



WP/21/9

IMF Working Paper

Is there Money on the Table? Evidence on the Magnitude of Profit Shifting in the Extractive Industries

by Sebastian Beer and Dan Devlin

I N T E R N A T I O N A L M O N E T A R Y F U N D

IMF Working Paper

Fiscal Affairs Department

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January 2021

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Abstract

Profit shifting remains a key concern in international tax system debate, but discussions are largely based on aggregate estimates, with less attention paid to individual sectors. Drawing on a novel dataset, we quantify tax avoidance risks in the extractive industries, a sector which is revenue critical for many developing economies. We find that a one percentage point increase in the domestic corporate tax rate has historically reduced sectoral profits by slightly over 3 percent; and the response tends to be more pronounced among mining than among hydrocarbon firms. There is only weak evidence transfer pricing rules contain tax minimization efforts of MNEs in our sample, but interest limitation rules (e.g., thin capitalization or earnings based rules) do reduce the observable extent of profit shifting. Our findings highlight the challenge of taxing income in the natural resource sector and suggest how fiscal regime design might be strengthened.

JEL Classification Numbers: H25

Keywords: International Corporate Taxation, Multinational Firms, Mining, Petroleum, Profit Shifting, Debt, Interest Limitations, Transfer Pricing, Production Sharing Agreements

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I. INTRODUCTION¹

International taxation remains at the forefront of current tax policy debate. Challenges with the current system have placed it under unprecedented stress,² with attention driven by the magnitude of international profit shifting in the aggregate (see Heckemeyer and Overesch, 2017 and Beer and others, 2019 for reviews of the literature). Research into tax avoidance in particular industries has been uneven and focused largely on the financial sector, however (see for example, Merz and Overesch, 2016; Overesch and Wolff, 2019; Joshi, Outslay, and Persson, 2020, Fatica and Gregori, 2020).

In this paper, we quantify the extent of profit shifting in the extractive industries, a sector which stands out for several reasons. First, natural resource companies contribute more than half of total revenue collections in many resource-rich developing economies (IMF, 2019). Countries relying that heavily on a single industry need to ensure their tax systems are tailored to the specificities of that industry. If tax avoidance renders profit-based taxes ineffective, more distorting instruments, such as production-based royalties and taxes are often advocated (see for example, Durst, 2016). Second, some of the world's largest and most sophisticated multinational enterprises (MNEs) dominate the sector. In Africa, a third of total FDI inflows are directed towards mining operations and 80 percent of government payments from the mining sector derive from MNEs (IMF, 2020). Understanding the sensitivity of the tax base to international tax avoidance incentives is thus more pertinent in the extractive industries than in other sectors. Third, the extraction of natural resources is heavily reliant on intangible assets and specialized services. Given that these factors have been shown to facilitate profit shifting in other contexts (Grubert, 2003; Dischinger and Riedel, 2011; Hebous and Johanesson, 2015), it is likely that the sector's response to tax rate differentials differs from cross-sectoral estimates.

Profit shifting opportunities in the extractive industries, like elsewhere, arise primarily in the transactions between related parties within the same MNE group.³ While MNEs are typically required to transact with affiliated entities on arm's-length terms, the "facts and circumstances" nature of transfer pricing analysis provides ample gray areas for MNEs to shift profits and tax administrators often deal with incomplete information when making a judgement whether abusive transfer pricing is taking place.⁴ Key tax avoidance channels in the industry include (i.) the debt-financing of operations, where high interest loans across entities create tax shielding benefits for the MNEs at the expense of host jurisdictions; (ii.) exploiting the opacity of markets, where profits are shifted by underquoting prices for intermediate products or over-remunerating offshore affiliates that provide technical services; (iii.) realizing capital gains related to the

¹ We would like to thank Thomas Baunsgaard, Ruud De Mooij, Vitor Gaspar, Shafik Hebous, Jan Loeprick and participants of the FAD seminar for valuable comments on a draft version of this paper.

² See, for example, IMF (2019)

³ Straight tax evasion, such as via under-reporting production volumes is excluded from our analysis.

⁴ As noted by Vann and Cooper (2016): "... it is not difficult to be frustrated by the operation of the current international norms in the transfer pricing area."

exploitation of natural resource wealth offshore, in countries that do not tax such gains.⁵ Tax treaties often compound the problem of aggressive tax avoidance. By limiting withholding taxes on outgoing payments or restricting source countries' right to tax capital gains, treaties can increase tax rate differentials and thus heighten the incentive to relocate profits.

The perceived threat of tax avoidance and wider concerns about the ability of governments to collect a fair share from the sector have gradually increased scrutiny on the sector and improved data availability, which we leverage for this paper. Since 2014, EU- and Canada-based MNEs are required to disclose their payments to governments worldwide on a Country-by-Country (CBC) basis.⁶ The financial reports of more than 600 different MNE groups with subsidiaries located in over 160 countries form the basis of our analysis at the firm-level. We merge the payment reports with the ORBIS database, which includes information on a group's balance sheet, its profit and loss accounts, as well as the location of affiliated entities. We are thus able to explain payments made to governments worldwide with group-specific production capabilities (as reflected in the consolidated balance sheet) and profit shifting incentives (as revealed by the location of affiliated entities). One drawback of the CBC information is that it only presents a partial picture, namely of the payments made by European and Canadian MNEs. To gauge global revenue implications, we draw on a novel dataset, the Resource Revenue Database,⁷ which records detailed natural resource revenues for an unbalanced panel of 74 countries between 2000 and 2018. We complement this dataset with aggregate EITI reports for several African economies.

Our empirical analysis, based on micro- and macro- data, suggests significant profit shifting risks in the sector. Overall, we find that a one percentage point increase in the corporate tax rate has historically reduced reported profits of mining and hydrocarbon entities by more than 3 percent. This sensitivity exceeds cross-sectoral estimates of profit shifting, but is consistent with evidence on important sectoral variation (Barrios and others, 2018) and the elevated risks previously identified in the hydrocarbon sector (Beer and Loeprick, 2015).⁸ Moreover, we document that mining companies tend to respond more strongly to international tax differentials than oil and gas firms, which may reflect the less frequent use of joint ventures and production sharing

⁵ Capital gains from the sale of assets, which can be substantial in natural resources, can be transferred offshore to escape taxation. These gains can arise when, for instance, new information causes the value of a mining license to sharply increase. Monitoring these gains can be difficult, particularly for capacity-constrained tax authorities.

⁶ The Accounting Directive 2013/34/EU requires European-based MNEs to record their payments to governments worldwide since 2014. The Canadian analog of these reporting obligations – the Extractive Sector Transparency Measures Act – came into effect in 2015.

⁷ The Resource Revenue Database is an unbalanced panel dataset, recording detailed revenue information for 74 countries, gathered by desk economist from the IMF.

⁸ Barrios and others report that the standard deviation of semi-elasticities across sectors is around 4.5. With normally distributed profit shifting opportunities, and an average value of 0.45, this result implies that the sensitivity of the 2.5 percent most extreme tax avoiding sectors is below -9.

contracts in mining or the increased challenge of determining arm's length prices for some related-party transactions.

Our paper contributes to the literature in several ways. First, we extend an emerging literature on sectoral differences in tax avoidance. Information on the degree and variation of profit shifting is key for directing scarce tax administrative resources in risk-based audits, designing tailored anti-abuse rules, and understanding distortions caused by uneven avoidance opportunities. Barrios and d'Andria (2018) document sectoral variation, but do not disclose industry-specific profit shifting estimates. Beer and Loeprick (2017) quantify the extent of profit shifting in the oil and gas industry using a sample of around 1500 firm-level observations, with entities located in 12 (mostly advanced) economies. The sample used in this paper comprises around 3000 observations of both hydrocarbon and mining companies, located in more than 130 countries, and classified into their primary sector (mining or petroleum).⁹ We are thus able to provide a more comprehensive assessment of profit shifting in the extractive industries worldwide. Our findings are broadly in line with the results presented in Beer and Loeprick (2017), but highlight specific risks associated with mining operations.

Second, we examine the elasticity of profit-shifting worldwide, including in developing economies. Previous micro-level estimates largely reflect tax avoidance behavior of MNE subsidiaries located in Europe and the US, as commercial databases provide limited information on firms' unconsolidated balance sheets and profit and loss accounts elsewhere. The requirement for extractive companies to publish their payments to governments on a country-by-country basis puts us in the unique position to examine firm-level profits globally. We use ownership information recorded in the Orbis database to capture profit shifting incentives that could drive these payments. In contrast to unconsolidated financial information, such ownership information recorded in Orbis is globally available.¹⁰ By merging the CBC reports with Orbis, using a matching procedure that exploits company names provided in both datasets, we are able to tell, for each CBC payment made to governments worldwide, the location of other entities in the same corporate group and the consolidated balance sheet of the parent.

Third, we shed light on the effectiveness of two primary anti-abuse measures in the sector: transfer pricing rules and interest limitation rules. Transfer pricing rules - which essentially require that related parties charge prices that would accord with what unrelated parties would do in the same circumstances - have been shown to curb profit shifting risks among non-financial firms (Lohse and Riedel, 2015; Beer and Loeprick, 2015) and hydrocarbon entities (Beer and Loeprick, 2017). In the extractive industries, transfer pricing risks emerge from the potential underpricing of natural resource products and the overpayment for a range of routine and specialized goods

⁹ A small number of MNEs in the sample with a trading focus on interests in both petroleum and mining have been classified based on the author's assessment of the balance of their overall company operations.

¹⁰ In other words, while Orbis would provide an accurate depiction of an MNE group's unconsolidated accounts only for subsidiaries located in Europe, it nevertheless provides information on the geographic location of all affiliated entities.

and services received from related parties (Readhead, 2018). While the results of our analysis indicate a mitigating effect of transfer pricing rules on the sensitivity of taxable profits, we are not able to statistically reject the possibility that transfer pricing rules are ineffective.¹¹ However, in line with previous work on the effect of thin capitalization rules (Overesch and Wamser, 2010; Buettner and others, 2012; Blouin and others, 2014), we find that profit shifting risks are reduced by half in countries that limit the amount of interest deductible for tax purposes.

Fourth, we contribute to the understanding of differences between macro and micro-derived estimates of profit shifting. Beer and others (2019) show that studies using macro data find larger semi-elasticities on average and provide two explanations: on the one hand, data gaps in macro data - such as on the location of a country's MNE affiliates worldwide or on assets at the subsidiary level - may lead to biased estimates. On the other, the restructuring of transactions or financing arrangements in response to tax changes takes time, and the larger estimate in macro data, which typically includes many more years than panel data, may reflect the importance of adjustment costs. We combine micro and macro data in a seemingly unrelated regression (SUR) framework to study differences in semi-elasticities systematically. Moreover, we draw upon ownership information recorded in the micro data to compute representative tax rate differentials at the country level. When controlling for productive activity and ownership structures, we are unable to reject that the semi-elasticities in our micro and macro data are the same, suggesting that systematic differences found in previous work are more likely due to biased estimates than the importance of adjustment costs.

Finally, our findings are relevant for ongoing policy discussion on international taxation. The widespread perception that the current international tax system is ill-suited to achieve a fair allocation of tax revenues, and rising public debt levels, have led to an unprecedented openness to new, more fundamental approaches to taxing corporations (see e.g. Beer and others 2019, De Mooij and others, 2019; OECD, 2019). However, acknowledging the particularities of the sector - notably, the presence of rents due to location-specific factors - the extractive industries are mostly carved out of these broader proposals. The findings in this paper underscore the need for many countries to re-examine their fiscal regimes for the extractive industries, either by imposing stronger profit shifting limitations (especially on interest) or through more fundamental fiscal regime reform.¹² Both the wider application of simplified approaches, such as administrative pricing or safe harbors that reduce situations requiring full transfer pricing analysis, or the reliance on more formulaic approaches, offer ways forward that might address these problems.

The remainder of the paper is structured as follows. The first section describes the data and empirical approach. The second section provides key descriptive statistics. The third section presents estimation results and combines sector-specific elasticity-estimates with revenue

¹¹ That is, merely having the rules in place (which is what our dataset captures) is not sufficient to have a material effect on profit shifting behavior.

¹² See proposals for developing countries in Baunsgaard and Devlin (2021).

information to gauge the likely revenue losses from profit shifting in the extractive industries. The fourth section concludes.

II. DATA AND ESTIMATION APPROACH

Estimation overview

Following previous work (see e.g. Hines and Rice, 1994), we estimate the sensitivity of reported profits with respect to international tax rate differentials to identify profit shifting. Our baseline regression takes the following form:

$$\log(\pi_{kct}) = \beta(\tau_{ct} - \bar{\tau}_{tk}) + \gamma'X_{ctk} + \alpha_c + \nu_t + \varepsilon_{ctk} \quad (1)$$

Where π_{kct} denotes taxable profits of MNE group k in country c and year t . Our main interest lies in the coefficient β , which captures the semi-elasticity of taxable profits with respect to an international tax rate differential ($\tau_{ct} - \bar{\tau}_{tk}$). In the presence of profit shifting, the coefficient is expected to take a negative sign. Equation (1) can be interpreted as a production function estimation, where any residual correlation with a tax rate differential, after controlling for production potential, is interpreted as evidence for profit shifting.

We use statutory CIT rates to capture profit shifting incentives and to create tax rate differentials. In the extractive industries, these rates are arguably a less-than-perfect proxy for net tax savings opportunities. On the one hand, extractive firms are sometimes afforded tax rates that do not align with the general rate applying to companies operating in other sectors.¹³ On the other hand, countries often levy additional taxes or apply increased rates on operations in the petroleum and mining sector to account for the presence of rents (e.g. by imposing additional resource rent taxes over and above CIT). In addition, the tax treatment of affiliates in the same group and country may depend on the entities' line of business: regular CIT regimes often apply to firms in extractive groups not directly engaged in the operation of extracting resources, and several countries afford particular business lines such as trading or the provision of administrative services a reduced rate as a way to encourage these activities to be done locally.

The actual tax savings from relocating profits can therefore depend on the sector the extractive company is operating in; the business lines of affiliated companies; the applicability of special regimes; and the use of negotiated fiscal terms in contracts. However, as this information is not publicly available for a large set of firms, we revert to using statutory CIT rate information and acknowledge the potential of measurement error and the implied attenuation bias (see e.g. Griliches and Hausman, 1986), which would bias estimated coefficients toward zero. Given the large coefficient estimates we find, we are less concerned about such bias.

¹³ For example, they may negotiate a preferential rate in an investment contract or be awarded incentives such as tax holidays. Many of these industry-specific rates are kept confidential.

We use micro- and macro data to estimate two variants of equation (1). Our main data sources for estimating equation (1) at the firm level are CBC reports¹⁴ and the Orbis database. We combine information from the newly compiled Resource Revenue Database and the Orbis database, as discussed subsequently, to estimate the equation at the country-level. Both datasets are complemented with EITI reports, at the micro- and macro-level, respectively. To make efficient use of the data, we derive semi-elasticities in a seemingly unrelated regression (SUR) framework (see Zellner, 1962; Zellner and Huang, 1962; and Zellner, 1963). This allows us to increase estimation precision and test whether the estimated semi-elasticities differ between macro- and micro-data. We estimate the system of equations using weighted least squares to account for the potential that the magnitude of idiosyncratic shocks at the micro- and macro-level differ, and report heteroscedasticity robust standard errors.

The vector X_{ctk} includes control variables to account for country- and firm-specific differences that may drive reported profitability, also in the absence of tax avoidance:

- **Productive capacity.** Most importantly, we capture productive capacity with two variables at the micro level: the stock of consolidated fixed assets, as recorded in the ORBIS database, and the logarithm of royalty payments, as recorded in the CBC data. We use country-level royalty payments to capture productive capacity in the macro data. We expect productive capacity to be positively associated with profits and negatively with tax rates, due to the effect of taxation on the cost of capital (King, 1974). Accordingly, including proxies for productive capacity should tend to reduce the measured semi-elasticity in absolute terms.
- **Other firm-specific variables and data controls.** Following Barrios and others (2018), we include the number of entities in the same group to control for potential effects from group size on individual entity profitability. We include an indicator variable (*Source*) to capture systematic differences between EITI reports and CBC reports. Finally, we include two sets of country- and year-specific fixed effects (one for each data source) to capture structural differences between countries that are constant over time and differences across time that are constant between countries.
- **Supply- and demand factors.** We further include several control variables from the IMF's WEO database to control for country-specific demand and supply factors that could impact profitability. Specifically, we control for the magnitude of international trade by including the sum of imports and exports as a percent of GDP, the market size and potential demand in source countries, by including the logarithm of GDP and of the population size, and for effects of the real exchange rate by including nominal exchange rates and inflation. Moreover, we initially include both an energy and a non-energy commodity price index, published by the World Bank, and later replace these variables with year-specific fixed effects to capture systematic changes in profitability across time.

¹⁴ The reports are compiled by the Natural Resource Governance institute. See <https://resourceprojects.org>

Micro-based estimates

We use CBC reports to approximate firm-specific tax bases and to capture productive potential in source countries. Specifically, the reports record the payments made by affiliates of consolidated groups to governments in 157 countries, on a country-by-country basis, covering the period between 2014 and 2019.¹⁵ Each report provides a breakdown of seven different payment types.¹⁶ We use two of these: first, we divide payments made for taxes on profits by the statutory tax rate τ to approximate the tax base π . Second, we use royalty payments to control for differences in production levels. We complement the CBC reports with disaggregated EITI reports for 15 African economies, which record company-level payment information between 2004 and 2016.

We use the Orbis database to capture profit shifting incentives and to expand the set of control variables. Specifically, we merge the CBC reports with information in the Orbis database, using a string-matching procedure on company names. Out of 6300 payment-level observations, we are able to match the company names for slightly more than 4500 observations, which pertain to more than 600 distinct consolidated groups. For these groups, we record the location of affiliated entities worldwide and construct the tax rate differential $(\tau_{ct} - \bar{\tau}_{tk})$, where $\bar{\tau}_{tk} = \frac{1}{N_k} \sum_i \tau_{it}$ is the (unweighted) average statutory tax rate prevailing in group k and year t . Moreover, we record each group's consolidated stock of fixed assets to capture differences in productive assets that could drive differences in taxable profits in source countries.

Macro-based estimates

The Resource Revenue database provides a granular breakdown of petroleum- and mining-related revenues for 74 countries, covering the period between 2000 and 2018 in an unbalanced panel format. Following the micro-based approach, we divide taxes levied on the profits of corporations at the country-level, divided by the statutory tax rate to approximate country-specific tax bases. Moreover, we use royalty payments to capture output differences in the extractive industries across countries. In our baseline estimations, we do not distinguish between mining and hydrocarbon entities and thus combine revenue streams pertaining to these commodities. When estimating differences between mining and hydrocarbon operations, we use the commodity specific revenue information to approximate the tax base and to approximate

¹⁵ In the regression analysis.

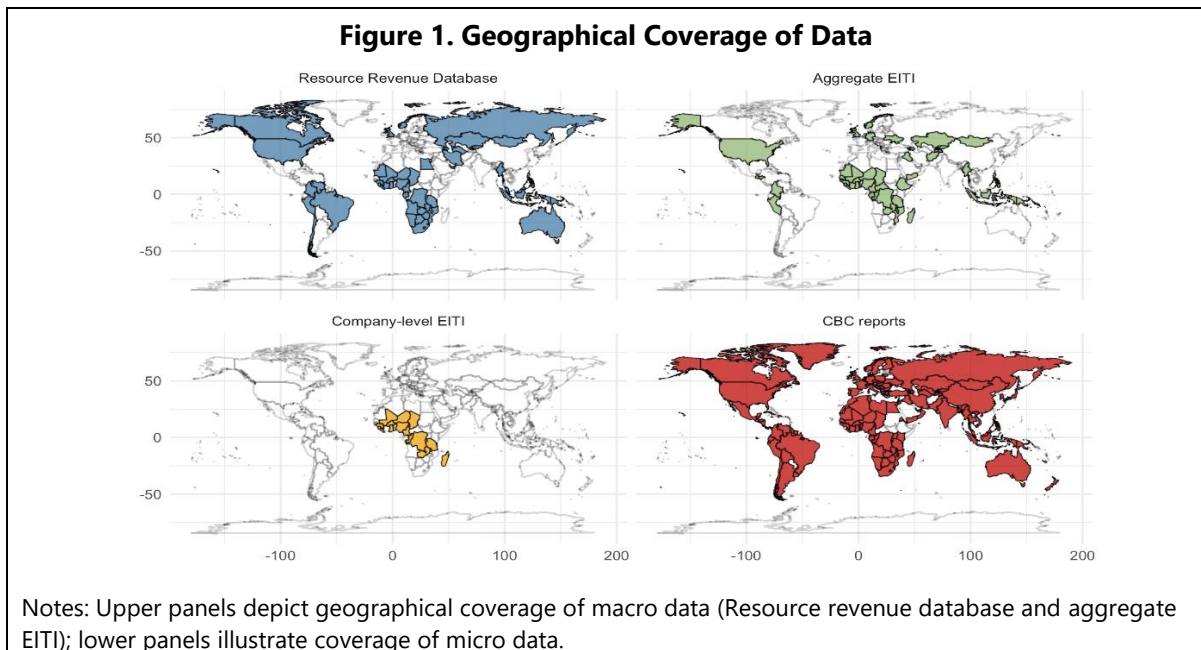
¹⁶ Companies must report the following types of payments: (i.) production entitlements, (ii.) taxes on income, production, or profits, (iii.) royalties, (iv.) dividends, (v.) signature, discovery or production bonuses, (vi.) license fees, rental fees, entry fees, and other considerations for licenses or concessions, (vii.) payments for infrastructure improvements.

differences in productive capacity using royalty payments. Aggregate EITI reports from 53 countries between 1999 and 2017 complement this data at the country-level.¹⁷

We use the Orbis database to capture country-specific profit shifting incentives, also in the macro-data. Previous macro-based quantifications of the elasticity of taxable profits either neglected tax rates abroad or approximated net tax savings opportunities by using GDP or trade weights on global CIT rates (see e.g. Crivelli and others, 2016). We instead construct tax rate differentials that capture profit shifting incentives of a “typical” MNE in the extractive industries on a country-level. Specifically, having merged CBC reports with the Orbis dataset, we can compute the average tax rate of each multinational group in the extractive industries for each year. Using the previous notation, we denote this average by $\bar{\tau}_{tk}$. To construct representative tax rate differentials, we simply average the group-specific variable across all groups that do have a presence in a given country, say country c : $\bar{\tau}_{tc} = 1/K_c \sum_{k \in c} \bar{\tau}_{tk}$, with K_c denoting the number of groups with a presence in country c . We then approximate net tax savings opportunities of country c 's representative firm with $(\tau_{ct} - \bar{\tau}_{tc})$.

III. DESCRIPTIVE STATISTICS

We exploit four data sets recording payment information of extractive firms globally. Figure 1 illustrates the geographic coverage of these data.

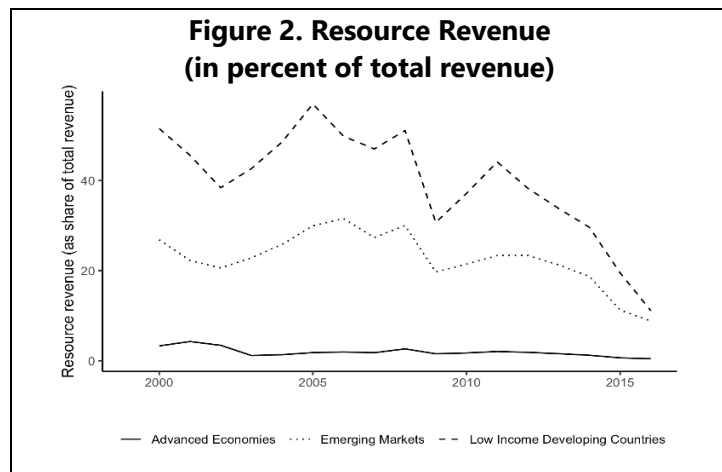


¹⁷ Aggregate EITI reports provide detailed information on extractives-related revenues but do not differentiate between petroleum and mining-related tax revenue streams (this must be derived from examining each company in turn).

We can illustrate the structure of the micro dataset, and the magnitude of some payments, based on the oil industry major BP. ORBIS shows that BP PLC owns over 1500 subsidiaries worldwide, in more than 80 jurisdictions. Not all subsidiaries are directly engaged in the extraction of natural resources. In 2018, BP's financial reports detail the payments made to 22 governments worldwide.¹⁸ For instance, the combined payments to the government of Azerbaijan amounted to over 13 billion USD, or more than 70 percent of total government revenues in that year. In the empirical analysis, we use proxies for real activity, including information on local royalty payments and the consolidated stock of fixed assets at the parent level, to estimate an industry-specific production functions that accounts for tax avoidance opportunities.

The macro dataset illustrates the importance of the extractive industries for government revenues globally. Among the 74 countries covered in the data, resource-related revenues amount to one third of total revenues, on average, or 10 percent of GDP. Figure 2 illustrates revenues for different country groups. Among the low-income countries covered in the database, natural resource revenue accounted for an average of 40 percent of total revenue between 2000 and 2012. Commodity prices declined thereafter, and so did natural resource revenues. With an average of slightly more than 20 percent before 2012, the reliance on natural resource endowments is smaller among emerging markets. In advanced economies, resource revenues only account for 5 percent of total revenues.

The exhaustibility of natural resource deposits, large up-front costs for exploration, and the uncertainty of returns, have led to elevated complexity in taxing natural resource operations (Keen and Boadway, 2008). Governments typically rely on a combination of instruments, often including profit-based taxes, production-based royalties, equity participation in the form of production sharing agreements or



joint ventures with national oil companies, and fees. Profit-based taxes, which include corporate income taxes and resource rent taxes, accounted for more than 40 percent of total natural resource revenue until 2012, while royalties ranked second, contributing around 30 percent.

Table 1 summarizes descriptive statistics of key variables. Data sources for our dependent variables (*taxable profit/CIT base*) and *royalty* payments are discussed above. We retrieve *tax rate* information from KPMG and PwC tax guides. *Total assets* are only available for micro-level observations and taken from the ORBIS database. *Open* is the ratio of exports plus imports

¹⁸ <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/group-reports/bp-report-on-payments-to-governments-2018.pdf>

divided by GDP and based on the IMF's WEO database, as are *population* and a country's *GDP*. *Low-tax affiliate* is an indicator variable taking the value of one for groups that comprise an affiliate located in one of the countries listed by Hines and Rice (2009). We collected information on *transfer pricing* rules and *thin capitalization* rules¹⁹ from KPMG and PwC tax guides. We record the year that transfer pricing rules were complemented with mandatory documentation requirements to introduce variation over time. The *control of corruption* indicator is taken from the World Bank governance indicators dataset. Finally, *Macro data* and *Oil* are indicator variables showing that 22 percent of the combined sample represents macro data and 43 percent are associated oil production.

	Number of observations	Minimum	Mean	Maximum	SD
log(taxable profit/CIT base)	3542	-6.28	3.71	11.53	3.53
log(Royalty)	3542	0.00	1.94	11.31	2.67
Tax rate differential	3523	-0.28	0.01	0.33	0.07
log(Total assets)	2333	-2.03	15.93	19.83	2.85
Open	3349	0.17	71.44	415.48	40.80
log(GDP)	3523	5.93	12.31	16.84	2.21
log(Population)	3542	-2.37	3.38	7.24	1.51
log(Group Number)	3523	0.69	2.48	6.05	1.11
Low-tax affiliate	3524	0.00	0.59	1.00	0.45
Thin capitalization	3508	0.00	0.58	1.00	0.49
TP rules	3510	0.00	0.68	1.00	0.47
Control of corruption	3516	-1.83	0.12	2.29	1.16
Macro data	3542	0.00	0.22	1.00	0.42
Oil	3529	0.00	0.43	1.00	0.50

Dataset	Observations	Countries	Years	Period
Resource revenue database	1194	74	19	2000-2018
Aggregate EITI reports	391	53	19	1999-2017
CBC reports	4599	157	6	2014-2019
Company-level EITI	1732	15	13	2004-2016

¹⁹ Note in Table 1 these are notated as "thin capitalization" as shorthand, but the indicator includes countries using an EBITDA based approach as advocated under BEPS Action 4.

IV. EMPIRICAL RESULTS

Baseline Results

We first analyze the aggregate extent of profit shifting in an equation-by-equation regression approach. After documenting limited variation in the measured semi-elasticities between the micro- and macro-data, we increase estimation precision by estimating the equations jointly in a SUR framework.

Separate Estimations of Micro and Macro Data

Table 3 summarizes results, with heteroscedasticity robust standard errors in square brackets. Columns 1 to 3 present results for the micro data. The first specification estimates the coefficients on a country's own tax rate and the coefficient on the (unweighted) average tax rate abroad separately. While a negative correlation between a country's tax rate and reported profit in this country could be due to a range of reasons, the positive effect of foreign tax rates on domestic profitability is a clear sign of profit shifting. Both effects are statistically significant at the 5 percent level. The second model replaces the separate tax variables with a tax rate differential to increase estimation precision and adds year- and country fixed effects. In the third Model, we add controls for productive capacity in the source country, proxied by the stock of the parent's fixed assets and the logarithm of royalty payments. Following our expectation, including these controls almost halves the measured sensitivity of reported profits from -5.8 in the second model to -3 in the third.

Columns 4 to 6 present results for the macro data. The first model leaves the coefficients on the domestic tax rate and the representative foreign tax rate unrestricted. The estimated effects are significant at conventional statistical levels and take expected signs. We restrict the coefficients on the tax rate variables in subsequent specifications and add country- and year fixed effects in Model 5 and royalty payments, as a proxy for productive capacity in the source country, in Model 6. The measured semi-elasticity decreases from -4.67 in the second macro estimation (Model 5) to -3.7 in the third micro estimation. Overall, the results thus provide robust evidence for profit shifting, with the measured coefficients indicating that reported profits decrease by 3 to 4 percent in response to a 1 one percentage point increase in the tax rate differential.

Throughout the estimations, we find the CIT base is positively associated with the size of a country (positive effect of log of GDP) and with its per capita income level (negative partial effect of population). The exchange rate exerts a consistent negative effect and inflation tends to increase the returns to extractive investments. Trade openness impacts the CIT base positively in the macro data but negatively in the micro data. Similarly, the size of the representative firm impacts the CIT base negatively in the macro dataset, but at the firm level, the size of a corporate group is positively related with the tax base.

Table 3. Baseline Results

Ordinary least squares, unbalanced panel datasets						
Macro data covers period between 1999 and 2018, Micro data covers period between 2010 and 2018						
Data type	Micro			Macro		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
CIT rate	-6.930*** [1.230]			-2.856*** [0.616]		
Other rate	3.055** [1.448]			3.630** [1.722]		
CIT rate - Other rate		-5.799*** [0.997]	-2.990*** [1.253]		-4.670*** [0.751]	-3.738*** [0.758]
Log (Royalties)			0.585*** [0.033]			0.133*** [0.034]
Log (Total Assets)			0.389*** [0.030]			
Log (Gdp)	0.311*** [0.067]	0.310*** [0.066]	0.455 [1.029]	1.246*** [0.043]	1.246*** [0.041]	1.454*** [0.200]
Openness	-0.005*** [0.001]	0.024** [0.011]	0.022 * [0.012]	0.019*** [0.002]	0.021*** [0.003]	0.020*** [0.003]
Log (Population)	-0.219*** [0.084]	6.615 [6.196]	5.428 [5.681]	-0.328*** [0.055]	0.284 [0.391]	-0.195 [0.405]
Inflation	0.037*** [0.009]	0.003 [0.019]	-0.006 [0.017]	0.001 [0.002]	-0.001 [0.002]	-0.002 [0.002]
Log (Foreign exchange)	-0.082*** [0.027]	1.437 [0.883]	0.686 [0.850]	-0.046*** [0.017]	-0.059 [0.235]	0.034 [0.228]
Source	-0.983*** [0.393]	-1.211** [0.579]	-0.849 [0.807]	-1.972*** [0.232]	0.325 [0.386]	0.38 [0.372]
Log (Group size)	0.781*** [0.049]	0.667*** [0.055]	-0.140 * [0.076]	-0.362*** [0.073]	-0.358*** [0.074]	
Energy price index	0.008 [0.007]			0.010*** [0.004]		
Non-energy price index	-0.045 * [0.026]			-0.012 * [0.007]		
Intercept	1.946 [1.898]	-12.66 [22.527]	-22.392 [23.408]	-5.759*** [0.889]	-5.919*** [0.586]	-8.205*** [2.213]
Year fixed effects	NO	YES	YES	NO	YES	YES
Country fixed effects	NO	YES	YES	NO	NO	YES
Observations	2564	2564	2165	723	723	723
Adjusted R2	0.187	0.320	0.477	0.683	0.680	0.891

Notes: *, **, and *** indicate statistical significance at the 1, 5 and 10 percent level respectively. Heteroscedasticity robust standard errors in brackets.

Joint Estimation

We test differences between the semi-elasticities in the micro- and macro data using a seemingly unrelated regression (SUR) framework. Throughout, we leave the effects of the control variables between the macro- and micro equations unrestricted and account for a non-uniform variance of residual errors by using the inverse variance of the data-specific residuals, respectively, in a weighted least squares estimation.

Table 4 presents results. Following our baseline regressions, we start with a reduced specification that controls for macro variables and commodity price indices, and subsequently add additional control variables, including country-specific fixed effects and year fixed effects (Model 2) and controls for productive capacity (Model 3 and 4). In the first model, the micro-based estimate is larger, with the difference of 2.9 being statistically significant at the 1 percent level. The difference lessens considerably, and loses statistical significance, when including country- and year-fixed effects in the second model.

When restricting the coefficient on the tax rate differential between the micro- and macro data, we find a semi-elasticity of -4.6. The third model adds controls for productive capacity, resulting in the semi-elasticity to decrease to -3.6. Finally, we drop insignificant explanatory variables in the fourth model, which increases the sample size slightly, to 2915 observations, while leaving estimated effects largely unchanged.

Pooled weighted least squares regressions, unbalanced micro and macro data				
	Model 1	Model 2	Model 3	Model 4
Restricted coefficient on (CIT rate - Other rate)	-4.081*** [0.545]	-4.603*** [0.512]	-3.559*** [0.641]	-3.557*** [0.641]
Difference between macro and micro coefficient	2.889*** [1.153]	-0.302 [1.622]	-0.748 [1.463]	-0.798 [1.445]
Real controls	no	no	yes	yes
Year fixed effects	No	Yes	Yes	yes
Country fixed effects	no	yes	yes	yes
Observations	3287	2888	2888	2915
Adjusted R2	0.654	0.704	0.838	0.838

Notes: *, **, and *** indicate statistical significance at the 10, 5 and 1 percent level respectively. Heteroscedasticity robust standard errors in brackets. All specifications include year fixed effects. Last specification drops insignificant controls.

Nonlinearities and Alternative Tests of Profit Shifting

The aggregate semi-elasticity of -3.5 is larger than estimates reported in previous studies. Using a meta-analysis approach, Beer and others (2020) report a semi-elasticity of around 1.5 for recent years.²⁰ Beer and Loeprick (2017) report semi-elasticities for the hydrocarbon sector of between 1.5 and 3.2.

At least three factors could explain the difference between our findings and previous work:

- First, non-linearities in the response of taxable profits to tax rate differentials, possibly due to fixed costs of tax avoidance, could play a role. Dowd and others (2017) report that US multinationals with tax haven affiliates are more sensitive to taxation, with the semi-elasticity of taxable profits being increased by between 3.4 and 7.2 among this group.
- Second, tax rates may be a suboptimal device for the identification of profit shifting, particularly because the actual tax rates applying to specific firms are not being observed in our data. Statutory tax rate changes are infrequent and episodic, imposing a common shock to all firms in a country, which may be correlated with other decisions that affect corporate profitability but are unrelated to tax avoidance. The use of tax rate differentials increases variation and expands the ways to control for non-tax related decisions. But they, too, do not fully resolve endogeneity concerns.
- Third, profit shifting incentives are expected to vary across countries, industries, and firms; and the present study may include firms that are more sensitive to tax differences. For instance, differences in industry structure and profit drivers between petroleum and mining operations could imply an increased sensitivity of corporate profits in the mining sector (Baunsgaard and Devlin, forthcoming), which has not been studied systematically.

Non-Linearities

We investigate the importance of non-linearities by introducing an indicator function that takes the value of one for MNE groups that comprise an affiliate in a low tax jurisdiction, as defined in Hines and Rice (1994). In our sample, the indicator variable is one for 33 percent of all groups and 60 percent of all observations. The first column in Table 3 interacts this indicator variable with the tax rate differential to test whether semi-elasticities differ systematically. The negative coefficient on the interaction confirms the increased sensitivity of groups with low-tax affiliates, but the coefficient is not statistically significant. The coefficient on the indicator (not interacted) suggests that low-tax affiliates report, on average, 30 percent less profit, an effect that is significant at the 1 percent level.

²⁰ The authors find evidence for an increasing trend in the sensitivity of reported profits. While the average reported in studies was closer to 1, the increasing trend implies that the most likely estimate for current studies is closer to 1.5.

Countries' tax policies change frequently and the classification of Hines and Rice (1994) may not fully capture the tax savings opportunities of specific groups. We thus follow Dowd and others (2017) in replacing the low-tax indicator with a 3rd degree polynomial in the tax rate differential to capture potential non-linearities. The semi-elasticity of affiliates without tax avoidance incentives – that is, a company facing no tax rate differential – is now estimated at 1.5, while the coefficients on both second and third orders of the tax rate differential are large and statistically significant. When evaluated using the observed distribution of tax rate differentials, the results imply that the central 50 percent of observations would adjust their reported profits by between 1 and 3.25 percent in response to a one percentage point increase in corporate taxes.

In sum, these results suggest that the strong presence of extractive affiliates in low-tax jurisdictions explain, at least to some extent, the increased sensitivity of taxable profits.

Alternative Identification Devices

Dharmapala and Riedel (2013) use earnings shocks at the parent-company level as an alternative identification device for profit shifting. We build on this idea and compare the earnings response to shocks in high-tax countries with the response in low-tax countries. If observations facing an above average tax rate differential systematically benefit to a lesser extent from a group-wide increase in profitability, holding other factors constant, the shock propagation within the group provides indirect evidence for profit shifting.

We use commodity prices and group-level profitability as earnings shocks (Table 5). In all specifications, we find a positive direct effect of the earning shock variable on reported profits, but negative coefficients on the interaction between the earning shock variable and a dummy variable for high-tax locations. Large standard errors impede drawing definite conclusions when using the oil price index as an identification device (Model 3). However, the interaction is significant at the 10 percent level when using mineral prices in the fourth model. This implies that reported profits increase as the price for minerals increases, but significantly less so among firms (and countries) facing an above average tax rate differential. In the fifth and sixth column, we restrict the sample to micro-level observations and use parent-level profitability (profits divided by total assets) as an identification device. We continue to find that recorded profit at the subsidiary level responds positively to increases in parent-level profitability. However, the impact is significantly reduced in high-tax jurisdiction.

Using consolidated profit as an explanatory variable raises endogeneity concerns, especially in groups comprising a limited number of affiliates. To gauge the potential of bias introduced in this way, the sixth column replaces consolidated profit with the difference of consolidated profit and taxable profits at the subsidiary level. The effects remain unchanged, providing additional indirect evidence for profit shifting.

Table 5. Non-Linearities and Alternative Profit Shifting Identification

Pooled weighted least squares regressions, unbalanced micro and macro data						
Shock variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
			Oil price index	Metal price index	Parent profitability	Parent profitability (excluding own profits)
(Cit rate - Other rate)	-3.047*** [1.044]	-1.488 [0.989]				
Low-tax affiliate in group	-0.291*** [0.133]					
(Cit rate - Other rate)* Low-tax affiliate in group	-0.441 [1.491]					
(Cit rate - Other rate)^2		- 10.538*** [4.364]				
(Cit rate - Other rate)^3		- 63.620*** [15.368]				
High tax rate differential			0.032 [0.417]	0.378 [0.432]	-0.942*** [0.267]	-0.942*** [0.267]
Earnings shock			0.001 [0.002]	0.001 [0.002]	0.329*** [0.106]	0.324*** [0.104]
High tax rate differential x Earnings shock			-0.009 [0.008]	-0.010 * [0.005]	-0.417** [0.197]	-0.413** [0.196]
Observations	2915	2915	2915	2915	2148	2148
Adj R2	0.837	0.838	0.828	0.828	0.407	0.407

Notes: *, **, and *** indicate statistical significance at the 10, 5 and 1 percent level respectively. Heteroscedasticity robust standard errors in brackets. All specifications include year- and country fixed effects, as well as controls for productive capacity.

Heterogeneity in Profit Shifting

The ability of MNEs to relocate profits depends on factors that likely vary at the industry- country- and firm level. For instance, the transparency of product prices could potentially restrain the ability of MNE investors to shift profits in the petroleum industry relative to mining. But profit shifting opportunities depend on factors that go beyond the sector a company is operating in and include tax administrative capacity or the presence of anti-abuse measures. We examine these drivers of profit shifting in turn.

Differential Effects between Petroleum and Mining

At least three factors could lead to an increased sensitivity of taxable profits in the mining industry. First, the petroleum sector has notably more transparent pricing of what is produced upstream, and there are numerous traders outside the large oil producers readily able to price

whatever type of oil product is produced. There is less transparency around gas prices. Nevertheless, gas products could be priced with reference to oil indices as needed, using the energy content of the gas as the starting point. Many mines, however, produce products that are kept within vertically integrated firms to be processed further (see PCT 2017). This relative opacity presents greater opportunities for MNEs to determine their own transfer prices, which are harder for tax authorities to challenge.

Secondly, many petroleum producers operate under joint venture arrangements with independent parties, which might limit the scope for producers to inflate costs to reduce source country taxes. These joint venture arrangements create incentives for their members to monitor each other's costs and audit production activities. These arrangements, which are much less common in mining, indirectly benefit revenue authorities by limiting the extent to which producers are able to inflate costs, since doing so would potentially risk anti-trust sanctions.

Thirdly, the use of production sharing contracts, which are common²¹ in petroleum production, presents a clear structural difference to mining, where they are seldom seen. While the fiscal terms contained within these agreements can be fiscally equivalent to other approaches such as tax/royalty systems, they have differences in their administration and design that might attenuate profit shifting opportunities. These agreements might mandate higher standards of project auditing and reporting to monitoring authorities. In turn those authorities, which are often specialized state-owned companies (rather than government ministries) may have relatively more industry expertise, giving them the ability to detect unconventional activity that may be tax-motivated and to also monitor revenue flows in real time (relative to a tax audit that might several years later).

The RR database differentiates between mining and oil related revenues, which allows for a direct approximation of the underlying tax bases. For CBC reports, we rely on a text analysis of company names to classify firms as either operating in the hydrocarbon or mining sector,²² which we complement by manual verification. We define the indicator variable Oil to take the value of one when the underlying tax base (in the macro data) or profit (in the micro data) is related to hydrocarbon operations. In our sample, the indicator takes the value of one for 43 percent of the observations.

Table 6 presents estimations that examine systematic differences between hydrocarbon and mining operations. All specifications, except Model 5, include all control variables tested in our baseline regressions (Table 1), with coefficients on control variables remaining unrestricted between micro- and macro information. Overall, we find tentative evidence that mining

²¹ From a data perspective, it is worth noting many advanced economies – particularly in Europe, North America and Australia - use tax/royalty systems.

²² We categorize firms as mining entities if their company names includes one of the following: coal, mining, gold, cement, copper, metals, mines, minerals, platinum, iron, diamonds, diamond, lithium, or nickel. We classify firms as hydrocarbon entities if their company names include exploration, oil, or energy.

operations are more sensitive to tax rate differentials than hydrocarbon entities. The difference in measured semi-elasticities ranges between 1 and 2 and attains statistical significance at the 5 percent level when controlling for productive capacity and year-fixed effects in addition to the broad range of control variables includes throughout (Model 3). However, when including country-fixed effects, the difference lessens to 1.2 and measured confidence bands increase (Model 4). Measured effects remain unchanged when dropping insignificant explanatory variables in Model 5.

Pooled weighted least squares regressions using unbalance micro and macro data					
	Model 1	Model 2	Model 3	Model 4	Model 5
CIT rate – Other rate	-5.387***	-5.421***	-5.340***	-4.758***	-4.721***
	[0.866]	[0.874]	[0.820]	[1.216]	[1.218]
(CIT rate – Other rate)*Oil	2.025 *	2.041 *	2.138**	1.235	1.13
	[1.061]	[1.069]	[1.019]	[1.350]	[1.348]
Oil	0.862***	0.853***	0.495***	-0.019	0.000
	[0.078]	[0.078]	[0.080]	[0.101]	[0.100]
Year fixed effects	No	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	Yes	yes
Real controls	No	No	Yes	Yes	yes
Observations	3298	3298	2899	2899	2926
Adjusted R2	0.667	0.669	0.71	0.817	0.817

Notes: *, **, and *** indicate statistical significance at the 10, 5 and 1 percent level respectively. Heteroscedasticity robust standard errors in brackets. Last specification drops insignificant controls.

Country-Level Drivers

Table 7 examines country-level drivers of profit shifting. All estimations include the set of control variables used in the last specification of Table 4.

We start by testing the effectiveness of transfer pricing legislation in reducing the sensitivity of taxable profits. The indicator *TP rules* takes the value of one when a country requires transfer pricing documentation and published accompanying guidance on accepted approaches. In line with previous work (Lohse and Riedel, 2013), we find that the existence of TP rules tends to reduce the sensitivity of taxable profits. However, in our sample, the effect of transfer pricing documentation seems to be inconsistent, leading to an insignificant coefficient estimate.²³

The second model analyzes interest limitation rules, relying on an indicator function that takes the value of one in countries and years that restrict the deductibility of interest payments. The

²³ Our data on transfer pricing rules follows Beer and Loeprick (2017) who use the existence of TP documentation requirements as a proxy for TP rules that are implemented effectively (that is, they are more likely to actually be enforced if authorities have defined reporting requirements). The results remain unchanged when using other measures capturing the importance of TP rules.

effects of both the indicator variable and its interaction with the tax rate differential are qualitatively similar to transfer pricing rules but is measured with greater certainty. The statistically significant coefficient on the interaction suggests that the sensitivity of taxable profits is reduced by half in countries that rely on either an EBITDA rule or a debt to equity ratio. This resembles earlier findings on the effectiveness of thin capitalization rules (Overesch and Wamser, 2010; Buettner and others, 2012; Blouin and others, 2014). The negative coefficient on the indicator suggests that reported profits are somewhat smaller in countries with effective interest limitation rules, possibly due to an increased compliance burden (Saunders-Scott, 2015).

The third model examines whether production sharing contracts influence profit shifting patterns. We introduce a dummy variable that takes the value of one for countries and years with a production sharing framework. While these agreements seem to be associated with a reduced sensitivity of taxable profits - potentially due to their established reporting and information provisions discussed above - limited variation in the indicator leads to insignificant results.²⁴

Column 4 tests the importance of governance quality, using the World Bank's control of corruption variable. However, both the variable and its interaction with the tax rate differential are insignificant.

Table 7. Country- and Group-Level Determinants of Profit Shifting				
Pooled weighted least squares regressions using unbalance micro and macro data				
	Model 1	Model 2	Model 3	Model 4
(Cit rate - Other rate)	-3.656***	-4.286***	-3.940***	-3.092***
	[0.869]	[0.744]	[0.886]	[0.725]
TP rules	-0.061			
	[0.113]			
(Cit rate - Other rate)*TP rules	0.059			
	[1.102]			
Thin cap rule		-0.223 *		
		[0.131]		
(Cit rate - Other rate)*Thin cap rule		2.450 *		
		[1.268]		
Production sharing			-0.101	
			[0.304]	
(Cit rate - Other rate)*Production sharing			0.719	
			[1.404]	
Control of corruption				0.259
				[0.238]
(Cit rate - Other rate)*Control of corruption				-0.58
				[0.595]
Obs	2904	2902	2915	2892
AdjR	0.836	0.836	0.836	0.836

Notes: All specifications include the control variables of Model 5 in Table 3 and add potential determinants of profit shifting at a time. *, **, and *** indicate statistical significance at the 10, 5 and 1 percent level respectively. Heteroscedasticity robust standard errors in brackets.

²⁴ The dummy variable approach to examining production sharing does not enable a diversity of approaches across countries to be evaluated – the variable is probably too narrowly defined. Moreover, once countries have chosen the production sharing approach, there appears to be little transition to alternative fiscal regimes (e.g., tax/royalty system).

Accounting for More General Heterogeneity

Tax avoidance opportunities – and as a result the semi-elasticity – may vary at the group level beyond factors we are able to control for in the estimations. In particular and building on the system (1.a.-1.b), the semi-elasticities might follow a stochastic dynamic of the following form:

$$\beta = \beta + \delta' z_{ckt} + \eta_k \quad (2)$$

where β is the main coefficient of interest, the vector z includes variables that drive observed semi-elasticities (deterministically), such as the presence of interest limitation rules, and the stochastic component η represents differences in profit shifting opportunities at the group (or country) level.

With stochastic variation, the semi-elasticity is potentially correlated with other explanatory variables included in X , risking that simple OLS estimates that do not control for this variation are biased. To prevent such bias, we first estimate group-specific semi-elasticities, using a dummy variable regression approach. We then derive the mean semi-elasticity as a weighted average of the group-specific semi-elasticities (below referred to as fixed-effect estimate), using the inverse standard error of each estimate as a weight. If the stochastic component is not correlated with the explanatory variables, however, a generalized least squares estimation can increase identification efficiency. The system of equations has a block-diagonal covariance matrix, with disturbances differing between the macro- and micro-data. We use the estimated semi-elasticities at the group level to compute variation of both η_k^1 and η_c^2 and then use this information to construct efficient GLS estimates. Following the logic of our baseline regressions, we treat observations at the macro level to derive from representative country-specific groups.

Table 8 presents results. The upper panel shows GLS coefficient estimates of both the semi-elasticity and control variables. The estimated semi-elasticity under the fixed effect assumption is presented in the lower panel of the table. Overall, the estimates strengthen the previously presented evidence: with a semi-elasticity of around 3, profits are quite sensitive to tax rate differentials, and more so among MNEs with affiliates in low-tax jurisdictions, among mining companies, and in countries that lack interest limitation rules.

The first three columns re-estimate variants of the baseline specification. Column 1 shows results when a group-specific fixed effect replaces the country-specific fixed effect from the baseline specification and all variables included in earlier regressions, except for productive capacity, are controlled for. Including proxies for productive capacity reduce the coefficient estimates of both the GLS and the fixed effect estimation. The third column controls for country-specific fixed effects in addition to the group-specific fixed effects.²⁵ The fixed effects assumption implies a

²⁵ For the macro-sample, these are the same.

semi-elasticity of 2.3 in this specification, which is significant at the 5 percent level. In contrast, the GLS estimate indicates a semi-elasticity of 1.2.

Models 4 to 8 test selected deterministic drivers of profit shifting in addition to allowing for unobserved heterogeneity. Overall, the estimations support the importance of interest limitation rules, low-tax affiliates, and the distinction between mining and hydrocarbon operations in explaining profit shifting aggressiveness.

Table 8. Further Robustness Checks

Random coefficients, SUR estimation								
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
CIT rate-Other rate	-4.690***	-3.878***	-1.195	0.958	-4.779 *	-1.032	-4.809 *	1.107
	[0.941]	[0.840]	[1.362]	[1.658]	[2.458]	[1.684]	[2.627]	[3.122]
Low-tax affiliate				-0.206				
				[0.158]				
(CIT rate-Other rate)*Low-tax affiliate				-3.478 *				
				[2.005]				
Oil					-0.048			
					[0.113]			
(CIT rate-Other rate)*Oil					7.930 *			
					[4.324]			
Production sharing						-0.375		
						[0.387]		
(CIT rate-Other rate)*Production sharing						0.073		
						[3.899]		
Thin capitalization present							-0.002	
							[4.794]	
(CIT rate-Other rate)*Thin capitalization present							5.369 *	
							[3.040]	
TP rules								-0.021
								[0.198]
(CIT rate-Other rate)*TP rules								-3.135
								[3.955]
Real controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Group-specific fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-specific fixed effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effect estimate of semi-elasticity	-4.045***	-3.291***	-2.307***	-	-	-	-	-
	[1.110]	[0.969]	[1.010]					
R2	0.494	0.579	0.682	0.684	0.663	0.682	0.683	0.679
Obs	2912	2607	2631	2631	2631	2631	2583	2625

Interpretation of Findings

What do the estimations imply for global revenue losses from tax avoidance in the extractives industries? To answer this question, we compute country-specific semi-elasticities, ϵ_i , which take the presence of interest limitation rules and the relative importance of mining operations into account (Table 9).

		Interest Limitation	
		No	Yes
Mining operations	Yes	-6.105	-2.862
	No	-4.477	-1.234

Notes: Table summarizes the conditional semi-elasticities, which are based on unreported regression.

Following the basic conceptual framework of profit shifting by Hines and Rice (1994), we combine these semi-elasticities with information on country-specific tax bases from resource operations, *Base*, and tax rate differentials to approximate revenue losses as

$$Loss_c = \epsilon_c(\tau_c - \bar{\tau}_c)Base_c \tau_c \quad (3)$$

Table 10 summarizes simulation results for a sample of 138 countries that report resource-related tax revenues. Revenue losses are averaged between 2015 and 2018, and the distribution of the product of country-specific elasticities with tax rate differentials is winzorized at the top and bottom 1 percent to avoid extreme observations. Overall, the findings imply that revenue losses from profit shifting amount to 0.06 percent of the GDP of included countries, or around USD 44 billion.²⁶ Large revenue losses are more frequent in low income and developing countries, where the median country loses 0.04 percent of GDP in tax revenue. With a weighted average of 0.15 percent, revenue losses are largest in emerging markets.

	Number of countries	Revenue losses (in percent of GDP)			Revenue loss (in USD billion)
		Median	Unweighted average	Weighted average	
Global	138	0.01	0.21	0.06	43.75
Developing Countries	44	0.04	0.15	0.08	1.41
Emerging Markets	64	0.01	0.39	0.15	41.10
Advanced Economies	30	0.00	0.01	0.00	1.24

²⁶ The combined GDP of included countries is USD 76.6 trillion, on average, between 2015 and 2018.

V. CONCLUSION

Our findings align with the general perception that international profit shifting by MNEs in the natural resource sector is a material threat to domestic resource mobilization. It is telling that the different datasets used to analyze tax avoidance in this paper arrive at similar conclusions. The most compelling result is the impact of interest limitation rules in constraining profit shifting.

In two areas though, the empirical results are contrary to our initial hypotheses. Firstly, we find only weak evidence of the efficacy of transfer pricing rules to constrain international profit shifting, raising the question of whether transfer pricing laws are providing “peace of mind” rather than direct impact. Without proactive and effective enforcement that sends a strong signal that transfer mispricing will be challenged, the mere presence of transfer pricing laws doesn’t appear to deter profit shifting. Our results contrast previous findings on the efficacy of transfer pricing rules (Lohse and Riedel, 2013) and should be interpreted cautiously. A more nuanced indicator that could differentiate country approaches to combating transfer mispricing (e.g. by adopting more prescriptive pricing approaches) would help shed light on the conditions needed for TP rules to work.

Secondly, while we do find an increased sensitivity of taxable profits among mining firms relative to hydrocarbon operations, the difference is statistically significant only in a few cases. This suggests the fundamental characteristics of the business of resource extraction - including above-average use of intangible assets - and the implied opportunities for tax optimization are less heterogeneous than we had expected. Relatedly, we find no evidence the prominence of production sharing arrangements in petroleum had a statistically significant effect on profit shifting behavior; even though point estimates also indicate a slightly reduced semi-elasticity.

Ongoing international reform discussions do not (yet) fully reflect the challenges of collecting income tax from the extractive industries. There is a need for a concerted effort to close off many of the current profit shifting channels by strengthening and simplifying transfer pricing rules; limiting interest deductions; improving tax treaty practices; limiting tax incentives; and strengthening investment negotiation practices. In addition, for those countries imposing capital gains tax on indirect transfers, protections could be strengthened.

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