GLOBAL DISTRIBUTION OF REVENUE LOSS FROM CORPORATE TAX AVOIDANCE: RE-ESTIMATION AND COUNTRY RESULTS

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Abstract: International corporate tax is an important source of government revenue, especially in lower-income countries. An innovative study of the scale of this problem was carried out by International Monetary Fund researchers and published in 2016. We first re-estimate their model and then explore the effects of introducing higher-quality revenue data from the International Centre for Tax and Development–World Institute for Development Economics Research Government Revenue Database. Whereas IMF researchers report results for two country groups only, we present country-level results to make the most detailed estimates available. Our findings support a somewhat lower estimate of global revenue losses of around US$500 billion annually and indicate that the greatest intensity of losses occurs in low-income and lower-middle-income countries and across sub-Saharan Africa, Latin America and the Caribbean and South Asia. © 2018 UNU-WIDER. Journal of International Development published by John Wiley & Sons, Ltd.

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1 INTRODUCTION

International corporate tax is an important source of government finance in all regions of the world and is responsible for a larger share of total tax revenues on average in lower-income countries. At present, the most comprehensive study of the global losses is that of International Monetary Fund (IMF) researchers (Crivelli, De Mooij, & Keen, 2016).
The authors use panel data for 173 countries over 33 years to explore the magnitude and nature of international fiscal externalities—specifically, the spillovers from tax policy decisions in individual jurisdictions onto others. They develop and apply a new method enabling a distinction between spillover effects through real investment decisions and through avoidance techniques and quantify the revenue impact of the latter. In particular, they estimate an equation with corporate tax base as the dependent variable with ‘tax haven’ corporate tax rates as one of the independent variables, in order to evaluate the scale of the spillover. As Crivelli et al. (2016) argue, the avoidance associated with tax havens can in principle be assessed by simply ‘turning off’ in their model the effects on tax bases operating through that channel.

Using this approach, Crivelli et al. (2016) estimate global revenue losses at around US$650 billion annually, of which around one-third relate to developing countries. The intensity as a share of gross domestic product (GDP) is somewhat higher in the latter compared with Organization for Economic Co-operation and Development (OECD) economies. Cobham and Gibson (2016) combine this finding with data on the relatively greater reliance on corporate tax revenue in developing countries to show that the estimated losses are around 2–3 per cent of total tax revenue in OECD countries, but 6–13 per cent in developing countries. Even bringing this additional data to bear, however, the published findings of Crivelli et al. (2016) do not allow for a more granular understanding of the pattern of revenue losses.

There are also concerns over the revenue statistics that make up a central part of the data set. Crivelli et al. (2016) use data on corporate income tax (CIT) revenues and statutory tax rates from the private data set of the IMF’s Fiscal Affairs Department. The recent creation of the International Centre for Tax and Development–World Institute for Development Economics Research (ICTD–WIDER) Government Revenue Database (GRD), which combines data from several major international databases and a new compilation from IMF Article IV and country staff reports, provides a potential alternative—and has also provided the basis for powerful criticism of the IMF data set. A further data issue relates to the definition and treatment of ‘tax havens’, upon which the main results rest.

There are therefore three main issues with which the current paper is concerned. First, we set out to re-estimate the original findings and then to test their robustness to the introduction of higher-quality revenue data and alternative series of effective tax rates. Our headline estimate is of revenue losses of around US$500 billion globally, compared with nearly US$650 billion in Crivelli et al. (2016). The majority of the reduction in the total estimate relates to OECD countries, however, meaning that we also find an even greater differential in the intensity of losses suffered by lower-income countries. Secondly, we experiment with an alternative approach to defining ‘tax havens’, which enables us to check the robustness of their results in this regard—although a number of avenues remain for future research to explore here.

Finally, we offer a disaggregation of our results. Crivelli et al. (2016) provide results for two groups of countries only: OECD and non-OECD countries. Following re-estimation, we disaggregate to country level and demonstrate the underlying heterogeneity within these groups. Our research is, thus, not only a re-estimation of an earlier econometric study but also an extension of global and regional comparative analysis that, through the presentation and regrouping of country-level estimates, allows for new insights into the geography of international corporate tax avoidance. These new insights might shed new light on the political economy of international corporate tax, and for example, why some countries may be more or less likely to support reforms of international tax rules.
The remainder of the paper is structured as follows. The next section presents briefly some additional findings from the literature, focusing on revenue loss estimates and the methodology of Crivelli et al. (2016). The third section presents the data used and a comparison to that employed in the original work. The fourth and fifth sections present the results of our re-estimation of the baseline regressions and revenue estimates, followed by a more detailed breakdown of revenue estimates for our preferred model. The final section concludes with a discussion of questions for further research.

2 LITERATURE ON REVENUE LOSS ESTIMATES

In this brief literature review, we focus on the revenue loss estimates of base erosion and profit shifting (BEPS) for lower-income countries. While the literature on international tax avoidance extends far wider, our focus here is on the narrow question of revenue losses—which is both the most high-profile aspect of research findings and, typically, the most controversial. As Crivelli et al. (2016) note, persuasive quantification of the revenue at stake through cross-border tax avoidance has proved elusive. Fuest and Riedel (2012) provide a critique of many of the estimates that had been made to that point.

In the aftermath of the global financial crisis and the fiscal problems that followed in many countries, the public and policy makers alike focused greater attention on the tax avoidance of multinational companies. Researchers, too, addressed greater efforts to estimating the scale and nature of the associated tax losses.

Clausing (2016) finds that profit shifting by US-headquartered multinationals is likely to have cost that country alone between US$77 billion and US$111 billion by 2012, having increased substantially over time. That trend and the overall scale of losses are supported by Cobham and Janský (2017) who use the same data set to estimate global revenue losses in a range from US$130 billion to around US$200 billion. Both papers highlight the limitations of using data on activities of multinationals from one major economy only but argue that this is preferable to current alternatives. In particular, Orbis, the leading database of company balance sheets, has been shown to have such severe and systematic limitations through the under-representation of both lower-income countries and major profit-shifting hubs that its use for global analysis cannot be supported (a finding supported by Cobham & Loretz, 2014).

Both Dharmapala (2014) and Hines (2014) discuss the relatively low values of estimated sensitivities of reported profits to tax rate differences, but without addressing the possibility of bias because of the Orbis data that underlie most of the studies they examine. Hines (2014) goes as far as to argue that estimates of 2 or 4 per cent probably overstate the potential tax revenue to be had by eradicating BEPS, although this is focused on developed rather than developing countries. Earlier estimates focused on developed countries and not reliant on Orbis data do not appear consistent with this. Zucman (2014) estimates that profit-shifting to low-tax jurisdictions reduces the tax bill of US-owned companies by about 20 per cent; and that US-owned companies would have paid $200 billion in additional taxes in 2013 if the effective tax rate paid had not fallen from 30 to 20 per cent between 1998 and 2013. Clausing (2009) estimates that US$60 billion was lost to profit shifting by United States multinational enterprises in 2004, which represented 35 per cent of United States federal corporate income tax collections.

Some of the existing literature suggests that revenue costs might be particularly high for developing countries, with an overview of historical efforts stretching decades provided by
Reuter (2012) and, more recently, Johannesen and Pirttilä (2016). This is supported by Fuest, Hebous, and Riedel (2011), who find evidence of larger profit shifting for developing countries. Specifically, they find that the effect of the host country corporate tax rate on the debt ratio of multinational affiliates in developing economies is positive and larger than the same effect for affiliates in developed economies. Answering a similar research question and arguing that Orbis has recently increased its coverage considerably in less-developed countries, Johannesen, Tørsløv, and Wier (2017) use it to find that profit shifting is more prevalent in less-developed countries. They argue that this may explain why many developing countries opt for low corporate tax rates in spite of urgent revenue needs and severe constraints on the use of other tax bases. However, neither of the two studies extend their results to provide tax revenue loss estimates. Reynolds and Wier (2016) do extend their estimates to revenue but only for one country, South Africa, finding that profit-shifting lowers the tax—GDP ratio by 0.05 percentage points. If accurate, that would suggest South Africa is more successful than the United States, for example, in preventing abuse—or alternatively, it could indicate that South Africa operates as a hub for profit-shifting from elsewhere, reducing net losses to a negligible level. In contrast, we find in this paper that South Africa suffers losses of between 1.6 and 1.9 per cent of GDP—substantial, although not near the top of the range we find for all countries.

Recent estimates have focused on estimating the revenue implications of a related phenomenon—the misalignment of profits and economic activity. Using the limited balance-sheet firm-level data for the developing countries, Cobham and Loretz (2014) showed a clear pattern of misalignment to the benefit of a small number of profit-haven jurisdictions and to the detriment of lower-income countries in the sample. Cobham and Janský (2017) used the same data as Zucman (2014)—a comprehensive survey of the international operations of US-headquartered multinational groups—to reveal major misalignments for middle-income and other countries, with a number of small jurisdictions capturing a tax base disproportionate to their economic activity. They also found that a number of developing countries have a low share of US multinationals’ profits relative to the economic activity located in them and that this has substantial revenue costs.

Researchers at international organizations have also made important recent contributions to the literature. UNCTAD (2015) used national-level data on returns to foreign direct investment to estimate the scale of revenue losses because of profit shifting through investment conduit jurisdiction. Lower-income countries were found to lose around US$100 billion a year to this one channel. Using firm-level Orbis data, OECD (2015) estimated a global loss of US$100 billion to US$240 billion in 2014, or 4 to 10 per cent of all CIT revenues (and up to US$2.1 trillion over 2005–2014). Hypothetically, a ‘full’ balance sheet data set with equivalent coverage in lower-income countries and ‘tax havens’ might be expected to yield sharply higher estimates under this approach.

It is in this context that the estimates of long-run revenue costs of the IMF’s Crivelli et al. (2016) have provided an important point of reference, and for that reason, it is the re-estimation and extension of their work to which this paper is addressed. The authors estimate spillover equations of the following form:

\[ b_{it} = \lambda b_{it-1} + \varphi \tau_{it} + \gamma W_{ij} \tau_{ij} + \xi X_{it} + \alpha_i + \mu_t + \epsilon_{it}, \]  

(1)

where \( b_{it} \) denotes the corporate tax base in country \( i \) in time \( t \), \( \tau_{it} \) the domestic tax rate, \( W_{ij} \) a weighted average of the tax rates in countries \( j \neq i \) (a number of versions are defined below), \( X_{it} \) a vector of controls, while \( \alpha_i \) and \( \mu_t \) are, respectively, country-specific and
time-specific effects. Equation (1) is extended in this paper to consider, more specifically, spillovers by country size, using a measure of ‘GDP-weighted’ statutory tax rates (weighting tax rates by GDP); by the tax haven list, with ‘haven-weighted’ rates (an unweighted average of tax rates only in those countries that are included in the list of tax havens); by geographic proximity to obtain ‘distance-weighted’ rates (weighting tax rates by the inverse distance between capitals); and alternatively with average effective tax rates (AETRs).

Those estimations allow, in turn, revenue loss estimates to be made at the country level. For profit-shifting losses, this is achieved by ‘turning off’ the effects on tax bases of avoidance via havens and calculating the revenue effect as the implied change in tax base multiplied by the applicable tax rate. The short-run revenue (in per cent of GDP) lost by country $i$ in period $t$ as a consequence of profit shifting through tax havens can be estimated as

$$L_{it} = \tau_{it} \hat{\phi} \left( \tau_{it} - W^h \tau_{-it} \right),$$

where per Equation (1), $\hat{\phi}$ is the estimated coefficient on the tax term (imposing equality of coefficients on own and spillover effects, separately for OECD and non-OECD groups, the restricted coefficients from Table 3) and $W^h \tau_{-it}$ denotes the haven-weighted average tax rate. Long-run estimates are obtained as

$$LL_{it} = \frac{\tau_{it} \hat{\phi} \left( \tau_{it} - W^h \tau_{-it} \right)}{1 - \hat{\lambda}},$$

where $\hat{\lambda}$ is the estimated coefficient on the lagged corporate tax base.

According to Crivelli et al. (2016), thus defined, the loss can be thought of as answering the question: how much revenue would country $i$ gain, if opportunities for profit shifting were to be eliminated by raising the average rate in tax havens to the level of its own?

The empirical answer by Crivelli et al. (2016), and thus by us in this paper, relies on a number of assumptions, some of which are tested by Crivelli et al. (2016) and discussed here. For example, most variables in the model might be endogenous, but Crivelli et al. (2016) find that allowing all controls to be potentially endogenous yields broadly similar results. Also, various assumptions are inherent in the different weightings of rates. In the case of haven-weighted rates, the assumption is implicit that it is equally easy to use any haven for profit-shifting (highlighting a weakness of using a relatively long list with many havens of various importance) but impossible to use other countries for it (in contrast, highlighting a weakness of using a relatively short list of havens and thus excluding some other havens). In this and other cases such as the quality of revenue data and AETRs, we empirically investigate the assumptions and provide robustness checks.

### 3 DATA

We are grateful to the IMF researchers for providing us with their data set and code and for discussing freely their approach. Crivelli et al. (2016) report 173 countries over the 1980–2013 period; with alternative data, detailed below, we arrive at an unbalanced data set of 49 to 120 countries over the same period. We make equivalent changes to the data, including interpolation of the tax rate series for years with missing tax rates,
for the construction of weighted average tax rates, and we update the data on distances and GDP.¹

We follow Crivelli et al. (2016) in excluding resource-rich countries from the exercise in the sense that their tax bases are not treated as dependent variables, because they will likely have distinct drivers and reflect a variety of distinct tax design choices; the tax rates set by these countries are, however, included in constructing the various average tax rates used as explanatory variables. We follow this approach and use the same group of resource-rich countries.²

Our data differ in three areas. Most importantly, we introduce revenue data from the ICTD–WIDER GRD. The GRD was created in response to the absence of a consistent, high quality, public data source for revenues. As the creators at the ICTD set out (Prichard, Cobham, & Goodall, 2014), no pre-existing source met these criteria. The set of papers published at the launch of the GRD confirmed both issues with the quality of data in IMF studies and the failure of multiple researchers to replicate the results of a number of papers by researchers in the IMF Fiscal Affairs Department. The subsequent publication of a version of the IMF data set marked an important step towards transparency, although it also confirmed that crucial issues remain—such as inconsistent GDP series (McNabb, 2016).

The drawbacks of the IMF’s revenue data are not the only reasons to use the GRD. One of the GRD’s strengths is a better coverage for some countries and years. The GRD also explicitly states a hierarchy for its country-specific data sources with preferences given to sources with more years and more detailed disaggregation of revenues. Furthermore, the GRD explicitly informs its users when some estimates seem problematic, because of their credibility or other issues. As long as there is a sufficient attention given to the ongoing updates of the GRD, it should remain a valuable source of revenue data for developing countries, either on its own or in combination with the IMF’s data—a strategy we follow here.

In addition, we introduce alternative data on AETRs and on the definition of ‘tax havens’. Crivelli et al. (2016) use AETR data from Abbas and Klemm (2013) that are available only for 43 countries over the period 1996–2007.³ We consider other estimates, from the Orbis data used by Cobham and Loretz (2014) and the Bureau of Economic Analysis data on US-headquartered multinationals used by Cobham and Janský (2017).

For ‘tax haven’ definitions, the IMF authors rely on a list created by Gravelle (2013), on the basis of observed phenomena from a US perspective. In a similar line, we consider the

¹We use CEPII data on distances to construct the inverse-distance-weighted average CIT rates. However, some countries’ distances are not available, and in those cases, we assigned one of the neighbouring countries with the closest capitals instead: Montenegro (Bosnia and Herzegovina), Kosovo (Macedonia) and San Marino (Italy). Furthermore, instead of using data on GDP from the IMF World Economic Outlook (WEO), we use the World Bank’s World Development Indicators data when we extend the sample because of incomplete WEO data (specifically its series on GDP per capita in constant 2005 USD).
²These are defined as: Bahrain, Chad, Republic of Congo, The Islamic Republic of Iran, Kazakhstan, Kuwait, Libya, Mexico, Nigeria, Norway, Oman, Russian Federation, Saudi Arabia, Syrian Arab Republic, Trinidad and Tobago, United Arab Emirates, Venezuela and Yemen. However, the grounds for using this specific group of resource-rich countries are not clear. For example, Algeria, Angola, Australia, Brunei Darussalam, Ecuador, Equatorial Guinea and Mongolia are not included in the resource-rich country list, despite having substantial natural resources. We leave robustness checks in this area to future research, which might use various definitions of resource-rich countries for their exclusion or could include them in the regression analysis but with a dummy variable for the group, to enable them to vary (although this does not fully allow for distinct drivers and tax design choices as argued by the authors).
³Argentina, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Czech Republic, Ecuador, Egypt, Estonia, Ghana, Hong Kong SAR, Hungary, India, Indonesia, Israel, Kenya, Korea, Latvia, Lithuania, Malaysia, Mauritius, Morocco, Namibia, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Senegal, Singapore, South Africa, Sri Lanka, Tanzania, Thailand, Turkey, Uganda, Ukraine, Uruguay and Zambia.
alternative list of the six major profit misalignment jurisdictions of the Netherlands, Ireland, Luxembourg, Bermuda, Switzerland and Singapore, identified for US-headquartered multinationals by Cobham and Janský (2017). This alternative data-driven list has its disadvantages (e.g. it excludes a number of countries often considered tax havens such as Cayman Islands) as well as advantages (included are only six of some of the tax havens most important for multinationals, which might account for most corporate activities by tax havens globally, in contrast with longer tax haven lists, which might give unwarranted weight to small unimportant havens). In short, we use the two lists, based on Gravelle (2013) and Cobham and Janský (2017), as two alternatives and robustness checks for each other, rather than preferring one strongly over the other.

Additional alternatives for future research could include measures based on the secrecy score component of the Tax Justice Network’s Financial Secrecy Index. The index and its approach are detailed in Cobham, Janský, and Meinzer (2015), which also sets out the risks of systematic biases in ‘tax haven’ lists and the related problem of there being no accepted

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**Table 1. Descriptive statistics**

| Observations | Mean    | Max.  | Min.  | Std. Dev. |
|--------------|---------|-------|-------|-----------|
| Crivelli et al. (2016) |         |       |       |           |
| Statutory CIT rate, in per cent | 2185 | 33.33 | 61.80 | 2.00 | 9.65 |
| GDP-weighted average tax rate, in per cent | 2185 | 38.56 | 48.04 | 29.16 | 4.82 |
| Haven-weighted average CIT rate, in per cent | 2185 | 28.24 | 35.39 | 21.34 | 4.20 |
| Inverse-distance-weighted average CIT rate, in per cent | 2185 | 31.32 | 41.21 | 18.60 | 4.64 |
| CIT revenue, per cent of GDP | 2185 | 2.73 | 16.54 | 0.00 | 1.73 |
| OECD countries | 893 | 2.80 | 8.02 | 0.26 | 1.26 |
| Non-OECD countries | 1292 | 2.68 | 16.54 | 0.01 | 1.98 |
| CIT base, per cent of GDP | 2185 | 9.03 | 70.97 | 0.00 | 6.75 |
| OECD countries | 893 | 8.75 | 29.99 | 1.06 | 4.61 |
| Non-OECD countries | 1292 | 9.22 | 70.97 | 0.00 | 7.89 |
| AETR, in per cent | 391 | 22.86 | 40.27 | −11.61 | 9.19 |
| GDP-weighted AETR, in per cent | 391 | 21.26 | 23.74 | 19.00 | 1.49 |
| Agricultural value-added, per cent of GDP | 1847 | 11.74 | 64.05 | 0.04 | 10.74 |
| GDP per capita, 2000 USD | 1995 | 13 235 | 87 717 | 127 | 15 298 |
| Trade openness, per cent of GDP | 1999 | 78.87 | 436.95 | 6.32 | 45.03 |
| Inflation, in per cent | 1930 | 36.10 | 11749.64 | −4.47 | 366.03 |
| Additional data |         |       |       |           |
| CIT revenue, per cent of GDP (GRD) | 2129 | 2.57 | 11.20 | 0 | 1.48 |
| OECD countries (GRD) | 962 | 2.76 | 7.87 | 0 | 1.29 |
| Non-OECD countries (GRD) | 1167 | 2.41 | 11.20 | 0.01 | 1.61 |
| CIT base, per cent of GDP (GRD) | 2129 | 8.60 | 64.88 | 0 | 6.08 |
| OECD countries (GRD) | 962 | 8.74 | 29.11 | 0 | 4.68 |
| Non-OECD countries (GRD) | 1167 | 8.49 | 64.88 | 0.02 | 7.02 |

Notes: Showing observations for non-resource-rich countries. AETR, average effective tax rates; GDP, gross domestic product; GRD, Government Revenue Database; OECD, Organization for Economic Co-operation and Development. Source: Authors’ calculations based on data from Crivelli et al. (2016) and the GRD.

Dowd, Landefeld, and Moore (2017) use IRS firm-level filings to identify a near-identical list of key profit-shifting jurisdictions for the United States: Bermuda, the Cayman Islands, Ireland, Luxembourg, the Netherlands and Switzerland. Unfortunately, Cayman data are not provided in the BEA’s public disaggregation.
definition or objectively verifiable criteria for tax havenry. As both Ireland and the Netherlands demonstrate, however, there are jurisdictions with a fair degree of financial transparency in other areas, which offer relatively targeted means to achieve effective tax rates much lower than their statutorily determined level. A more specific definition may eventually be needed, such as a specific ranking based on objectively verifiable criteria for corporate profit-shifting havens. Average effective rates may offer a way in, to determine the ‘haven’ list, or alternatively aggregated data from multinationals’ country-by-country reporting if this is eventually required to be made public.

Table 1 displays the descriptive statistics for the original sample and our own, which appear broadly similar in many cases. However, there are important differences that are more easily seen in Figures A1, A2, A3, A4 in the Appendix. Table 2 summarizes the three alternatives to the original approach.

Figure A1 displays revenue from the CIT in per cent of GDP, and Figure A2 shows CIT rates, both across the period from 1980 to 2013 for various groups of countries. Figure A3 shows values of AETRs, estimated as the ratio of corporate tax to gross profit, based on the Bureau of Economic Analysis data used by Cobham and Janský (2017). Figure A4 shows estimates of haven-weighted AETRs using data from various sources. Crivelli et al. (2016) use two versions of AETRs, and we estimate a haven-weighted average for each of them (i.e. AETR1 and AETR2 in Figure A4). We create two averages using the Bureau of Economic Analysis data used by Cobham and Janský (2017): one standard and one 5-year moving average to smooth out some sharp changes over the time (i.e. AETR3 and AETR4 in Figure A4). The final two are based on the Orbis data used by Cobham and Loretz (2014)—the first one is based on averages of companies in a given country in a given year, whereas the second one is estimated as the total of taxes reported by the total of profits reported in a given country in a given year (i.e. AETR5 and AETR5 in Figure A4).

### 4 RESULTS

This section presents our regression estimates. The results below show the estimated parameters of Equation (1) discussed in section 2 above.

Table 3 presents the main regression results. Table 3 corresponds to its counterpart in the paper of Crivelli et al. (2016), presenting the baseline spillover regressions for various

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5One likely minor issue is that in the Stata do file kindly provided, 28 is used as the number of tax havens, but in the data, there are up to 31 such jurisdictions (with two of them, Montserrat and San Marino, having data for only 2012 and 2013). The denominator does not appear to vary accordingly by year.
Table 3. Base spillovers by income level, ‘haven’-weighted tax rates

| Dependent variable | (1)          | (2)          | (3)          | (4)          | (5)          | (6)          |
|--------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Data for base      | IMF          | IMF          | IMF          | GRD          | GRD          | GRD          |
| CIT base, lagged   | 0.906*** (.0623) | 0.768*** (.0552) | 0.873*** (.0692) | 0.971*** (.0599) | 0.770*** (.0522) | 0.840*** (.0680) |
| CIT rate           | -0.0918** (.0193) | -0.0596 (.108)  | -0.123* (.0525)  | -0.0926** (.0345) | -0.0673 (.133)  | -0.135* (.0572)  |
| CIT rate, haven    | 0.352** (.0300) | 0.342* (.0528)  | 0.515* (.0684)  | 0.289* (.0832)  | 0.254 (.158)  | -0.00734 (.983)  |
| Inflation (log)    | 0.144 (.688) | -0.0625 (.793) | 0.136 (.732)  | 0.725* (.0936)  | -0.102 (.650) | 0.293 (.521)  |
| Trade openness     | 0.0403** (.0373) | -0.0211 (.137) | 0.00758 (.651) | 0.0120 (.441)  | -0.0246** (.0181) | 0.00860 (.606)  |
| GDP per capita (log)| 0.0924 (.945) | 0.448 (.711)  | 1.334 (.403)  | 0.394 (.705) | 0.574 (.633) | 2.114* (.0510)  |
| Agriculture        | -0.134 (.311) | -0.134 (.311) | -0.134 (.311) | -0.113 (.400) | -0.113 (.400) | -0.113 (.400) | -0.113 (.400) |
| Time trend         | 0.165** (.0325) | 0.157* (.0615) | 0.267** (.0430) | 0.131* (.0987) | 0.0893 (.222) | 0.0842 (.591)  |
| Constant           | -339.5** (.0349) | -321.5* (.0712) | -554.5** (.0407) | -271.4 (.101) | -184.4 (.225) | -179.8 (0.577)  |
| Observations       | 1687 | 624 | 949 | 1602 | 649 | 829 |
| Number of countries | 103 | 28 | 72 | 101 | 29 | 69 |

Notes: We tested, similarly to Crivelli et al. (2016), the restriction that $\phi = -\gamma$ with the null hypothesis that the base spillover and the own-tax effects are identical but with opposite sign. The $p$-values from the testing for the six specifications are 0.0977, 0.0939, 0.1734, 0.8138, 0.5983 and 0.9825. The null hypothesis is not rejected for any of the regressions in Table 3 at the 0.05 significance level and only barely in two cases at the 0.10 significance level. Imposing the restriction, which should then lead to an improvement in efficiency in most cases and is significant at the 0.05 level for four out of the six specifications. GDP, gross domestic product; GRD, Government Revenue Database; IMF, International Monetary Fund. Source: Authors’ calculations based on data from Crivelli et al. (2016) and the GRD.
versions. The six estimated regressions differ in the tax revenue and rate data used, as summed up in Table 2, with only the tax haven list being the same one for all six specifications. In all results in Table 3, we use the tax haven list of Gravelle, that is, in line with Crivelli et al. (2016). Table 3 shows two sets of regressions—the first three re-estimated using the data provided by the authors and the second three using GRD revenue data. The results across the two revenue data sets are quite similar. In each case, the results are presented in sets of three regressions—one for all countries, one for OECD members and one for other countries.

A comprehensive set of results for all of the various versions outlined in Table 2, including the AETRs and a different list of tax havens, is given in Appendix Table A1. The results based on those various approaches differ to some extent, as would be expected, from those reported in Crivelli et al. (2016). In addition, they are generally less likely to obtain statistical significance. The own rate effects are often statistically insignificant (and in some cases, positive). The haven-weighted rate is often insignificant. For the sake of consistency with Crivelli et al. (2016), we use the sets of results presented in Table 3 to re-estimate the revenue cost of BEPS below.

In estimating the revenue costs of BEPS, we follow the approach explained in Equations (2) and (3) in section 2, and in line with Crivelli et al. (2016), we use two sets of estimates parameters, one for OECD members and the other for non-members and use the country-specific and year-specific values of tax rates. We start with restricted coefficient estimates (not reported in Table 3 because these are obtained by an additional estimation). These coefficients are reported in Table 4 (and later used in Tables 5 and 6, plugged in as described in Equations (2) and (3) in section 2) for combinations of OECD and non-OECD groups and three sets of estimates: (i) the published estimates of Crivelli et al. (2016); (ii) our re-estimations of Crivelli et al. (2016) using their data, which are close but not precise; and (iii) our re-estimations of Crivelli et al. (2016) using the GRD data, which show wider differences. For these combinations, we then present the re-estimated illustrative short-run and long-run revenue loss calculations for 2013 in Tables 5 and 6, respectively, and corresponding to Equations (2) and (3) in section 2, respectively. The GRD-based estimates for OECD countries are somewhat lower because of its estimate of $\hat{\phi}$, the estimated coefficient on the tax term in Table 3, being only two-thirds of the estimates based on IMF revenue data. It follows that non-OECD countries are affected twice as much as OECD countries in terms of GDP, according to these GRD-based revenue estimates.

5 DISAGGREGATED REVENUE LOSS ESTIMATES

We focus now on the long-term estimates of the revenue (in per cent of GDP) lost by each country $i$ in period $t$ as a consequence of profit shifting through tax havens in 2013, that is, $LL_{it}$. We show various graphs by regions, income groups and over time for both relative values in per cent of GDP and absolute values in US dollars (after multiplying the former with GDP in US dollars). In each case, we provide the comparison of our re-estimation of Crivelli et al. (2016) (referred to in graphs as IMF) and their re-estimation with the GRD data (referred to as GRD).

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6The reason for the use of agriculture in only certain models is not clear, but we replicate the original approach here in order to allow full comparison of the results.
Consider first the broad patterns over time, using the original division into OECD and non-OECD groups (the label ‘o’ refers to OECD, ‘n’ to non-OECD countries). Figure A5 in the Appendix demonstrates the rise of profit shifting over time. The IMF and GRD estimates for non-OECD countries are much more closely aligned than those for OECD countries, although the trends are similar in both. Also at the country level, the IMF-based and GRD-based estimates do not differ much. Indeed, the correlation coefficient of the two revenue estimates based on different data is indeed very high, above 0.99—even though individual outlying differences, where, for example, there are discrepancies in underlying GDP source, can be large indeed. As we see below, these differences can have substantial effects on the eventual findings.

Figure 1 below provides a more detailed breakdown of the same results, still in terms of dollars. The OECD countries are the biggest absolute losers, but low and lower middle-income countries see strong growth in losses during the commodity boom of the 2000s. Figure 2 shows the strikingly different pattern in terms of shares of GDP. Low-income

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Table 4. Restricted coefficient estimates derived from results in Table 3, 2013

|                | \( \hat{\lambda} \) | \( \hat{\phi} \) | \( \hat{\lambda} \) | \( \hat{\phi} \) |
|----------------|---------------------|------------------|---------------------|------------------|
| OECD           | 0.784               | 0.053            | 0.864               | 0.148            |
| Re-estimations, same data | 0.786               | 0.053            | 0.874               | 0.140            |
| Re-estimations, GRD data    | 0.797               | 0.034            | 0.851               | 0.143            |

GRD, Government Revenue Database; OECD, Organization for Economic Co-operation and Development. Source: Authors’ calculations based on data from Crivelli et al. (2016) and the GRD.

Table 5. Re-estimating the illustrative short-run revenue loss calculations for 2013

| % of GDP OECD | Billion USD OECD | % of GDP Non-OECD | Billion USD Non-OECD |
|---------------|------------------|--------------------|----------------------|
| Published estimates | 0.207          | 95                | 0.178               | 28                 |
| Re-estimations, same data | 0.208          | 95                | 0.183               | 28                 |
| Re-estimations, GRD data    | 0.134          | 61                | 0.189               | 29                 |

GDP, gross domestic product; GRD, Government Revenue Database; OECD, Organization for Economic Co-operation and Development. Source: Authors’ calculations based on data from Crivelli et al. (2016) and the GRD.

Table 6. Re-estimating the illustrative long-run revenue loss calculations for 2013

| % of GDP OECD | Billion USD OECD | % of GDP Non-OECD | Billion USD Non-OECD |
|---------------|------------------|--------------------|----------------------|
| Published estimates | 0.960          | 439               | 1.316               | 208                |
| Re-estimations, same data | 0.971          | 443               | 1.458               | 223                |
| Re-estimations, GRD data    | 0.660          | 301               | 1.264               | 193                |

GDP, gross domestic product; GRD, Government Revenue Database; OECD, Organization for Economic Co-operation and Development. Source: Authors’ calculations based on data from Crivelli et al. (2016) and the GRD.
and lower middle-income countries face consistently the heaviest losses, but these are less extreme and less volatile, moving from each decade to the next.

Recall that the basic logic behind the estimate of the revenue cost of BEPS is that it is the implied change in corporate tax bases from ‘turning off’ the haven channel, multiplied by the applicable CIT rate to produce an estimate in per cent of GDP. Interestingly, this is independent of the CIT revenue of a given country in a given year—it depends only on the CIT rate (and on the level of GDP, if we wish to consider absolute values in currency terms). The implied change in corporate tax bases depends for each country and year on the value of CIT rate relative to the haven-weighted average.

This difference, shown in Figure 3, is also what seems to be driving most of the results over time, that is, the decreasing cost of BEPS as a share of GDP. When considered in US

![Figure 1. Revenue loss estimates over time, US$ billion, by income group. GRD, Government Revenue Database; IMF, International Monetary Fund; OECD, Organization for Economic Co-operation and Development. [Colour figure can be viewed at wileyonlinelibrary.com]](image)
dollar terms, the steady rise of world GDP over the past three decades acts as a counterweight to the decreasing difference between the ‘haven’ and ‘non-haven’ tax rates, resulting in a degree of stability in the estimated costs of BEPS over time.

This might be viewed as evidence that lowering corporate tax rates is an effective tool against avoidance. Narrower studies, however, such as Cobham and Janský (2017) and Clausing (2016) provide evidence that profit shifting has grown strongly—even as effective tax rates have fallen sharply. Cobham and Janský (2017) document effective tax rates for US-headquartered multinationals of 0–5 per cent in the major misalignment jurisdictions to which most profit is shifted, compared with 15–20 per cent in the USA and other economies on average. The issue may then be an artefact of the methodology, relying on differentials in statutory rates while incentives are driven instead by effective rates. Future research might

Figure 2. Revenue loss estimates over time, % of gross domestic product, by income group. GRD, Government Revenue Database; IMF, International Monetary Fund; OECD, Organization for Economic Co-operation and Development. [Colour figure can be viewed at wileyonlinelibrary.com]
go further in exploring whether other data sources for effective rates can generate regressions with stronger results than we found in section 3. Similarly, future research should go further in exploring how this approach might be adjusted so that the CIT rate is less important, and the currently observed CIT revenue is given more prominence.

As noted, one strength of the approach here is that more disaggregated results can be obtained, and we present some of these now. Figure 4 shows the pattern of losses by region and by income group, as a share of GDP. Despite the differences in underlying IMF and GRD revenue data, the rankings are relatively consistent. Sub-Saharan Africa, Latin America and the Caribbean and South Asia suffer relatively intense losses and lower middle-income and, above all, low-income countries.

Table A2 in Appendix shows the detailed country-level findings for revenue losses for 2013. Using the more conservative GRD results, 14 countries from Argentina to Zambia face losses of between 3 and 7 per cent of their GDP. A further 38 countries, from Bhutan to the USA, face losses of between 1 and 3 per cent of their GDP. At the same time, 22 countries appear to make revenue gains greater than 1 per cent of GDP from profit shifting—from the more likely (e.g. Cyprus and Lebanon) to the less so (e.g. Iraq and Brazil). The consistency of the IMF and GRD-based estimates is noticeable. So too is the somewhat mechanical nature of the estimate, with groups of countries with the same statutory rate showing the same estimated losses as a share of their GDP. In addition, the detail of the figure reveals many unexpected placings in the overall ranking. Those that gain include more than 40 countries—most not generally considered to benefit from profit shifting nor to actively seek it. Those that lose most are generally lower-income countries, including notable commodity exporters but also a curiosity in the European secrecy jurisdiction of Malta.

Regarding the uncertainty in the results, it is possible to approximate the standard errors underlying the country-specific revenue estimates. In line with Crivelli et al. (2016), we estimate the one standard deviation range. For this, we need the standard errors of the estimated parameters employed in the estimation of revenue costs. Evaluating the uncertainty
in the short-run estimates, we suffice with the standard error of $\hat{\phi}$ from the relevant GRD-based constrained regression. For OECD countries, the one-standard deviation range for the short-run revenue estimates is thus between $-0.0019465$ and $0.0700503$, around the actual point estimate of $0.0340519$. For non-OECD countries, the range is between $0.074475$ and $0.2123252$, around the actual point estimate of $0.1434001$. To evaluate the uncertainty in the long-run estimates, we further need the standard error of $\hat{\lambda}$ from the same regression, and we use the Equation (3) above ($\hat{\phi}/(1 - \hat{\lambda})$) to obtain the approximations of standard errors.

In this approximation, we assume that there is no relationship between $\hat{\phi}$ and $\hat{\lambda}$ (for a more complex estimates, the covariance matrix from the restricted regression coupled with bootstrap could be used). Using this assumption, we obtain that the one-standard deviation range for the long-run revenue estimates between $-0.007891781$ and $0.43713845$, around the point estimate of $0.167373808$, for OECD countries and a range between $0.326959651$ and $3.033407814$, around the point estimate of $0.96314075$, for non-OECD countries. All

Figure 4. Average losses/gross domestic product by region and by income. GRD, Government Revenue Database; IMF, International Monetary Fund; OECD, Organization for Economic Co-operation and Development. [Colour figure can be viewed at wileyonlinelibrary.com]
in all, the ranges are quite wide and especially so for long-term estimates and OECD countries. Nevertheless, wide confidence bands are standard in the literature, and the intervals that we obtained are in line with confidence intervals in Crivelli et al. (2016). In other words, even with these relatively rigorous estimates, there is substantial uncertainty regarding the estimates of revenue cost.

6 CONCLUSION

In this paper, we re-estimate the work of Crivelli et al. (2016) and, to a large extent, confirm their findings. We establish their broad robustness to the use of alternative government revenue data and explored, with less success, changes to the definition of ‘tax havens’ used and to AETRs. In addition to contributing to the academic research on this important subject, our contribution can be considered an open-source robustness check of Crivelli et al. (2016), using the widely available GRD. In addition, we publish with this paper the full detail of country-level revenue loss estimates for our preferred model, as a contribution to more granular policy analysis and to further research.

There is clearly space to develop a methodological approach that goes beyond statutory tax rates and responds more closely to the actual incentives that multinationals face for profit shifting. But the central findings of this leading analysis of global tax avoidance by multinational companies appear broadly solid. The estimated tax loss with the preferred GRD data is around US$500 billion, compared with US$650 billion in the original paper.

In addition and especially strongly with our preferred revenue data, the intensity of losses is substantially greater in low-income and lower middle-income countries; and in sub-Saharan Africa, Latin America and the Caribbean and in South Asia compared with other regions. Notwithstanding the scope for further challenges and improvement to the methodology and data over time, this appears to offer broadly compelling evidence of two important points: that lower-income countries in general suffer more intense corporate tax avoidance (even before considering their greater reliance on tax revenues from CIT); and that there are substantial variations among countries by income and by region, such that policy makers should pay close attention to their specific situation.

At the global level, policy makers such as those at the G77 should consider whether to pursue an internationally representative tax body to allow consideration of rule changes that would benefit those who suffer the greatest losses. The immediate research agenda point to working more effectively with existing data, as indicated above. The real breakthrough, however, is likely to come only when multinationals’ country-by-country reporting data are made public, and the full extent and nature of the misalignment between profits and the location of real economic activity are laid bare. While there is scope to refine further estimates of the type presented here, the substantial uncertainty associated will only be diminished when this comprehensive data are made available.

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**APPENDIX**

![Figure A1](wileyonlinelibrary.com)  
Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

Figure A1. Revenue from corporate income tax, in per cent of gross domestic product. GRD, Government Revenue Database; IMF, International Monetary Fund; OECD, Organization for Economic Co-operation and Development. [Colour figure can be viewed at wileyonlinelibrary.com]
Note: The data are presented here without the extrapolated tax rates.
Source: Authors’ calculations based on data from Crivelli et al. (2016).

Figure A2. Corporate income tax rates, 1980–2013. OECD, Organization for Economic Co-operation and Development. [Colour figure can be viewed at wileyonlinelibrary.com]
Figure A3. Average effective corporate income tax rates, 1980–2013. OECD, Organization for Economic Co-operation and Development. [Colour figure can be viewed at wileyonlinelibrary.com]

Note: The data show also the extrapolated tax rates.

Source: Authors’ calculations based on data from Cobham and Janský (2017).

Figure A4. Haven-weighted average effective corporate income tax rates, 1980–2013. AETR, average effective tax rate. [Colour figure can be viewed at wileyonlinelibrary.com]

Note: The data show also the extrapolated tax rates.

Source: Authors’ calculations based on data from Crivelli et al. (2016), (Cobham and Loretz 2014), and Cobham and Janský (2017).
Source: Authors’ calculations based on data from Crivelli et al. (2016) and the GRD.

Figure A5. Revenue losses, US$ billion, Organization for Economic Co-operation and Development (OECD) versus non-OECD. GRD, Government Revenue Database; IMF, International Monetary Fund. [Colour figure can be viewed at wileyonlinelibrary.com]
Table A1. Additional regression results

| Data for base | (7) IMF | (8) IMF | (9) IMF | (10) GRD | (11) GRD | (12) GRD |
|---------------|---------|---------|---------|----------|----------|----------|
| Tax haven list | Tax rate | Tax rate | Tax rate | Tax rate | Tax rate | Tax rate |
| CIT base, lagged | 0.918*** (0) | 0.797*** (0) | 0.882*** (0) | 0.982*** (0) | 0.798*** (0) | 0.838*** (0) |
| CIT rate | -0.0773** (0.0373) | -0.0611 (0.102) | -0.104 (0.100) | -0.0820** (0.0478) | -0.0705 (0.132) | -0.1302** (0.0495) |
| Inflation (log) | 0.0031 (0.803) | -0.0796 (0.755) | 0.123 (0.755) | 0.646 (0.119) | -0.0884 (0.702) | 0.395 (0.486) |
| Trade openness | 0.0366** (0.0035) | -0.0182 (0.207) | 0.00165 (0.924) | 0.00942 (0.553) | -0.0241** (0.0170) | 0.0143 (0.450) |
| GDP per capita (log) | 0.139 (0.918) | 0.226 (0.844) | 1.524 (0.321) | 0.350 (0.744) | 0.473 (0.694) | 2.420** (0.0390) |
| Agriculture | 0.100 (0.403) | -0.100 (0.403) | 1.524 (0.321) | 0.350 (0.744) | 0.473 (0.694) | 2.420** (0.0390) |
| Time trend | 0.0799 (0.189) | 0.0689 (0.292) | 0.116 (0.242) | 0.0914 (0.178) | 0.0506 (0.345) | -0.0515 (0.677) |
| CIT rate, haven weighted | 0.0966 (0.182) | 0.106 (0.252) | 0.107 (0.374) | 0.1203 (0.172) | 0.115 (0.209) | -0.190 (0.281) |
| CIT base, lagged | -0.163.2 (0.206) | -0.137.0 (0.317) | -241.2 (0.237) | -188.2 (0.180) | -102.5 (0.367) | 93.94 (0.708) |
| Constant | Observations | 1687 | 624 | 949 | 1602 | 649 | 879 |
| Number of countries | 103 | 28 | 72 | 101 | 29 | 69 |

(Continues)
| Data for base | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) |
|--------------|------|------|------|------|------|------|------|------|------|
| Tax haven list | GRD | GRD | GRD | GRD | GRD | GRD | GRD | GRD | GRD |
| Tax rate | Gravelle | Gravelle | Gravelle | Gravelle | Gravelle | Gravelle | Gravelle | Gravelle | Gravelle |
| Inflation (log) | 0.115 (0.587) | 0.119 (0.634) | 0.153 (0.599) | −0.115 (0.560) | 0.108 (0.657) | −0.057 (0.755) | −0.216 (0.375) | −0.417 (0.198) | −0.211 (0.123) |
| Trade openness | 0.00179 (0.935) | −0.00500 (0.402) | −0.00411 (0.897) | −0.00562 (0.765) | −0.00969* (0.0940) | −0.0104 (0.687) | 0.00917 (0.390) | 0.000608 (0.970) | −0.0114 (0.314) |
| GDP per capita (log) | 0.869 (0.332) | 0.327 (0.767) | 1.572 (0.198) | 0.283 (0.755) | 0.396 (0.788) | 1.114 (0.319) | −0.441 (0.641) | −5.185*** (0.0178) | 0.288 (0.741) |
| Agriculture | −0.0825 (0.422) | −0.106 (0.410) | −0.106 (0.410) | −0.106 (0.410) | −0.464** (0.0705) | −0.464** (0.0705) | −0.464** (0.0705) | −0.464** (0.0705) | −0.464** (0.0705) |
| Time trend | 0.148*** (8.43e-05) | 0.202* (0.0072) | 0.129** (0.0112) | 0.166*** (3.24e-07) | 0.177* (0.0969) | 0.149*** (0.00173) | 0.0730* (0.0504) | 0.00398 (0.947) | 0.155*** (0.00428) |
| CIT base, lagged | 0.910*** (0) | 0.775*** (7.48e-06) | 0.886*** (0) | 0.908*** (0) | 0.766*** (0.000138) | 0.857*** (0) | 0.795*** (0) | 0.685*** (6.48e-11) | 0.821*** (0) |
| AETR1–6 | −0.00211* (0.0547) | 0.000343 (0.747) | −0.0585 (0.116) | −0.0610 (0.153) | −0.0204 (0.324) | −0.147** (0.0395) | −0.0210 (0.121) | −0.0242 (0.190) | −0.000357 (0.981) |
| AETR1–6, haven weighted | 0.121 (0.331) | −0.00527 (0.956) | 0.262 (0.185) | 0.337* (0.0755) | −0.0588 (0.773) | 0.541** (0.0271) | −0.0204 (0.368) | −0.0396 (0.241) | −0.0304 (0.612) |
| Constant | −304.7*** (3.90e-05) | −404.8* (0.00626) | −272.6*** (0.000694) | −338.6*** (1.70e-07) | −352.8* (0.0896) | −311.9*** (0.0010) | −139.4* (0.0537) | 50.93 (0.658) | −309.1*** (0.00357) |
| Observations | 308 | 52 | 242 | 308 | 52 | 242 | 971 | 517 | 340 |
| Number of countries | 37 (22) | 7 (23) | 29 (24) | 37 (25) | 7 (26) | 29 (27) | 47 (28) | 25 (29) | 19 (30) |
| Data for base tax haven list | GRD-Gravelle | AETR4 | GRD-Gravelle | AETR4 | GRD-Gravelle | AETR4 | GRD-Gravelle | AETR5 | GRD-Gravelle | AETR5 | GRD-Gravelle | AETR6 | GRD-Gravelle | AETR6 | GRD-Gravelle | AETR6 |
|-----------------------------|--------------|------|--------------|------|--------------|------|--------------|------|--------------|------|--------------|------|--------------|------|--------------|------|
| **Inflation (log)**         | -0.185 (0.466) | -0.296 (0.325) | -0.142 (0.307) | 0.699 (0.195) | -0.0932 (0.798) | 0.322 (0.450) | 0.844 (0.179) | -0.165 (0.695) | 0.566 (0.266) |
| **Trade openness**          | 0.0114 (0.260) | -0.0100 (0.630) | -0.000009 (0.943) | -0.0439 (0.169) | -0.0430 (0.330) | -0.0742* (0.0639) | -0.00664 (0.341) | 0.0323** (0.0372) | 0.0459 (0.203) |
| **GDP per capita (log)**    | -1.075 (0.283) | -4.393*** (0.0497) | -0.308 (0.742) | 2.284* (0.0628) | -2.314 (0.254) | 5.476*** (0.0120) | 2.187 (0.274) | -1.193 (0.602) | 0.860 (0.505) |
| **Agriculture**             | -0.527*** (0.0463) | 0.0739*** (0.0135) | 0.0357 (0.521) | 0.137** (0.0202) | -0.832*** (7.28e-05) | 0.101*** (1.10e-08) | 0.328 (0.113) | 0.159 (0.167) | 0.107 (0.213) | 0.0182 (0.935) |
| **Time trend**              | 0.793*** (0) | 0.709*** (0) | 0.807*** (0) | 0.800*** (0) | 0.854*** (0) | 0.526*** (0) | 1.067*** (0) | 0.707*** (2.76e-10) | 1.014*** (0) |
| **AETR1-6**                 | -0.0181 (0.142) | -0.0188 (0.188) | -0.00709 (0.552) | -0.366*** (0.00973) | 0.159 (0.270) | -0.277*** (0.00346) | 0.0166 (0.261) | 0.0118 (0.270) | 0.0209 (0.356) |
| **AETR1-6, haven weighted** | -0.0788*** (0.000329) | -0.0802* (0.0776) | -0.0074 (0.253) | -0.307*** (0.00070) | -0.555*** (5.63e-06) | -0.391 (0.133) | -0.561*** (2.80e-05) | -0.473*** (8.88e-08) | -0.542*** (0.0245) |
| **Constant**                | -136.8** (0.0191) | -15.28 (0.887) | -267.5** (0.0213) | 1670*** (6.05e-05) | 2072*** (8.30e-09) | 1537 (0.120) | -334.8 (0.149) | -196.9 (0.268) | -42.01 (0.925) |
| **Observations**            | 971 | 517 | 360 | 361 | 192 | 140 | 373 | 194 | 150 |
| **Number of countries**     | 47 | 25 | 19 | 28 | 25 | 57 | 28 | 27 |

AETR, average effective tax rates; GDP, gross domestic product; GRD, Government Revenue Database; IMF, International Monetary Fund. Source: Authors’ calculations based on data from Crivelli et al. (2016) and other sources described in the text.

Notes: P-values in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.
| Country                      | IMF billion | GRD billion | IMF % GDP | GRD % GDP |
|------------------------------|-------------|-------------|-----------|-----------|
| Guyana                       | 0.24        | 0.21        | 8.05      | 6.97      |
| Chad                         | 1.09        | 0.95        | 8.05      | 6.97      |
| Malta                        | 0.49        | 0.43        | 5.30      | 4.59      |
| Comoros                      | 0.03        | 0.03        | 5.10      | 4.42      |
| Guinea                       | 0.33        | 0.29        | 5.10      | 4.42      |
| Zambia                       | 1.13        | 0.98        | 5.10      | 4.42      |
| Pakistan                     | 12.06       | 10.45       | 5.10      | 4.42      |
| Argentina                    | 24.71       | 21.41       | 5.10      | 4.42      |
| Eritrea                      | 0.16        | 0.14        | 4.58      | 3.98      |
| Namibia                      | 0.56        | 0.49        | 4.58      | 3.96      |
| St. Lucia                    | 0.06        | 0.05        | 4.40      | 3.81      |
| St. Kitts and Nevis          | 0.03        | 0.03        | 4.23      | 3.66      |
| St. Vincent and the Grenadines | 0.03    | 0.03        | 3.98      | 3.45      |
| Mozambique                   | 0.53        | 0.46        | 3.60      | 3.11      |
| Guatemala                    | 1.69        | 1.47        | 3.14      | 2.72      |
| Dominica                     | 0.01        | 0.01        | 2.81      | 2.43      |
| Grenada                      | 0.02        | 0.02        | 2.81      | 2.43      |
| Costa Rica                   | 1.36        | 1.18        | 2.81      | 2.43      |
| Gambia, The                  | 0.02        | 0.02        | 2.70      | 2.34      |
| Solomon Islands              | 0.03        | 0.03        | 2.70      | 2.34      |
| Central African Republic     | 0.06        | 0.05        | 2.70      | 2.34      |
| Bhutan                       | 0.06        | 0.05        | 2.70      | 2.34      |
| Burundi                      | 0.07        | 0.06        | 2.70      | 2.34      |
| Malawi                       | 0.10        | 0.09        | 2.70      | 2.34      |
| Swaziland                    | 0.10        | 0.09        | 2.70      | 2.34      |
| Sierra Leone                 | 0.12        | 0.11        | 2.70      | 2.34      |
| Niger                        | 0.20        | 0.17        | 2.70      | 2.34      |
| Rwanda                       | 0.21        | 0.18        | 2.70      | 2.34      |
| Haiti                        | 0.22        | 0.19        | 2.70      | 2.34      |
| Benin                        | 0.23        | 0.20        | 2.70      | 2.34      |
| Nicaragua                    | 0.31        | 0.26        | 2.70      | 2.34      |
| Mali                         | 0.31        | 0.27        | 2.70      | 2.34      |
| Senegal                      | 0.42        | 0.36        | 2.70      | 2.34      |
| Uganda                       | 0.61        | 0.53        | 2.70      | 2.34      |
| El Salvador                  | 0.67        | 0.58        | 2.70      | 2.34      |
| Tanzania                     | 0.86        | 0.75        | 2.70      | 2.34      |
| Kenya                        | 1.22        | 1.06        | 2.70      | 2.34      |
| Ethiopia                     | 1.28        | 1.11        | 2.70      | 2.34      |
| Tunisia                      | 1.31        | 1.13        | 2.70      | 2.34      |
| Morocco                      | 2.83        | 2.45        | 2.70      | 2.34      |
| Peru                         | 5.69        | 4.93        | 2.70      | 2.34      |
| Philippines                  | 7.36        | 6.37        | 2.70      | 2.34      |
| India                        | 47.53       | 41.17       | 2.70      | 2.34      |
| Togo                         | 0.10        | 0.09        | 2.29      | 1.98      |
| Dominican Republic           | 1.36        | 1.18        | 2.29      | 1.98      |
| Fiji                         | 0.08        | 0.07        | 1.90      | 1.65      |
| Lao People’s Dem. Rep.       | 0.19        | 0.17        | 1.90      | 1.65      |
| Sri Lanka                    | 1.24        | 1.07        | 1.90      | 1.65      |
| South Africa                 | 6.73        | 5.83        | 1.90      | 1.65      |
| Burkina Faso                 | 0.21        | 0.18        | 1.71      | 1.48      |
| Bangladesh                   | 2.40        | 2.08        | 1.71      | 1.48      |

(Continues)
| Country                        | IMF billion | GRD billion | IMF % GDP | GRD % GDP |
|-------------------------------|-------------|-------------|-----------|-----------|
| United States                 | 277.61      | 188.83      | 1.66      | 1.13      |
| Japan                         | 68.79       | 46.79       | 1.37      | 0.93      |
| Antigua and Barbuda           | 0.01        | 0.01        | 0.90      | 0.78      |
| Seychelles                    | 0.01        | 0.01        | 0.90      | 0.78      |
| Belize                        | 0.01        | 0.01        | 0.90      | 0.78      |
| Liberia                       | 0.02        | 0.02        | 0.90      | 0.78      |
| Barbados                      | 0.04        | 0.03        | 0.90      | 0.78      |
| Panama                        | 0.36        | 0.32        | 0.90      | 0.78      |
| Sao Tome and Principe         | 0.00        | 0.00        | 0.86      | 0.75      |
| Guinea-Bissau                 | 0.01        | 0.01        | 0.86      | 0.75      |
| Djibouti                      | 0.01        | 0.01        | 0.86      | 0.75      |
| Cape Verde                    | 0.02        | 0.01        | 0.86      | 0.75      |
| Lesotho                       | 0.02        | 0.02        | 0.86      | 0.75      |
| Mauritania                    | 0.04        | 0.03        | 0.86      | 0.75      |
| Tajikistan                    | 0.07        | 0.06        | 0.86      | 0.75      |
| Zimbabwe                      | 0.09        | 0.08        | 0.86      | 0.75      |
| Jamaica                       | 0.12        | 0.11        | 0.86      | 0.75      |
| Honduras                      | 0.16        | 0.14        | 0.86      | 0.75      |
| Nepal                         | 0.17        | 0.14        | 0.86      | 0.75      |
| Côte d’Ivoire                 | 0.24        | 0.21        | 0.86      | 0.75      |
| Bolivia                       | 0.26        | 0.22        | 0.86      | 0.75      |
| Ghana                         | 0.39        | 0.34        | 0.86      | 0.75      |
| Uruguay                       | 0.49        | 0.43        | 0.86      | 0.75      |
| Myanmar                       | 0.51        | 0.44        | 0.86      | 0.75      |
| Malaysia                      | 2.70        | 2.33        | 0.86      | 0.75      |
| Colombia                      | 3.19        | 2.76        | 0.86      | 0.75      |
| Indonesia                     | 7.48        | 6.48        | 0.86      | 0.75      |
| China, P.R.: Mainland         | 77.13       | 66.81       | 0.86      | 0.75      |
| France                        | 29.08       | 19.78       | 1.06      | 0.72      |
| Belgium                       | 5.13        | 3.49        | 1.01      | 0.69      |
| Portugal                      | 1.63        | 1.11        | 0.74      | 0.51      |
| Belarus                       | 0.39        | 0.34        | 0.56      | 0.49      |
| Germany                       | 22.09       | 15.02       | 0.61      | 0.42      |
| Spain                         | 8.11        | 5.52        | 0.60      | 0.41      |
| Australia                     | 8.90        | 6.05        | 0.60      | 0.41      |
| Luxembourg                    | 0.33        | 0.23        | 0.55      | 0.37      |
| New Zealand                   | 0.76        | 0.52        | 0.42      | 0.29      |
| Italy                         | 7.84        | 5.33        | 0.38      | 0.26      |
| Canada                        | 4.98        | 3.39        | 0.27      | 0.19      |
| Greece                        | 0.64        | 0.43        | 0.26      | 0.18      |
| Israel                        | 0.52        | 0.35        | 0.19      | 0.13      |
| Denmark                       | 0.62        | 0.42        | 0.19      | 0.13      |
| Austria                       | 0.80        | 0.54        | 0.19      | 0.13      |
| Netherlands                   | 1.53        | 1.04        | 0.19      | 0.13      |
| Finland                       | 0.41        | 0.28        | 0.16      | 0.11      |
| Korea, Republic               | 1.64        | 1.12        | 0.14      | 0.09      |
| Slovak Republic               | 0.06        | 0.04        | 0.06      | 0.04      |
| United Kingdom                | 1.56        | 1.06        | 0.06      | 0.04      |
| Botswana                      | 0.00        | 0.00        | 0.03      | 0.02      |
| Ecuador                       | 0.02        | 0.02        | 0.03      | 0.02      |
| Sweden                        | 0.03        | 0.02        | 0.01      | 0.00      |

(Continues)
Table A2. (Continued)

| Country                        | IMF billion | GRD billion | IMF % GDP | GRD % GDP |
|--------------------------------|-------------|-------------|-----------|-----------|
| Switzerland                    | −0.26       | −0.18       | −0.04     | −0.03     |
| Estonia                        | −0.01       | −0.01       | −0.05     | −0.03     |
| Turkey                         | −0.77       | −0.52       | −0.09     | −0.06     |
| Chile                          | −0.26       | −0.18       | −0.09     | −0.06     |
| Iceland                        | −0.01       | −0.01       | −0.09     | −0.06     |
| Poland                         | −0.70       | −0.47       | −0.14     | −0.09     |
| Czech Republic                 | −0.27       | −0.18       | −0.14     | −0.09     |
| Hungary                        | −0.18       | −0.12       | −0.14     | −0.09     |
| Slovenia                       | −0.10       | −0.07       | −0.20     | −0.14     |
| Ireland                        | −0.66       | −0.45       | −0.30     | −0.20     |
| Thailand                       | −1.69       | −1.46       | −0.42     | −0.37     |
| Egypt                          | −1.10       | −0.96       | −0.42     | −0.37     |
| Croatia                        | −0.25       | −0.21       | −0.42     | −0.37     |
| Madagascar                     | −0.07       | −0.06       | −0.42     | −0.37     |
| Armenia                        | −0.04       | −0.04       | −0.42     | −0.37     |
| Ukraine                        | −1.07       | −0.93       | −0.61     | −0.53     |
| Taiwan Province of China       | −4.49       | −3.89       | −0.93     | −0.80     |
| Singapore                      | −2.76       | −2.39       | −0.96     | −0.83     |
| San Marino                     | −0.02       | −0.02       | −0.96     | −0.83     |
| Romania                        | −1.93       | −1.67       | −1.05     | −0.91     |
| Brazil                         | −25.19      | −21.82      | −1.15     | −1.00     |
| Iraq                           | −2.55       | −2.21       | −1.15     | −1.00     |
| Lithuania                      | −0.54       | −0.47       | −1.15     | −1.00     |
| Serbia                         | −0.50       | −0.44       | −1.15     | −1.00     |
| Latvia                         | −0.35       | −0.30       | −1.15     | −1.00     |
| Georgia                        | −0.18       | −0.16       | −1.15     | −1.00     |
| Lebanon                        | −0.52       | −0.45       | −1.19     | −1.03     |
| Mauritius                      | −0.14       | −0.12       | −1.19     | −1.03     |
| Maldives                       | −0.03       | −0.02       | −1.19     | −1.03     |
| Turkmenistan                   | −0.50       | −0.43       | −1.24     | −1.07     |
| Jordan                         | −0.43       | −0.38       | −1.28     | −1.11     |
| Uzbekistan                     | −0.71       | −0.62       | −1.29     | −1.12     |
| Montenegro                     | −0.06       | −0.05       | −1.29     | −1.12     |
| Moldova                        | −0.10       | −0.09       | −1.32     | −1.14     |
| Bulgaria                       | −0.71       | −0.62       | −1.32     | −1.15     |
| Paraguay                       | −0.40       | −0.35       | −1.32     | −1.15     |
| Bosnia and Herzegovina         | −0.25       | −0.22       | −1.32     | −1.15     |
| Albania                        | −0.17       | −0.15       | −1.32     | −1.15     |
| Mongolia                       | −0.15       | −0.13       | −1.32     | −1.15     |
| Macedonia                      | −0.14       | −0.12       | −1.32     | −1.15     |
| Kyrgyz Republic               | −0.10       | −0.08       | −1.32     | −1.15     |
| Cyprus                         | −0.30       | −0.26       | −1.37     | −1.19     |

GDP, gross domestic product; GRD, Government Revenue Database; IMF, International Monetary Fund. Source: Authors’ calculations.

**SUPPORTING INFORMATION**

Additional Supporting Information may be found online in the supporting information tab for this article.