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Exploring Residual Profit Allocation

by Sebastian Beer, Ruud de Mooij, Shafik Hebous, Michael Keen, and Li Liu

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Abstract

Schemes of residual profit allocation (RPA) tax multinationals by allocating their 'routine' profits to countries in which their activities take place and sharing their remaining 'residual' profit across countries on some formulaic basis. They have recently and rapidly come to prominence in policy discussions, yet almost nothing is known about their impact on revenue, investment and efficiency. This paper explores these issues, conceptually and empirically. It finds residual profits to be substantial, but concentrated in a relatively few MNEs, headquartered in few countries. The impact on tax revenue of reallocating excess profits under RPA, while adverse for investment hubs, appears beneficial for lower income countries even when the formula allocates by destination-based sales. The impact on investment incentives is ambiguous and specific both to countries and MNE groups; only if the rate of tax on routine profits is low does aggregate efficiency seem likely to increase.

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I. INTRODUCTION

After decades of intellectual immobility, practical discussions of international corporate tax reform, in the G-20 and more widely, have recently come to show an extraordinary openness to, and capacity to generate, fundamentally new approaches. Prompted in large part by perceived difficulties in taxing effectively the profits of multinational enterprises, and particularly on encompassing new, digital-heavy business models within the century-old international tax architecture,[1] there is now an unprecedented willingness among many policy makers to move away from established norms, which insist that profits be allocated across countries for taxation solely by application of arm's length pricing[2] and which attribute no right to tax profits to 'market' (or 'destination') countries in which sales or use occur: see for example the ideas outlined in OECD (2019a). These are radical proposals—but their development, driven by tax practitioners and lawyers, has to a large degree outpaced economic analysis.

This paper focuses on one such development, which has quickly become central to the current debate: the emergence of proposals falling within a family of schemes referred to here as ones of 'Residual Profit Allocation' (RPA).[3] These proceed by breaking down the profits of a multinational group into two components. Profits representing a 'routine' return on activities and functions performed in particular jurisdictions—calculated either by arm's length pricing methods or some mechanical markup—are allocated for taxation to those jurisdictions. The group's remaining 'residual profit'—meaning the excess of its aggregate profits over its total routine earnings—are then allocated across jurisdictions for taxation on some formulaic basis. The latter marks a truly fundamental departure from the current and long-established international tax norms, in two respects. The first is by allocating some profits not by arm's length pricing but on the basis of a groups' overall profitability—which eliminates any scope for reducing tax liability by shifting profits between members of the group. The second, for the specific allocation schemes under discussion, is by envisaging some allocation of profits to jurisdictions in which, under current rules, multinationals would simply have no liability to corporate tax. .

As its name suggests, the RPA idea comes more from the transfer pricing tradition in international taxation than from the economic literature. Indeed, splitting residual profits across jurisdictions is already one permissible approach under standard transfer pricing guidelines—but

[1] These concerns are related to a wider perception that recent years have seen a generalized increase in market power. IMF (2019a), for example, finds that markups in advanced economies increased, on average, by 8 percent since 2000. The significance of digitalization in this context remains contentious (Basu, 2019) though there are signs that markups are higher, and have increased more, in digitally-intensive activities (Calligaris and others, 2018).

[2] The principle, that is, that transactions between entities within a multinational group be valued for tax purposes at the prices which independent parties would arrive at.

[3] 'Allocation' in such labels is sometimes replaced by 'split.'

only on a transactional basis.[4] In contrast, RPA schemes, apply a formulaic allocation to the totality of the multinational group. There are of course similarities here with the allocation of the multinational's total profits under schemes of formula apportionment, but the distinct treatment of routine earnings under RPA proposals brings significant and novel issues, conceptual and empirical. How large, for instance, are residual and routine profits in practice, and how are they distributed across multinational groups and countries? Which countries would gain tax revenue, and which would lose on moving to an RPA scheme? What would be the impact on investment and efficiency? Policy makers will want answers to these questions before they seriously consider any movement towards RPA. Yet these issues have received almost no attention from economists. This paper aims to begin filling that gap by providing a first look at the empirics and theory of RPA schemes.

There are now several proposals—by academics, ministries of finance and multinationals themselves—for specific schemes within the RPA family. These differ primarily in how, and the extent to which, residual profits are allocated. In a path breaking paper, Avi-Yonah, Clausing and Durst (2009) propose allocation by destination-based sales.[5] Auerbach and others (2019) propose instead allocation by adjusting destination-based sales so as to attribute a larger share of the residual to jurisdictions in which costs relating to sales can reasonably be supposed to have been incurred. Several proposals envisage a modified form of RPA, allocating only some part of residual profits mechanically, the rest being allocated by traditional arm's length pricing. The U.K., for example, has proposed allocating that part of companies' residual earnings which seems to derive from some form of user participation (generating data by online searching for example) to the countries in which those users are located,[6] and the U.S.[7] has proposed allocating that part attributable to 'marketing intangibles'—things like trademarks and customer lists[8]—to those market jurisdiction to which they relate[9] [10] Almost nothing is known, however, about the practical economic implications of any of these schemes.

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[4] As set out in OECD (2018), such profit splits are envisaged when both sides of a transaction or related transactions make unique contributions that are hard to value, with the appropriate method of splitting varying with the facts and circumstances of the case.

[5] Meaning sales in the country of final consumption.

[6] HM Treasury (2018a,b).

[7] Indeed, as noted in IMF (2019b) one could interpret the GILTI (Global Intangible Low Taxed Income) element of the 2017 Tax Cuts and Jobs Act as a form of RPA scheme, with the routine return on activities abroad calculated as 10 percent on tangible assets (and left for taxation there) while half of the resulting residual is allocated for taxation in the U.S.

[8] As opposed, for example, to 'trade intangibles,' such as patents, which have more general value.

[9] Some multinationals themselves, such as Uber, have made proposals of this kind (Chadwick, 2019).

[10] While there are also some similarities with the OECD's recent proposal for a 'unified approach' to reforming the international tax architecture (OECD, 2019b), the differences are substantial. In particular, part A of that proposal differs from the schemes analyzed here in that it would not allocate any explicit taxing rights over routine profits, would allocate only part of the residual on a formulaic basis (related to sales revenue), would apply only to a subset of companies, and would be overlain on top of the existing system. This paper therefore does not assess the conceptual or empirical features of the unified approach (an early assessment of the latter being provided by Cobham, Faccio and Fitzgerald (2019)).

This paper, which builds on and extends analysis in IMF (2019b), does not aim to explore the vast range of possible RPA schemes or delve into all the issues of their detailed design. It is rather to establish some core stylized facts and analytical features without which such discussion cannot meaningfully take place. The empirics of this are challenging, since the fundamental concepts of routine and residual profit have no direct accounting counterpart to be culled from existing datasets, and nor is the required combination of consolidated and unconsolidated company information readily available in consistent form. All of this calls for reliance on some plausible but untested assumptions, and some eclecticism in the use of distinct data sources. On the analytical side, the novelty comes simply from key aspects of the impact of RPA schemes—notably, on incentives to invest—having previously received no formal attention.

To this end, the analysis begins by developing an analytical framework for thinking about generic RPA schemes and comparing them with current international tax practice based on the principle of arm's length pricing. Section 3 then describes data challenges and summarizes the datasets used, which Section 4 exploits to establish stylized facts on the extent and nature of residual and routine profits. The revenue effects (absent behavioral response) of moving from current arrangements to RPA schemes with allocation by destination-based sale or real capital are explored in Section 5; Section 6 then examines likely effects on investment and efficiency. Section 7 concludes.

II. Analyzing Residual Profit Allocation Schemes

To identify the likely implications of movement to some form of RPA, and to guide the later empirics, this section sets out a model of multinational decision-making under both a generic RPA scheme, and, for comparison, under present arrangements based on the application of the arm's length principle.

The analysis focuses on a multinational that invests an amount k_i in country i, with $i = 1, .., N$, and incurs financial costs of rK, where $K \equiv \sum_{i=1}^{N} k_i$. There is perfect certainty, so the (pretax) cost of capital, r, is simply the safe rate of return (which we take as fixed throughout the analysis). While we generally refer to k_i as 'capital,' in this timeless world it can be interpreted as any form of productive spending, with r the corresponding price.

A. Residual Profit Allocation

At the core of the RPA approach is a distinction between two elements of the multinational group's total profits. One is the 'routine' profit that it earns from its functions and activities in each jurisdiction i, corresponding in the simple setting here to rk_i; for present purposes, routine profit can be thought of as simply representing a normal return on the multinational's real investments. The other element, defined not by country but at the level of the unitary business, is 'residual profit', denoted by Π: this is the excess of earnings before financing costs, denoted

$F(k)$, over total routine profit (where the vector of capital stocks $(k_1, .., k_N)$ is denoted by k). That is:

$$\Pi(k) = F(k) - rK, \tag{1}$$

In this simple and timeless setting, residual profit corresponds to the rents earned by the multinational.[11] Under an RPA scheme, each jurisdiction i taxes the routine profits earned there at some rate t_i and is allocated some share ω_i of the residual profit, which it taxes at the (possibly different) rate τ_i. Tax payable in i is thus:

$$T_i^{RPA} = \tau_i \omega_i \Pi + t_i r k_i. \tag{2}$$

Note that taxable routine profits are assumed to be defined gross of financing costs, which are instead assumed deductible in calculating the residual; and that, since they are levied on distinct bases, it is assumed that neither tax is deductible against the other.

Beyond the requirement that $\sum_{i=1}^{N} \omega_i = 1$, for the moment we make no assumptions on the nature of the weighting scheme. In particular, we allow for the possibility that the weights vary with *k*. This dependence may be explicit, a case we will look at later. Or it may reflect the reduced form character of the firm's profit structure being used here: the weights might for example be based on destination-based sales (a leading case in the empirics below), with the cross-jurisdiction pattern of those sales depending on the firm's investment decisions (reduced transport goods, for instance, meaning lower costs of selling where production takes place—a central motivation for traditional bricks and mortar investment).

Under an RPA scheme, the multinational's after-tax profits are thus:

$$\big(1 - W(\tau, k)\big)\Pi(k) - \sum_{i=1}^{N} t_i r k_i \,, \tag{3}$$

where $W(\tau, k) \equiv \sum_{i=1}^{N} \tau_i \omega_i(k)$ is the weighted average tax rate on residual profits. The multinational's only choice variables are the k_i, with necessary conditions:[12]

$$(1 - W)\left(\frac{\partial F}{\partial k_i} - r\right) - \frac{\partial W}{\partial k_i}\Pi - t_i r = 0. \tag{4}$$

[11] The mapping between the transfer pricing concepts of routine and residual profits and those of (respectively) normal profits and rent is not exact, but close enough for present purposes: see Box 2 of Auerbach and others (2019).

[12] For brevity, we assume interior solutions throughout.

Rearranging (4) gives the marginal effective tax rate (METR) in country i —defined as the amount by which the marginal value product of capital in country i exceeds the required pre-tax return, expressed as a proportion of the latter—under a generic RPA scheme as:

$$METR_i^{RPA} \equiv \left(\frac{\frac{\partial F}{\partial k_i} - r}{r}\right) = \frac{t_i}{(1-W)} + \frac{\partial W}{\partial k_i}\left(\frac{\Pi}{r(1-W)}\right). \quad (5)$$

The first term on the right of (5) shows the impact on investment of the tax on routine profit to be amplified by the taxation of the residual (because the latter increases the additional pre-tax return needed to cover the former). The second indicates that even if each jurisdiction taxes only residual profit, here equivalent to rent, investment is distorted to the extent that it affects the weights by which the MNE's rent is allocated for taxation and hence the overall effective rate at which those rents are taxed. Whatever its sign, this second effect—of a kind that also arises under traditional schemes of formula apportionment—is stronger the larger are residual profits and, unlike the usual case, is company-specific.

B. Current Arrangements

Under the current system, which for simplicity we refer to as one of arm's length pricing (ALP), the multinational's profits are taxed by allocating, using methods of ALP, all of its profits (residual as well as routine) to the jurisdictions in which it is active. To model this, it is convenient to conceive of the multinational's liability in i as comprised of two elements. The first is a tax, at rate τ_i, on that part of its residual profit which it declares in i: this is denoted by π_i, and is referred to as the 'excess profit' declared in i. The second element is a tax at rate m_i on the routine return to its investment in i, which is assumed to be deductible against τ_i.[13] Tax liability in i is thus:

$$T_i^{ALP} = \tau_i \pi_i + (1-\tau_i) m_i r k_i \,, \quad (6)$$

so that τ_i can be thought of as capturing an origin-based tax on rents declared in i while m_i corresponds to the usual marginal effective tax rate for a closed economy (or an open one in which profit shifting across jurisdictions is impossible).[14] The imperfect operation of ALP, however, allows the multinational some discretion as to where its profits are assessed. This is captured by supposing that

[13] An example may help illustrate this formulation. Suppose, for instance, that only some proportion ϕ of financing costs are deductible in i. Then the multinational's liability there is

$$T_i^{SA} = \tau_i(\pi_i + r k_i) - \tau_i \phi r k_i = \tau_i \pi_i + (1-\tau_i) m_i r k_i$$

where in this instance $m_i = \frac{\tau_i(1-\phi_i)}{1-\tau_i}$.

[14] This is most easily seen by supposing that there is only one jurisdiction i, in which case maximizing after-tax profit $\Pi(k) - T^{ALP}(k) = (1-\tau)(\Pi(k) - mrk)$ gives $\Pi'(k) = mr$, and hence $METR^{ALP} = m$.

$$\pi_i = \pi_i^*(k_i) + s_i, \tag{7}$$

where s_i denotes profit shifted into i and π_i^* the corresponding level of excess profits in i purged of profit shifting (referred to for that reason as 'purged' profits, and assumed to depend only on k_i).

We shall not need to model how these purged profits are defined, but note that since aggregate profit shifting is zero, that is

$$\sum_i s_i = 0, \tag{8a}$$

and all profits must be declared somewhere the sums across countries of excess and of purged profits equal aggregate profit:

$$\sum_i \pi_i = \sum_i \pi_i^* = \Pi(k)\,. \tag{8b}$$

Shifting profits incurs some (nondeductible) cost $c(s_i, k_i)$, non-negative, increasing and convex in the absolute value of s_i and decreasing in rk_i.

Using (6) and attaching a multiplier μ to the constraint in (8a) the Lagrangian for the multinational's problem, which is to choose the activity levels in, and profits shifted into or out of each jurisdiction, is to maximize with respect to *k* and *s* its after-tax profits

$$\max_{k,s}\left\{\sum_i \{(1-\tau_i)(\pi_i^*(k_i) + s_i - m_i r k_i) - c(k_i, s_i)\}\right\} + \mu \sum_i s_i\,. \tag{9}$$

Considering first the multinational's investment decision, using (8b) the first order condition on k_i implies that the METR under arm's length pricing is given by:

$$METR_i^{ALP} = m_i + \left(\frac{1}{(1-\tau_i)r}\right)\frac{\partial c}{\partial k_i}\ . \tag{10}$$

The implication, given that $\frac{\partial c}{\partial k_i} < 0$, is that the METR is lower, in all countries, than the 'standard' METR, m_i, that applies when profit shifting is impossible.[15] As in Hines and Rice (1994), the possibility of profit shifting thus encourages investment in both high and low tax countries: it does so in high tax countries because shifting profits elsewhere allows a reduction of the tax

[15] 'Impossible' here corresponding to the idea that shifting costs are prohibitively large and independent of k_i; in terms of the cost function introduced in (11) below, it corresponds to $\theta \to 0$.

burden on the profits generated by investment; and it does so in low tax countries because a larger local capital stock reduces the costs of shifting profits inwards.

When the cost of profit shifting takes the form, used shortly below,

$$(k_i, s_i) = \frac{1}{2\theta}\frac{s_i^2}{rk_i}, \tag{11}$$

the METR in (10) becomes:

$$METR_i^{ALP} = m_i - \left(\frac{1}{2\theta(1-\tau_i)}\right)\left(\frac{s_i}{rk_i}\right)^2. \tag{12}$$

Turning to the multinational's profit shifting decision, the first order condition on s_i is that:

$$(1-\tau_i) - \frac{\partial c}{\partial s_i} + \mu = 0, \tag{13}$$

which, assuming the cost function to be as in (11), implies profits shifted into i to be:[16]

$$s_i = \theta rk_i\left(\sum_{j=1}^{N}\tau_j\left(\frac{k_j}{K}\right) - \tau_i\right). \tag{14}$$

Thus (and with similarities to Hines and Rice (1994) and Huizinga and Laeven (2008)),[17] profits are shifted into (out of) i iff the tax rate there is lower (higher) than the capital-weighted average tax rate elsewhere.

III. DATA

The concepts of routine and residual profit, at the heart of RPA proposals, have no counterpart in accounting or other standard data sources, and consequently even quite basic understanding of their general significance and nature is lacking. This section describes the two datasets that we use to explore them empirically, suited to different aspects of their characterization and between which the subsequent narrative switches. One comprises a panel of multinational group-level micro data, reflecting a cross-section of consolidated accounts across a sample of large

[16] Differentiating the cost function in (11) and using the result in (13) to give

$$(1-\tau_i)k_i - \frac{1}{\theta}s_i + \mu k_i = 0, \tag{A.1}$$

the result follows on summing this over i (using (8b), solving for μ, and substituting back into (A.1)

[17] The difference is that these papers take shifting costs in (11) to be inversely related to 'true' profits (π_i^*, in the present notation) rather than capital, leading to correspondingly different weighting in (14).

multinational groups; the other comprises macro data, capturing a cross-section of aggregate country-level information.

A. Firm-Level Data by MNE Group

This dataset is constructed from the consolidated financial statements of the 10,000 largest multinational enterprises (MNEs) recorded in the S&P Capital IQ database for 2011-2017. After initial data cleaning, to exclude firms with missing, negative, or extreme values of key variables, the baseline sample comprises 8,854 MNEs. In 2017, these collectively owned total assets of US $658 trillion, total net fixed assets (including property, plant, and equipment) of USD 32 trillion, and reported USD 5.3 trillion of taxable profits. The total revenue of the smallest MNE in the sample is USD 1.196 billion: that is well above, for example, the threshold of EUR 750 million that is used for the country-by-country reporting[18] and the proposed threshold for an EU-wide common consolidated corporate tax base (CCCTB). [19] The average tax rate, calculated as total current tax divided by total pre-tax profit, is around 21 percent.

Table 1. Descriptive Statistics by HQ Location

Headquartered in	Number of Companies	Share of Fixed Assets	Share of EBIT	Average Tax Rate
Advanced Economies	5,961	57.5%	70.7%	20.1%
Emerging Markets	2,044	27.8%	19.8%	22.2%
Low-Income Developing Countries	22	0.1%	0.1%	21.4%
HQ Undisclosed	827	14.6%	9.4%	19.7%

Source: IMF staff calculation based on S&P Capital IQ database.
Note: This table summarizes the MNE group-level data used in the following analysis by the country in which the multinational group is headquartered.

As shown in Table 1, most of these MNEs are headquartered in advanced economies; these own nearly 60 percent of all fixed assets in the sample and earn 70 percent of the total pre-tax profits. Around one quarter are headquartered in emerging markets, though on average their fixed assets are 1.5 times larger than their counterparts in advanced economies. Only 22 are headquartered in low-income developing countries, and they are substantially smaller.

Table 2 shows the distribution of sample multinationals by sector, together with their share of all fixed assets and EBIT in the sample.[20] There is considerable heterogeneity across industry sectors, including in the return on fixed assets (column (5), defined as the ratio of earnings before interest

[18] Country by country reporting, required under Action 13 of the G20-OECD project on Base Erosion and Profit Shifting (BEPS), requires multinationals to report annually, for each tax jurisdiction in which they do business, key information on their business activities and tax payments.

[19] European Commission (2016).

[20] Subtracting routine profit from EBIT, as we shall, the residual is then effectively defined net of financing costs, as in the model of Section 2.

and taxes (EBIT) to fixed assets), markup (column (6), defined as the ratio of EBIT to the cost of goods sold (COGS)[21]) and the ratio of fixed assets to COGS (column (7)).

Table 2. Descriptive Statistics by Sector

Industry Sector	Number of Companies (1)	Share of Fixed Assets (%) (2)	Share of EBIT (%) (3)	Average Tax Rate (%) (4)	Return on fixed assets (%) (5)	Mark-up (%) (6)	K/COGS (%) (7)
Agriculture, Forestry and Fishing	30	0.1%	0.1%	24%	24%	10%	40%
Construction	321	1.9%	1.9%	20%	20%	7%	35%
Finance, Insurance and Real Estate	1,003	7.0%	13.1%	21%	37%	12%	33%
Manufacturing	2,940	29.5%	40.0%	24%	26%	13%	51%
Retail Trade	673	4.9%	5.8%	27%	23%	7%	30%
Services	841	4.5%	8.2%	22%	36%	20%	55%
Transportation, Communication, Utilities	1,345	39.8%	22.1%	19%	11%	19%	179%
Wholesale Trade	783	2.1%	3.0%	19%	28%	4%	14%
Industry Unknown	918	10.3%	5.8%	15%	11%	13%	121%
Average, unweighted					24%	12%	49%
Average, weighted (with fixed assets)					19%	13%	65%

Source: IMF staff calculation based on S&P Capital IQ database.
Note: This table summarizes the MNE group-level data by industry sector.

B. Country-Level Data

The micro data just described have the merit of capturing directly profits at the level of the corporate group[22]—which is that at which residual profits are defined. These consolidated data provide no information, however, on the pattern of an MNE group's activities and circumstances across jurisdictions, and so do not enable the attribution of routine profit by jurisdiction or the allocation of residual by destination-based sales. For that, and to assess the revenue impact of reform, we turn to country-level data.

Information on capital assets by jurisdiction is taken from three sources. The main source is UN national accounts statistics for gross fixed capital formation.[23] Using the perpetual inventory method, the UN tables allow approximating corporate non-financial capital stocks for 51 countries. The second source used is the private capital stock series published by Bui and others (2019), which provides data for an additional 77 countries. As this latter variable includes housing assets, we adjust this series by multiplying it by the median ratio of non-financial corporate

[21] Cost of goods sold includes all intermediate purchases from third parties and direct labor costs, [and hence is a lower bound for total costs of production).

[22] Attempts to construct consolidated aggregated statement from available unconsolidated data commonly flounder on missing values.

[23] Data downloaded from un.data.org.

capital stocks (as reflected in the UN series) to non-financial private capital stocks (as reflected in Bui and others, 2019). The UN series captures the largest economies, so the inaccuracies introduced by the adjustment to the dataset of Bui and others (2019) is to some degree muted. The third source is national accounts statistics for gross fixed capital formation taken from the WEO. Using the perpetual inventory method provides information for an additional 32 countries, which is again adjusted similar to the Bui and others (2019) series.[24]

Destination-based third party sales—which will be used to explore the implication of destination-based RPA—are calculated by taking GDP minus net exports from the IMF's *World Economic Outlook*.

Country level macro data are also used to estimate current country-level declared excess profits[25] π_i . From (6), dividing national-level corporate income tax (CIT) revenues by the statutory tax rate gives:[26]

$$\frac{T_i^{ALP}}{\tau_i} = \pi_i + \left(\frac{(1-\tau_i)m_i}{\tau_i}\right) rk_i \,, \tag{15}$$

so that, under the assumption[27] that $(1-\tau_i)m_i/\tau_i \approx 1$, we estimate π_i as $\left(\frac{T_i^{ALP}}{\tau_i}\right) - rk_i$, for definiteness taking a value for the routine return of return r of 7.5 percent (see below) and using statutory tax rate information contained in the IMF's *WoRLD* database.[28]

Appendix I lists, and provides key macro variables for all countries in the sample). Table 3 summarizes the data, with all variables averaged between 2015 and 2017 to reduce the influence of outliers. The final sample comprises 129 countries; the omissions include some but by no means all investment hubs. There is evidently massive heterogeneity across the sample: the absolute level of taxable income ranges from 52 million to over 1 trillion USD; non-financial corporate capital stocks vary between USD 566 million and over USD 73 trillion; and countries' shares of destination-based sales range from trivial to one fourth.

[24] Due to missing corporate tax revenue information, the final sample does not include all countries for which capital stock data exists.

[25] This will be used in Section V for assessing the revenue impact of movement to an RPA.

[26] Note that for present purposes the subscript i now refers to a country rather than a corporate group.

[27] This is exact if, for instance, $\tau_i = 0.2$ and m_i =0.25.

[28] *World Revenue Longitudinal Data*, at http://data.imf.org/?sk=77413F1D-1525-450A-A23A-47AEED40FE78

Table 3. Descriptive Statistics: Global Sample

	Minimum	Mean	Maximum	Sum
CIT revenue (in billion USD)	0.01	17.45	449.13	2250.79
CIT base (in billion USD)	0.02	67.72	1789.37	8735.87
Capital stock (in billion USD)	0.27	565.75	20235.09	72981.27
CIT rate (in percent)	9.00	24.29	55.00	-
Sales weight (in percent)	0.00	0.78	26.60	-
Capital stock to GDP (in percent)	21.40	104.14	273.31	-
CIT base to GDP (in percent)	2.69	17.42	98.52	-
FDI to GDP (in percent)	3.89	75.93	1546.33	-

Source: IMF WEO, WoRLD, UN statistics, Bui and others (2019), Notes: the sample includes 129 country-level observations.

For analysis using the closed economy METRs (m_i in the notation of Section II), attention is confined to the 40 countries for which the Oxford University Centre for Business Taxation database provides estimates.[29] These are weighted averages over four types of assets (plant & machinery, structure, inventory, and intangibles) and three types of finance (retained earnings, new equity and debt).

IV. Routine and Residual Profit: Some Stylized Facts

The strategy adopted in what follows is to first estimate routine profit and then subtract this from earnings before interest and tax to infer an estimate of residual profit. Implicit in this, it should be noted, is that interest payments are taken to be deducted in calculating residual profit. There are however, alternative approaches that would seek to allocate these directly across countries. Graetz (2008), for instance, suggests allocating interest expenses by reference to the share of tangible assets in each, on the grounds that such assets most obviously provide effective collateral for borrowing; Auerbach and others (2019) suggest doing so by sales or by an adjusted gross income concept. The issue evidently deserves further analysis; the approach adopted, here, however, is driven by data limitations.

A. Routine Profits

Two methods are used to proxy routine profit, thought of as corresponding broadly to a normal return on investment. The common logic underlying them, given the absence of information on the value of intangible assets, is to attach a return to tangible inputs sufficiently high to encompass some broadly reasonable allowance for a normal return on all assets, tangible and intangible. Driven by data limitations, this is inevitably a crude approach—as is also true, for example, of the 'GILTI' provisions of the Tax Cuts and Jobs Act, the logic of which is essentially

[29] Oxford University Centre for Business Taxation Tax Database, at: https://ora.ox.ac.uk/objects/uuid:81f28d9a-fe6e-445b-8d34-a641b573d986

the same: applying a 10 percent return on tangible assets as a rough-and-ready way of covering also a basic return to intangibles.

The methods are:

- A *tangibles-based approach*, modeled on the U.S. GILTI provision, that estimates routine profit by applying some notional rate of return to tangible assets (*K* when using the consolidated group level data, k_i when using the country-level). Results are reported for a range of notional returns, but where definiteness is helpful, we focus on notional rates of 7.5 and (a GILTI-like) 10 percent.

- A '*COGS-based*' *approach* (possible only using the group-level micro data) which infers routine earning by applying some markup to the total direct COGS. Again, reporting results for a range of vales, when useful we take benchmark mark-ups of 3.75 and 5 percent.[30]

It is assumed in what follows that the appropriate notional return on tangibles or mark up on COGS is the same for all multinationals. The latter is heroic, as both principle and the summary statistics in Table 2 point to quite wide variation in markups. Those statistics also suggest that, COGS being in nominal terms around twice as large as tangible assets, a notional return on tangible assets of *r* corresponds, very roughly, to one-half the markup on COGS.

To the extent that these methods mis-estimate routine profits, there will be corresponding error in the implied estimate of residual profits. The GILTI approach of taking as benchmark a 10 percent return on tangible assets, for example, will likely understate the rent[31] earned by enterprises largely reliant on tangible assets and overstate that earned by intangible-heavy but barely profitable enterprises. All that can be said is that both approaches, like GILTI, make as coherent an attempt to approximate a routine return on all assets as is currently possible.

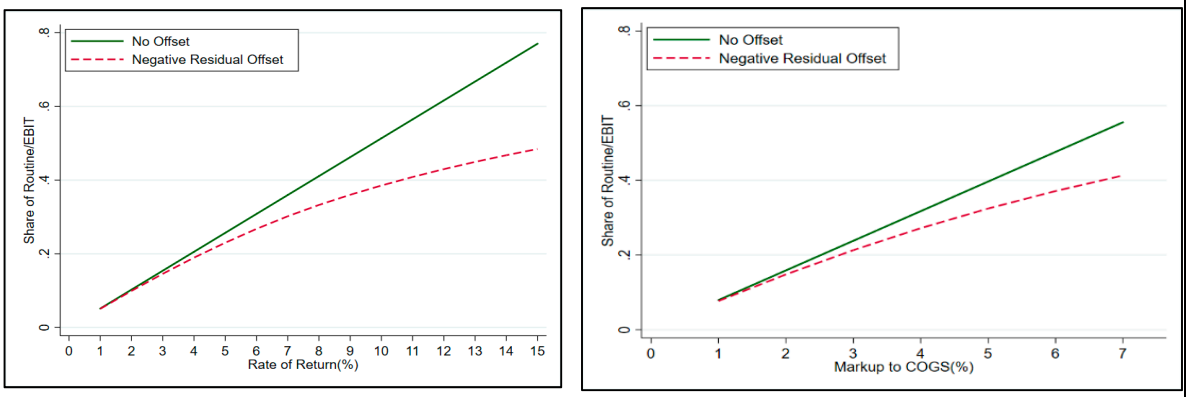
Turning to results, Figure 1 shows, for the MNE-level data, the share of routine profits in total profit under alternative assumptions on the routine rate of return, for each of the tangible-based (left panel) and COGS-based (right panel) approaches. These calculations require some assumption on the treatment of negative residual profits (on which more below). The solid line indicates the share of routine profit if negative residuals are not offset against routine profits; the dashed line assumes instead that they are offset. With such offset, routine returns are a smaller part of the total, this effect becoming more marked at higher presumed returns. Taking the illustrative values of the presumed rate of return on tangible assets of 10 percent and markup on COGS of 5 percent, routine profits account for around 40-50 percent of total profits in the

[30] Auerbach and others (2019) highlight that this approach carries some risk of cascading (as items entering inter-MNE trade may in effect be multiply taxed) and discuss potential approaches. The quantitative significance of this (especially at low rates of tax on routine profits) is, however, unclear: no attempt is made to adjust for this in the analyses that follow.

[31] For brevity, we elide here the point that rents accrue over time rather than in any single period.

absence of offset, and for about 30 percent of the total profit of those earning positive profit.

Figure 1. Share of Routine in Total Profit, by Presumed Routine Rate of Return



Source: Own calculations based on S&P Capital.
Note: The charts show the variation of routine profit, relative to total, in relation to the presumed return on capital (left chart) and markup on COGS (right chart).

Figure 2a. Routine Profits in Percent of the Total Tax Base and its Correlation with Income Per Capita

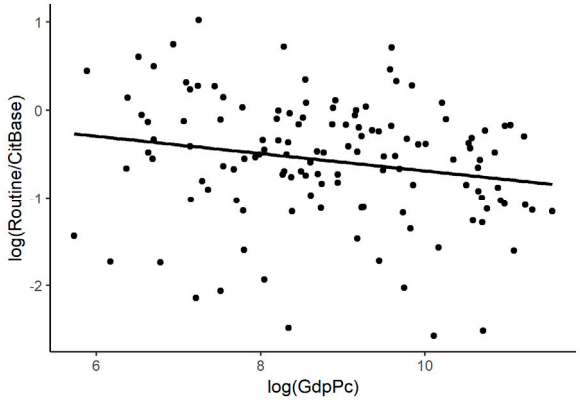
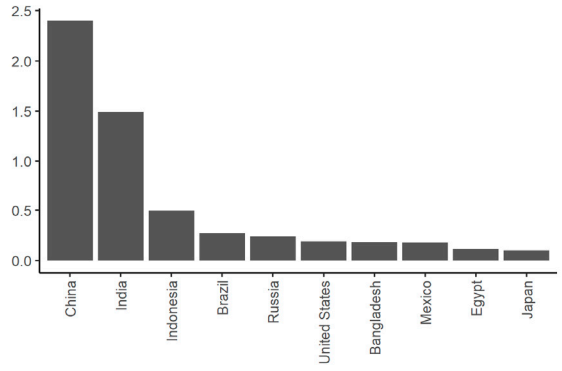


Figure 2b. Capital Stocks Relative to GDP Per Capita – Top 10



Source: WEO, WoRLD, UNCTAD, Bui and others (2019).
Notes: Figure 2a presents routine returns as a share of current CIT base (in logs) relative to GDP per capita (in logs); the line shows a simple linear regression between these variables. Figure 2b shows the ten countries with the largest ratios of capital stock to GDP per capita.

The macro-level data enable the estimation of routine profit at the country level. To give a sense of their scale, Figure 2a shows (the log of) routine profits (at an assumed routine return on capital of 7.5 percent) relative to the current CIT base. Strikingly, routine profit exceeds the current CIT base in 23 countries, suggesting that current systems there not only fail to capture any residual profit but do not even reach all routine earnings—a point we return to later. In most countries, however, the routine component alone is smaller than the current CIT base. These results are obviously sensitive to the presumed rate of routine return, but the more robust point which emerges is a negative relationship between the ratio of routine profit to the current CIT base and GDP per capita.

Figure 2b shows the 10 countries with the largest capital stocks, standardized by GDP per capita. Emerging markets clearly outnumber advanced economies in this list.

B. Residual Profits

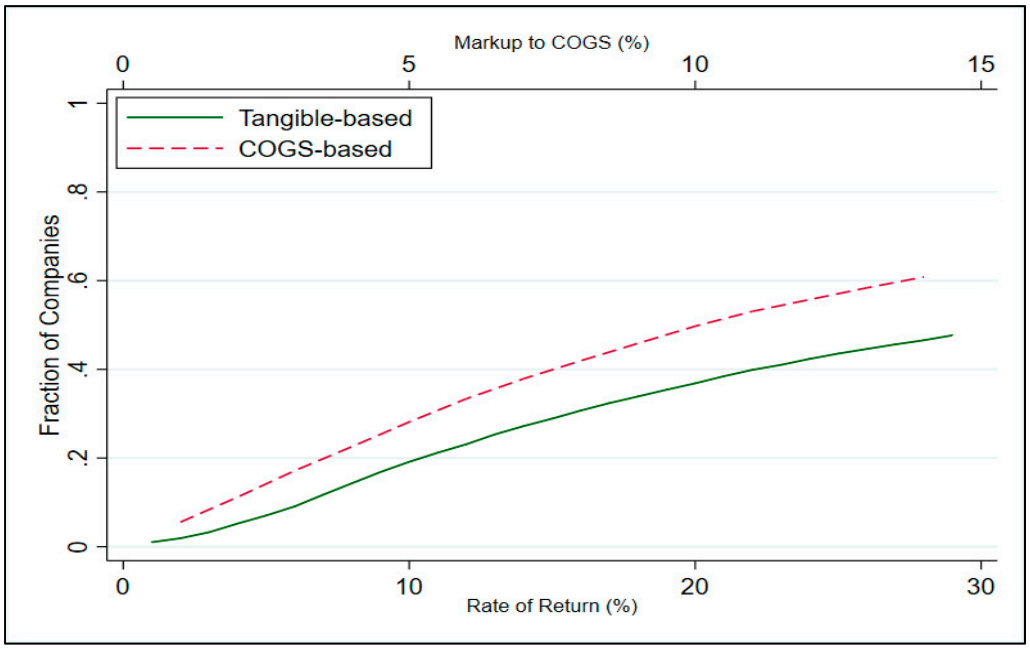
Subtracting the multinational's routine profits from its earnings before interest and taxes (which we identify with F(k) in the notation above) gives its residual profit Π(k). Since the routine return reflects a normal return to capital, firms would be expected to survive if and only if, over the course of time and in present value, they made non-negative residual profits. In any period, however, it may be that residual profits are negative. And this, we now see, may well be the case for many large multinationals.

Focusing on the subset of MNEs with positive group-wide pre-tax profit F in 2017 (including, that is, routine profit)— which account for 90 percent of the groups in the sample—we compute residual profit for each MNE at varying rates of return to tangible assets and of mark-ups on COGS. Figure 3 shows the fraction of firms with an implied negative residual. Under either approach, at the benchmark return and markup, this is a substantial proportion of all multinational groups: 19 percent have negative residual profit at a 10 percent return to tangible fixed assets, and 28 percent do so at a mark-up on COGS of 5 percent. Those with negative residuals are on average smaller and (unsurprisingly) have relatively low total taxable profits under current rules. Under the mark up approach, for example, the 28 percent of MNEs with negative residual profit own only around 12 percent of fixed assets, and earn only around 1 percent of taxable profits. Negative residual profits are of course less pervasive at lower presumed routine returns and markups: at a 5 percent return to fixed assets, for example, the proportion of groups with a negative residual falls to 8 percent, and at a 2 percent markup under the COGS approach it falls to 11 percent. Even in these cases, however, negative residual profits are far from rare.[32]

Table 4 provides a sectoral breakdown of the occurrence of negative residual profits, again under both the tangibles and COGS based approaches. It shows wide variation across sectors, reflecting differences in capital intensity and value added among them. These differences also serve as a reminder of the dangers of assuming markups to be the same in all sectors. It may be, for instance, that much of the wholesale sector is relatively heavy in tangible assets (property and the like)—and so unlikely to have negative residual earnings given a relatively generous mark up on tangibles—but operates on a low margin—and so likely to appear to have negative residual when applying a relatively generous mark up to COGS.

[32] 2017 was not unusual in this respect: much the same pattern of negative residuals is found for the previous six years.

Figure 3. Proportion of MNEs with Implied Negative Residual Profit, 2017



Source: Own calculation based on S&P Capital IQ database.
Note: This figure shows the share of firms with negative residual profits in the S&P sample, at varying rates of return to tangible assets (solid line) and markup on COGS (dashed line).

Table 4. Proportion of Firms with Implied Negative Residual Profit, by Sector
(2017, in percent)

Approach:	Return to Tangible Assets		Markup to Costs	
Rate:	7.50%	10%	3.75%	5%
Agriculture, Forestry and Fishing	17.9	21.4	39.3	46.4
Construction	6.5	8.4	23.4	33.4
Manufacturing	8.3	13.1	14.0	20.9
Transportation, Communications, and Utilities	31.9	46.8	12.6	17.5
Wholesale Trade	8.4	12.6	65.2	72.7
Retail Trade	12.1	18.1	31.6	42.9
Finance, Insurance and Real Estate	10.0	14.1	15.7	20.5
Services	9.4	13.0	19.1	25.1

Source: Own calculation based on S&P Capital IQ database
Note: This table shows the proportion of firms with negative residual profits in the S&P sample by industry sector, in 2017, at various rates of routine profit and markup on COGS.

These results make clear that the question of how to handle negative residual profits—which has been recognized in the scant literature, but not resolved[33]—would likely have substantial practical importance.

[33] See for instance the discussion in Auerbach and others (2019).

Looking beyond a single year, spells of negative residual profit are not necessarily short. Table 5 shows, for instance, that at a routine return on tangible assets of 7.5 percent, over 10 percent of MNEs showed negative residual profits in all seven years of the sample period. Still more relevant to firms' long run survival than the number of years of negative residual earnings is the present value of its residual profits. Table 6 shows the proportion of all firms with a negative present value of residual earnings over the full period 2011-2017, discounting at rates of 5, 7.5 and 10 percent for the tangible based approach and one half the rate for the COGS based approach. These proportions are in some cases strikingly large—perhaps implausibly so.

Table 5. Duration of Spells of Implied Negative Residual Profit

Approach	Tangible Based			COGS Based		
Notional rate of return:	5.0%	7.5%	10.0%	2.5%	3.75%	5.0%
0	80.5%	71.1%	64.1%	71.5%	62.3%	54.4%
1	8.8%	9.5%	9.2%	9.5%	9.8%	9.6%
2	4.2%	5.9%	6.5%	5.8%	6.5%	7.6%
3	2.6%	3.9%	4.5%	3.4%	5.0%	5.2%
4	1.5%	3.0%	4.2%	2.6%	4.0%	5.4%
5	1.3%	3.1%	3.8%	2.6%	4.0%	5.5%
6	0.5%	1.6%	2.7%	1.7%	2.8%	3.8%
7	0.6%	2.0%	5.1%	2.9%	5.5%	8.4%

Source: Own calculation based on S&P Capital IQ database

Note: The tables shows the proportion of firms with the indicated duration of negative residual profits, among those with complete spells in the sample period.

Table 6. Proportion of Firms with Negative PV of Residual Profit

Approach	Tangible Based			COGS Based		
Notional rate of return:	5.0%	7.5%	10.0%	2.5%	3.75%	5.0%
Notional interest rate:						
5%	2.7%	2.6%	2.7%	7.7%	7.6%	7.7%
7.5%	8.4%	8.4%	8.5%	13.9%	14.0%	14.1%
10%	14.8%	14.8%	14.9%	20.6%	20.6%	20.6%

Source: Own calculation based on S&P Capital IQ database.

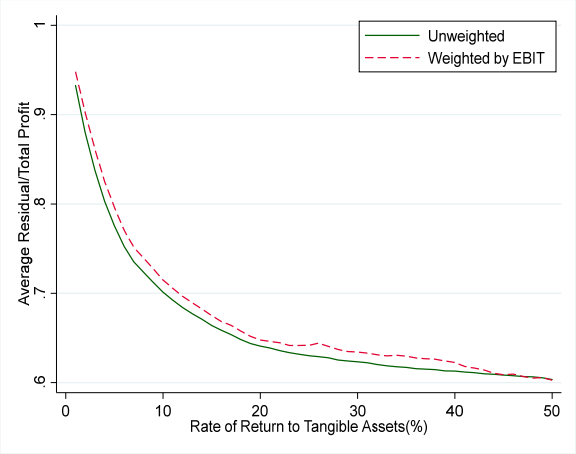
Note: The table shows the proportion of MNEs with negative present value of residual profits over the sample period, evaluated at nominal interest rate of 5, 7.5, and 10 percent, respectively.

There are, nonetheless, many multinationals showing positive residual profits, though of course their number depends on the presumed routine return or markup. For such MNEs, Figure 4 provides a sense of the scale of these residual profits by showing the average ratio of residual to total profits for a range of values for the presumed return under the tangible-based and COGS-based approaches. (This is of course essentially the flipside of the ratio of routine to total profits, as in Figure 1, for those with positive residuals.) The impression is that residual profits do indeed account for a considerable proportion of multinational profits. At a notional return on tangible assets of 10 percent, for instance, residual profit averages about 70 percent of total profits for all firms with a positive residual. When weighted by pre-tax profit, the overall ratio of residual to

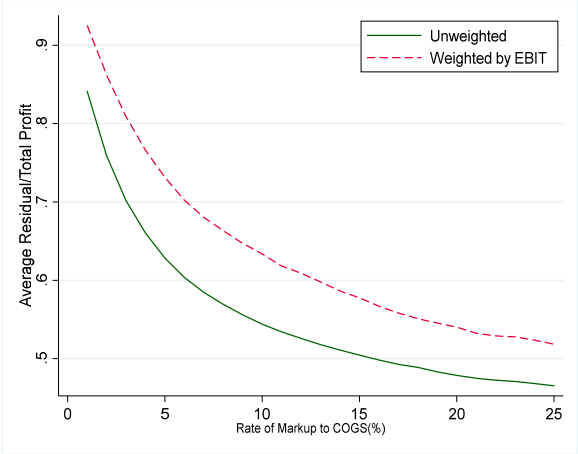
total profit is around 71 percent, and increases to 75 percent at a notional return of 7.5 percent. This is perhaps not surprising as the weighting gives more significance to residual returns in more profitable firms, which is likely to be higher than those with lower profits. Under the alternative COGS-based approach, the overall ratio of residual return to profit is 68 percent at a 5-percent mark-up, and 66 percent at a 3.75 percent mark-up to COGS, again for all firms with a positive residual.

Figure 4. Residual Relative to Total Profits for Firms with Positive Implied Residual

(a) By Notional Return to Tangible Assets



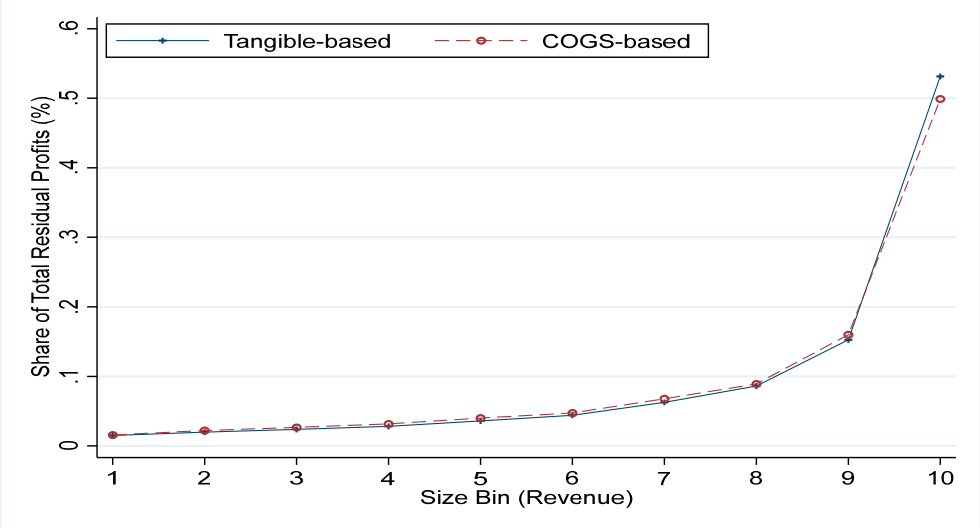
(b) By Markup on COGS



Source: Own calculation based on S&P Capital IQ database.
Note: This figure shows the average ratio of residual to total profit at varying rates of notional return to tangible assets in the left panel, and of markup to COGS in the right panel. Only firms with a positive residual are included, implying that the sample changes with the assume routine return. In both panels, the solid line depicts the unweighted average ratio of residual to total profit, and the dashed line the overall ratio of residual to total profit weighted by pre-tax profits.

These large positive residual profits prove to be concentrated among a very few multinationals: Figure 5 shows that the largest 10 percent of corporate groups (by sales revenue) account for more than half of all positive residual profits under the tangibles-based return approach (at a notional rate of 7.5 percent), and slightly less than half of all positive residuals under the COGS-based approach (at a markup of 3.75 percent). Within this group, the 100 companies with the largest residual—roughly one percent of the sample—account for more than 28 percent of total residual profits, with a ratio of residual return to total profit of 85 percent. These firms account for only about 17 percent of all tangible assets in the sample, so that they are relatively intangible-heavy. In comparison, the 50 percent of multinationals with the smallest positive residual account for only around 6 percent of the aggregate total residual, though still with an high average ratio of residual to total profits (of 65 percent).

Figure 5. Distribution of Residual Profits by Firm Size



Source: Own calculation based on S&P Capital IQ database.
Note: this figure shows the share of total residual profits across firm revenue quartiles, with a notional rate of return to fixed assets of 7.5 percent and a markup to COGS of 3.75 percent, respectively.

Looking again beyond the snapshot of 2017, Table 7 reports the movement of residual profits between quintiles over the six years of the sample, at a notional return on tangible assets of 7.5 percent. There is considerable persistence: the probability of a multinational group in the top quintile by absolute residual profits in one year being in that same quintile the next is over 70 percent, while the probability of remaining in the lowest quintile is nearly 90 percent.

Table 7. Persistence of Residual Profit

Current year	Year t+1 residual profit quintile				
residual profit quintile	1	2	3	4	5
1	72.12	16.91	5.63	3.45	1.9
2	14.75	62.07	19.81	2.91	0.46
3	5.21	14.62	61.07	17.96	1.14
4	3.01	2.45	12.6	69.03	12.9
5	1.81	0.4	1.28	8.34	88.18

Source: Own calculation based on S&P Capital IQ database.
Note: This figure shows the probability of moving from current-year quintile of residual profit to each of the quintiles next year, assuming a notional rate of return to fixed assets of 7.5 percent. The rows denote the current-year quintile residual profits, while the columns denote the quintiles in the following year.

Table 8 casts light on one other dimension of the distribution of residual profits. For both approaches to estimating routine profits, and a variety of assumed returns, it shows that the bulk of residual profits is earned by multinationals that have their headquarters in a relatively small number of countries. Under both tangibles-based and COGS-based approaches, around 75-85 percent of aggregate residual profit accrues to companies headquartered in just 10 countries, and more than half accrues to MNEs headquartered in the same four, with the United States

alone accounting for around one-third.[34] Companies are not, of course, currently taxed solely by reference to where they are headquartered; and nor is this envisaged under any RPA scheme of which we are aware. Nonetheless, the country of headquartering is likely in many cases to coincide with the residence of the parent company, so that the table gives some impression of what allocation entirely by residence might imply. And, more generally, to the extent that policy makers appear to have in mind some notion of 'their' national companies—however tenuous it might be, given the pervasiveness of cross-border shareholding—these results cast some light on the likely practical politics of discussing alternative allocations of taxing rights under an RPA approach.

Table 8. Implied Residual Profit by Country of Headquarters, 2017

Tangible-Based				COGS-Based			
7.5%		10%		3.75%		5%	
United States	33%	United States	36%	United States	33%	United States	35%
China	10%	Japan	8%	China	12%	China	11%
Japan	8%	China	7%	Japan	7%	Japan	6%
United Kingdom	6%	United Kingdom	7%	United Kingdom	6%	United Kingdom	6%
Germany	6%	Germany	7%	Germany	5%	Germany	5%
France	5%	France	5%	France	4%	France	4%
South Korea	4%	South Korea	4%	South Korea	4%	South Korea	4%
Switzerland	3%	Switzerland	3%	Canada	2%	Canada	3%
Taiwan Province, PRC	2%	Taiwan Province, PRC	2%	Switzerland	2%	Switzerland	3%
Hong Kong, SAR	2%	Hong Kong, SAR	2%	Hong Kong, SAR	2%	Hong Kong, SAR	2%
Rest of the World (ROW)	21%	ROW	20%	ROW	23%	ROW	23%

Source: Own calculation based on S&P Capital IQ database
Note: This table lists top 10 countries, by headquarters of the MNE parent company, with the largest amount of residual profits, at varying rates of cost mark-up and return to fixed assets.

V. Revenue Effects of Moving to an RPA Scheme

Combining equations (2) and (6) and recognizing (in obvious notation) the potential difference in investment under the two regimes, the revenue gain to country *i* on moving from the current ALP system to an RPA scheme can be written as

[34] Alternative assumed returns generally leave the United States at the head of the table but change the rankings of other countries.

$$\Delta T_i \equiv T_i^{RPA} - T_i^{ALP} = \underbrace{\tau_i\left(\omega_i \Pi(k^{ALP}) - \pi_i(k^{ALP})\right)}_{Reallocation\ of\ excess\ profits} + \underbrace{(t_i - (1-\tau_i)m_i) r k_i^{ALP}}_{Treatment\ of\ routine\ profit} + \underbrace{r t_i (k_i^{RPA} - k_i^{ALP})}_{Investment\ effect}$$

$$+ \underbrace{\tau_i \omega_i \left(\Pi(k^{RPA}) - \Pi(k^{ALP})\right)}_{Reflecting\ aggregate\ efficiency\ gain}, \qquad (16)$$

the assumption being made here—there being no natural alternative for current purposes—that country i taxes residual profits allocated to it at the same rate as it currently taxes profits under ALP. There are thus four effects at work.[35] The first term in (16) reflects the extent to which the residual profit allocated to i exceeds the excess profits currently declared there. The second is the change in the revenue collected in direct relation to routine profit. The third is the revenue consequence of any change in investment. and the fourth is the revenue gain to i from any increase in efficiency in moving to RPA, in the sense of increased pre-tax rents.

This section uses the macro country-level data to set about quantifying the first two effects in (16)—which we refer to as the 'reallocation of excess profits' and 'routine rate' effects—which arise in the absence of behavioral effects. Throughout, it is assumed that adoption of the RPA analyzed is universal. The likely effect on real decisions, which shapes the third and fourth effects, is addressed in Section VI.

A. The Reallocation of Excess Profits

The first effect in (16), $\tau_i(\omega_i \Pi - \pi_i)$, is evidently driven by the choice of weights ω_i defining the allocation under RPA. Jurisdiction i gains revenue on this account if and only if its allocated share of residual profit, ω_i, exceeds its share of reported residual profits π_i/Π under ALP.

As a useful benchmark, it can be shown that global tax revenue increases with adoption of an RPA scheme on this account if each country is allocated a share of residual profits equal to its share of 'purged' (no shifting) profits, $\pi_i^* / \sum_j \pi_j^*$.[36] The intuition for this is that such a scheme is (which is of conceptual rather than practical relevance) effectively returning shifted profits to where they were shifted from, which will be from a lower to a higher tax rate jurisdiction. Beyond

[35] We do not consider here the reduction in taxable profits inherent in moving to the taxation of enterprises on a consolidated basis (through the cross-border jurisdiction offsetting of losses). This also arises under formula apportionment, and previous work in that context suggests that the effect can be substantial, perhaps in the order of 10 percent of aggregate corporate tax revenues: See in particular Cobham and Loretz (2014) and De Mooij, Liu and Prihardini (2019).

[36] To see this, note from (7) and (8b) that with these weights, $\omega_i \Pi - \pi_i = \pi_i^* - \pi_i = -s_i$; hence $\sum_i \Delta T_i = -\sum_i \tau_i s_i$. Multiplying (13) by s_i, summing over i and using (8a) gives

$$-\sum_i \tau_i s_i = \sum_i s_i \left(\frac{\partial c}{\partial s_i}\right).$$

Adding to those in the text the further assumption that $c(k_i, 0) = 0$, the result follows on noting that s_i and $\frac{\partial c}{\partial s_i}$ take the same sign.

this, however, little can be said about the revenue effect of an RPA-induced reallocation of excess profit without specifying the precise weights used.

For this, we focus in what follows mainly on allocation by the destination of sales, meaning that ω_i is taken to be the proportion of the multinational's sales that are to third-party residents of jurisdiction *i*. This is as proposed by Avi-Yonah, Clausing and Durst (2009) and similar to the proposal of Auerbach and others (2019), which differs only in weighting by sales net of costs directly attributable to those sales.[37] Other specific forms of RPA now under discussion have elements akin to destination-basing. This is most clearly so for the suggestion to allocate the return to marketing intangibles to the destination country; it has echoes too in proposals that would allocate at least some of the residual to jurisdictions of user participation, which are often those in which a related service is consumed.[38] To that extent, the results that follow provide something of an upper bound on the reallocation of excess profits implied by these less far-reaching proposals.

Two (further) caveats to the empirics that follow should be noted, though their significance is unclear. One is that it is assumed in analyzing the destination-based RPA that the place of third party sales would remain as at present; this sets aside the incentive that such a scheme creates to arrange for final sales to third parties to take place in low tax jurisdictions (perhaps through independent distributors) in order to reduce the overall taxation of residual profits. The other is that the RPA schemes analyzed will be assumed to apply to all corporate earnings, when in practice they may well apply only to multinationals (and perhaps just a subset limited by size or sector); we return to this shortly.

Reallocation of Excess Profits under Destination- and Capital-Based RPA

While the magnitude of the residual of course does not change with its reallocation,[39] that reallocation, between jurisdictions applying different tax rates, does affect the global revenue raised by its taxation. Estimating this effect, $\sum_i \tau_i\big(\omega_i \Pi(k^{SA}) - \pi_i(k^{SA})\big)$, for the macro data set, the effect of moving to destination-based RPA is an increase in total tax revenue of around USD 168 billion, which is about 7.1 percent of total CIT revenue.[40] That the effect is positive and sizable is as one would expect, given the presumption that excess profits are currently declared in low rather than high tax jurisdictions, and are relatively large.

[37] If, for example, such costs are directly proportional to sales, then the scheme of Auerbach and others (2019) is equivalent to simple destination basing.

[38] There are also echoes of the Unified Approach proposed by the OECD, though as noted that is fundamentally different from the schemes considered here.

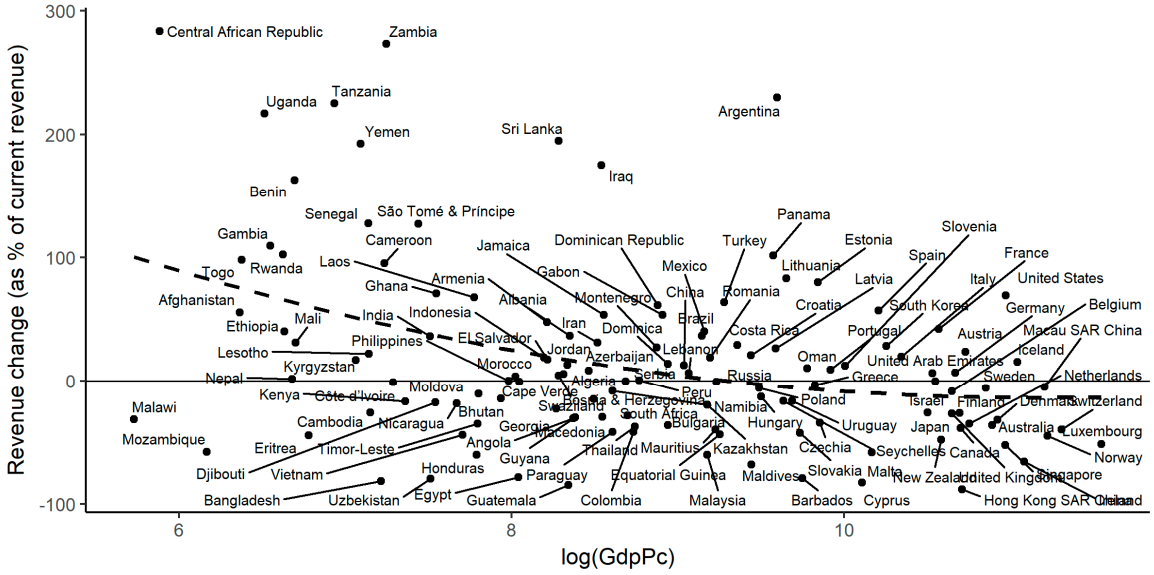
[39] Meaning that $\sum_i\big(\omega_i \Pi(k^{SA}) - \pi_i(k^{SA})\big) = 0$. Behavioral responses will of course generally change the magnitude of residual profits, a point addressed in the next section.

[40] Aggregate CIT revenue in the sample is USD 2370 billion; the unweighted average change in tax revenue is an increase of 15 percent.

Country-specific effects on corporate tax revenue of moving to destination-based RPA (expressed as a percent of current CIT revenue, and as of 2017) are shown in Figure 6, with the dashed line showing the regression between this revenue change and GDP per capita. The striking and perhaps surprising feature emerges of a broad tendency for lower income countries to gain revenue more than do higher: the largest proportionate increase is in the Central African Republic (290 percent), for example, and the largest reduction is in Hong Kong SAR (-85 percent).

Figure 6. Revenue Gains from the Reallocation of Excess Profits under Destination-Based RPA

(2017, by income per capita)



Source: Authors' computations.

Notes: Dashed line depicts fitted regression line, explaining revenue change (in percent of current revenue) by log (GDP) and its square. Data are for 2017 (and so for the United States use the CIT rate prior to the Tax Cuts and Jobs Act).

One potential limitation of this analysis, not readily overcome given that only aggregate data are available to us, is, as noted, that it presumes the destination-based RPA to apply to all companies (including for example wholly domestic ones), which—though there has been relatively little academic discussion of this—may be unlikely in practice. It is straightforward to show that the full coverage of the RPA scheme assumed above reallocates more excess profit to any jurisdiction i than would a more limited scheme if and only if i's share of uncovered excess profit is less than its share of share of consumption (or, more generally, its weight ω_i).[41] To the extent that this uncovered profit relates to purely domestic enterprises, this is most likely to be the case for jurisdictions with a relatively low rate: intuitively, these benefit from the wider approach

[41] This follows on writing the excess profit of the representative MNE in jurisdiction j as $\pi_j = \pi_j^C + \pi_j^{NC}$, where C and NC refer, in obvious notation, to covered and uncovered components and comparing the reallocation of excess profits to i under the wider scheme, $\tau_i\left(\omega_i \sum_j \left(\pi_j^C + \pi_j^{NC}\right) - \left(\pi_i^C + \pi_i^{NC}\right)\right)$, to that under the narrower, $\tau_i\left(\omega_i \sum_i \pi_j^C - \pi_i^C\right)$.

because of the reallocation to them of what under the narrower approach would be uncovered profits elsewhere. Conversely, the results may on this account overstate the revenue gain to higher tax countries; and the estimate of the overall revenue impact above may also be upward-biased. It is difficult, however, to speculate on the likely magnitude of the effects.

To explore more systematically what drives the revenue effects shown in Figure 6, the first two columns in Table 9 report the results of regressing the estimated tax base changes from the reallocation of excess profits (relative to current CIT revenue) from moving to destination-based RPA on a range of country-specific variables (centered at their means). The CIT rate and GDP per capita both prove statistically significant, with opposite signs. As one might expect, countries with higher CIT rates gain more tax base under RPA: on average, the tax base increases by 2 percent for each percentage point higher CIT rate. The tendency for the gain to be greater in lower income countries suggested by Figure 6 proves to be strongly statistically significant. Nor is this because these countries are more likely to run trade deficits: the trade deficit has no significant effect. The impact on 'investment hubs'—countries in which the ratio of foreign direct investment (FDI) to GDP exceeds 1.5[42]—is very large: they stand to lose 57 percent of their tax base. The dummy for resource rich economies[43] is slightly negative but insignificant. Additional regression results (not reported) show that country size (as measured by GDP) to be uncorrelated with the simulated effects on the tax base.

An alternative to using destination-based sales as an allocation factor—coming close to the idea of taxing where real production occurs—is to allocate residual profits by the location of capital stocks; $\omega_i = k_i/K$. Unlikely to appeal in practice, given the current interest in allocating some tax base to market countries, this serves as an extreme case to develop some sense of the possible effects operating though the impact of investment on weighting factors ω_i.

The drivers of the revenue impact of moving from current arrangements to a system of capital-based RPA are reported in the final two columns of Table 9. For individual countries, the outcomes can be markedly different from those under destination-based RPA. The United States, for example. would gain roughly 70 percent of its current CIT base when using destination-based sales as an allocation key but only 33 percent when using capital stocks instead. Conversely, China would gain 12 percent of its current CIT base when allocating the residual based on destination-based sales, but the gain would more than double (35 percent) when using capital stocks instead. The overall picture of the implied redistribution of the tax base, however, is much the same with the capital-based allocation as under the destination-based: CIT rates continue to explain revenue changes, but with a slightly smaller coefficient; investment hubs lose a formidable share of their tax base; and developing countries tend to gain revenue.

[42] In our sample, there are eight cases in which this FDI threshold is exceeded: Cyprus, Hong Kong, Ireland, Luxembourg, Malta, Mozambique, Seychelles, and Singapore.

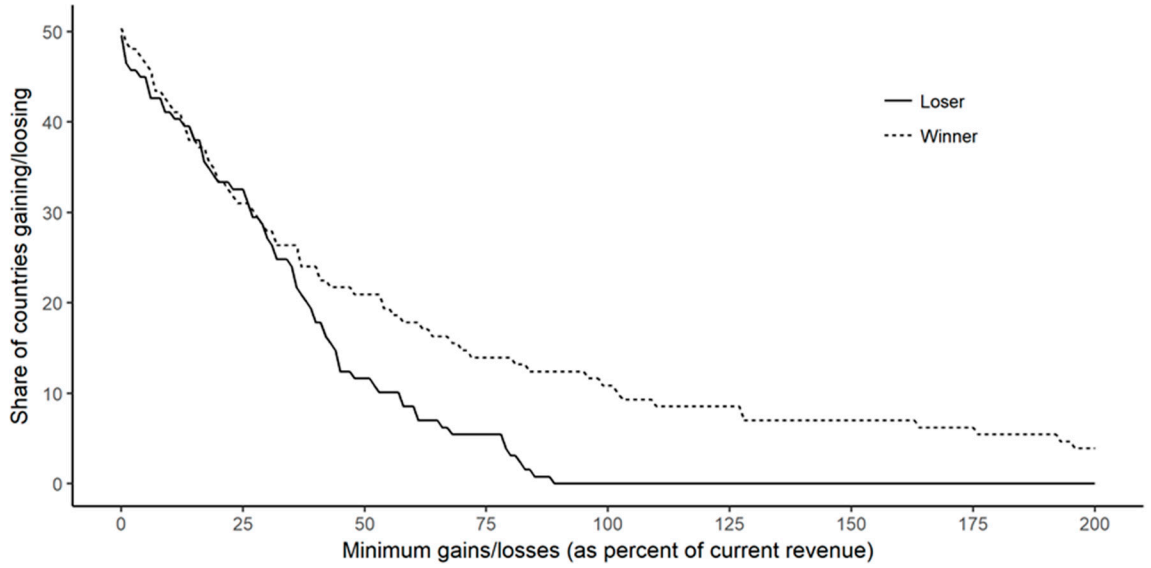
[43] It seems likely that these countries would in any event be excluded from any destination-based reallocation of taxing rights.

Table 9. Drivers of the Reallocation of Excess Profits in Moving to Destination- or Capital-Based RPA

Dependent variable: simulated change in tax base (as percent of current tax base)				
Allocation factor	Destination-based sales		Capital stocks	
Explanatory variables	Column 1	Column 2	Column 3	Column 4
Intercept	20.281***	22.001***	15.266***	17.445***
	[6.729]	[7.284]	[6.969]	[7.509]
CIT rate	2.083 ***	2.388***	1.680 **	1.899***
	[77.058]	[0.815]	[78.750]	[0.832]
log(GDP per cap.)	-15.436***	-18.484***	-10.548***	-15.550**
	[4.879]	[7.445]	[4.640]	[7.752]
Resource rich	-7.711	-18.911	-0.139	-10.181
	[16.109]	[16.303]	[16.688]	[17.384]
FDI/GDP>1.5	-56.649***	-59.706***	-60.280***	-63.171***
	[15.236]	[13.877]	[15.786]	[15.240]
Trade deficit		-0.601		-0.751
		[0.502]		[0.572]

Source: Authors' computations.
Notes: The dependent variable is the total revenue effect (as a share of current CIT revenue) of moving from the current system to an RPA scheme with weights as indicated; *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels. Standard errors in square brackets.

Figure 7. Patterns of Revenue Effects from the Reallocation of Excess Profits in Moving to Destination-Based RPA



Storyline goes here

Source: Authors' computations.
Note: This figure shows the proportion of countries in the sample for estimated to experience at least the indicated revenue gain or loss (in absolute value) from the reallocation of excess profits in moving to destination-based RPA.

Figure 7 provides further insight into the size and distribution of revenue changes, showing the proportion of countries that gain and lose revenue (relative to their current CIT revenues) at different levels of gain or loss. The dashed line represents winners and the solid line losers. While the effect on global revenue is modest, as seen above, the effects for particular countries are in many cases large relative to current corporate tax revenues. For example, around 30 percent of all countries in the sample would lose at least 25 percent of their current CIT revenue; and around 30 percent would gain at least 25 percent. Again, potentially relevant to the politics of the debate, there are noticeably more large revenue gainers than there are losers.

Decomposing the Reallocation of Excess Profits

The revenue effect of reallocating excess profit just examined actually arises from two quite distinct sources. One is the elimination of profit shifting. The other is the reallocation of purged profits across countries. Denoting by[44] $\beta_i = \frac{\pi_i^*}{\Pi}$ the ratio of purged profits in i to residual profits and recalling (7), this can be seen by rewriting the first term in (16) as

$$\tau_i[(\omega_i - \beta_i)\Pi - s_i]. \quad (17)$$

The distinction between these two effects is of some importance. The effect of eliminating profit shifting will be the same under all RPA schemes (and some others). The effect through the reallocation of purged profits, however, will vary between them: recalling (16), it is only in this, and in the sharing of any effects on overall efficiency, that the revenue effects of alternative RPA schemes differ.

To explore the two distinct effects shown in (17) empirically, two things are needed. One is a specification of the weights ω_i. For this we again consider in turn—as something of opposites—two possibilities: allocating the residual by the destination of sales, as above, and (more briefly) by the location of capital.

Also needed are estimates of the s_i, or the β_i recalling (7), given that π_i can be estimated as from (15), an estimate of either is enough to infer an estimate of the other. For this we use two alternative methods:

- Under the '*cost-function based*' approach, we estimate s_i from (14). This requires an estimate of the parameter θ of the cost function in (11). As shown in Appendix II, under an assumption that, across countries, $\mathrm{E}[\beta_i|k_i] = \frac{k_i}{K}$ (meaning that underlying purged profits are on average proportionate to capital stocks), this can be backed out from consensus estimates of a related parameter (the semi-elasticity of reported gross profits

[44] It is assumed here that $\Pi \neq 0$.

with respect to the home-foreign tax rate differential). This leads us to take $\theta = 2.55$.[45] An estimate of β_i then follows from the implication of (7) that $\beta_i = (\pi_i - s_i)/\Pi$.

- Under the '*activity-based*' approach,[46] instead of drawing on the modeling of Section II we simply assume that excess returns in the absence of profit shifting are proportional to country-specific capital stocks, so that $\beta_i = \frac{k_i}{K}$; the profit shifting component is then estimated as $s_i = \pi_i - \frac{k_i}{K}\Pi$.

Each approach captures important considerations likely to drive profit shifting but ignores others. Through (14), the cost-function based approach centers around differentials in headline CIT rates that are one obvious driver of profit shifting, but ignores others, such as special tax regimes. The activity-based approach, in contrast, can hope to capture profit shifting that exploits special tax schemes of various kinds that are not reflected in headline statutory tax rates, but wholly ignores the role of headlines tax rates.

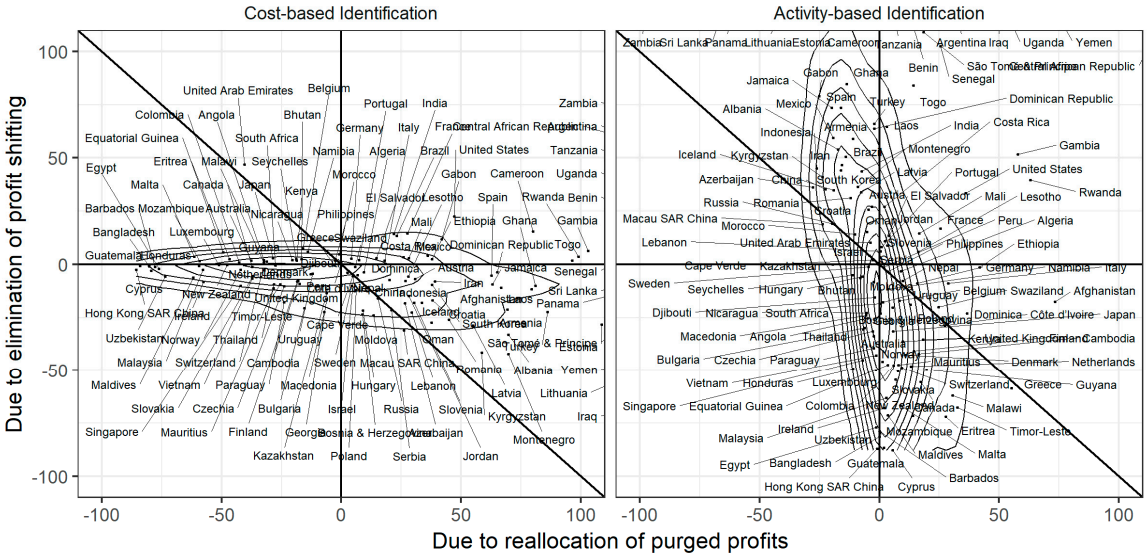
The two panels of Figure 8 show, under each of these two approaches to identifying profit-shifting, the decomposition in (17) when using destination-based sales as an allocation factor. The horizontal axis shows revenue changes due to the reallocation of excess profits purged of profit shifting; the vertical axis depicts revenue changes due to the elimination of profit shifting. The downward sloping diagonal is the zero-revenue change frontier, along which $(\omega_i - \beta_i)\Pi = s_i$. Countries above this line gain revenue from the reallocation of excess profits implied by moving to destination-based RPA while countries below it lose revenue. The contours report level curves of the density of revenue changes across the two component terms. For the cost-function based approach (in the left panel) the dispersion along the horizontal axis indicates that it is the reallocation of purged profits that drives the overall reallocation of excess profits: several countries would gain more than 100 percent of their current revenue through this route, while the effect of profit shifting, whether positive or negative, generally does not exceed 50 percent of the current tax base. Matters are the other way around however, using the activity-based identification strategy: the dispersion of effects is more pronounced along the vertical axis, indicating a greater importance of profit shifting in driving the overall reallocation of excess profits. The implication is that the balance of the two effects depends sensitively on how one infers the extent of profit shifting: this appears to be less marked when related to the difference in statutory tax rates than when related to differences in activity as indicated by the location of capital.

[45] Using the Delta method and standard errors of the semi-elasticity reported in Beer and others (2019), we obtain a standard error of 0.58 for this parameter.

[46] 'Capital-based' would be more accurate, but risks confusion with capital-based allocations of residual profit.

Figure 8. Country-Specific Decomposition of Revenue Effects of Moving to Destination-Based RPA

(in percent of current revenue)



Source: Authors' computations.

Notes: The figure shows the country-specific revenue changes (in percent of current CIT revenue) due to elimination of profit shifting (vertical axis) and due to the reallocation of profits purged of profit shifting (horizontal axis)—as in equation (17). The diagonal line shows the zero-revenue change surface along which $(\omega_i - \beta_i)\Pi = s_i$. Circles are level curves of two-dimensional density estimates. The left panel provides the decomposition using cost-function based identification approach; the right panel uses the activity-based identification approach.

Key features of the decomposed revenue effects are shown in Table 10. The first six rows show results for a destination-based RPA. The first three of these identify profit shifting using the cost-function based approach. Collectively, countries are estimated to gain USD 62 billion in tax revenue due to the elimination of profit shifting and an additional USD 106 billion due to the reallocation of purged profits (from low to high-tax countries). These amount to 2.6 and 4.5 percent of global CIT revenues, respectively. The unweighted average revenue effect is smaller (5 percent), more heavily driven by the reallocation of purged profits (5.4 percent), with the elimination of profit shifting on average actually reducing countries' tax revenue (by -0.4 percent), reflecting the losses suffered by small countries. The middle three rows, still focused on destination-based RPA, instead use the activity-based approach. The total effect is of course the same, But, as Figure 8 suggests, the relative importance of the profit shifting component increases both at the average country level and globally. The greater effect of profit shifting under the activity-based approach may reflect the importance of special tax incentive regimes not captured in the cost function-based approach, though it will also reflect cross-country differences in capital intensity and/or productivity.

For brevity, we do not repeat this full decomposition analysis for the case in which allocation is by capital rather than destination-based sales. The final three rows of Table 10, however, show

revenue effects in this case, using the cost-function based approach to identifying profit shifting. While average revenue effects due to an elimination of profit shifting are the same as in the first three rows (since profit shifting is identified in the same way), the impact of reallocating purged profits is smaller—reflecting the presumption that these profits are closely related to capital use.

Table 10. Decomposition of Average Residual Reallocation Effects
(in percent of initial corporate tax revenue)

	Profit shifting	Reallocation of purged profits	Total
	(1)	(2)	(3)
Destination-based sales allocation, cost function based approach			
Country-specific average (in percent of revenue)	-0.43	5.44	5.02
Global revenue change (in percent of revenue)	2.61	4.48	7.09
Global revenue change (in billion USD)	62	106	168
Destination-based sales allocation, activity-based approach			
Country-specific average (in percent of revenue)	3.9	1.12	5.02
Global revenue change (in percent of revenue)	4.61	2.48	7.09
Global revenue change (in billion USD)	109	59	168
Capital-based allocation, cost function based approach			
Country-specific average (in percent of revenue)	-0.43	4.33	3.9
Global revenue change (in percent of revenue)	2.61	2	4.61
Global revenue change (in billion USD)	62	48	109

Source: Authors' computations.
Notes: Table provides descriptive statistics of simulated revenue effects, differentiating between revenue changes due to the elimination of profit shifting (column 1), due to the reallocation of purged profits returns (column 2) and, the sum of the two, due to the reallocation of excess profits (column 3).

To further understand the forces driving the decomposition of effects underlying the reallocation of excess profits, Table 11 reports the results of regressing the distinct simulated effects of eliminating profit shifting and reallocating purged profits on country-specific variables. Columns 1 and 2 report on destination-based RPA using the cost-function based approach, columns 3 and 4 on a capital-based RPA using the same approach, and columns 5 and 6 on destination-based RPA with activity-based identification.

Column 1 shows that CIT rates are the main driver behind revenue changes due to the elimination of profit shifting; this is of course a direct consequence of profit shifting being calibrated under the cost-function based approach on the basis of difference in CIT rates; no other variable, including GDP per capita, has a significant impact. There is in this column, for instance, no sign that the gain from eliminating profit shifting varies with the income level. Column 2 shows that the reallocation of purged profits tends to generate revenue losses in investment hubs and to benefit less advanced economies. Columns 3 and 4 show that the same conclusions apply under capital-based RPA, though the country-specific effects are of course quite different. Columns 5 and 6, using the activity-based approach, again suggest that the elimination of profit shifting would benefit countries with high CIT rates. Now, however, this correlation is not imposed by definition, but rather empirically observed. Investment hubs,

unsurprisingly, also lose revenue in this specification, but now (in contract to the previous columns) entirely through the elimination of profit shifting. Moreover, consistent with prior evidence (such as in Crivelli and others, 2016), the results suggest that developing countries stand to gain more from the elimination of profit shifting than do advanced economies. As with the other specifications, Column 6 indicates that reallocation of purged returns is significantly to the benefit of developing countries, but the scale of the effect is noticeably less.

Table 11. Drivers of the Components of Reallocation of Excess Returns

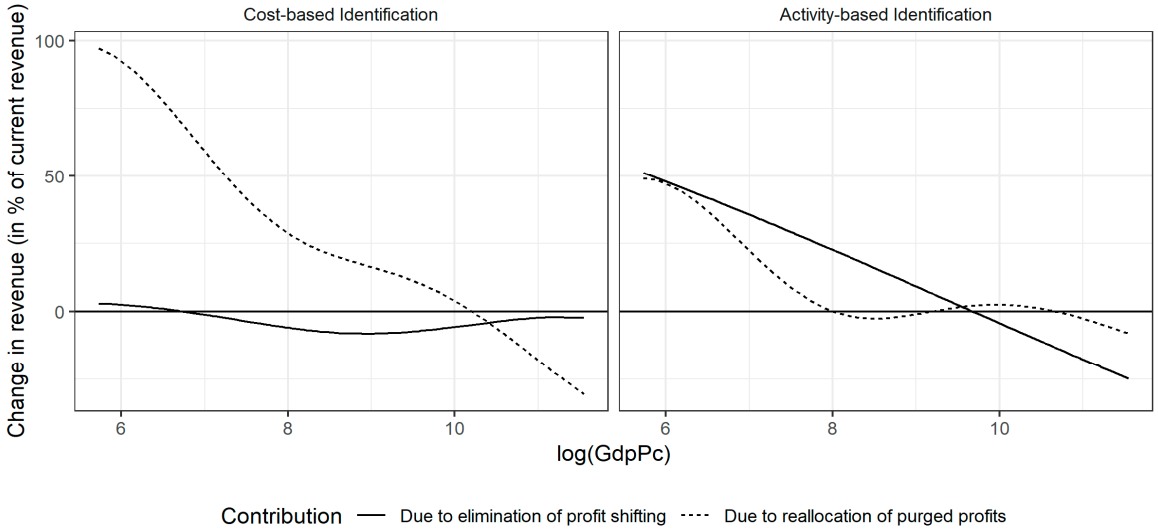
	Destination-based RPA, cost-function approach		Capital-based RPA, cost-function approach		Destination-based, Activity-based approach	
Component	PS	Realloc.	PS	Realloc.	PS	Realloc.
Column	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-5.931***	26.212***	-5.931***	21.197***	15.266***	5.014***
	[0.641]	[6.806]	[0.641]	[7.104]	[6.969]	[2.301]
CIT rate	1.627***	0.456	1.627***	0.053	1.680**	0.402
	[0.132]	[0.802]	[0.132]	[0.819]	[0.788]	[0.263]
log(GDP per cap.	-0.133	-15.303***	-0.133	-10.415***	-10.548***	-4.888***
	[0.435]	[4.808]	[0.435]	[4.574]	[4.640]	[1.984]
Resource rich	0.032	-7.744	0.032	-0.172	-0.139	-7.572
	[2.305]	[16.612]	[2.305]	[16.867]	[16.688]	[5.973]
FDI/GDP>1.5	6.224	-62.873***	6.224	-66.504***	-60.280***	3.631
	[4.237]	[13.926]	[4.237]	[15.044]	[15.786]	[3.864]
Adjusted R^2	0.703	0.139	0.703	0.08	0.111	0.078
Observations	129	129	129	129	129	129

Source: Authors' computations.

Notes: Table presents regression results, explaining simulated revenue changes due to the elimination of profit shifting (columns labeled 'PS') and due to the reallocation of purged profits (columns labeled 'Realloc.')—corresponding to the decomposition in (17)—for both a destination sales and capital stock-based allocation. The last two columns present results using the activity-based identification of profit shifting. *,**, and *** indicate statistical significance at the 10%, 5%, and 1% level. Standard errors in square brackets.

Visualizing a key aspect of these results, Figure 9 shows, using a local linear ridge regression, how the relative importance, under destination-based RPA, of the two components of the residual reallocation effect varies with GDP per capita. Using the cost-function based identification strategy, the difference by per capita income is driven almost entirely by the reallocation of purged profits: while low income countries gain revenue on this account, high income countries tend to lose. No great difference across income groups arises in terms of profit shifting: this component is driven, as in Column 2 of Table 11, by CIT rates only, and these are not very strongly correlated with income levels. The right panel shows results using instead the activity-based identification approach. Here, both the reallocation of purged profits and the elimination of profit shifting work in favor of lower income countries.

Figure 9. Reallocation of Excess Returns Under Destination-Based RPA by Income Group: Total and Decomposition



Source: Authors' computations.
Notes: This figure shows the breakdown of the residual reallocation effect into effects (as in (17)) from the elimination of profit shifting (solid line) and the reallocation of purged profits (dashed line) across income groups. The sum of these components is the same at each income level, independent of the identification strategy.

B. Routine Profit Effect

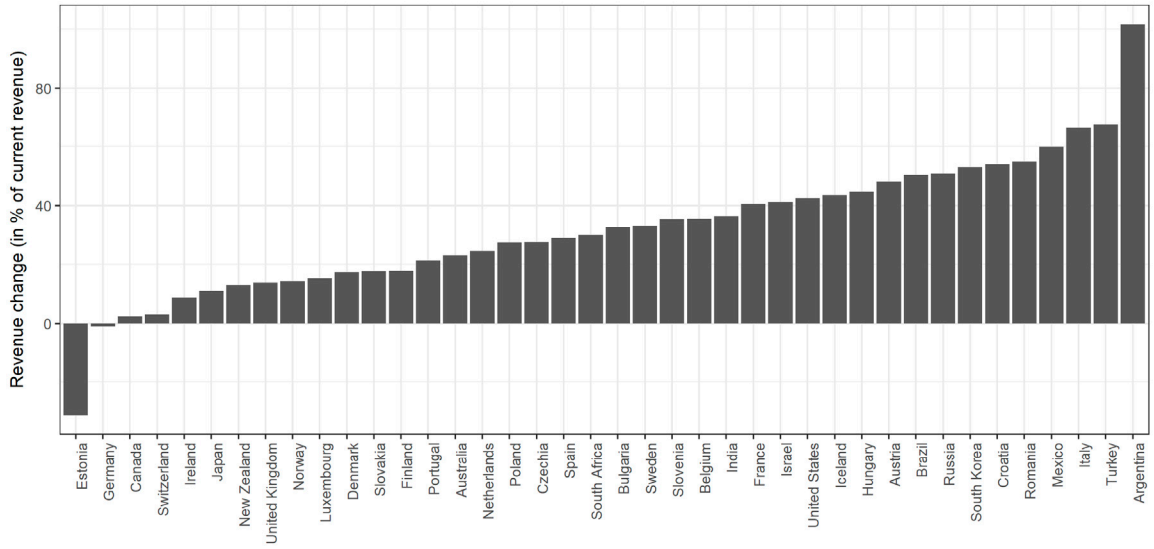
The revenue impact through the second term in (16)—which is of course independent of the weighting scheme chosen—will evidently depend on the rate at which routine profits are taxed under an RPA. While the possibility of taxing residual and routine profits at different rates is recognized in Auerbach and others (2019),[47] the rate at which the latter in particular might be set has received almost no attention. There are two obvious possibilities.

One is that routine profits will be taxed at current statutory rates, so that $t_i = \tau_i$.. Figure 10 illustrates the additional revenue effects in this case, which are given by $[(\tau_i - (1-\tau_i)m_i)rk_i^{ALP}$, expressed as a percentage of current revenue. This effect is of course negative for countries in which the closed economy METR m_i exceeds the grossed up statutory tax rate $\frac{\tau_i}{1-\tau_i}$. In Estonia, for instance, the METR is 31 percent while the statutory tax rate is only 20 percent, leading to losses of 31 percent of current tax revenue if routine returns were to be taxed at the statutory rate. At the other extreme lies Argentina, where the statutory rate is 35 percent while the closed economy METR tax rate is 27 percent: revenue would then increase by 101 percent. The key point

[47] Though not, for instance, in any of the proposals referred to in the Introduction or in Avi Yonah, Clausing and Durst (2009).

that stands out from the figure, however, is that revenue would substantially increase in virtually all countries if they were to tax routine profits at their current statutory rates.

Figure 10. Revenue Impact of Changed Treatment of Routine Profits Under RPA



Source: WEO, GFS, author's computations

Recall, however, the assumption that no part of financing costs would be deducted in the calculation of routine profits. If some allowance were to be made for financing costs, including of course interest, against routine profits, the revenue impact would of course be smaller—possibly much smaller (with the effects operating through the residual consequently larger than above). This leads to a second possible benchmark assumption on the rate of tax on routine profits, which is to suppose that such an allowance for financing costs is given by each country in its taxation of routine profits as to leave the marginal tax on investment (leaving aside taxes on the return to that investment) at its current level. This implies that:

$$t_i = (1 - \tau_i)m_i. \tag{18}$$

In this case, there is no impact on revenue through the treatment of routine profit: the second term in (16) simply vanishes.[48]

[48] The question again arises as to the implications of assuming all profits to be covered by the RPA. These are more straightforward for routine than for residual profits (since the effect does not depend on the weighting scheme): revenue in jurisdiction i increase with coverage under RPA in jurisdiction i if and only if $t_i > (1 - \tau_i)m_i$. The extent of coverage is thus in this respect immaterial under the assumption in (18).

VI. Impact on Investment and Efficiency

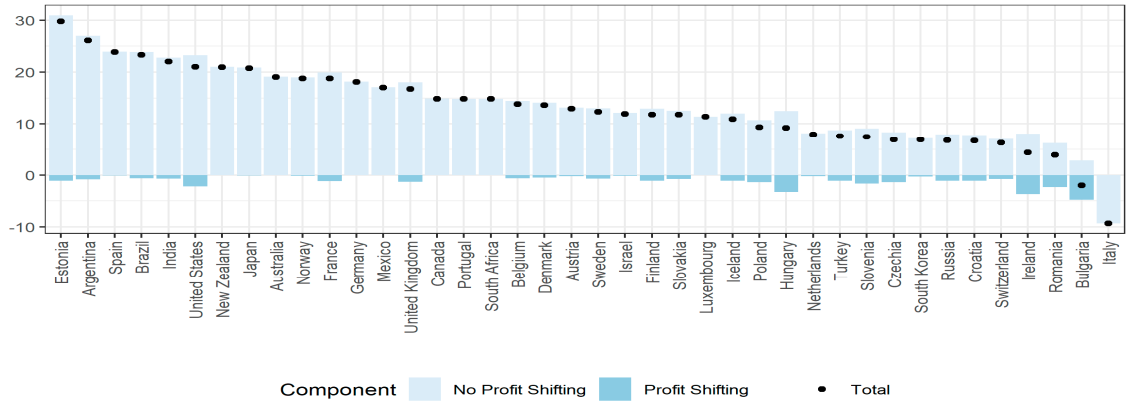
A primary concern with the adoption of any RPA scheme, as with all major corporate tax reforms, is its potential impact on the level of investment.[49] This of course matters not only for revenue, as in the final two terms of (16), but, still more fundamentally, for investment, growth and, more generally, the efficiency of the tax system. This section explores these effects, focusing on the impact of reform on the marginal effective tax rate (METR) as analyzed in Section II.

A. Incentives to Invest

The METR under current ALP arrangements, given by (12) above, has two components. The first of these, m_i, is that conventionally calculated for closed economies (or, more generally, ignoring the possibility of profit shifting). The second captures the reduction in the METR, in all countries, that is created by the possibility of profit shifting: for the calculation of this, we use the estimate of θ discussed above.

Figure 11 reports the resulting estimates of the METR under ALP, $METR^{ALP}$, broken down into these components. They average around 15 percent, but with wide variation. The profit shifting term is evidently generally dwarfed by the closed economy term but is larger, as one would expect, for countries with either very high or very low statutory tax rates. Bulgaria, for instance, stands out as notable outlier because the closed economy 'no profit shifting' marginal effective rate m_i is sufficiently low that the profit shifting effect, reflecting a statutory rate that is also low, is large enough to turn the overall METR negative, suggesting that the marginal incentive to invest there is higher than it would be in the absence of taxation.

Figure 11. Current METRs, with Profit Shifting



Source: WEO, GFS, author's computations

[49] Attention also often focuses on the cross-country location of investment, with the average effective tax rate (AETR) taken as a key indicator. Under RPA schemes, however, the AETR is not uniquely defined, in the sense that, through the weights ω_i it generally depends on the pattern of activities, and tax rates on residual profits, in all jurisdictions.

To calculate $METR^{RPA}$, the marginal effective rate under RPA, as given in (5), three assumptions are required.[50] The first is the rate at which routine profits are taxed. As above, we consider two possibilities: taxation at the same rate as residual profits, in turn equal to the current statutory rate; and taxation so as to leave the effective tax on capital unchanged, as in (18). The second assumption needed is on the nature of the weighting scheme for the allocation of residual profit, shaping the second term in (5). To derive some sense of the potential significance of this, we focus on the case in which this weighting is by the capital stock k_i (taken from the country-level dataset), so that $W(\tau, k) = \frac{\sum_i \tau_i k_i}{K}$, and hence:

$$\frac{\partial W}{\partial k_i} = \frac{1}{K}(\tau_i - W). \tag{19}$$

Intuitively, this weighting scheme can be seen as something of an upper bound on effects through this route. Under destination-based taxation, for instance, the weighting scheme would be exactly the same as this if sales in each jurisdiction were proportional to capital there. In practice, however, while it seems plausible to suppose that there would be some link between sales and physical capital in any location, it is likely to be far looser than simple proportionality, suggesting a non-zero but lesser impact of investment decisions on the allocation of residual profits. Given (19) and recalling (5), the final assumption needed, affecting the extent of impact through the induced change in the effective tax rate on residual profits, is the ratio of residual to routine profit. For this the denominator is taken from the capital stock figures described above and assuming a routine return of 7.5 percent, while the numerator Π is calculated as the sum over all countries of the country-specific excess profits estimated as in (15).

For the capital-based weighting scheme underlying (19), the $METR^{RPA}$ in (5) can be written as

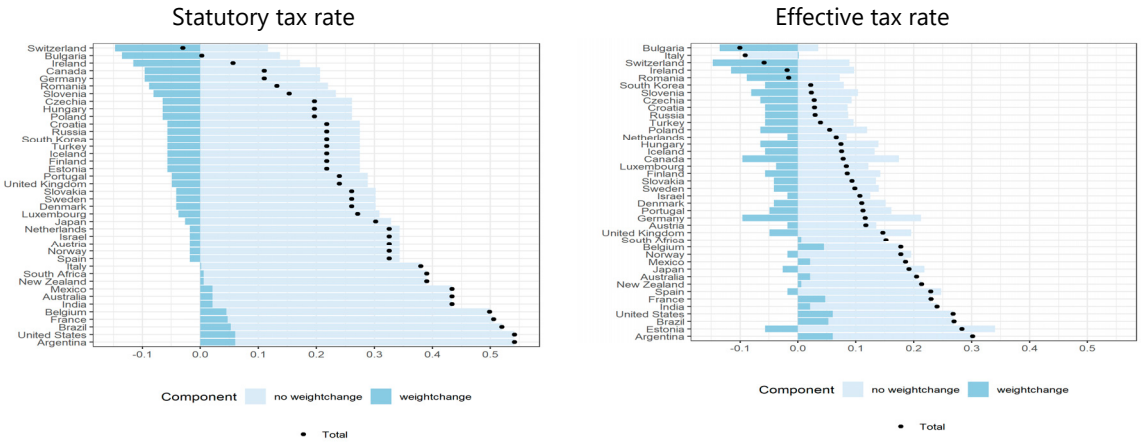
$$METR_i^{RPA} = \left(\frac{1}{1-W}\right)\left(t_i + \alpha(\tau_i - W)\frac{\Pi}{rK}\right), \tag{20}$$

with the dummy variable α serving simply as a reminder that whilst the results reported below include the weighting terms ($\alpha = 1$), in some contexts it may be appropriate to ignore or otherwise attach less importance to this term. Where it applies, however, the effect of this weighting effect is to raise (lower) the METR for investment—by companies with positive residual—in countries with relatively high (low) statutory tax rates on residual profits, because additional investment there then raises (lowers) the overall weighted average rate on residual profits. As noted earlier, the presence of the weighting effect means that, even though subject to a common set of tax rules, different multinationals may face quite different METRs when operating in the same jurisdiction, reflecting differences in the groups' overall pretax rate of return $\frac{\Pi}{rK}$: highly profitable MNEs face a higher METR than otherwise in jurisdictions applying a

[50] We also continue to assume here that each jurisdiction taxes residual profits at its current statutory CIT rate.

statutory rate above the weighted average, and a lower METR where the tax rate is below that average.

Figure 12. METR^{RPA} under Alternative Assumptions on the Tax Rate on Routine Profits



Source: WEO, GFS, authors' computations.
Notes: The figures shows the decomposition of $METR^{ALP}$ under capital-based RPA for two different tax rate scenarios. 'No weighting change' refers to the first term in (20), and 'weight change' to the second (with $\alpha = 1$).

Figure 12 reports the $METR^{RPA}$ as in (20) under the two alternative assumptions on the rate of tax on routine returns, t_i, and showing separately the effect of the weighting term. Not surprisingly, the METR is higher when routine profits are taxed at the current statutory rate, rather than—perhaps more plausibly, for the reasons above—at a more modest level corresponding roughly to standard closed economy METRs. For most countries, and in both cases, the main component of the METR is that deriving from the tax on routine profits. But the impact through the effect of investment in changing the overall effective rate (which, being independent of the rate at which routine profits are taxed, is the same in both panels) is by no means trivial, and for most countries actually tends to reduce the METR and so encourages investment: in several cases, the reweighting effect reduces the METR by 5 percentage points or more.

Turning to the comparison of METRs under the two arrangements, combining (5) and (12) gives the change in the marginal effective tax rate on moving to an RPA scheme as

$$METR_i^{RPA} - METR_i^{ALP} = \underbrace{\left(\frac{t_i}{1-W} - m_i\right)}_{Baseline\ effect} + \underbrace{\left(\frac{\alpha(\tau_i - W)}{1-W}\right)\frac{\Pi}{rK}}_{Reweighting\ effect} + \underbrace{\left(\frac{1}{2\theta(1-\tau_i)}\right)\left(\frac{s_i}{rk_i}\right)^2}_{Elimination\ of\ profit\ shifting} \qquad (21)$$

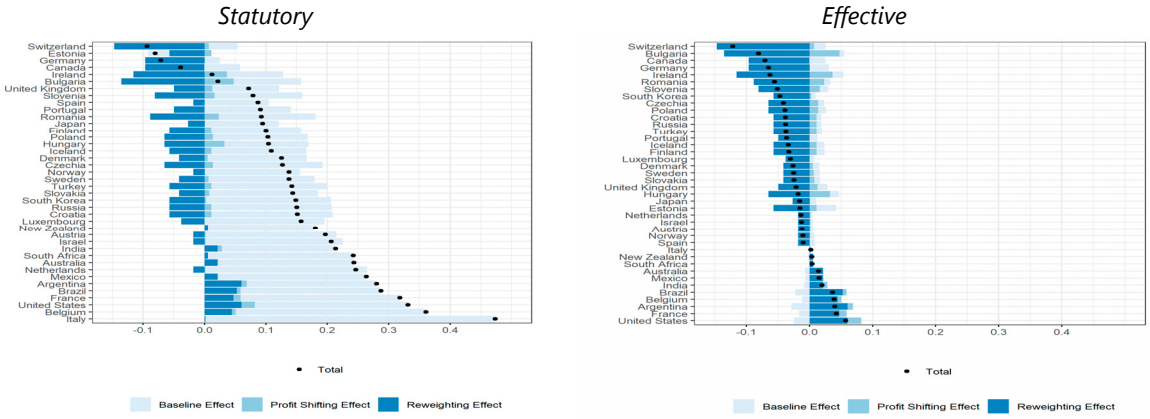
There are thus several effects at work. The first, 'baseline' effect captures the "pure" difference between the standard closed economy METR and an RPA scheme in which the allocation of residual profit does not depend on investment. Through this term, METRs tend to increase on moving to any RPA scheme in which the rate of tax on routine profit, grossed up to reflect the

taxation of residual profits, exceeds the no-shifting METR. The second effect is the impact that arises under capital-based RPA through the change in the weighted average tax rate, the sign of which, as just noted, is ambiguous in principle but in many countries likely to be negative. The third effect, which, in contrast, leads unambiguously to an increased METR in moving to an RPA scheme, reflects its elimination of the general encouragement to investment provided by opportunities available under ALP to shift profits to low tax jurisdictions.

Figure 13 reports the absolute change in the METR consequent upon moving to capital-based RPA under each of the two assumptions on the rate of tax on routine profits, in each case identifying the three effects in (21). If, in the left panel of the figure, routine profits are taxed at the current statutory rate, the baseline effect is generally so large—reinforced, albeit modestly, by the effect through the elimination of profit shifting—that the METR is generally much higher under RPA. These effects are independent of the weight used in the RPA scheme. Under capital-based RPA, they are muted by the further effect through the impact of investment in changing the overall average rate for most countries tends to reduce the METR. This effect, as seen above, is in some cases quite marked: in four countries (Switzerland, Estonia, Germany and Canada), it is so strong that the METR actually falls on moving to the RPA scheme. Overall, moving to the capital-based RPA scheme raises the METR in almost all countries

In sharp contrast, however, if, as in the right panel of Figure 13, the routine tax rate is set so as to leave the tax on capital unchanged, the effect of the changing weights under RPA means that for most countries the METR is lower under RPA than under current arrangements. Even in this case, however, the METR in some countries with a high statutory tax rate (such as in 2017 the U.S., France, Argentina, Belgium, Brazil, India, Mexico and Australia) increases on moving to capital-based RPA.

Figure 13. Effects on METRs of Moving to Capital-Based RPA



Source: WEO, GFS, authors' computations.
Notes: The figure shows the decomposition of the change in METR in moving to capital-based RPA. Baseline effect does not account for elimination of profit shifting nor for reweighting effect. The three components correspond to t the three term in (20).

B. Efficiency effects

The impact of reform on the inefficiency of the corporate tax system—meaning here the shortfall of residual profits $\Pi(k)$ (identified with rent) from their maximal value—impacts revenue directly, through the final term in (16), and is evidently important in itself. It is closely related to the impact on METRs: when there is only one jurisdiction, efficiency is improved by a reform if and only it reduces the METR in absolute value, bringing it closer to zero. Here, with the multinational active in several jurisdictions, a similar role is played by the capital-weighted average METR.[51] The results shown in Figure 13 thus leave the efficiency impact of moving from the current system to a capital-based RPA scheme uncertain, under each of the alternative assumptions on the rate of tax applied to routine profits, since in each case it increases the METR in some countries while reducing it in others. The issue is thus a quantitative one.

Exploring this, Table 12 reports on the impact on the capital-weighted average METR, and hence efficiency, of moving from current arrangements to a capital-based RPA scheme (though as seen shortly, the results apply more generally).

The capital-weighted average METR evidently increases substantially on movement to the RPA scheme—and efficiency consequently declines—if routine profits are taxed at the statutory tax rate. This is as one might expect, given that in this case the METR increases in almost all countries. If, on the other hand, the tax on routine profits is set so as to leave the effective tax on capital unchanged, then the weighted average METR, and hence efficiency, is essentially unchanged: even though in this case the METR falls in the large majority of countries it increases by enough in sufficiently large ones to leave overall efficiency broadly unchanged.

In neither case, notably, is aggregate efficiency manifestly increased by movement to the RPA scheme. The tentative implication is that an overall efficiency gain from moving to an RPA scheme is unlikely unless routine profits are taxed at a low rate or—recalling that the results here presume capital-weighting—residual profits are allocated by some factor markedly less sensitive to investment than capital itself.

[51] Defining $k^* = \text{argmax}\,\Pi(k)$, to the first order

$$\Pi(k^*) - \Pi(k) \approx \sum_i \frac{\partial \Pi}{\partial k_i}(k_i^* - k_i) = \sum_i METR(k_i) k_i \sigma_i$$

where the equality uses $\frac{\partial \Pi(k_i)}{\partial k_i} = METR(k_i)$ (with $METR(k_i^*) = 0$), and σ_i denotes (minus) the arc elasticity of k_i with respect to $METR_i$. Taking the latter to be constant, the conclusion follows.

Table 12. Efficiency Effects of Moving to Capital-Based RPA

	Average METR	Capital- weighted average METR
Current	13	17
RPA with routine profits taxed at:		
Current statutory rate	28	38
Current effective rate	11	18

Source: Authors' computations.

One other striking point should be noted. Table 12 assumes a capital-based RPA scheme: the RPA variant, that is, under which the weights are most directly sensitive to investment. One might expect that this would be a source of aggregate inefficiency in itself. But the implications for aggregate efficiency are exactly the same in the polar opposite case in which the weights are wholly unaffected by investment. (This follows on using in (5) the implication of (19) that $\sum_i \frac{\partial W}{\partial k_i} k_i = 0$). Under a destination-based RPA, for instance, the capital-weighted METR, calculated at the statutory rate will again be 38 percent—and the impact on aggregate efficiency will be the same.

VII. CONCLUSIONS

Schemes of residual profit allocation have risen rapidly to prominence in practical policy debate, but with almost none of the underlying economic analysis needed for coherent decision-making. While the broad structure of such schemes has some familiar features, developing such an analysis encounters not only conceptual issues—in identifying core economic features of such an approach, for instance, and understanding its likely behavioral impacts—but, even more, challenges from the absence of direct observations on the key quantities on which such schemes hinge. While the results presented here, exploring key conceptual and practical aspect of RPA schemes are thus inevitably tentative, resting to some extent on untested assumptions, several apparently robust results do emerge.

Residual profits, it appears, are, in aggregate, considerable, perhaps 70 percent or so of the total profits of the very largest multinational groups. They are also highly concentrated in companies headquartered in a handful of countries, notably the United States. Many large multinationals, however, appear to have negative residual profits, and with some persistence, so that the practical question of how to handle such residual losses, which has been little considered, is one of real practical importance.

The analysis also casts light on the various drivers of the impact on tax revenues of moving to some form of RPA, with particular focus on that arising from the reallocation of excess profits (profits, that is, in excess of routine), away from where they are currently declared and instead as dictated by the weights used to allocate the residual under RPA. Moving to a destination-based RPA, for instance, increases global corporate tax revenue by around 8 percent. Effects at country-level are more—and in some cases, very—marked. Unsurprisingly, investment hubs lose

considerable revenue. Less obviously, but of evident importance, is that low income countries tend to gain revenue—and that is not because they tend to run trade deficits, but seems to be largely because, as previous work has shown, under current arrangements they lose more, as a share of their total corporate tax revenue, than do more advanced economies. No less important, for many countries it appears that routine profits exceed the current base of their CIT, pointing to potentially significant revenue gains through that component of the RPA.

Incentives to invest are unambiguously reduced under RPA, in all countries, to the extent that it eliminates profit shifting. Further effects arise, however, from the weighting scheme used under RPA: under capital-based allocation of the residual, for example, incentives to invest decrease further in high tax countries, and the effect can be quite substantial. A key role is played, moreover, by the rate at which routine profits are taxed. If this is set in line with current METRs (as conventionally calculated, ignoring profit shifting), then METRs under capital-based RPA fall in most countries. Since it increases in several larger countries, however, global efficiency is largely unchanged. Efficiency gains require low taxation of routine profit.

There remain of course many further issues to address. The treatment of interest expense that we have followed, for example—implicitly assuming it to be deducted in calculating residual profit, so enabling that residual to be identified with rents —is by no means the only or politically most likely approach. Identifying routine and residual profits from available data, moreover, is far from straightforward. The impact on the tax-setting incentives that governments face also remain to be considered: on this there are doubtless lessons to learn from previous work on tax competition under formula apportionment,[52] but distinct issues of strategic tax setting also arise under RPA in relation to the potential distinction between the rate of tax applied to residual and routine profit. And practical RPA proposals differ more widely than has been considered here in both the extent to, and the precise manner in which, the residual is allocated, in many cases resting on keys that are hard to operationalize from available data.

For many years, the policy debate on international tax reform lagged behind economic analysis of these issues. Now the risk is of the reverse: of significant policy decisions being made with limited conceptual and empirical understanding of the likely consequences. The aim here has simply been to take a first step towards addressing that danger.

[52] Such as Pethig and Wagener (2007).

Appendix I. Country-Level Variables

Unit		(in USD)	(in billion USD)	(in percent)			(in percent of CIT base)		
Country	Income group	GdpPc	CitRev	CitRate	Salesweight	Assets to Gdp	Profit shifting share	Reallocation share	Total
Malawi	Low income	308.09	0.21	30	0.01	38.20	0.98	-32.43	-31.46
Central African Republic	Low income	359.58	0.01	30	0.00	48.84	6.40	277.40	283.80
Mozambique	Low income	477.51	0.98	32	0.02	52.82	1.63	-59.25	-57.61
Afghanistan	Low income	582.02	0.24	20	0.04	40.18	-11.05	66.72	55.66
Togo	Low income	589.36	0.08	29	0.01	98.22	1.78	96.44	98.22
Uganda	Low income	674.57	0.28	30	0.04	90.94	7.52	209.41	216.93
Gambia	Low income	699.02	0.02	31	0.00	58.03	6.31	103.09	109.40
Rwanda	Low income	755.16	0.12	30	0.01	53.92	3.58	98.96	102.55
Ethiopia	Low income	760.13	1.40	30	0.11	55.31	2.53	37.91	40.44
Nepal	Low income	798.09	0.71	25	0.04	93.55	-5.00	6.85	1.85
Benin	Low income	809.50	0.14	30	0.01	112.92	6.75	156.35	163.09
Mali	Low income	813.27	0.37	30	0.02	82.31	2.94	28.09	31.03
Eritrea	Low income	879.51	0.22	34	0.01	29.30	2.51	-46.70	-44.19
Tanzania	Low income	1029.15	0.62	30	0.07	115.44	8.64	216.87	225.51
Kyrgyzstan	Lower middle income	1170.29	0.15	10	0.01	246.96	-41.42	58.67	17.25
Yemen	Lower middle income	1201.86	0.24	20	0.06	62.36	-29.44	222.03	192.59
Senegal	Low income	1260.17	0.29	30	0.03	82.58	5.19	122.68	127.88
Lesotho	Lower middle income	1265.91	0.07	25	0.00	98.28	-5.75	27.97	22.22
Cambodia	Lower middle income	1275.68	0.55	20	0.03	65.89	-7.74	-18.10	-25.85
Bangladesh	Lower middle income	1358.86	3.55	25	0.34	113.47	-1.01	-80.23	-81.24
Cameroon	Lower middle income	1389.99	0.79	33	0.05	126.78	15.47	80.02	95.48
Zambia	Lower middle income	1405.50	0.40	35	0.03	180.17	46.95	226.32	273.26
Côte d'Ivoire	Lower middle income	1462.47	0.72	25	0.05	47.89	-3.87	2.63	-1.24

Kenya	Lower middle income	1574.22	2.56	30	0.11	64.17	1.66	-18.62	-16.96
São Tomé & Príncipe	Lower middle income	1701.35	0.01	25	0.00	104.68	-11.34	138.81	127.47
India	Lower middle income	1826.85	78.92	35	3.22	114.73	14.27	21.95	36.22
Uzbekistan	Lower middle income	1831.68	3.05	11	0.08	94.57	-5.73	-73.63	-79.36
Djibouti	Lower middle income	1888.56	0.09	25	0.00	135.17	-4.59	-12.83	-17.42
Ghana	Lower middle income	1895.90	1.14	25	0.08	129.83	-10.02	81.10	71.08
Nicaragua	Lower middle income	2147.65	0.67	30	0.02	115.29	2.09	-20.53	-18.44
Vietnam	Lower middle income	2219.53	9.43	21	0.28	104.20	-6.77	-37.24	-44.00
Laos	Lower middle income	2383.75	0.24	24	0.02	94.67	-11.56	79.34	67.79
Honduras	Lower middle income	2416.38	0.74	28	0.03	273.31	-0.73	-59.47	-60.19
Timor-Leste	Lower middle income	2430.00	0.02	10	0.00	21.40	-9.50	-25.60	-35.10
Moldova	Lower middle income	2450.43	0.18	12	0.01	134.50	-24.06	13.45	-10.61
Bhutan	Lower middle income	2797.56	0.14	30	0.00	159.72	2.40	-16.66	-14.26
Philippines	Lower middle income	2935.83	11.22	30	0.45	99.10	2.48	-2.46	0.02
Morocco	Lower middle income	3056.40	4.80	31	0.15	139.59	4.75	-0.93	3.82
Egypt	Lower middle income	3113.10	12.45	23	0.43	129.89	-2.17	-76.09	-78.26
Cape Verde	Lower middle income	3123.16	0.06	25	0.00	126.84	-5.53	4.81	-0.72
Indonesia	Lower middle income	3626.20	37.38	25	1.28	192.26	-7.86	26.76	18.89
Armenia	Lower middle income	3693.10	0.23	20	0.02	137.10	-21.31	69.26	47.95

El Salvador	Lower middle income	3707.69	0.82	30	0.04	106.28	2.91	14.68	17.59
Georgia	Lower middle income	3903.24	0.38	15	0.02	110.20	-16.46	-6.11	-22.57
Sri Lanka	Lower middle income	3957.85	1.18	28	0.11	137.09	-2.07	197.22	195.15
Swaziland	Lower middle income	3966.32	0.11	28	0.01	59.13	-1.14	5.71	4.57
Algeria	Upper middle income	4084.70	4.53	26	0.24	84.09	-3.70	9.41	5.70
Jordan	Lower middle income	4173.57	0.98	20	0.07	115.13	-14.88	28.17	13.29
Guatemala	Lower middle income	4196.51	2.05	25	0.10	77.79	-0.72	-83.99	-84.71
Albania	Upper middle income	4242.06	0.24	15	0.02	166.52	-32.97	69.73	36.76
Angola	Lower middle income	4329.31	6.73	30	0.16	116.93	1.91	-32.37	-30.46
Guyana	Upper middle income	4373.34	0.15	30	0.01	57.56	1.29	-31.22	-29.93
Azerbaijan	Upper middle income	4750.23	1.71	20	0.06	210.44	-18.26	26.57	8.31
Bosnia & Herzegovina	Upper middle income	4882.52	0.26	10	0.03	99.54	-23.45	8.70	-14.76
Iran	Upper middle income	5006.64	9.95	25	0.47	120.53	-7.96	39.01	31.04
Iraq	Upper middle income	5128.88	0.96	15	0.26	64.39	-48.38	223.67	175.29
Macedonia	Upper middle income	5154.42	0.21	10	0.01	123.96	-22.37	-7.12	-29.49
Jamaica	Upper middle income	5200.52	0.42	25	0.02	164.65	-9.41	63.03	53.62
Namibia	Upper middle income	5474.26	0.59	33	0.02	104.76	5.79	-14.09	-8.30
Paraguay	Upper middle income	5481.46	0.80	10	0.05	106.13	-17.83	-23.88	-41.71
Serbia	Upper middle income	5934.66	0.81	15	0.06	106.52	-21.40	20.97	-0.42

South Africa	Upper middle income	5991.38	17.83	28	0.46	122.78	-0.49	-27.58	-28.07
Colombia	Upper middle income	6207.08	16.27	30	0.44	81.36	0.93	-42.57	-41.65
Thailand	Upper middle income	6263.60	18.21	20	0.53	124.26	-9.31	-28.05	-37.35
Peru	Upper middle income	6437.97	6.86	29	0.28	96.74	0.56	-0.17	0.39
Montenegro	Upper middle income	7148.39	0.05	9	0.01	145.67	-42.27	69.63	27.36
Dominican Republic	Upper middle income	7192.95	1.56	27	0.10	108.62	-3.65	65.15	61.50
Gabon	Upper middle income	7411.23	0.49	33	0.02	151.67	11.74	41.94	53.68
Dominica	Upper middle income	7645.18	0.01	27	0.00	50.18	-2.33	16.11	13.77
Bulgaria	Upper middle income	7645.95	1.19	10	0.07	127.55	-20.61	-15.44	-36.05
China	Upper middle income	8422.08	449.13	25	15.35	173.78	-7.34	20.14	12.79
Lebanon	Upper middle income	8659.43	1.06	15	0.09	120.56	-22.69	29.28	6.58
Brazil	Upper middle income	9387.30	69.91	34	2.66	133.83	13.49	23.12	36.61
Mexico	Upper middle income	9525.31	39.01	30	1.60	148.24	4.09	36.05	40.14
Malaysia	Upper middle income	9669.74	18.49	24	0.39	77.15	-2.58	-57.72	-60.30
Kazakhstan	Upper middle income	9694.12	7.60	20	0.21	181.67	-13.40	-6.19	-19.59
Romania	Upper middle income	9856.09	3.84	16	0.27	134.17	-25.96	45.00	19.04
Mauritius	Upper middle income	10174.22	0.33	15	0.02	74.42	-11.25	-28.24	-39.50
Russia	Upper middle income	10219.78	49.52	20	1.87	166.48	-15.96	15.23	-0.73
Equatorial Guinea	Upper middle income	10452.91	0.81	35	0.02	80.18	5.56	-49.31	-43.75

Turkey	Upper middle income	10726.04	13.39	20	1.22	107.89	-22.26	86.06	63.80
Costa Rica	Upper middle income	11616.39	1.55	30	0.08	96.04	3.26	25.88	29.14
Croatia	Upper middle income	12580.53	1.08	20	0.07	107.77	-16.86	38.00	21.15
Maldives	Upper middle income	12645.63	0.21	15	0.01	74.67	-6.12	-61.83	-67.95
Poland	High income	13216.67	9.46	19	0.66	66.69	-12.16	6.21	-5.94
Hungary	High income	13375.74	2.26	14	0.17	115.61	-21.71	8.97	-12.74
Panama	Upper middle income	14402.34	1.53	25	0.08	221.68	-13.73	115.43	101.70
Latvia	High income	14620.15	0.46	15	0.04	117.77	-28.68	55.05	26.37
Argentina	Upper middle income	14741.66	8.00	35	0.88	96.56	34.43	195.69	230.12
Seychelles	High income	15322.75	0.09	30	0.00	162.67	2.44	-18.76	-16.33
Lithuania	High income	15581.39	0.67	15	0.06	185.76	-47.51	130.90	83.39
Uruguay	High income	16153.76	1.95	25	0.08	94.93	-4.46	-11.94	-16.40
Slovakia	High income	16912.45	3.27	22	0.12	68.47	-5.47	-37.11	-42.58
Barbados	High income	17163.23	0.13	25	0.01	104.07	-1.14	-77.69	-78.83
Oman	High income	17686.09	1.06	14	0.09	110.47	-27.45	37.66	10.21
Greece	High income	18506.18	3.57	28	0.28	22.29	-0.59	-2.83	-3.42
Estonia	High income	18831.06	0.44	20	0.03	156.41	-28.33	108.58	80.24
Czechia	High income	19069.34	6.94	19	0.25	103.16	-10.28	-23.97	-34.24
Portugal	High income	20298.20	6.66	30	0.29	97.13	1.91	7.31	9.22
Slovenia	High income	22203.45	0.76	18	0.06	83.29	-18.10	30.38	12.28
Cyprus	High income	24601.51	1.21	13	0.03	46.44	-3.09	-79.32	-82.41
Malta	High income	26022.10	0.74	35	0.01	49.73	3.50	-61.47	-57.96
Spain	High income	27113.72	29.73	27	1.68	129.34	-5.25	62.65	57.40
South Korea	High income	28427.44	39.48	24	1.89	134.37	-9.67	37.95	28.28
Italy	High income	31142.94	38.67	30	2.52	52.87	1.68	18.13	19.82
Japan	High income	36456.47	204.43	31	6.34	81.46	2.89	-28.62	-25.73

United Arab Emirates	High income	37556.61	21.19	55	0.44	95.54	46.83	-40.41	6.41
Israel	High income	38214.99	10.28	25	0.44	108.74	-5.23	5.14	-0.08
France	High income	38991.72	58.92	36	3.45	63.30	14.59	27.57	42.16
New Zealand	High income	39546.07	9.92	28	0.26	71.27	-0.29	-47.66	-47.95
Belgium	High income	42128.80	18.13	34	0.64	77.46	7.42	-16.10	-8.68
United Kingdom	High income	42235.12	73.29	20	3.85	72.02	-9.06	-17.43	-26.49
Germany	High income	43092.87	89.62	30	4.52	63.54	2.59	4.20	6.79
Finland	High income	44221.83	5.98	20	0.33	60.52	-7.93	-18.53	-26.45
Canada	High income	44419.88	58.07	27	2.25	50.04	-1.20	-37.13	-38.33
Hong Kong SAR China	High income	44847.28	18.30	17	0.44	123.46	-2.45	-85.65	-88.10
Austria	High income	45825.14	9.69	25	0.52	102.43	-6.89	30.72	23.83
Netherlands	High income	46880.56	25.09	25	1.00	54.16	-2.81	-32.22	-35.03
Sweden	High income	51744.73	15.09	22	0.68	109.12	-10.10	4.36	-5.75
Australia	High income	53725.84	79.30	30	1.81	111.39	1.70	-37.69	-35.99
Denmark	High income	55429.35	9.28	23	0.40	61.71	-5.17	-26.72	-31.89
Singapore	High income	58132.70	13.42	17	0.32	111.11	-10.00	-42.11	-52.12
United States	High income	58332.70	394.54	39	26.60	59.77	22.53	47.03	69.56
Iceland	High income	62614.11	0.57	20	0.03	153.41	-18.08	33.70	15.61
Ireland	High income	65212.54	8.52	13	0.29	58.25	-8.15	-57.62	-65.77
Macau SAR China	High income	73773.76	0.72	12	0.04	122.89	-31.12	26.07	-5.05
Norway	High income	74897.17	19.19	26	0.50	86.91	-2.50	-42.08	-44.59
Switzerland	High income	81576.52	20.47	21	0.84	60.68	-5.93	-33.57	-39.51
Luxembourg	High income	103688.99	2.91	28	0.05	72.63	-0.20	-51.22	-51.42

Appendix II. Inferring θ using the Semi-Elasticity of Taxable Profits

Before-tax profits in jurisdiction *i*, gross of routine profits there (so corresponding broadly to EBIT), are given by

$$f_i \equiv \pi_i + rk_i = \pi_i^* + s_i + rk_i = \left\{1 + \frac{\beta_i \Pi}{rk_i} + \theta(\Delta\bar{\tau}_i)\right\} rk_i \qquad \text{(A. 1)}$$

where the first equality follows from (7) and the second from using in (14) the definition of β_i and further defining $\Delta\bar{\tau}_i = \sum_{j=1}^{N} \tau_j \left(\frac{k_j}{K}\right) - \tau_i$. With the assumption that $\mathrm{E}[\beta_i|k_i] = \frac{k_i}{K}$, this implies a semi-elasticity of reported gross pretax earnings with respect to the tax differential of

$$\frac{\partial \ln \mathrm{E}[f_i|k_i]}{\partial(\Delta\bar{\tau}_i)} \approx \frac{\theta}{1 + \frac{\Pi}{rK} + \theta \mathrm{E}[\Delta\bar{\tau}_i|k_i]}\,. \qquad \text{(A. 2)}$$

The recent meta-study of Beer, de Mooij and Li (2019) suggests a consensus value of $\frac{\partial \ln \mathrm{E}[f_i|k_i]}{\partial \Delta\bar{\tau}_i} = 1.5$, while for the sample used here, $\mathrm{E}[\Delta\bar{\tau}|k_i]$ =0.04 and $\frac{\Pi}{rK} = 0.47$. Rearranging (A.2) and evaluating at these values gives $\theta = 2.55$.

Moreover, we obtain approximate confidence intervals for θ using the Delta Method:

$$SE(\theta) = \frac{\theta}{(1 - \epsilon \mathrm{E}[\Delta\bar{\tau}_i|k_i])} \left[\frac{1}{\epsilon} + \mathrm{E}[\Delta\bar{\tau}_i|k_i]\right] se(\epsilon) \qquad \text{(A. 3)}$$

where we define $\epsilon \equiv \frac{\partial \ln \mathrm{E}[f_i|k_i]}{\partial \Delta\bar{\tau}}$. Using a standard error of 0.3 for the estimated ϵ gives $SE(\theta)$=0.53.

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