcomes the well-known caveat that the coverage of Orbis is limited for some MNEs and ensures that the unconsolidated accounts of individual subsidiaries are representative of the worldwide operation of the MNE group.12 On the other hand, while Orbis provides consistent information on a large number of firms in Europe, it does not include much information about small low-tax jurisdictions (see, e.g., Tørsløv, Wier, and Zucman, 2018). The revenue analysis using Orbis may therefore underestimate the magnitude of revenue gains for many countries, as most tax avoidance occurs with counterparties in these low-tax jurisdictions (Davies et al., 2018).

The final sample comprises 58,345 unique companies in 7,772 MNE groups during 2011–2016. Table 1 shows the distribution of firms in broad country groups, where columns depict the location of the respective subsidiary, while the rows show the location of the ultimate parent company. The final sample mainly consists of subsidiaries of European MNEs. Nevertheless, the data set provides some information on their activities in the rest of the world, including in many emerging economies, and on the worldwide activities of 9,881 subsidiaries from more than 2,000 non-European MNEs.

10 While this addresses the issue of double counting, Clausing (2020) notes that adjusting for equity income or using profit-type return would not capture all foreign-to-foreign profit shifting. She also provides a more in-depth discussion of the properties of BEA and IRS data.

11 All subsidiaries are majority owned by their ultimate parent company, either directly or indirectly. An MNE group is defined as a corporate group that owns at least one subsidiary in a different country than where the parent company resides.

12 This selection process differs from Cobham and Loretz (2014), who include all MNE subsidiaries in their sample. On average, companies selected in our sample are considerably larger in terms of turnover, fixed assets, and number of employees than in their analysis.
2. Bureau of Economic Analysis

The BEA publishes annual data on the aggregate finances and operations of US-based MNEs, with separate statistics for US parent companies and their majority-owned foreign affiliates in 199 countries.\(^\text{13}\) For affiliates in 52 countries, there is detailed information on the foreign income tax paid by all affiliates, their reported profit, and the level of fixed assets in each country. Although data availability narrows the number of countries included in our analysis, the countries with reported data make up around 92 percent of total worldwide profits of majority-owned affiliates. The BEA provides information on sales by origin as well as partial data on sales by destination. Specifically, for each country where an affiliate is located, it reports goods and services supplied to unaffiliated persons in either the United States, the host country, or other foreign countries.\(^\text{14}\) For about 10 percent of sales to unaffiliated persons, the destination country is not specified in the BEA data. However, in the benchmark survey years, data is provided on the destination region (i.e., Canada, Europe, Latin America and Other Western Hemisphere, Africa, ...

\(^{13}\) The data used for the analysis covers the entire operation of the affiliates and has not been prorated by the ownership share of the US parent.

\(^{14}\) BEA Activities of US MNEs Table II.E 2 Goods and Services Supplied by Affiliates, Country by Destination.
Middle East, and Asia Pacific) for these sales. To allocate sales to countries within each region specified by the BEA, data on bilateral exports is used.

3. Internal Revenue Service

To enhance tax transparency, the Organization for Economic Cooperation and Development (OECD) has adopted Country-by-Country (CbC) reporting by MNEs as a minimum global standard. More than 60 tax jurisdictions, including the United States, have required large MNEs to report on their income, taxes paid, and other indicators of economic activity such as employment and assets on a country-by-country basis. The IRS publishes aggregate data based on these reports covering 142 tax jurisdictions. Data are available for 2016 and 2017.16

4. Descriptive Statistics

Table 2 reports basic statistics of each of the three data sets for the profit measure, the apportionment factors, and (effective) tax rates. Panel A shows firm-level data from Orbis. We use the variable “Profit/Loss Before Taxes” to represent profits.17 Its mean value is almost US$10.5 million, but with a range between a loss of US$12.6 billion and a profit of US$31.3 billion. Overall, 27 percent of the subsidiary-year observations shows a loss. When calculating taxable profit for each subsidiary under SA (i.e., without loss consolidation but with loss carryforward), the mean is markedly higher at US$14.5 million, that is, 38 percent larger than the mean of profit/loss of all companies.18 Orbis provides information about fixed assets and employment in each subsidiary, which are the two formula factors used in our analysis.19

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15 BEA Activities of US MNEs Table II.D 7 Sales by Affiliates to Unaffiliated Foreigners in Foreign Countries Other Than the Host Country, by Country of Destination. The most recent benchmark year is 2014; benchmark surveys are completed every five years.
16 In 2020, the OECD released CbC data of 26 countries. In principle, this could be used to do a similar exercise for multiple countries. For the United States, it would also shed light on the impact of FA on the revenue from inbound investment by foreign MNEs.
17 While this is the most comprehensive measure of profit that is liable to tax in the financial statement, profit/loss before taxes does include income from equity investment and hence income from own affiliates, if any. Double counting of profits for those with affiliates would imply that total tax base when measured with earnings before tax can be overestimated. To check the robustness of our analysis, we use “Operating Revenue and Losses” as an alternate profit indicator and report the results in Appendix A (Appendices A–C are available online).
18 Our calculations assume that group relief exists at neither the domestic nor the international level. As some countries do allow for domestic relief/loss consolidation, the tax base presented here likely presents an upper bound of true tax base under SA (and the difference with FA is likely to be smaller). For example, 18 of the 27 EU member states provide a form of domestic group relief/consolidation. Only few countries currently allow for cross-border loss offsets.
19 Information about salaries is also available in Orbis but is missing for subsidiaries in many countries. We therefore do not explore formulas that include the payroll factor. Also, information about sales by destination is not available from Orbis.
Table 2  
Descriptive Statistics for Key Variables

| Panel A. The Orbis Data Set, 2011–2016 (Firm-Level Data) |
|---------------------------------|------------|------------|------------|------|------|
| Observations | Mean | Standard Deviations | Min | Max |
| Profit/loss before taxes | 241,986 | 10.49 | 190 | −12,590 | 31,260 |
| Tax base, SA | 241,889 | 14.45 | 201 | 0 | 31,260 |
| Turnover | 245,480 | 163.5 | 1,503 | 0 | 192,800 |
| Fixed assets | 245,480 | 151 | 1,799 | 0 | 129,100 |
| No. of employees | 245,480 | 349 | 3,409 | 0 | 372,562 |
| Effective tax rate, mean | 336 | 0.21 | 0.25 | 0 | 1.75 |

Panel B. The BEA Data Set, 2011–2018 (Aggregate Data per Jurisdiction/Year)*

| Economic profit | 452 | 35,279 | 148,786 | −1,162 | 1,186,068 |
| Taxable income | 405 | 33,185 | 123,844 | 11 | 848,900 |
| Payroll | 1,309 | 19,693 | 166,848 | 0 | 2,338,111 |
| Employment (‘000 persons) | 1,323 | 320 | 2,291 | 0 | 28,566 |
| Value added | 1,184 | 43,653 | 325,549 | −8,909 | 4,207,521 |
| Fixed assets | 448 | 257,578 | 1,310,694 | 915 | 11,031,551 |
| Tax | 396 | 9,221 | 39,541 | 4 | 331,712 |
| Effective tax rate | 386 | 0.28 | 0.17 | 0.01 | 0.96 |

Panel C. The IRS Data Set, 2016–2017 (Aggregate Data per Jurisdiction/Year)*

| Profit | 277 | 12,151 | 88,991 | −6,204 | 1,179,986 |
| Profit, non-loss-making companies only | 181 | 22,106 | 122,862 | 13 | 1,310,477 |
| Employment (‘000 persons) | 277 | 229 | 1,696 | 0 | 22,903 |
| Fixed assets | 277 | 50,681 | 418,888 | 4 | 5,538,479 |
| Tax | 277 | 2,258 | 19,285 | 0 | 262,773 |
| Effective tax rate | 276 | 0.20 | 0.12 | 0 | 0.69 |

Note: All values except number of employees and tax rates are in million US dollars. The maximum average tax rate can be (very) large due to aggregation (e.g., if tax is paid by some profit-making firms while the aggregate profit is low due to losses made by other firms). Appendix A1 provides a full list of jurisdictions. Asterisk denotes that observations with negative tax or an effective tax rate greater than 1 have been dropped.
Panel B of Table 2 describes aggregate statistics by country-year based on the BEA data. In this data set, two alternative proxies of the tax base are used. The first is reported “economic profit,” which reflects operating income, excluding capital gains and losses and income from equity investments (which are usually exempt, to avoid double taxation). It represents the balance of all reported profits and losses by US-based MNEs operating in the country and is smaller than the true CIT base due to restrictions to loss offset within and across company groups. In computing the revenue implications of tax base changes under FA, we use the effective (or average) tax rate, defined as taxes paid over the reported profit before tax. The second proxy for the tax base (labeled “Taxable income” in Table 2) is estimated by taking data on CIT paid in each country of operation, divided by the prevailing statutory CIT rate for that country. This proxy captures the impact of losses but could suffer from measurement error if the standard CIT rate does not apply to every unit of profit.

The BEA data has the richest information on possible formula factors among the three data sets, containing fixed assets, payroll, employment, and sales by destination. This allows us to explore two multiple-factor formulas. The first, Cobb-Douglas (CD) formula, combines asset and payroll shares—to roughly reflect the shares of capital income and labor income in aggregate value added. The proportion of the tax base allocated to country \(j\) at time \(t\) under the CD formula is defined as

\[
\omega_{CD,j,t} = \frac{1}{3} \alpha_{asset,j,t} + \frac{2}{3} \alpha_{payroll,j,t}.
\]

The second multiple-factor formula is that used in the CCCTB proposal for the EU. Under this proposal, the share of the tax base allocated to country \(j\) is defined as

\[
\omega_{CCCTB,j,t} = \frac{1}{3} \alpha_{assets,j,t} + \frac{1}{3} \alpha_{sales,j,t} + \frac{1}{3} \left( \frac{1}{2} \alpha_{payroll,j,t} + \frac{1}{2} \alpha_{employment,j,t} \right).
\]

Figure 1 uses the BEA data to indicate the shares of profit, taxable income, and the weights under each of the seven formulas, for three different groups of countries: the United States, a group of 10 “investment hubs” (defined as countries featuring in the world’s top 10 in terms of their inbound foreign direct investment [FDI]/gross domestic product [GDP] ratio), and the rest of the world. The share of profits allocated to the United States is 70 percent, while that of the investment hubs is 10 percent and of the rest of the world (ROW) is 20 percent. For the seven apportionment formulas, clearly, the share of the investment hubs is much smaller than it is for the profit variable, typically only between 2 and 3 percent of the global aggregate. The share of the United States in the formula weights ranges from 66 percent (for employment) to 79 percent (for assets). For ROW, shares range from 19 percent (assets) to 32 percent (employment). Because the weights of the formulas for

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20 The size of these factors will depend on country-specific macroeconomic conditions, including cyclical conditions, and thus affect the CIT’s role as an automatic stabilizer. However, the consolidated profit might be relatively more robust and less dependent on asymmetric shocks.
the United States are generally larger than the global share of US reported profits (except for the employment factor), we expect that moving to FA will lead to a gain in the apportioned tax base for the United States. For the investment hubs, we expect the opposite, that is, their tax base will shrink under FA. Such reallocation will have important global revenue implications, as the effective tax rates differ significantly between groups: for the United States it is 29 percent; for ROW it is 30 percent, on average; and for investment hubs, it is only 14.7 percent, on average. Reallocating one dollar of the tax base from investment hubs to ROW would thus more than double tax revenue from that dollar.

Panel C of Table 2 describes statistics from the IRS country-by-country reports for the 2016 and 2017 tax years. The variable “Profit” reflects the profit according to the prevailing rules of the country and can be based either on the company’s financial statements or their tax records. The tax variable includes income taxes and withholding taxes paid on payments received by the subsidiary. Data for profit-making companies is used to calculate the effective tax rates, while the aggregated profits and losses of all companies is used as the tax base. Similar to the BEA data, this is smaller than the true base because in practice there are restrictions to loss offsets. In 2017, profitable US MNEs reported total profits of US$2,399 billion across all jurisdictions, with more than half of these profits reported in the United States (US$1,310 billion). Loss-making US MNEs reported US$377 billion in

![Figure 1. Allocation of the tax base under various formulas (percent). The CCCTB is a weighting based on assets, sales, employment, and payroll. VA stands for value added and is based on the reported series from the BEA. The CD weighting is based on assets and payroll, an alternate measure of value added. Based on BEA data and IMF staff calculations.](image-url)
losses, of which US$130 billion was reported in the United States. The IRS data contain information on fixed assets and employment in foreign affiliates, allowing us to explore these two formula factors under FA. The narrower scope of the IRS data is reflected in the reported indicators: 52.9 million workers are employed by US MNEs covered by the BEA data, compared with 31.7 million covered by the IRS data.

B. Effects on Global Tax Revenue

This section discusses the revenue implications of FA by comparing the current allocation of taxable income in a country with the simulated allocation based on alternative formulas. The global revenue effect is simply the aggregation of the country-specific estimates. Only with the firm-level data from Orbis, it is possible to assess the impact of loss consolidation on the tax base. More details on the calculation are provided in Appendix A (available online).

Orbis data are used to assess the impact of cross-border loss consolidation on the global corporate tax base. As there is no explicit variable in Orbis that captures the stock of unused losses from past years, we calculate this stock from unused losses in the years between 2010 and 2016. We start with the loss carryforward in 2011, based on the reported losses in 2010. This is done both under SA and consolidation with FA. In subsequent years, the stock of losses carried forward grows with new losses and shrinks with the losses that are offset against profits in that year. Figure 2 shows how the stock of loss carryforward develops between 2011 and 2016 under SA (left) and FA (right). It reveals two important messages. First, the stock of loss carried forward grows in the initial years, because the additional new losses exceed the offset of prior losses. This growth levels off after a few years as the offsets become larger with the growing stock. Between 2015 and 2016, the stock even declines under SA and is virtually stable under FA. These dynamics imply that it can be misleading to assess the impact of loss consolidation based on the initial years, because the stock of loss carryforward has not yet converged to its new representative level. Therefore, effects are best assessed based on data for 2015 and 2016 when convergence has been achieved. Second, Figure 2 makes clear that the stock of loss carryforward is much larger under SA than under FA: under SA, it grows from an aggregate US$400–US$1,000 billion, while under FA it rises from a total of

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21 Due to the aggregate nature of the data, estimating the revenue effects of cross-border loss consolidation within company groups is not possible (as the data also offset losses between company groups).

22 While the amount of loss brought forward depends on the initial stock of losses, the year 2011 does not appear to be an outlier, as both the share of loss-making firms and the average amount of losses incurred in that year are similar to those reported in later years in our sample.

23 The analysis ignores limitations in the period of loss carryforward, which are relevant in several countries. However, because the period explored here is only five years and almost all countries have periods exceeding this, the assumption of unlimited carryforward does not have implications for the results.
US$200–US$500 billion. This is as expected, because cross-border loss offset within groups under FA significantly reduces the losses that are carried forward.

The difference in loss treatment under these two regimes affects the tax bases of countries. For all companies that incurred some losses in 2011, the global CIT base under cross-border consolidation is estimated to be 10 percent smaller than under SA with loss carryforward in 2016. Note that this number represents an upper bound on the tax base change, because some countries currently already allow for domestic relief/loss consolidation—which is not captured in this analysis.

To determine the net global revenue effect of FA, we also need to consider the impact of the reallocation of the tax base. If the base is relocated from low-tax countries to high-tax countries, for example, this would increase total tax revenue. Using Orbis data, we find that the relocation effect boosts global CIT revenue by 2.2 percent if assets are used in the formula and by 4.6 percent if employment is used. This partly offsets the reduction in the tax base (and commensurate reduction in tax revenue) from cross-border loss consolidation, and the overall revenue loss is 7.8 percent for the asset formula and 5.4 percent for the employment formula (Figure 3). With the IRS data, there is also a negative revenue effect overall. Similar to the Orbis data, this is driven by cross-border loss consolidation, which is only partly offset by the reallocation of the tax base.24 In contrast, in the BEA data, the reallocation of the tax base yields much larger positive effects, leading to an overall gain in global revenue, ranging between 6 and 15 percent, depending on the formula used. For the asset formula, the difference between the BEA and IRS data is due to the extent of relocation into the United States (which gains an additional

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24 As noted earlier, the IRS and BEA data are available only at the aggregate level, which means they include both intragroup loss consolidation (allowable under FA but not SA) and intergroup loss consolidation (not allowable under either FA or SA).
6 percent of the global tax base), combined with a relatively low effective tax rate of 19 percent for the United States in the IRS data. This is in sharp contrast to the BEA data, which reports an effective tax rate in the United States of 29 percent.  

C. Effects on the Distribution of Tax Revenue

Figure 4 summarizes the effects of FA on the distribution of CIT revenue paid by MNEs for different country groups: (a) United States versus ROW, (b) OECD versus non-OECD, and (c) those with a corporate tax rate above or below 10 percent. For each group, Figure 4 shows the median impact in percent of current tax paid by the MNEs in the sample. The bars show the effect based on any of the three data sets employed (Orbis, BEA, and IRS) and the formula used. Figure 5 highlights specifically the revenue effects for investment hubs.

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25 This is the average effective tax rate between 2011 and 2018. The effective tax rate in the United States fell to 18 percent in 2018 as a result of the Tax Cuts and Jobs Act.

26 Country-specific effects are reported in Appendix A. Revenue effects are averaged across time (2011–2018 for BEA, 2016–2017 for IRS, 2011–2016 for Orbis) and presented in percentage change relative to current revenue. If the tax rate is the same under SA and FA, then the percentage increase/decrease in revenue is the same as the percentage increase/decrease in the tax base (except when the tax rate is zero).

27 The revenue results are broadly similar if taxable income is used as the proxy for the tax base instead of profits; see Table C1. Also, if low-tax countries are selected based on their effective tax rate, results are very similar as those presented here.
1. United States versus Rest of World (Panel A)

Results for the United States are only provided for the BEA and IRS data, not for Orbis where US firms are poorly represented. The specific effects for the United States are important for understanding the results in other countries, given the very large share of the United States in the overall tax base (more than 50 percent) in the samples (see Figure 1). For instance, if the United States would gain significantly

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**Figure 4.** Summary of revenue effects by country groups (percentage change in CIT revenue). (a) The United States versus the rest of the world. (b) Level of economic development. (c) Level of statutory CIT rate.
under a certain formula, it might well be that all countries in ROW will lose and that the median loss would be relatively large. This can then explain the results in Panels B and C. Panel A in Figure 4 shows that US tax revenue from MNEs would expand under most formulas, except when the employment factor is used (in which case US tax revenue falls by 17 percent in the IRS data). In the BEA data, the revenue increase for the United States ranges from 1 percent for the employment factor to 21 percent for the asset factor; however, revenue in the United States falls under the asset factor when using the IRS data. The effect for the median country in ROW largely mirrors the effects for the United States. For example, tax revenue falls under the asset, payroll, and CD formulas, while it expands under the employment formula. These effects range from a decrease under the asset factor of around 7 and 22 percent in the BEA and IRS data, respectively, to an increase under the employment factor of between 29 and 61 percent. Under the sales by destination formula, we find that tax revenue in the median country in ROW increases.

2. Advanced versus Developing Economies (Panel B)

For Orbis data, we see that the median OECD country suffers a loss in revenue from FA, either when the asset factor or the employment factor is used. This partly reflects the impact of loss consolidation, which narrows the global tax base by 10 percent. The median non-OECD country shows a revenue increase if the employment factor is used, but not for the asset factor. This picture is somewhat different when we use data for US MNEs (either BEA or IRS). In these cases, OECD countries typically enjoy an expansion of revenue under most formulas, except the pure

\[\text{Figure 5. Summary of revenue effects for investment hubs (percentage change in CIT revenue).}\]

The CCCTB is a weighting based on assets, sales, employment, and payroll. VA stands for value added and is based on the reported series from the BEA. The CD weighting is based on assets and payroll, an alternate measure of value added. Based on IMF staff estimates.
asset factor. The latter mirrors the impact for the United States, which enjoys a gain from using the asset factor. The gain for OECD countries is largest under an employment apportionment, for which the median OECD country experiences a 59 percent revenue increase from US-based MNEs. For the median non-OECD country, revenue tends to decline under apportionment by assets or payroll. Yet it expands significantly (by nearly 85 percent) under apportionment by the number of employees. Interestingly, apportionment by destination sales also expands tax revenue in the median non-OECD country — presumably as consumption is high relative to production (reflecting, e.g., a trade deficit for MNEs or because people in these countries consume out of development aid or remittances).

3. High- versus Low-Tax Countries (Panel C)

Specific results for low-tax countries with a CIT rate below 10 percent are only presented for BEA and IRS data. The results from Orbis are omitted because it includes only one country classified as a low-tax jurisdiction (Montenegro). Figure 4 shows that countries with a CIT rate below 10 percent generally lose significantly from FA, although the variation between the data sets is large. For the BEA data, the revenue loss ranges between 78 and 94 percent; for the IRS data, it is nearly 100 percent, with many countries in the sample losing the bulk of their tax base. This is consistent with significant profit shifting into these countries under SA, which is eliminated under FA.

4. Investment Hubs (Figure 5)

Figure 5 shows the revenue effects of FA for the investment hubs, that is, the countries characterized by a high ratio of FDI to GDP (Damgaard and Elkjaer, 2017). In 2017, the top 10 economies with the highest ratio of inward FDI to GDP are Cyprus, Hong Kong Special Administrative Region, Hungary, Ireland, Luxembourg, Malta, Mauritius, the Netherlands, Singapore, and Switzerland. Thus, there is no overlap with the low-tax jurisdictions shown in Panel C of Figure 4. When using Orbis, the data is limited to only five countries: Hungary, Ireland, Luxembourg, Malta, and the Netherlands. Generally, we see that investment hubs lose significant tax revenue from the introduction of FA, regardless of the apportionment factor used. The reduction in tax revenue even exceeds 70 percent of the MNE’s current tax payments under some formulas. These results illustrate the large difference between the currently reported profits by US MNEs in these countries and the reported factor share used in the FA calculation to apportion their global profits. There is one

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28 BEA: Bermuda and United Kingdom Caribbean Islands, which is an amalgamation of the British Virgin Islands, Cayman Islands, and Montserrat. IRS: The Bahamas, Bahrain, Bermuda, Cayman Islands, Guernsey, and Jersey.

29 Based on 2017 Coordinated Direct Investment Survey (CDIS) and excluding resource-rich countries.
notable exception though, which is when Orbis data are used and apportionment is by assets: in that case, the median investment hub in Europe sees its tax revenue increase. This result reflects the small group of investment hubs when using Orbis data and the positive effect in four of the five countries where MNEs actually report large asset shares (the exception being Ireland). This could be due to the sample composition of the Orbis data sets, as the majority of firms are European owned with a large share of assets in Europe. Indeed, the result does not carry over to the BEA or IRS data for US MNEs.

D. Regression Results

To better understand the systematic relationship between the revenue impact of FA and country-specific characteristics, we regress for each apportionment formula the estimated percentage change in CIT revenue from moving to FA on a range of country-specific variables

$$\Delta CIT Revenue_{ijt} = \beta_1 \log GDPPC_{jt} + \beta_2 \tau_{jt} + \beta_3 Hub_j + \beta_4 Resource Rich_j$$

$$+ \beta_5 Trade Deficit_{jt} + \alpha_i + \eta_t + \epsilon_{ijt},$$

where the dependent variable $\Delta CIT Revenue_{ijt}$ is the percentage change in the CIT revenue in country $j$ year $t$ calculated using data source $i$ (Orbis, BEA, or IRS). The country-specific variables include per capita GDP in log ($\log GDPPC_{jt}$), which summarizes the level of economic development; the level of statutory CIT tax rate ($\tau_{jt}$); a discrete indicator that takes the value of one if a country is defined as an investment hub and zero otherwise ($Hub_j$); a discrete indicator that takes the value of one for resource-rich countries and zero otherwise ($Resource Rich_j$); and the level of trade deficit. The regression also includes a set of data source fixed effects ($\alpha_i$) and year fixed effects ($\eta_t$). $\epsilon_{ijt}$ denotes the error term.

Table 3 summarizes the regression results, where each column denotes the allocation method used to apportion the CIT revenue under FA. The results are broadly consistent with the descriptive evidence above. Specifically, the estimated coefficient for log per capita GDP tends to be negative for most factors, indicating that

30 A country is defined as resource rich if its resource revenues exceeded 1 percent of GDP over the sample period. Following this definition, there are 21 resource-rich countries in our sample: Angola, Australia, Bolivia, Canada, Chile, Colombia, Ecuador, Ghana, Indonesia, Kazakhstan, Mexico, Nigeria, Norway, Peru, Qatar, Russia, Saudi Arabia, South Africa, Trinidad and Tobago, United Arab Emirates, and Venezuela.

31 The regression in Table 3 pools all three data source together, hence restricting each control variable to have the same revenue impact across data sources. For robustness check we also run regression separately for each data source, thus allowing the coefficient to vary across data source. The revenue implication of each control variable remains qualitatively similar, and is not reported for space considerations.
| Apportionment Factor | Tangible Assets (1) | CCCTB (2) | Cobb-Douglas (3) | Employment (4) | Payroll (5) | Sales (6) | Value Added (7) |
|----------------------|---------------------|-----------|------------------|----------------|-------------|-----------|----------------|
| Per capita GDP (in log) | -0.035 (0.031) | -0.216*** (0.068) | -0.004 (0.054) | -0.224*** (0.051) | 0.041 (0.064) | -0.014 (0.085) | -0.025 (0.061) |
| Statutory CIT rate | 0.008 (0.011) | 0.028*** (0.010) | 0.032*** (0.008) | 0.041** (0.018) | 0.041*** (0.010) | 0.025* (0.013) | 0.020** (0.009) |
| Investment hub | -0.128 (0.168) | -0.292* (0.165) | -0.229* (0.131) | -0.340 (0.276) | -0.297* (0.153) | -0.460** (0.206) | -0.424*** (0.146) |
| Resource rich | 0.075 (0.181) | -0.247 (0.159) | -0.226* (0.132) | -0.964*** (0.297) | -0.371** (0.153) | -0.178 (0.198) | -0.301** (0.146) |
| Trade deficit | -0.001 (0.001) | 0 (0.001) | 0 (0.001) | -0 (0.001) | 0 (0.001) | 0.001 (0.001) | 0 (0.001) |
| $R^2$ | 0.035 | 0.153 | 0.106 | 0.109 | 0.115 | 0.066 | 0.082 |
| N | 403 | 242 | 270 | 405 | 272 | 243 | 272 |

Note: The dependent variable is the percentage change in the CIT revenue in country year calculated using data source. Asterisks denote significance at the 1% (***) and 10% (*) levels. Standard errors are in parentheses.
low-income countries gain more CIT revenue when the allocation factor is based on CCCTB or headcount employment, for example. The coefficient is positive (but insignificant), however, for payroll factors. The statutory CIT rate is estimated to be positive and highly significant in most columns. Hence, countries with higher CIT rates gain more revenue under FA, although an exception is for the asset formula, where this is not the case. Investment hubs tend to lose between 20 and 46 percent more than other countries (with the exception of the asset formula) — this holds even after controlling for the CIT rate. Interestingly, resource-rich countries also tend to lose from FA, except when the allocation factor is based on tangible assets. This is because the value of natural resources is not well represented by the allocation factors used in this analysis — which might explain why special formulas are generally employed to address the location-specific rents from natural resources. The trade deficit has no systematic impact on the revenue effects.

**IV. DYNAMIC EFFECTS OF FA**

An important omission from the analysis in the previous section is that it reflects the static impact of reforms, without accounting for changes in the behavior of MNEs or changes in corporate tax policies by individual countries. These dynamic effects could significantly change the impacts. Indeed, the literature suggests that moving from SA to FA would have several implications for efficiency. This section briefly discusses, respectively, effects on profit shifting, factor distortions, and tax competition.32

**A. Profit Shifting**

There is ample evidence that MNEs use a variety of tax planning techniques to shift taxable income between entities in the group to minimize their overall CIT liability (see, e.g., Beer, De Mooij, and Liu, 2020 for an overview). By taxing MNEs on a consolidated basis, FA eliminates the problems of ALP and thus reduces the scope for profit shifting. Estimates of the total revenue loss from profit shifting vary, but some suggest they are sizable (Jansky and Palansky, 2020).33 These effects are captured by our estimates in the previous section.

Profit shifting will not disappear altogether under FA, however. Rather, it would induce a different form of profit shifting by creating distortions in corporate

32 There are also important implications for tax administrations and for tax compliance costs. For instance, eliminating ALP would be a major saving in administrative and compliance costs. However, the administrative and compliance costs under FA are hard to predict without specifying more details on how it would be designed and implemented. For instance, calculation of a commonly agreed tax base would require effective information exchange between tax authorities.

33 Blouin and Robinson (2019) and Clausing (2020) debate the size of the revenue loss from profit shifting in the United States.
structures because related and unrelated parties will be treated differently. For instance, combining two independent firms would generally change their combined tax liability under FA, while such a group would be treated the same under SA (if transfer prices would be at arm’s length). Gordon and Wilson (1986) show that companies will have an incentive to spread excess returns to low-tax jurisdictions under FA by merging with companies in low-tax states. Also, Hines (2010) emphasizes ownership distortions due to FA by reallocating taxable income between operations in jurisdictions with differing tax rates; he notes, however, that ownership distortions can also arise under SA (see also Becker and Runkel, 2013), so the net impact is ultimately an empirical issue. Nielsen, Raimondos-Møller, and Schjelderup (2003) argue that shifting through organizational form might be especially large under conditions of imperfect competition. Empirical evidence in Buettner, Riedel, and Runkel (2011) shows that MNEs exploit the definition of the consolidated group strategically by running individual affiliates as separate unconsolidated firms for tax purposes if intragroup tax-rate differences are large, based on experience of German companies. Altschuler and Grubert (2009) use a simulation model that incorporates these distortions in organizational form, comparing CIT revenue in the United States under the current system with that under a unilateral adoption of FA, with an equal-weight formula of assets, payroll, and sales. Without behavioral responses, the static estimates suggest large revenue gains for the United States. However, with behavioral responses this revenue gain virtually disappears.

Despite the distortions in ownership structures, FA is generally thought to be less vulnerable to manipulation than SA. This was stressed by Musgrave (1973) as well as Saez, Slemrod, and Giertz (2012), who argue that financial decisions such as profit shifting are generally much more responsive to taxes than real decisions in investment or organizational structure. In the context of FA, this is confirmed by empirical evidence for Canada, where firms must use FA if they operate in multiple provinces using a single corporation and SA if they incorporate a separate affiliate in each province in which they operate. Mintz and Smart (2004) find that the elasticity of taxable income for firms that can shift income under SA is more than two times larger than it is for firms that use FA.

B. Factor Distortions

The CIT is known to distort investment under source-based systems. Under SA, investment effects have been shown to be important (Grubert and Slemrod, 1998; De Mooij and Ederveen, 2008). Under FA, the CIT becomes a tax levied on the factors of the formula (McLure, 1981). Hence, tax rate differences between countries distort the allocation of those factors, especially if those are mobile across borders. For instance, if assets are part of the formula, MNEs will have an incentive to locate more assets in low-tax countries and fewer in high-tax countries because such a relocation will expand the share of the consolidated profit that is taxed at the low rate. These distortions might be even larger than under SA.
Several studies quantify the distortions in factor allocations under FA, including in the payroll weight (Goolsbee and Maydew, 2000; Riedel, 2010) and asset factor (Gupta and Hofmann, 2003), as well as the respective employment, investment, and sales shares (Clausing, 2016). Sales by destination, however, is expected to produce much smaller behavioral effects because consumers are generally less responsive to differences in CIT rates than production factors.

A dynamic relocation of production factors in response to FA would benefit countries with low CIT rates and harm countries with high CIT rates. This effect is opposite from the profit-shifting effects reported in the previous section and will likely mitigate these revenue effects. Moreover, a relocation of capital will boost labor productivity in low-tax countries and reduce it in high-tax countries, which will be reflected in GDP and welfare. These effects are illustrated in a study by Bettendorf et al. (2010), who explore the impact of the CCCTB by using a CGE model for the European Union. From the static analysis in their study, it appears that low-tax countries like Ireland lose part of their tax base from the CCCTB. However, accounting for the dynamic effects on investment, it is found that Ireland will actually experience a net welfare gain from the CCCTB.

Apart from effects on the location of investment, FA can also affect investment through its impact on risk-taking. Cross-border loss offset under FA implies a more symmetric treatment of profits and losses. The CIT thus becomes a better insurance device, thereby encouraging risky investments due to the Domar-Musgrave effect. Empirical evidence finds that current limitations in loss offsets indeed reduce overall investment and risk-taking (Dressler and Overesch, 2013).

C. Tax Competition

Under FA, tax competition does not disappear, as countries can continue to compete with their tax rates to attract whatever factors are given high weight in the formula. This incentive may be even stronger than under SA, because the revenue gain from attracting such factors is not from a marginal increase in some local tax base but from the greater share of the group’s overall profit that is brought into tax (Nielsen, Raimondos-Møller, and Schjelderup, 2010). This intensity of tax competition, however, will depend on the choice of formula factors. As tax competition under FA produces lower tax rates if the formula share is more elastic (Pethig and Wagener, 2007), it is most intense when apportionment is based on asset shares, followed by payroll and sales. FA with a sales factor may mitigate or even eliminate tax competition (Eichner and Runkel, 2008).

Some studies have also explored tax competition through the choice of the formula factors, assuming jurisdictions are granted full fiscal autonomy with respect to formula design. In the United States, for example, states have increasingly moved toward a greater weight of the sales factor. Anand and Sansing (2000) find that importing states generally have incentives to increase the sales factor, whereas exporting states will tend to increase input factors. Edmiston (2002) uses a CGE model to
show the long-term economic gains if all US states would move to a sales formula. Omer and Shelley (2004) find significant strategic responses to the choice of formula factors in other states, that is, the probability of changing one’s formula weights is larger if neighboring states did that. This is consistent with tax competition for capital and jobs and may explain the convergence in the United States toward larger sales weights. Runkel and Schjelderup (2011) theoretically explore the optimal choice of the apportionment formula in a strategic setting. They find that the formula will contain both labor and capital factors, with the latter arising because it captures location-specific economic rents.

Overall, dynamic effects can significantly change the assessment of both the revenue impact and the wider economic impact of FA. These effects, however, depend on the precise magnitude of the behavioral responses, which are associated with considerable uncertainty. Dynamic effects are likely to be more important if production factors receive a large weight in the formula and less so if sales by destination receives a large weight.

V. CONCLUSION

This paper assesses the revenue implications of a system of FA to tax MNEs, both at the global level and for individual countries. The results are no more than illustrative: they differ significantly between the data sets used in the paper, and coverage of low-income countries in two of the data sets is sparse. Aggregate revenues might fall somewhat due to the effect of cross-border loss consolidation under FA, although this is muted by reduced profit shifting by MNEs. Distributional effects are found to be large. The largest revenue decreases are apparent in investment hubs and low-tax countries. Many large economies experience an increase in CIT revenue. Developing countries gain most if employment receives a large weight in the formula but also benefit on average from a formula based on sales by destination.

The policy relevance of the paper extends well beyond FA. For instance, the analysis makes transparent how profits would be allocated if it were to closely resemble the allocation of production factors or sales. This informs debates on the desirable allocation of taxing rights and profit attribution. Moreover, the analysis sheds light on the revenue implications of more incremental reforms that would only partly use formulary elements. For example, proposals for so-called residual profit allocation use FA for a fraction of the total profit (Avi-Yonah, Clausing, and Durst, 2009; Devreux et al., 2019; IMF, 2019; Beer, De Mooij, and Liu, 2020). Proposals in OECD (2020) also contain elements along these lines.

There are also limitations. For instance, there is lack of a global data set for MNEs that could comprehensively analyze FA reforms, including for low-income countries. This issue might be resolved in the future if a comprehensive database would be developed from the country-by-country reports of large MNEs. The analysis in this paper also shows the changes in the tax base from those MNEs represented in the data, but it is unclear what proportion of the total corporate tax payments these
companies are responsible for (see, e.g., OECD [2015] for a discussion of available data). In addition, the analysis presented here is static in nature and ignores behavioral responses by firms and governments. It also ignores general equilibrium effects, such as exchange rate effects if the tax base is shifted from source to destination.

The large distributional implications of FA imply that there will be significant political barriers to its adoption. Future research might help identify options to address these obstacles. For instance, one might identify the common formula that minimizes the revenue changes for countries, thereby possibly allowing for more factors or for more diversity in formulas applied to different sectors.

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DISCLOSURES

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APPENDIX

A1. Revenue Effects of FA by Economy

This appendix shows the revenue effects of FA for individual economies. It first presents results using our standard profit variable. Then, it explores the robustness of the results with the BEA data by using an alternative measure for taxable profits, based on CIT revenue.

Table A1 presents the change in CIT revenue collected from MNEs if there is global adoption of FA (in percentage change). The results are presented based on various apportionment factors and using three different data sets. For example, the “Employment” column shows the change in total CIT revenue from MNEs if the share of employees in each economy is used to allocate the consolidated profit of the MNE. Table C1 (available online) uses taxable income as the proxy for the tax base, rather than economic profit.
Table A1
Revenue Effects of FA by Economy (Percentage Change in CIT Revenue from MNEs)

| Economy/ Apportionment Factor | Data Set | BEA | Value | IRS | Orbis |
|-------------------------------|----------|-----|-------|-----|-------|
|                               |          |     |       |     |       |
|                               |          | Assets | Sales | Payroll | Employment | Value Added | CCCTB | CD | Assets | Employment | Assets | Employment |
| Africa, other countries       |          |        |       |       |       |           |       |     |        |             |       |             |
| Albania                       |          |        |       |       |       |           |       |     |        |             |       |             |
| Algeria                       |          |        |       |       |       |           |       |     |        |             |       |             |
| Americas, other countries     |          |        |       |       |       |           |       |     |        |             |       |             |
| Angola                        |          |        |       |       |       |           |       |     |        |             |       |             |
| Argentina                     |          | 4.5 | -7.6 | -21.5 | 32.0 | 21.0 | 0.7 | -12.9 | -32.2 | 47.3 | -47.6 | 1,049.4 |       |       |
| Armenia                       |          |        |       |       |       |           |       |     |        |             |       |             |
| Aruba                         |          |        |       |       |       |           |       |     |        |             |       |             |
| Asia and Oceania, other       |          |        |       |       |       |           |       |     |        |             |       |             |
| countries                     |          |        |       |       |       |           |       |     |        |             |       |             |
| Australia                     |          | 97.6 | 55.5 | 95.8 | 57.0 | 81.3 | 76.5 | 96.4 | 89.9 | -3.1 | -4.1 | -1.1 |       |       |
| Austria                       |          | 31.7 | 199.3 | 154.6 | 110.4 | 86.5 | 121.2 | 113.6 | -30.4 | 1.9 | -28.0 | -75.5 |       |       |
| Azerbaijan                    |          |        |       |       |       |           |       |     |        |             |       |             |
| Bahamas, The                  |          |        |       |       |       |           |       |     |        |             |       |             |
| Bahrain                       |          |        |       |       |       |           |       |     |        |             |       |             |
| Bangladesh                    |          |        |       |       |       |           |       |     |        |             |       |             |
| Barbados                      |          | -76.8 | -79.5 | -96.9 | -94.2 | -43.1 | -90.5 | 2,152.0 | -70.1 |     |       |             |       |       |
| Belarus                        |          | -37.7 | -2.9 | -3.7 | -29.1 | 10.0 | -19.0 | -15.1 | 35.1 | -25.3 | 17.4 | -4.9 |       |       |
| Bermuda                        |          | -76.7 | -86.3 | -91.3 | -93.9 | -85.0 | -85.2 | -86.4 | -92.9 | -99.9 |       |       |       |       |
| Country                  | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 |
|-------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bolivia                 | 30.0   | 167.5  |
| Bosnia and Herzegovina  | 59.4   | 225.3  | -20.2  | 69.3   |
| Botswana                | -38.6  | 305.7  |
| Brazil                  | 132.5  | 205.9  | 194.8  | 452.4  | 161.7  | 220.7  | 174.1  | 27.8   | 158.9  | -38.9  | -15.9  |
| British Virgin Islands  | -100.0 | -100.0 |
| Brunei Darussalam       | 65.7   | 5.5    |
| Bulgaria                | 59.4   | 242.2  | 79.8   | 158.6  |
| Cambodia                | 77.1   | 271.6  |
| Cameroon                | -52.8  | 30.5   |
| Canada                  | 29.8   | 21.0   | 4.7    | 30.2   | 15.9   | 22.8   | 13.1   | 19.3   | 21.7   |
| Cayman Islands          | -94.2  | -99.8  |
| Chile                   | 142.6  | 71.7   | 17.5   | 210.1  | 48.9   | 109.4  | 59.2   | -2.5   | 36.9   |
| China                   | -45.2  | 19.1   | -39.4  | 158.9  | -22.8  | 11.2   | -41.3  | -29.7  | 128.0  | -4.7   | -3.6   |
| Colombia                | 46.0   | 63.5   | 33.5   | 177.5  | 63.3   | 71.6   | 37.7   | 6.1    | 129.1  | -26.2  | 242.3  |
| Congo, Republic of      | 380.4  | -77.3  |
| Costa Rica              | -12.5  | -2.2   | 8.9    | 291.8  | 8.4    | 45.2   | 1.7    | -39.7  | 221.1  |
| Côte d’Ivoire           | -14.3  | 8.3    |
| Croatia                 | -41.8  | 85.6   | 3.5    | 31.2   |
| Curacao                 | 84.3   | -56.6  |
| Cyprus                  | -92.3  | 89.6   |
| Czech Republic          | 8.8    | 86.8   | 25.2   | 222.1  | 51.6   | 73.1   | 19.7   | -10.0  | 256.6  | -42.8  | -5.6   |
| Denmark                 | 71.1   | 25.8   | 165.0  | 91.4   | 100.9  | 21.6   | 133.7  | -22.2  | -6.7   | -2.0   | -20.4  |
| Dominican Republic      | -33.3  | 0.0    | -59.7  | 153.1  | -8.8   | 4.5    | -50.9  | -46.0  | 149.9  |
| Ecuador                 | -31.95 | 82.0035| -4.9152| 150.92 | 10.0279| 41.0187| -13.927| -53.3  | -14.1  |
Table A1 (Continued) Revenue Effects of FA by Economy (Percentage Change in CIT Revenue from MNEs)

| Economy/ Apportionment Factor | Data Set | BEA | IRS | Orbis |
|-------------------------------|----------|-----|-----|-------|
|                               |          | Value Added | CCCTB | CD    | Assets | Employment | Assets | Employment |
| Egypt                         | 151.106  | 28.2658     | 52.239 | 8.62005 |
| El Salvador                   |          |             |       |       |
| Equatorial Guinea             |          |             |       |       |
| Estonia                       |          |             |       |       |
| Europe, other countries       |          |             |       |       |
| Fiji                          |          |             |       |       |
| Finland                       | -4.8     | 60.7        | 59.9  | 49.8  |
| France                        | 29.9     | 194.5       | 138.9 | 155.2 |
| Gabon                         |          |             |       |       |
| Finland                       | 1,401.8  | 116.6       | 93.0  | 110.0 |
| Germany                       | 19.4     | 155.3       | 116.6 | 120.4 |
| Ghana                         |          |             |       |       |
| Gibraltar                     |          |             |       |       |
| Greece                        | 60.0     | 278.3       | 343.7 | 447.4 |
| Guam                          |          |             |       |       |
| Haiti                         |          |             |       |       |
| Germany                       | 26.2     | 1,272.0     | 59.9  | 239.2 |
| Hong Kong SAR                 | -76.4    | -27.2       | -33.6 | -29.8 |
| Hungary                       | -29.3    | 102.3       | -12.8 | 5.3   | -76.4 | -23.0 | 12.4 | 16.8 |
| Country                     | Growth Rate | Population | Income per Capita | Inflation Rate | GDP Per Capita | Gini Coefficient |
|----------------------------|-------------|------------|-------------------|----------------|----------------|------------------|
| Iceland                    | 1.7%        | 359.8      | 7.0               | -2.1           | 56.0           | 964.4            |
| India                      | -2.1%       | 2,577.4    | 56.0              | -5.4           | 53.6           | -44.0            |
| Indonesia                  | -5.4%       | 543.7      | 23.5              | -2.1           | 21.0           | 106.4            |
| Iraq                       | 4.7%        | 43.8       | 4.7               | -14.0          | 47.8           | 332.9            |
| Ireland                    | -12.1%      | 57.8       | -12.1             | -5.5           | 57.3           | 23.5             |
| Israel                     | -26.7%      | 28.4       | -26.7             | 5.9            | 28.4           | 57.8             |
| Italy                      | -4.6%       | 28.0       | -4.6              | 5.9            | 28.0           | 94.8             |
| Jamaica                    | -52.8%      | 85.1       | -52.8             | 5.9            | 85.1           | 94.8             |
| Japan                      | -34.0%      | 87.4       | -34.0             | 5.9            | 87.4           | 94.8             |
| Jersey                     | -99.9%      | 87.4       | -99.9             | 5.9            | 87.4           | 94.8             |
| Kuwait                     | -10.2%      | 26.7       | -10.2             | 5.9            | 26.7           | 94.8             |
| Latvia                     | -21.9%      | 136.5      | -21.9             | 38.6           | 136.5          | 94.8             |
| Lebanon                    | -99.9%      | 98.8       | -99.9             | 38.6           | 98.8           | 94.8             |
| Libya                      | -96.0%      | 136.5      | -96.0             | 129.9          | 136.5          | 94.8             |
| Lithuania                  | -96.0%      | 136.5      | -96.0             | 129.9          | 136.5          | 94.8             |
| Luxembourg                 | -57.0%      | 98.8       | -57.0             | 0.6            | 98.8           | 106.4            |
| Macau                      | 0.6%        | 2,405.6    | 0.6               | -49.0          | 2,405.6        | 332.9            |
| Macedonia, Former Yugoslavia Republic of Malawi | -57.0% | 2,405.6 | 0.6 | -49.0 | 2,405.6 | 332.9 |
| Malawi                     | -44.0%      | 332.9      | -44.0             | 0.6            | 332.9          | 106.4            |
Table A1 (Continued) Revenue Effects of FA by Economy (Percentage Change in CIT Revenue from MNEs)

| Economy/ Apportionment Factor | Data Set | BEA | Value Added | IRS | Orbis |
|-------------------------------|----------|-----|-------------|-----|-------|
|                               |          | Assets | Sales | Payroll | Employment |       | Assets | Employment | Assets | Employment |
| Malta                         | BEA      | 2 | 73.3 | 62.7 | 11.1 | 2 | 38.9 |
| Mauritius                     | IRS      | 2 | 74.3 | 99.3 | 17.2 | 2 | 61.4 |
| Mexico                        | Orbis    | 2 | 89.6 | 15.4 | 118.0 |
|                       |          | 2 | 55.9 | 28.9 | 27.2 |
| Monaco                       |          | 2 | 46.7 | 168.0 |
| Montenegro, Republic of       |          | 2 | 46.7 | 335.5 |
| Morocco                      |          | 2 | 46.7 | 570.5 |
| Mozambique                   |          | 2 | 74.3 | 2198.5 |
| Myanmar                      |          | 2 | 74.3 | 305.9 |
| Namibia                      |          | 2 | 74.3 | 507.5 |
| Netherlands                  |          | 2 | 74.3 | 3198.5 |
| New Zealand                  |          | 2 | 46.7 | 449.2 |
| Nicaragua                    |          | 2 | 46.7 | 1673.0 |
| Norway                       |          | 2 | 15.4 | 80.5 |
| Oman                         |          | 2 | 15.4 | 33.8 |
| Pakistan                     |          | 2 | 15.4 | 100.0 |
| Panama                       |          | 2 | 15.4 | 63.6 |
| Papua New Guinea             |          | 2 | 15.4 | 460.0 |
| Paraguay                     |          | 2 | 15.4 | 42.8 |
| Peru                         |          | 2 | 15.4 | 42.8 |
| Philippines                  |          | 2 | 15.4 | 555.6 |

Note: The table represents the percentage change in CIT revenue from MNEs for various economies, with data from different sources including BEA, IRS, and Orbis.
| Country                  | 12.3 | 71.5 | 13.2 | 200.9 | 58.1 | 63.6 | 12.9 | 15.3 | 281.3 | -6.1 | 7.2 |
|-------------------------|------|------|------|-------|------|------|------|------|-------|------|-----|
| Poland                  | -1.6 | 166.6| 52.7 | 150.5 | 115.5| 88.9 | 34.6 | -6.5 | 252.5 | -24.8| -14.3|
| Portugal                | 26.1 | 7.2  | 1.6  | 166.6 | 52.7 | 150.5 | 115.5| 88.9 | 34.6 | -6.5 | -91.3|
| Puerto Rico             | -6.9 | 90.8 | -8.0 | 135.0 | 35.3 | 62.2 | -7.6 | -3.0 | 125.3 | -8.5 | 9.8 |
| Qatar                   | -4.4 | -86.9| 50.5 | 511.5 | -19.7| 167.1|      |      |       |      |     |
| Romania                 | -72.9| -58.2| -72.2| -72.4 | -50.4| -67.8| -72.4| -73.8| -83.4 |      |     |
| Russia                  | 131.2| 83.7 | 74.8 | 131.2 | 83.7 | 74.8 |      | -6.3 | 13.6  |      |     |
| Saudi Arabia            |      |      |      |       |      |      |      |      |       |      |     |
| Senegal                 |      |      |      |       |      |      |      |      |       |      |     |
| Serbia                  | 26.1 | 588.8| -23.9| 101.9 |      |      |      |      |       |      |     |
| Singapore               | -72.9| -58.2| -72.2| -72.4 | -50.4| -67.8| -72.4| -73.8| -83.4 |      |     |
| Slovakia                | 18.8 | 182.4| -1.5 | 13.3  |      |      |      |      |       |      |     |
| Slovenia                | -17.1| 222.4| 88.2 | 311.7 | 86.7 | 135.1| 53.1 | 1.8  | 230.5 |      |     |
| South Africa            | -40.3| 28.4 | -13.0| 0.4   | -9.5 | -6.0 | -22.1| -22.3| -0.4  | -22.9| 2.3 |
| South Korea             | 15.2 | 116.9| 89.6 | 106.9 | 49.9 | 76.8 | 64.8 | -19.1| 44.5  | -1.6 | -27.6|
| Spain                   |      |      |      |       |      |      |      |      |       |      |     |
| Sri Lanka               |      |      |      |       |      |      |      |      |       |      |     |
| St. Kitts and Nevis     |      |      |      |       |      |      |      |      |       |      |     |
| St. Lucia               |      |      |      |       |      |      |      |      |       |      |     |
| Sweden                  | -53.1| 26.1 | 40.5 | 19.6  | 16.6 | 1.0  | 9.3  | -50.0| -22.4 | -15.1| -33.2|
| Switzerland             | -89.4| -71.8| -76.3| -87.7 | -52.3| -81.1| -80.6| -72.6| -90.5 |      |     |
| Taiwan Province of China| -32.8| -43.8| 10.3 | -29.1 | -40.1| -11.8| 25.0 |      |       |      |     |
| Tanzania                | 968.3| 1,112.0 |      |      |      |      |      |      |       |      |     |
| Thailand                | 16.3 | 19.8 | -52.8| 83.7  | 24.7 | 17.2 | -29.8| -26.4| 31.6  |      |     |
| Trinidad and Tobago     |      |      |      |       |      |      |      |      |       | -22.2| -31.6|
Table A1 (Continued) Revenue Effects of FA by Economy (Percentage Change in CIT Revenue from MNEs)

| Economy/Apportionment Factor | Data Set | BEA          | IRS           | Orbis         |
|------------------------------|----------|--------------|---------------|---------------|
|                              |          | Assets Sales Payroll Employment  |
| Tunisia                      |          | −60.3 155.1 −12.8 56.8 110.8 38.0 −28.7 |
| Turkey                       |          | 82.6 110.2 |
| Uganda                       |          | −53.8 316.4 −0.3 109.4 |
| Ukraine                      |          | −58.9 −62.3 −72.3 −38.9 −61.2 |
| United Arab Emirates         |          | −40.4 −53.0 |
| United Kingdom               |          | −0.6 27.3 68.2 60.6 53.2 30.4 45.3 |
| United Kingdom Islands,      |          | −14.9 −9.3 −15.8 −11.3 |
| Caribbean                    |          | −78.3 −92.8 −95.3 −94.7 −75.5 −88.7 −89.6 |
| United States                |          | −74.1 −56.7 |
| Uruguay                      |          | 20.9 5.6 18.2 0.9 10.9 12.0 19.1 |
| Venezuela                    |          | −74.4 269.5 |
| Vietnam                      |          | −400.9 236.1 |
| Virgin Islands               |          | −27.2 184.4 |
| Zambia                       |          | 99.8 742.7 |
| Median                       |          | −6.7 20.4 −3.7 60.6 15.9 21.6 −6.9 |
| Average                      |          | −6.2 42.2 14.3 110.9 27.1 36.2 6.1 |
| Aggregate                    |          | 10.4 13.5 |
|                              |          | 104.9 240.6 −11.0 17.4 |
|                              |          | −7.7 −1.4 −7.8 −5.4 |
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