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Global distribution of revenue loss from 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 important recent study of the scale of this problem was carried out by International Monetary Fund researchers Ernesto Crivelli, Ruud De Mooij, and Michael Keen. We first re-estimate their innovative model, and then explore the effects of introducing higher-quality revenue data from the ICTD–WIDER Government Revenue Database. Whereas Crivelli et al. 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- and lower middle-income countries, and across sub-Saharan Africa, Latin America and the Caribbean, and South Asia.

Keywords: corporate income tax, international taxation, tax avoidance, BEPS, developing countries

JEL classification: F21, F23, H25

Tables and figures: All authors' own work.

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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 et al. (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 total, 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 to Organisation 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 concerns over the revenue statistics which make up a central part of the dataset. Crivelli et al. (2016) use data on corporate income tax (CIT) revenues and statutory tax rates from the private dataset of the IMF’s Fiscal Affairs Department. The recent creation of the 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 also generated powerful criticism of the IMF’s private data. A further data issue relates to the definition and treatment of ‘tax havens’, upon which the main results rest. The authors use the list of Gravelle (2013), with little explicit motivation.

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 to 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 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, specifically OECD and non-OECD countries. Following re-estimation, we demonstrate the underlying patterns and heterogeneity among the different country 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 political economy of international corporate tax and, for example, why some countries are more or less likely to support the reform of the current global corporate tax system.

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, respectively, 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 is supported by Cobham and Janský (2015) who use the same dataset 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 (see also Cobham and Loretz 2014).

Some 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). This is supported by Fuest et al. (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. However, they do not extend their results to provide revenue estimates.

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 (2015) used the same survey data as Zucman (2014) on 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 due to profit shifting through investment conduit jurisdiction. Lower-income countries were found to lose around US\$100 billion a year to this one channel. Even with Orbis data, OECD (2015) estimated a global loss of US\$100 billion to US\$240 billion in 2014 (and up to US\$2.1 trillion over 2005–2014). A full dataset, 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:

$$b_{it} = \lambda b_{i,t-1} + \varphi \tau_{it} + \gamma W_{-it} \tau_{-it} + \xi X_{it} + \alpha_i + \mu_t + \varepsilon_{it} \quad (1)$$

where b_{it} denotes the corporate tax base in country i in time t , τ_{it} the domestic tax rate, W_{-it} a weighted average of the tax rates in countries $j \neq i$, X_{it} a vector of controls, while α_i and μ_t are, respectively, country-specific and time-specific effects. Equation (1) is extended to consider, more specifically, spillovers by country size, using a measure of 'GDP-weighted' statutory tax rates; by the tax haven list of Gravelle (2013), with 'haven-weighted' rates; by geographic proximity to obtain 'distance-weighted' rates; and alternatively with average effective tax rates.

Those estimations allow, in turn, revenue loss estimates to be made. 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:

$$L_{it} = \tau_{it} \hat{\varphi} (\tau_{it} - W^h \tau_{-it}) \quad (2)$$

where, per equation (1), $\hat{\varphi}$ 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:

$$LL_{it} = \tau_{it} \hat{\varphi} (\tau_{it} - W^h \tau_{-it}) / (1 - \hat{\lambda}) \quad (3)$$

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?

3 Data

We are grateful to the IMF researchers for providing us with their dataset 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 dataset 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, since 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 Government Revenue Database (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 International Centre for Tax and Development (ICTD) set out (Prichard et al. 2014), no pre-existing source met these criteria. The set of papers published at the launch of the GRD (ICTD 2014) 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 dataset marked an important step towards transparency, although it also confirmed that crucial issues remain—such as inconsistent GDP series (McNabb 2016).

In addition, we introduce alternative data on average effective tax rates (AETR) 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 (2015).

¹ We 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).

² These 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 is 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).

³ Argentina, 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.

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 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 (2015). 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 et al. (2015), which also sets out the risks of systematic biases in ‘tax haven’ lists and the related problem of there being no accepted 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, although average effective rates may offer a way in, if used to determine the ‘haven’ list.

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 which are more easily seen in Figures 1–4. Table 2 summarizes the three alternatives to the original approach.

Figure 1 displays revenue from the CIT in per cent of GDP and Figure 2 shows CIT rates, both across the period from 1980–2013 for various groups of countries. Figure 3 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 (2015). Figure 4 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 4).⁴ We create two averages using the Bureau of Economic Analysis data used by Cobham and Janský (2015): one standard and one 5-year moving average to smooth out some sharp changes over the time (i.e. AETR3 and AETR4 in Figure 4). 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 4).

⁴ One 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 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	-	9.19
				11.61	
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	13235	87717	127	15298
Trade openness, per cent of GDP	1999	78.87	436.95	6.32	45.03
Inflation, in per cent	1950	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.

Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

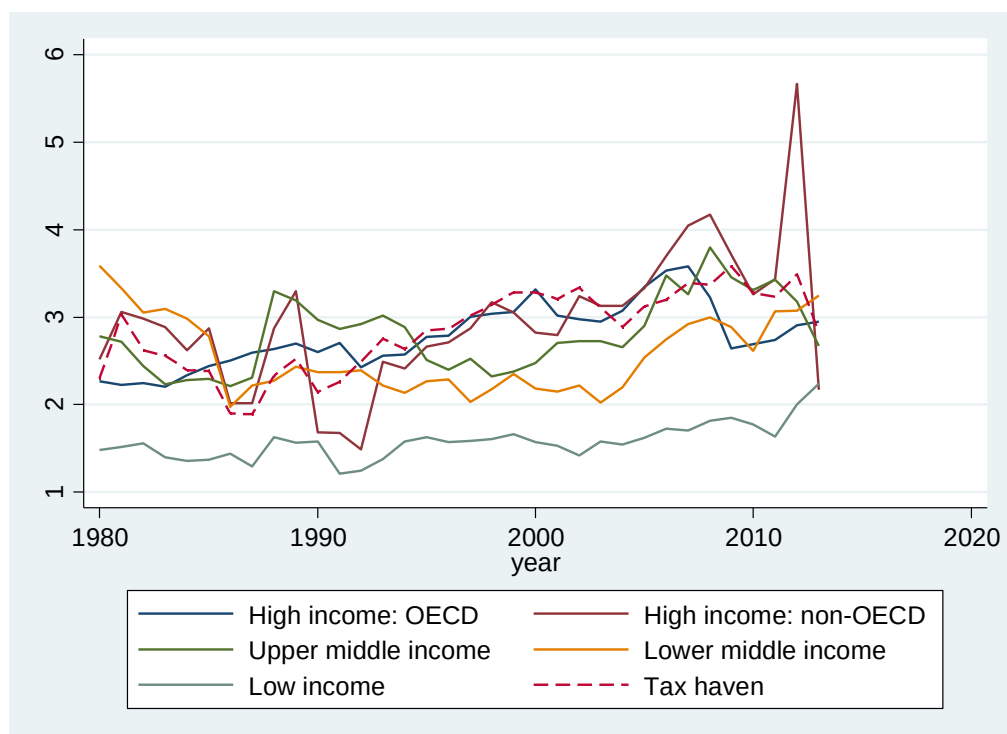
Table 2: The versions of estimates

Model component	Alternatives
Tax revenue data	IMF or GRD
Average effective tax rates	Six versions in all, two versions from each of the three following sources: data from Crivelli et al. (2016) using estimates by Abbas and Klemm (2013); the Orbis data used by Cobham and Loretz (2014); and the Bureau of Economic Analysis data used by Cobham and Janský (2015).
Tax haven list	Gravelle (2013) or Cobham and Janský (2015)

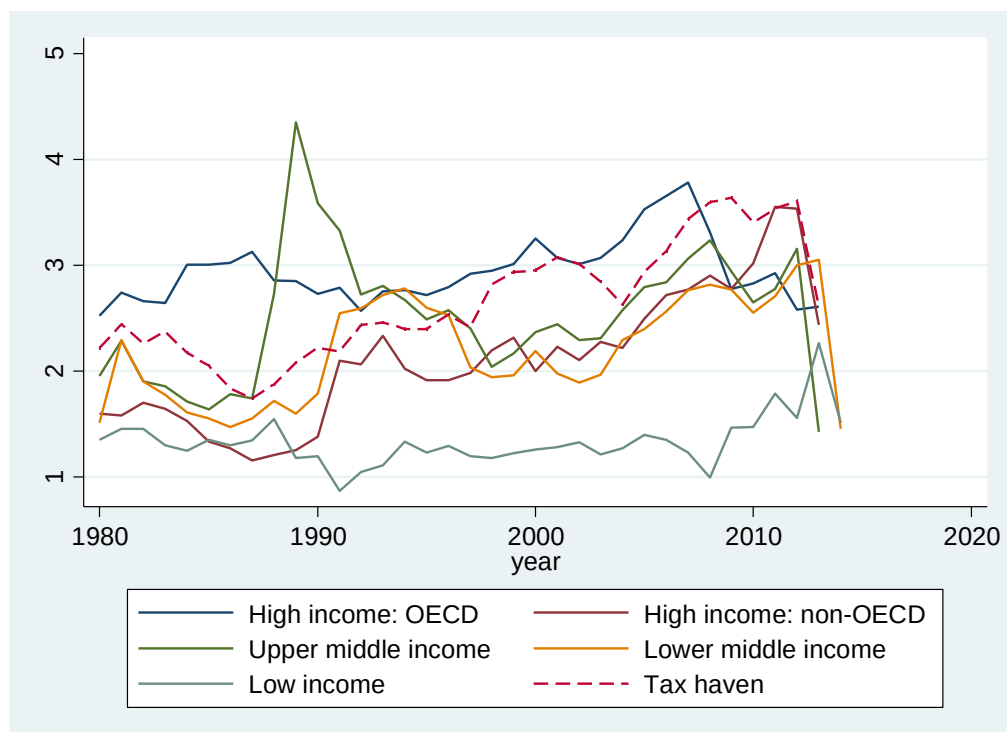
Source: Authors' illustration.

Figure 1: Revenue from corporate income tax, in per cent of GDP

(a) IMF data

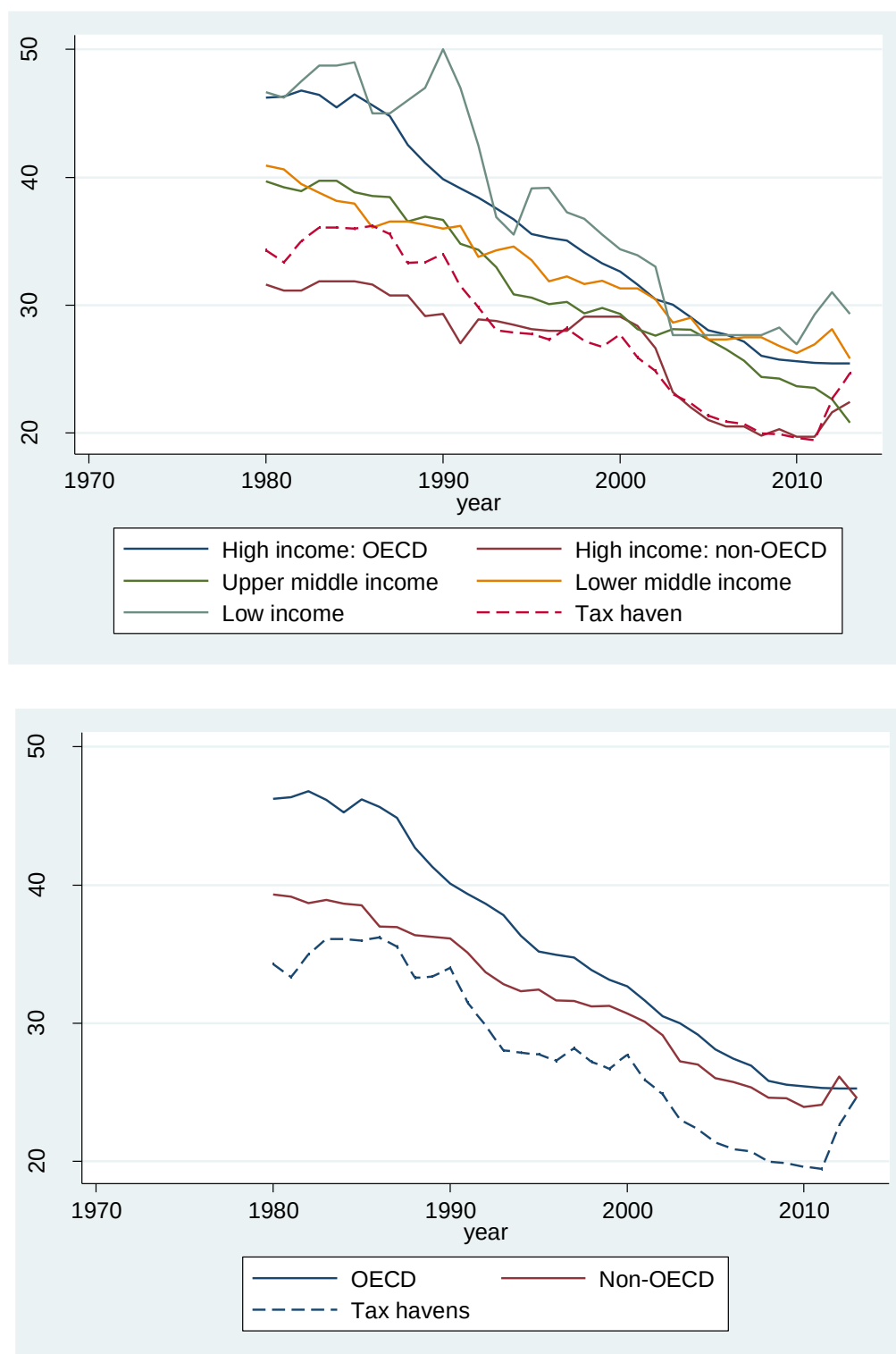


(b) GRD data



Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

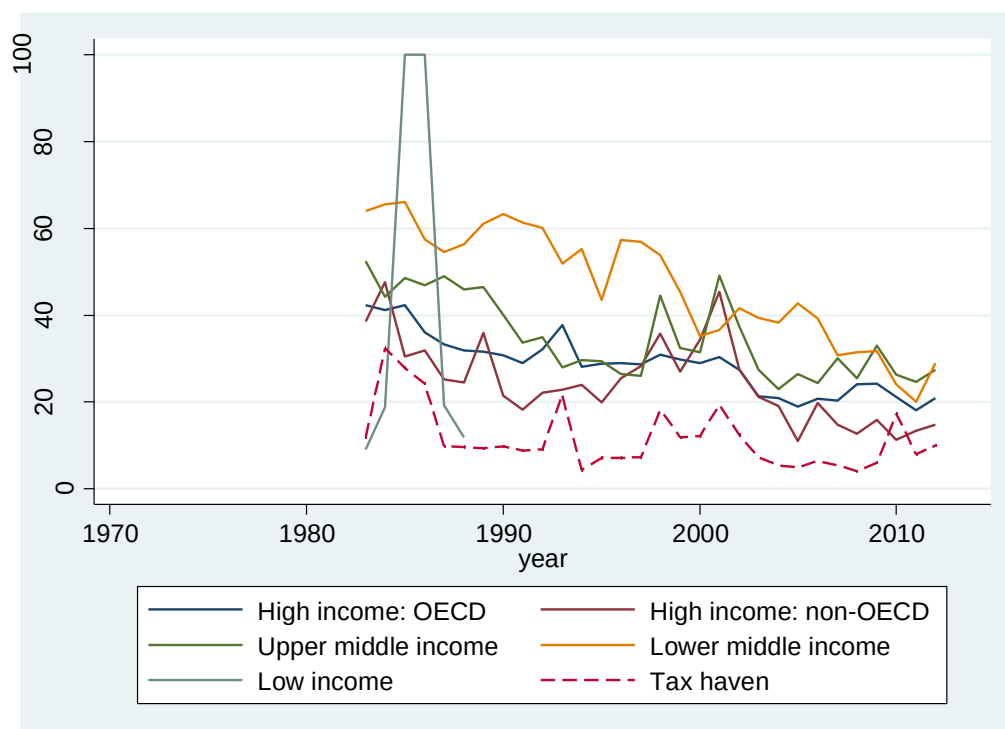
Figure 2: Corporate income tax rates, 1980–2013



Note: The data are presented here without the extrapolated tax rates.

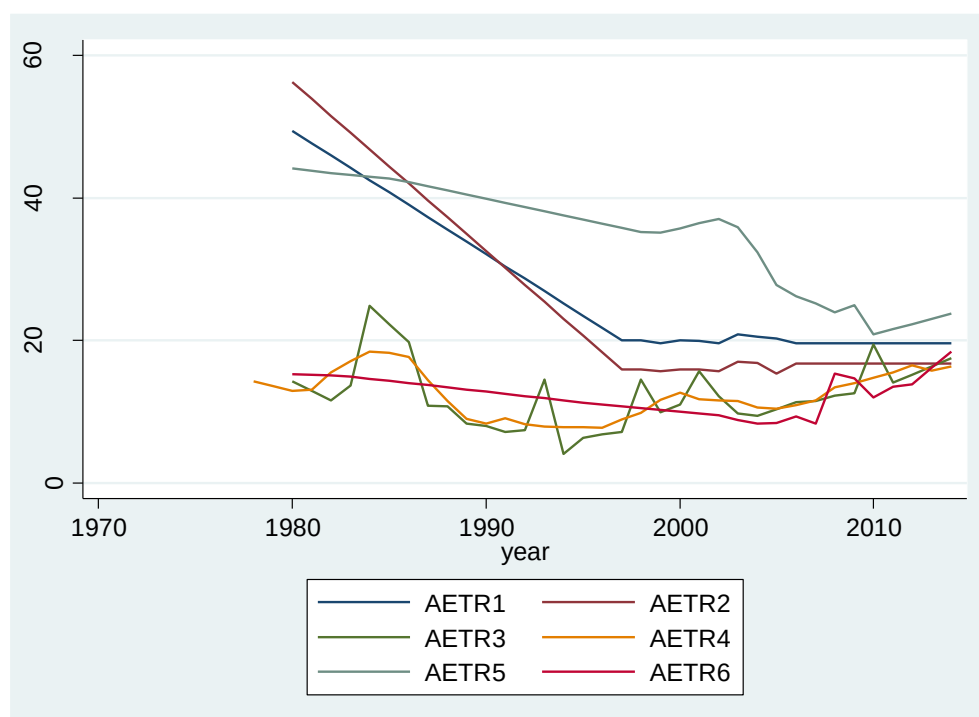
Source: Authors' calculations based on data from Crivelli et al. (2016).

Figure 3: Average effective corporate income tax rates, 1980–2013



Source: Authors' calculations based on data from the Bureau of Economic Analysis used by Cobham and Janský (2015).

Figure 4: Haven-weighted average effective corporate income tax rates, 1980–2013



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 (2015).

4 Results

Per Table 2, the models differ in the tax revenue and rate data used, and the tax haven list. The results based on those various approaches differ, 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. A comprehensive set of results for all of the various versions is given in Appendix Table A1.

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. Table 3 corresponds to its counterpart in the original paper of Crivelli et al. (2016), presenting the baseline spillover regressions for various versions. It shows two sets of regressions—one re-estimated using the data provided by the authors, and one using GRD revenue data. The results are very similar. We use these two sets of results to re-estimate the revenue cost of BEPS.

Table 3: Base spillovers by income level, ‘haven’-weighted tax rates

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	base	base	base	base	base	base
Data for base	IMF	IMF	IMF	GRD	GRD	GRD
CIT base, lagged	0.906*** (0)	0.768*** (0)	0.873*** (0)	0.971*** (0)	0.770*** (0)	0.840*** (0)
CIT rate	-0.0918** (0.0193)	-0.0596 (0.108)	-0.123* (0.0525)	-0.0926** (0.0345)	-0.0673 (0.133)	-0.135* (0.0572)
CIT rate, haven weighted	0.352** (0.0300)	0.342* (0.0528)	0.515* (0.0684)	0.289* (0.0832)	0.254 (0.158)	-0.00734 (0.983)
Inflation (log)	0.144 (0.688)	-0.0625 (0.793)	0.136 (0.732)	0.725* (0.0936)	-0.102 (0.650)	0.293 (0.521)
Trade openness	0.0403** (0.0373)	-0.0211 (0.137)	0.00758 (0.651)	0.0120 (0.441)	-0.0246** (0.0181)	0.00860 (0.606)
GDP per capita (log)	0.0924 (0.945)	0.448 (0.711)	1.334 (0.403)	0.394 (0.705)	0.574 (0.633)	2.114* (0.0510)
Agriculture		-0.134 (0.311)			-0.113 (0.400)	
Time trend	0.165** (0.0325)	0.157* (0.0615)	0.267** (0.0430)	0.131* (0.0987)	0.0893 (0.222)	0.0842 (0.591)
Constant	-339.5** (0.0349)	-321.5* (0.0712)	-554.5** (0.0407)	-271.4 (0.101)	-184.4 (0.225)	-179.8 (0.577)
Observations	1,687	624	949	1,602	649	829
Number of countries	103	28	72	101	29	69

Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

We start with restricted or constrained coefficient estimates reported in Table 4 (not reported in Table 3 since these are obtained by an additional estimation in Stata) 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. The GRD-based estimates for OECD countries are somewhat lower due to 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.

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

	$\hat{\lambda}$	$\hat{\phi}$	$\hat{\lambda}$	$\hat{\phi}$
	OECD	OECD	Non-OECD	Non-OECD
Published estimates	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

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	Billion USD	% of GDP	Billion USD
	OECD	OECD	Non-OECD	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

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	Billion USD	% of GDP	Billion USD
	OECD	OECD	Non-OECD	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

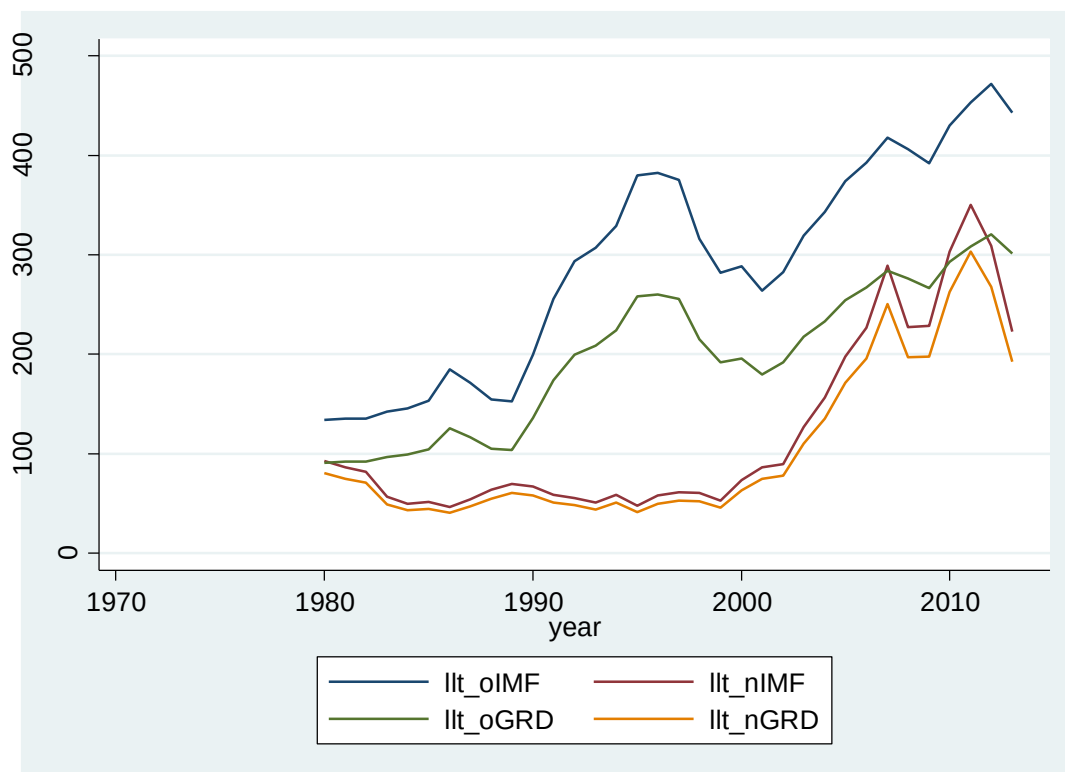
Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

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, i.e. 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).

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 3 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.

Figure 3: Revenue losses, US\$ billion, OECD vs non-OECD

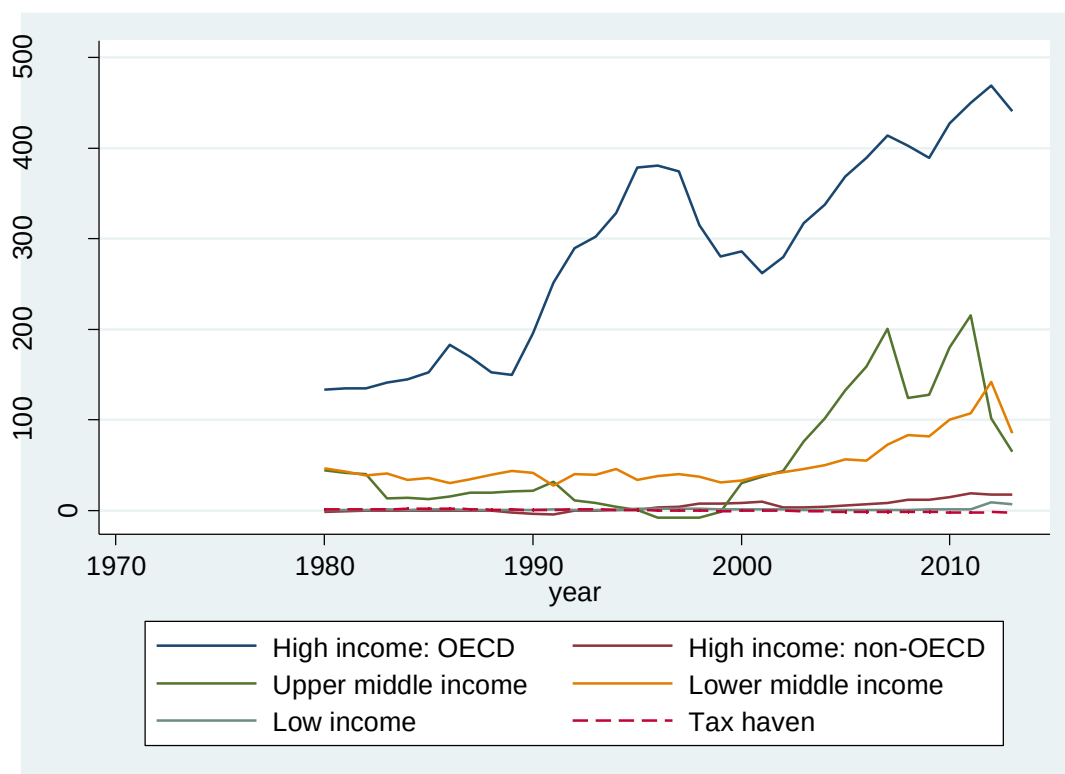


Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

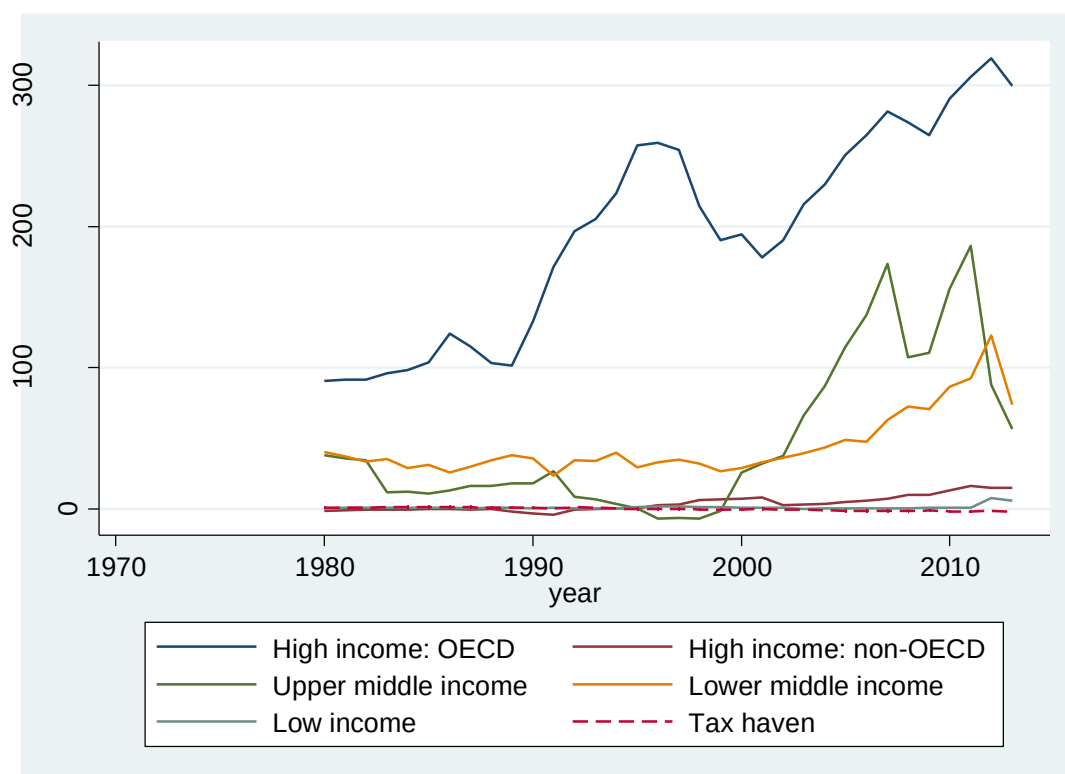
Figure 4 provides a more detailed breakdown of the same results, still in terms of dollars. The OECD countries are the biggest absolute losers, but low and lower middle-income countries see strong growth in losses during the commodity boom of the 2000s. Figure 5 shows the strikingly different pattern in terms of shares of GDP. Low- 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.

Figure 4: Revenue loss estimates over time, US\$ billion, by income group

(a) IMF



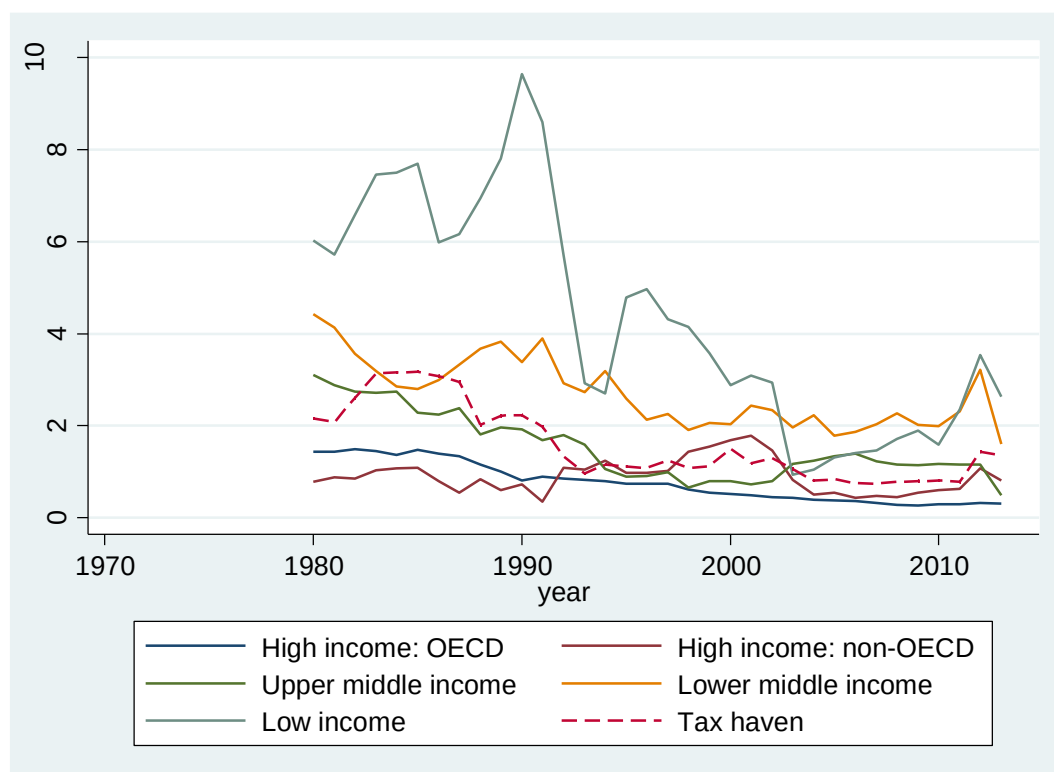
b) GRD



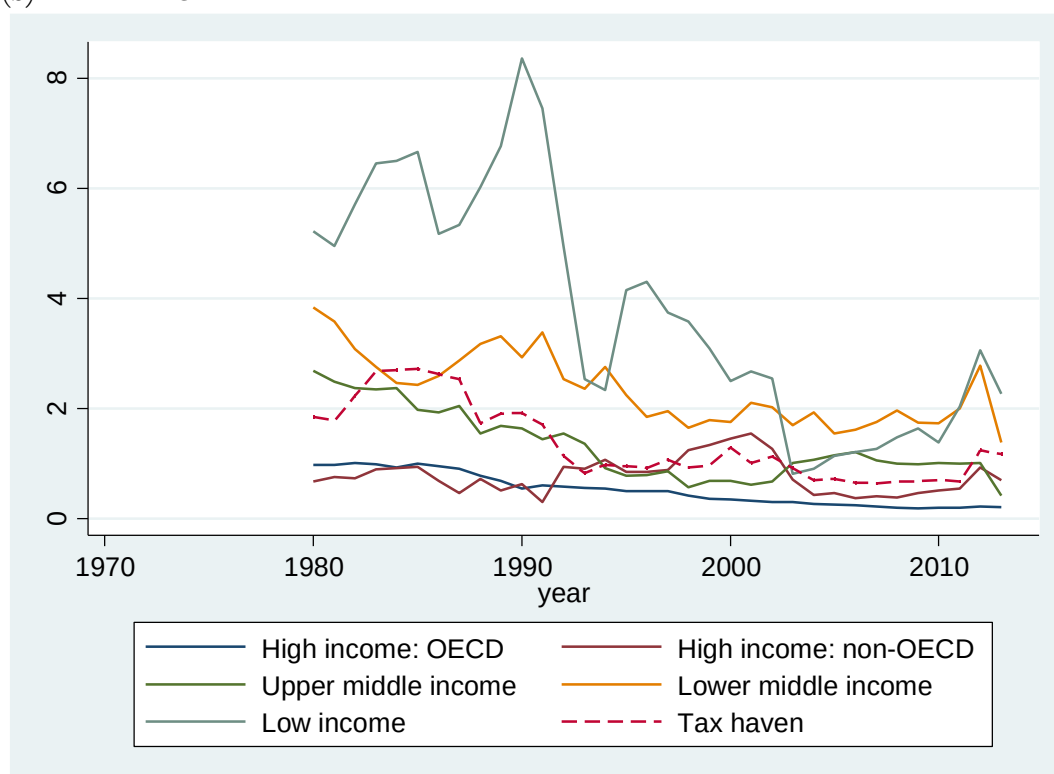
Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

Figure 5: Revenue loss estimates over time, % of GDP, by income group

(a) IMF



(b) GRD



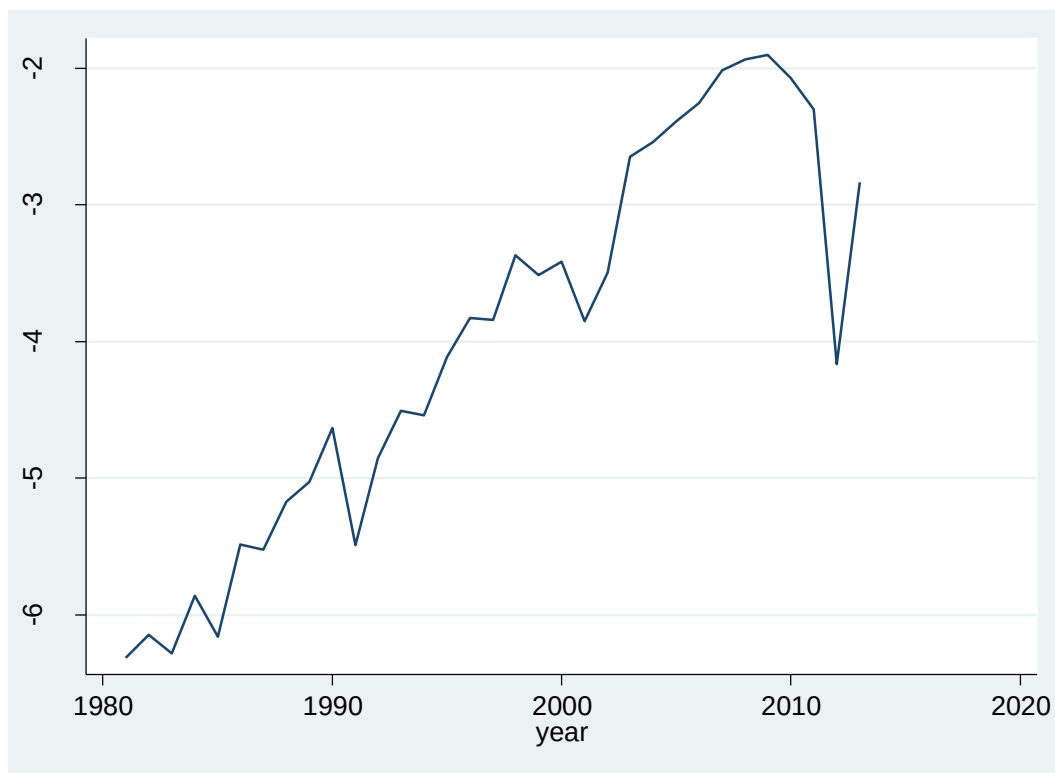
Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

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 6, is also what seems to be driving most of the results over time, i.e. the decreasing cost of BEPS as a share of GDP. When considered in US 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.

Figure 6: Average difference between corporate tax rate and haven-weighted average (in percentage points)



Source: Authors' calculations based on data from Crivelli et al. (2016) and other sources described in the text.

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 (2015) and Clausing (2016) provide evidence that profit shifting has grown strongly—even as effective tax rates have fallen sharply. Cobham and Janský (2015) 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 to 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 go further in exploring whether other data sources for effective rates can generate regressions with stronger results than we found in section 3.

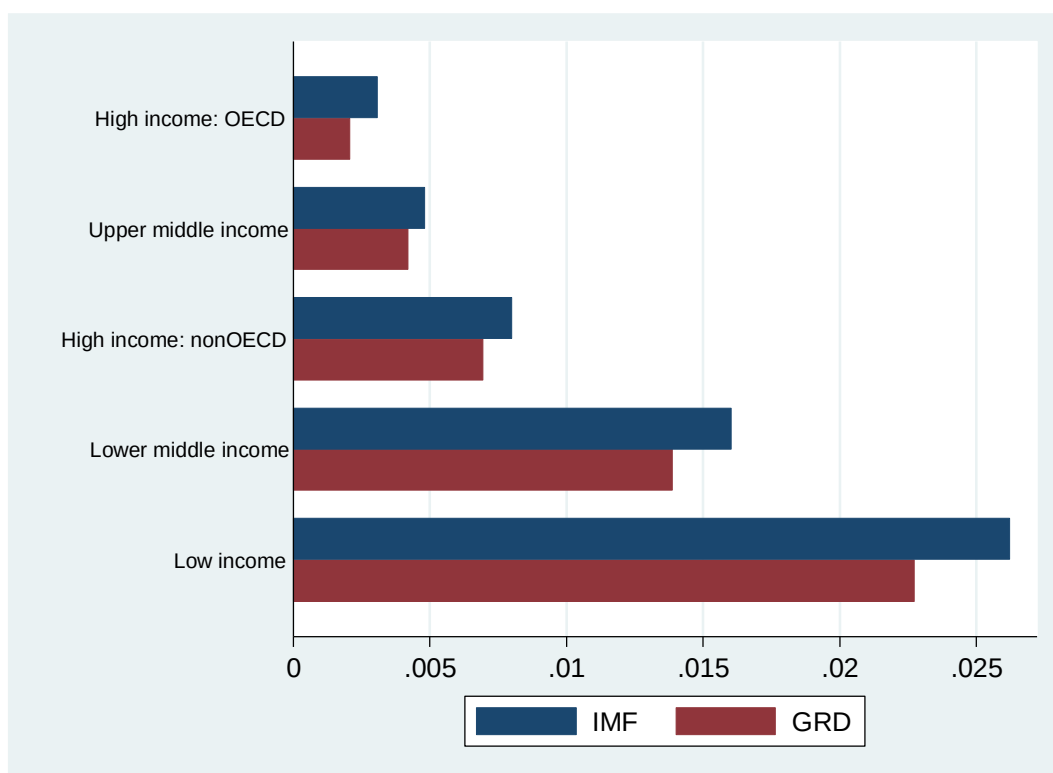
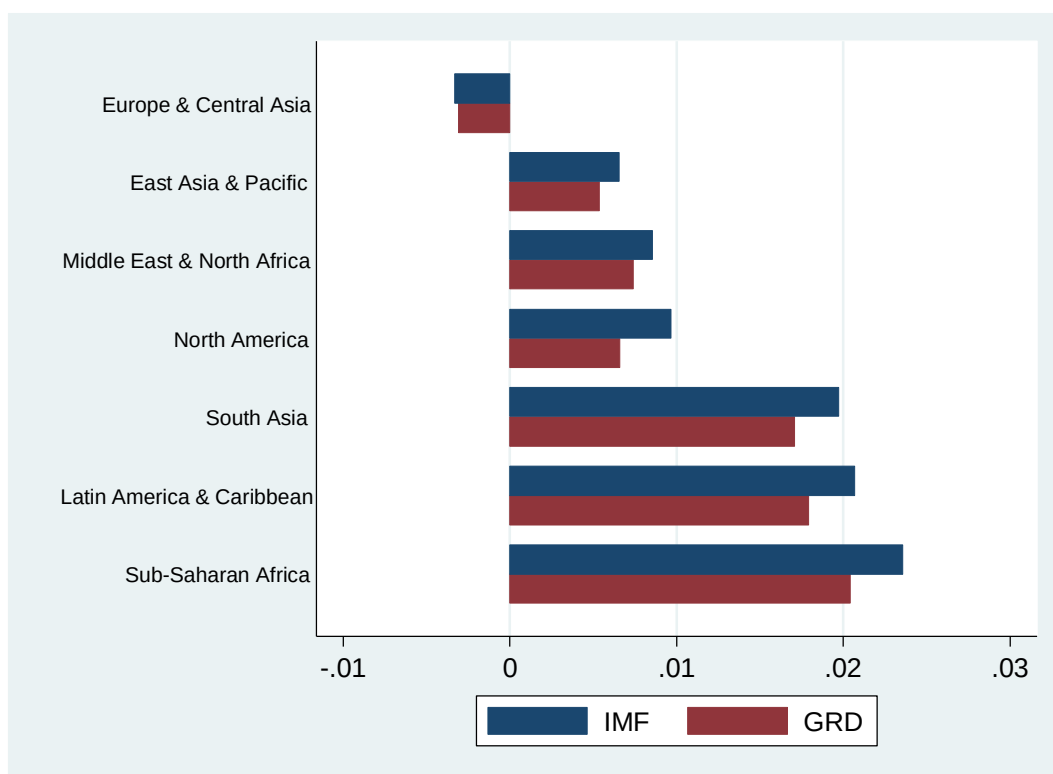
As noted, one strength of the approach here is that more disaggregated results can be obtained, and we present some of these now. Figure 7 shows the pattern of losses by region and by income group, as a share of GDP. Despite the differences in underlying IMF and GRD revenue data, the

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.

Figure 8 shows the country-level findings for revenue losses in 2013. 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.

The full 2013 results are detailed in Appendix Table A2. Using the more conservative GRD results, 14 countries from Argentina to Zambia face losses of between 3 per cent and 7 per cent of their GDP. A further 38 countries, from Bhutan to the USA, face losses of between 1 per cent 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).

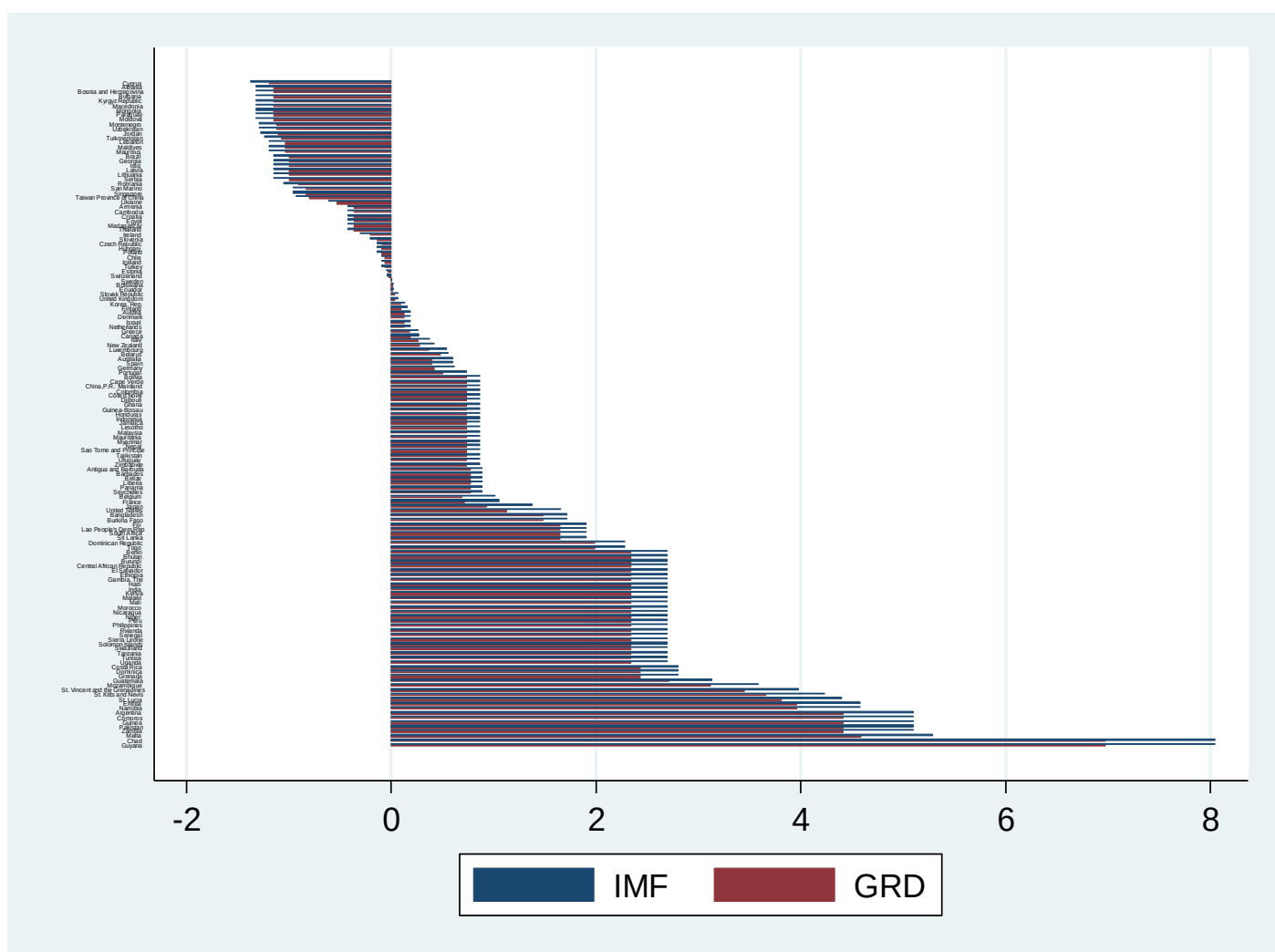
Figure 7: Average losses/GDP by region and by income



Note: Means of IIMF and IIGRD refer to the mean values of revenue loss estimates using IMF and GRD data, respectively.

Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

Figure 8: Illustrative revenue loss calculations as % of GDP, in US\$ billion, 2013



Source: Authors' calculations based on data from Crivelli et al. (2016) and the GRD.

6 Conclusion

In this paper, we re-estimate the work of Crivelli et al. (2016) and, to a large extent, confirm their findings. We established 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 average effective tax rates. 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 which 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 to 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- and lower middle-income countries; and in sub-Saharan Africa, Latin America and the Caribbean, and in South Asia compared to 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 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 points 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 is made public, and the full extent and nature of the misalignment between profits and the location of real economic activity is laid bare.

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Appendix

Table A1: Additional regression results

	(7)	(8)	(9)	(10)	(11)	(12)
Data for base	IMF	IMF	IMF	GRD	GRD	GRD
Tax haven list	Cobham & Janský	Cobham & Janský	Cobham & Janský	Cobham & Janský	Cobham & Janský	Cobham & Janský
Tax rate	Statutory	Statutory	Statutory	Statutory	Statutory	Statutory
CIT base, lagged	0.918*** (0)	0.797*** (0)	0.882*** (0)			
CIT rate	-0.0773** (0.0373)	-0.0611 (0.102)	-0.104 (0.100)	-0.0826** (0.0478)	-0.0705 (0.132)	-0.132** (0.0495)
Inflation (log)	0.0931 (0.803)	-0.0796 (0.735)	0.123 (0.755)	0.646 (0.119)	-0.0884 (0.702)	0.295 (0.486)
Trade openness	0.0366* (0.0635)	-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)			-0.0883 (0.503)	
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)	0.123 (0.172)	0.115 (0.209)	-0.190 (0.281)
CIT base, lagged				0.982*** (0)	0.798*** (0)	0.818*** (0)
Constant	-163.2 (0.206)	-137.0 (0.317)	-241.2 (0.237)	-188.2 (0.180)	-102.5 (0.367)	93.94 (0.708)
Observations	1,687	624	949	1,602	649	829
Number of countries	103	28	72	101	29	69

	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Data for base	GRD	GRD	GRD	GRD	GRD	GRD	GRD	GRD	GRD
Tax haven list	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle
Tax rate	AETR1	AETR1	AETR1	AETR2	AETR2	AETR2	AETR3	AETR3	AETR3
Inflation (log)	0.135 (0.587)	0.119 (0.634)	0.153 (0.599)	-0.115 (0.560)	0.108 (0.657)	-0.0570 (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)			-0.464* (0.0705)	
Time trend	0.148*** (8.43e-05)	0.202* (0.0672)	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* (0.0575)	-0.0588 (0.773)	0.541** (0.0271)	-0.0204 (0.368)	-0.0306 (0.241)	-0.0204 (0.612)
Constant	-304.7*** (3.90e-05)	-404.8* (0.0626)	-272.6*** (0.00694)	-338.6*** (1.70e-07)	-352.8* (0.0896)	-311.9*** (0.00110)	-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	7	29	37	7	29	47	25	19

	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Data for base	GRD	GRD	GRD	GRD	GRD	GRD	GRD	GRD	GRD
Tax haven list	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle	Gravelle
Tax rate	AETR4	AETR4	AETR4	AETR5	AETR5	AETR5	AETR6	AETR6	AETR6
Inflation (log)	-0.185 (0.466)	-0.296 (0.325)	-0.142 (0.307)	0.690 (0.195)	-0.0932 (0.798)	0.322 (0.450)	0.844 (0.170)	-0.165 (0.695)	0.568 (0.266)
Trade openness	0.0114 (0.260)	-0.0100 (0.630)	-0.000909 (0.943)	-0.0439 (0.169)	-0.0430 (0.330)	-0.0742* (0.0639)	-0.00664 (0.841)	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)			-0.201 (0.482)			0.204 (0.293)	
Time trend	0.0749** (0.0135)	0.0337 (0.521)	0.137** (0.0202)	-0.832*** (7.28e-05)	-1.011*** (1.10e-08)	-0.776 (0.113)	0.159 (0.167)	0.107 (0.213)	0.0182 (0.935)
CIT base, lagged	0.793*** (0)	0.709*** (0)	0.807*** (0)	0.890*** (0)	0.526*** (0)	0.854*** (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*** (0.00329)	-0.0802* (0.0776)	-0.0874 (0.253)	-0.307*** (0.000770)	-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)	1,670*** (6.05e-05)	2,072*** (8.30e-09)	1,537 (0.120)	-334.8 (0.149)	-196.9 (0.266)	-42.01 (0.925)
Observations	971	517	340	361	192	140	373	194	150
Number of countries	47	25	19	55	28	25	57	28	27

Source: Authors' calculations based on data from Crivelli et al. (2016) and other sources described in the text.

Table A2: Country-level revenue loss estimates, 2013

	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	3.96
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

	IMF billion	GRD billion	IMF % GDP	GRD % GDP
Bangladesh	2.40	2.08	1.71	1.48
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

	IMF billion	GRD billion	IMF % GDP	GRD % GDP
Sweden	0.03	0.02	0.01	0.00
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
Cambodia	-0.07	-0.06	-0.42	-0.37
Madagascar	-0.04	-0.04	-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

Source: Authors' calculations.