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The global allocation of extractive windfalls

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The Global Allocation of Extractive Windfalls*

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Abstract

Who benefits from commodity price shocks? This paper studies the geographic allocation of extractive MNEs profits generated by price shocks - usually called *windfall profits*. We combine new administrative data on the worldwide activity of MNEs with exhaustive oil, gas, and mining production data at the firm level. We show that extractive MNEs allocate a third of their profits in non-extractive countries, and that profitability and effective tax rates display a U-shaped relationship in this sector. We identify the allocation of windfall profits by leveraging differences in (i) the product specialization of extractive firms and (ii) commodity price changes, in a shift-share design. We provide evidence of overbooking of windfall profits in low-tax countries. For $1 increase in consolidated windfall profits, we observe a $0.2 increase in tax havens, $0.8 in extractive affiliates, and no increase in the rest of the group. We derive implications for government revenues using new stylized facts on effective tax rates in the extractive sector drawn from our data.

JEL Codes: H25, H26, F63

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1 Introduction

The new technologies required to limit carbon emissions should multiply mineral demand by four by 2040 (Kim et al., 2021), while in the oil and gas sector, the war in Ukraine has led to an unprecedented spike in the price of energy. These global trends create both significant price volatility and a sharp increase in extractive prices, bringing new revenue opportunities for resource-rich countries. Benefiting from these so-called *windfalls* is particularly important for developing countries, which both concentrate a large part of resources, and depend more heavily on them. However, little is known about how these windfall gains are actually allocated across countries. Extractive rents are typically shared between resource-rich countries and large multinational firms, providing both investment capacity and the technology to undertake risky and capital-intensive projects. The geographic distribution of future windfalls will depend both on the geographical location of resources and deposits, and on where these extractive MNEs locate their activities and tax bases.

The international nature of this question has left it largely understudied, partly due to a lack of data. Development economics has mostly focused on local windfalls generated by the extractive industry, treating cross-border spillovers as given (see Venables 2016; Cust and Poelhekke 2015 for reviews). International macroeconomics research has shown that multinational groups transmit profits and revenues across countries (Cravino and Levchenko, 2017). More recent work on profit shifting highlights the ability of multinational corporations to reallocate profits to low-tax jurisdictions (Guvenen et al., 2022; Tørsløv et al., 2023), suggesting that extractive groups can strategically shift windfalls. Bridging these strands of literature is crucial to understanding how gains from *the next wave of growth* (UNCTAD, 2024)—commodity revenues driven by the energy transition and technology sectors—will be distributed.

This paper is the first to study how extractive windfalls are distributed along the geography of the largest extractive multinational groups, and how this allocation affects the distribution of taxing rights across states. We combine newly available, comprehensive administrative data on the country-by-country allocation of extractive multinationals profits, sales, and tax payments with detailed information on mining, oil, and gas extraction sites. Using global price changes as group-specific profitability shocks, we study how windfalls are internally allocated within multinational firms and estimate the resulting fiscal windfalls collected by resource-rich states.

Our main dataset comes from Country-by-Country Reports (CbCRs) of large multinational firms with at least one active subsidiary in France, which we complement with voluntarily disclosed CbCRs. Since 2016, MNEs generating more than 750 million euros in global sales have to report each year their profits, revenues, assets, and number of employees in each country where they have a subsidiary. This unique data enables us to observe profits booked in all countries, including in tax havens heavily used by extractive firms - such as Switzerland and the British Virgin Islands - as well as in resource-rich developing countries, which are almost entirely absent from existing alternative databases like Orbis. We are one of the first papers to use these world CbCR data (see Fuest et al. 2025), and to our knowledge, the first to exploit the time variation of these data. Our final sample of extractive MNEs makes up around 35% of global production of extractive commodities done by MNEs. We complement this data with micro level information on mining, oil, and gas production, giving us information on both the specialization of MNEs in our sample and on the geographic location of their extractive activities.

We first provide new stylized facts on the distribution of extractive company profits, the effective tax rates they face, and the extent to which these profits diverge from the location of production factors. Extractive MNEs make a substantial part - 32%- of their profits in non-extractive countries, half of which are booked in tax havens. Second, we find that the profitability of extractive affiliates displays a U-shaped curve along the effective tax rate distribution: extractive firms display large profitability in low-tax affiliates, low profitability in consumption countries with higher tax rates, and large profitability in extractive countries, which tend to apply a higher tax rate on extractive activity. This stylized fact reflects the specificity of a sector in which the bargaining power of producing countries versus large firms depends on geological variables that determine the location of extractive assets and costs of production. Finally, using data on extractive production, we find that MNEs consolidated pretax profits and sales are highly correlated with the price of the main commodity - oil, gas, gold, copper, potash, etc -extracted by the group. This -non causal- price elasticity of profits is 1.62, and 0.43 for global sales.

We then study the distribution of profits associated with an increase in commodity prices across firms and countries - what we call *windfall profits*. We guide our analysis with an analytical framework of profit shifting and tax payments, inspired by Dharmapala and Riedel (2013). We consider the baseline case of an extractive multinational firm with an extractive affiliate and a low-tax affiliate. Our model indicates that an increase in the price of the commodity extracted should increase the total amount shifted to the low-tax affiliate through an increase in windfall profits. This result holds irrespective of whether the price increase causes a change in the intensity of profit shifting (i.e., the share of extractive profit shifted). At the project level, a commodity price increase also translates into fiscal windfalls. We find that profit shifting decreases the price elasticity of fiscal windfalls if its intensity (the share of shifted profit) changes with the price level.

To identify how country-level profits evolve following windfall profits, we exploit the correlation of consolidated profits with the price of the main commodity extracted by the firm. Our empirical strategy has the flavor of a triple difference-in-difference embedded in a shift-share design. We compare unconsolidated profits price-elasticity across groups, with a continuous treatment depending on group specialization in their main extractive commodity that we define pre-period. Within groups, we compare low-tax affiliates with non-tax haven and non-extractive affiliates. The identification assumption implies that group commodity specialization should be exogenous to the relative growth rate of tax haven affiliates compared to the rest of the group. The income shocks generated by price changes only have to be relevant, and not exogenous, for our approach to be valid (Goldsmith-Pinkham et al., 2020), which we find is largely the case.

We find that a 1% price increase is associated with a 0.56 percentage point higher price elasticity of profit in tax havens than in the rest of the group. We also study profit allocation across the different stages of production, from upstream - extraction - to midstream - refining - and downstream - distribution. Although they do not bear causal interpretation, coefficients are informative on where profits co-move the most with commodity prices.

Using an alternative instrumental variable approach, we find that a \$1 increase in consolidated profits of extractive firms leads to a \$0.2 increase in tax havens, \$0.88 increase in extractive affiliates, and a reduction (non-significant) of profits for the rest of the group.

We investigate the differential effect of price shocks on intra-group versus extra-group sales of affiliates. We find that prices have a null effect on extra-group sales of haven affiliates, while it is positive and significant for extractive affiliates, supporting the idea that profit increases in tax havens are driven by intra-group transactions. We also find no negative effect of price increases on losses made in tax havens, while it is significantly negative in extractive affiliates, suggesting that firms shift profits during gains, but keep losses in production countries. Furthermore, using information on the business activities of affiliates contained in CbCRs, we find that MNEs $\times$ country specialized in intra-group financing are the most positively affected by these price shocks.

In a second part of the paper, we estimate the magnitude of these shifted windfall profits using consolidated data on publicly listed firms (Compustat) covering 75% of total oil, gas, and mining production. Matching them with production data, we identify for each extractive firm the commodity in which it is specialized in. We then decompose the profits of each firm between windfall profits and residual profits by regressing consolidated profits on commodity prices, firm, and year fixed effects. We find that windfall profits represent 66% of total positive increases in profits, $102 billion every year on average between 2016 and 2023.

In the last part of the paper, we study the implications for fiscal windfalls in resource-rich countries. Tax instruments in the extractive sector often depart from regular income taxes, with the use of production taxes, production sharing, among others. It is typically hard to evaluate precisely the amounts of fiscal windfalls received by source countries, and CbCR data only covers taxes paid on income. We overcome this issue by building a novel mine and oil field-level dataset previously unused in the literature, by compiling all mandatory reports on payments made by firms listed in the EU, UK and Canada from 2016 to 2023, and the US in 2023. The firm sample represents more than 60% of global extractive production. Using this dataset, this paper is the first to evaluate the commodity price elasticity of effective fiscal windfalls of source countries.[1] We find that a 1% increase in oil, gas, and mining commodity prices increases fis-

[1] The only paper to our knowledge to partially exploit this data is Adebayo et al. (2021), focusing on gold mines and cross-country determinants.

cal windfalls by 1.01%, with a larger elasticity in the mining sector (1.21) compared to the oil sector (0.94). We further find that states with a low state capacity attract less revenue linked to commodity price increases. A 1% increase in commodity prices increases fiscal windfalls by 0.05 percentage points more in countries with a high state capacity for mining commodities, and 0.26 percentage points more for oil and gas projects. We further estimate the effect of an increase in windfall profits on government payments made by extractive firms. We find that a $1 increase in windfall profits at the MNE level leads to a $0.41 increase in payments to resource-rich countries.

Using our IV coefficient and our estimation of windfall profits from the previous section, we then conclude that on average, $26.5 billion windfall profits were shifted to tax havens each year, with large fluctuations - this figure adds up to $108 billion in 2021. We then provide a country-by-country decomposition based on where each firm extracts its commodities and the effective tax rates it faces.

Related Literature and Contributions. This paper contributes to three strands of the literature. First, we contribute to a large literature on extractive windfalls and commodity booms. Since Sachs and Warner (2001), the puzzling disconnection between resource endowment and local growth has been explored, showing that countries are adversely exposed to commodity price volatility (Van der Ploeg and Poelhekke, 2009) and that windfall management is challenging (Venables, 2016; Van der Ploeg and Venables, 2012; Arezki and Brückner, 2012; Beck and Poelhekke, 2023). Our paper demonstrates that a crucial stake in the management of windfalls also goes through the capacity of states to tax them and the distribution of taxing rights. We show that tax administration should be particularly concerned with the probability of profit shifting in times of commodity price booms. A strand of this literature shows that extractive booms are linked to illicit financial flows (Andersen et al., 2017; Hsieh and Moretti, 2006; Marcolongo and Zambiasi, 2022; Johannesen and Larsen, 2016; Bertinelli et al., 2022). In particular, Andersen et al. (2017) show that extractive commodity price booms lead to an increase in bank deposits held by source countries in tax havens, which they interpret as resource rent appropriated by ruling elites. These transfers are motivated by opacity, while we focus on the use of tax havens by firms to reduce their tax burden. Though the motivation of both flows is very different, both phenomena contribute to shifting windfalls from extractive countries to tax havens and to reducing states windfalls. We show that if countries rely on multinational firms for commodity extraction, they are exposed to profit shifting risks. The cost of profit shifting should be compared to the cost of other capital flight potentially taking place with alternative extraction systems.

Second, it directly contributes to the literature on profit shifting, which converges towards large estimates of the share of foreign multinational profits shifted in tax havens (around 36% of foreign profits according to Tørsløv et al., 2023 and Guvenen et al., 2022). Against this backdrop, a new reflection has emerged on how to tax residual profits, or profits that exceed a normal rate of return (Beer et al., 2023). Some works have shown that developing countries were particularly harmed by these practices because of a lack of resources to enforce their tax system and low institutional quality (Johannesen et al., 2020; Laudage Teles et al., 2024; Bachas and Soto, 2021). However, up to now, only Dharmapala and Riedel (2013) and Becker et al. (2020a) have studied the role of tax havens in the allocation of profit within a multinational group after profitability booms in a dynamic setting. In our case, focusing on a single sector with a profitability that is strongly linked to commodity prices allows us to use a more relevant income shock and to design a credible strategy based on group specialization. Our access to World Country-by-Country reports also significantly enhances the strength of our results because of the exhaustibility of the information we have on the activity of MNEs in every country, including tax havens not covered by Orbis.

Third, we contribute to the literature on the transmission of shocks within multinational firms. Cravino and Levchenko (2017) shows that firms contribute to the transmission of shocks across countries through parent-subsidiaries co-movements in productivity. Other papers (Budd et al., 2005; Boehm et al., 2019) show that parents and subsidiaries profitability are strongly correlated. We contribute to this literature by emphasizing the role of tax optimization practices in the allocation of revenues within multinational firms.

The rest of this paper is organized as follows. Section 2.1 provides elements on the context of the extractive industry, section 2.2 provides a theoretical framework on the effect of price changes on profit geographic allocation and fiscal windfalls. Section 3 describes the data source used, and new stylized facts on the links between commodity prices, fiscal windfalls, and extractive groups profits. Section 4 details our empirical strategy to identify the distribution of extractive windfalls and results. Section 5 investigates how fiscal windfalls vary when commodity prices change. Section 6 concludes.

2 Extractive Multinationals: Background

2.1 Institutional context

This section describes elements of background on the extractive sector, first on the importance of multinational firms in the sector, second on the specific tax regimes faced by extractive firms, and third on commodity price fluctuations.

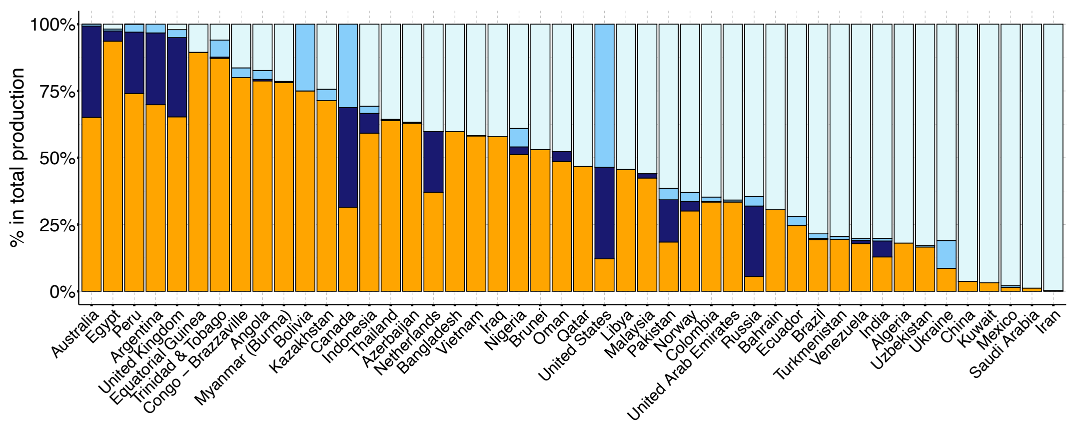
Reliance on foreign investments. Because extractive activity is highly intensive in capital and requires large upfront costs and risk-taking in exploration, resource-rich countries often rely on foreign investment to extract their resources. Figure 1 shows the share of foreign and local MNEs in oil & gas production as well as in the share of mine ownership by country. In half of oil-producing countries, the majority of total production is carried out by multinational corporations. The reliance on foreign firms is even more stringent in the mining sector, in which most industrial mines are owned by foreign firms.

When extraction is not carried out by multinational groups, oil-rich countries have, in many cases, developed their own publicly-held companies (see Figure A2 in Appendix). State-owned companies make up around 55% of global oil & gas production, non-state-owned MNEs represent 35%, while local firms make up only 10%. In the mining sector, in the absence of MNEs, industrial mines tend to be operated by local firms.[2]

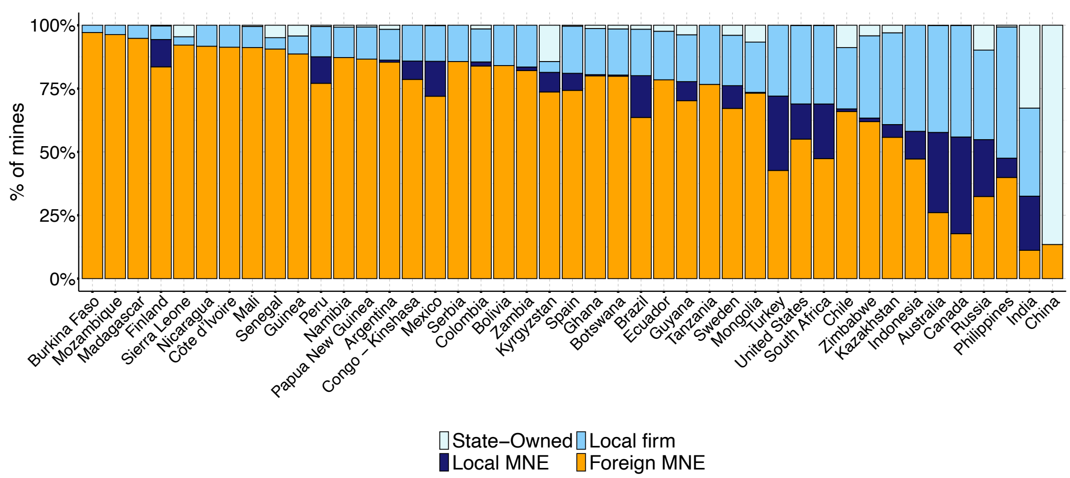
[2]Industrial mining makes up around 80% of global mining production, while artisanal small-scale mining represents only around 20%.

Figure 1: Ownership of production by country

(a) Oil & gas



(b) Mining



Sources: Rystad Upstream (Figure 1a) & S&P Metals and Mining (Figure 1b).

Lecture: Between 2012 and 2022, 62% of oil and gas production was made by foreign MNEs in Thailand, and close to 100% of mines located in Burkina Faso were owned by foreign MNEs.

Sample of countries: Figure 1a: Countries producing more than 500M barrels per year. Figure 1b: Countries with at least 50 mines on their soil.

Notes: National oil companies are defined as companies held at more than 50% by the state, directly or indirectly. For simplicity reasons, we consider that all Chinese mining firms are state-owned.

Extractive tax regime. Compared to other sectors, extractive firms face specific tax schemes, which often include top-up taxes on profits or production-based taxes such as royalties on top of regular corporate income taxes. The rationale behind these supplementary taxes is that firms are paying the owner of the resource (often the states, sometimes local communities) for the right to extract a non-renewable product.[3]

Figure 2 displays the historical evolution of effective corporate income tax rates of the mining, oil & gas, and other sectors derived from Compustat. It shows that the extractive sector has not experienced the same decline in the general effective tax rate since the middle of the 1980s. The consolidated effective tax rate faced by oil and gas companies has remained higher than in other sectors since the 1970s, with an almost 20pp difference today. The mining effective tax rate is also stable through time, but lower than for oil & gas companies by around 10pp.

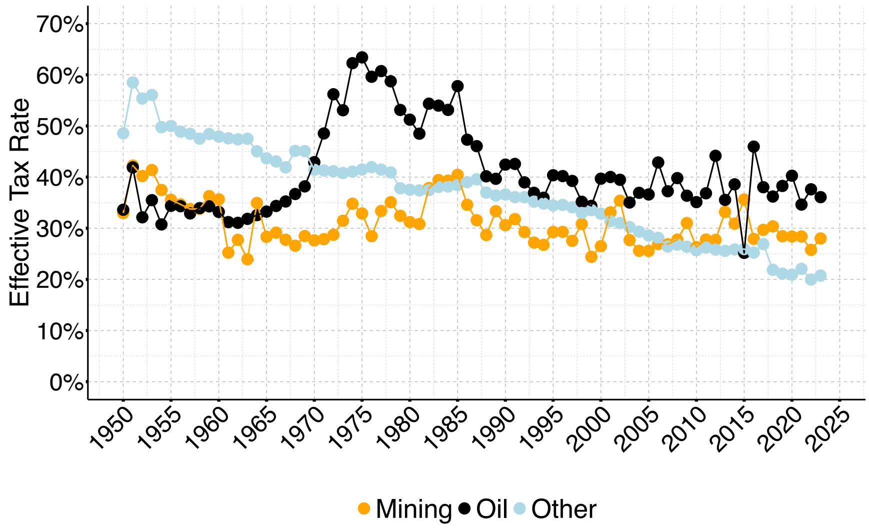
Specific extractive taxes on other bases than profits must be added to corporate income taxes not taken into account in Compustat, making the series for oil & gas and mining a lower bound. Interestingly, this heterogeneity in tax rates across sectors means that extractive groups integrated downstream face a strong discontinuity in their fiscal regime along value chains. While extractive functions face a specific higher tax regime, refining, transformation, and distribution activities are usually subject to the regular corporate income tax system.[4]

Fluctuations of commodity prices. Extractive firms face large fluctuations in commodity prices, as shown in Figure 3, showing the price index of the commodities included in our analysis, with 2003 as the baseline year. The 2003-2013 period displays a general increase in the price of many minerals, often referred to as the commodity boom, only interrupted around 2015-2016 due to the slowdown of economic growth in China. Interestingly, commodities display large differences in price variances, with iron ore prices, for instance, surging tenfold over the last two decades while aluminum remained relatively stable. We will use price variation from 2016 onward in our empirical analysis, which marks the beginning of a rebound in commodity prices.

[3]This specificity has led to exclude the extractive sector from pillar one of reform proposals for global corporate taxation led by the OECD (Baunsgaard and Devlin, 2021).

[4]An exception being the Excess Profit Tax implemented in France, which specifically targeted the refining sector in France.

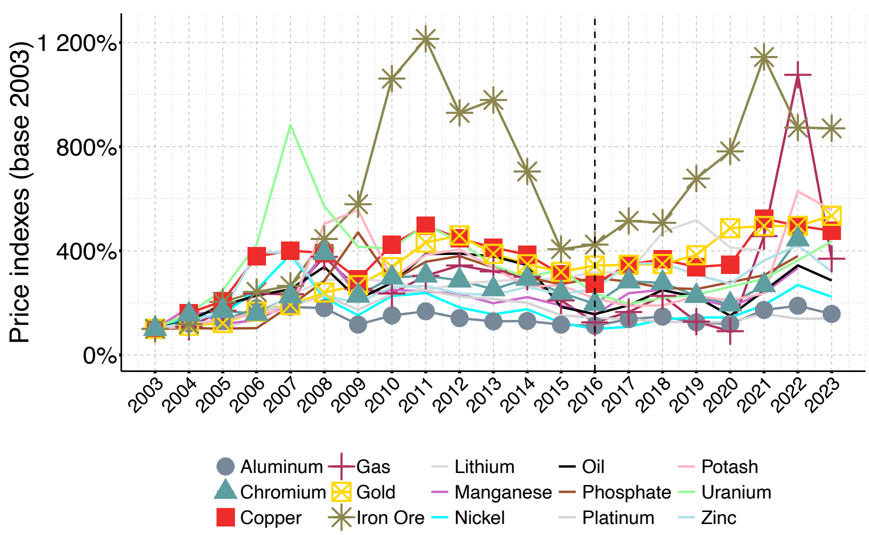
Figure 2: Historical tax rates by sector



Sources: Compustat Global & North America.

Notes: This graph shows the evolution of the effective tax rates of listed firms depending on their NAICS ("211" for oil MNEs, "212" for mining MNEs). Effective tax rates are computed as the ratio between the sum of all positive consolidated tax payments and the sum of all positive consolidated profits in a given year.

Figure 3: Commodity Prices Fluctuations



Sources: United States Geological Survey, IMF, Rystad Upstream.

Notes: This graph shows the evolution of the prices of the commodities in which MNEs present in CbCR data specialize. Prices are normalized by their 2003 levels. The vertical dashed line marks the start of our CbCR panel in 2016.

2.2 A conceptual framework of windfalls and profits

Effect of price changes on global profits and sales. In extractive multinational groups, total (i.e., consolidated) profits and sales will respond to commodity price changes. These groups often conduct refining, transformation, and distribution activities on top of their extractive activity, which will affect their total sales and income price elasticities. In fully specialized groups, this elasticity should be quite high and encompass both the mechanical increase in prices and the change in production. In less specialized groups, for example, energy companies not producing solely petroleum, revenue elasticity will be lower as the share of first-order impacted production in total production will be lower than one, and other products will only respond through second-order effects. As for pretax profits of extractive firms, their elasticity with respect to prices will depend on the level of prices and the cost structure of the firm. If commodity prices are close to breakeven prices, an increase of prices by one per cent will have a larger effect in proportion to actual profits.

Within-group profit distribution and international tax structure. The allocation of these profits across affiliates within groups will determine the allocation of the tax base for states.[5] Given that firms can, to a certain extent, manipulate their intra-group transactions, they can redistribute part of the extractive profits to low-tax countries to reduce their overall tax burden. To illustrate this, we build a simple model based on Dharmapala and Riedel (2013) with one representative MNE operating in two countries. In a source country a, the MNE conducts all extractive activity and other downstream activity that the group might undertake. In a country b, the MNE affiliate conducts all support activities. These can include financial, marketing, insurance, or lending activities, through which MNEs can transfer profits through a mispricing of services.

The MNE generates pre-tax profits π_a in country a with level of state capacity τ_a and π_b in country b, facing different corporate income tax rates t_a and t_b respectively. Without loss of generality, we assume that $t_a > t_b$. The MNE has the option to shift a share s of its profits π_a from country a to country b. This share can encompass any type of profit shifting, such as commodity

[5] And the allocation of revenues to some extent, as some extractive-specific taxes are based on revenues.

mispricing[6], overpricing of services carried by the affiliate in b, transfer of dividends or interests. Shifting profits incurs a shifting cost $C(s, \pi_a, \tau_a)$. This cost includes the resources mobilized by the firm to engage in tax avoidance, such as hiring a team of tax lawyers, developing transfer pricing schemes, or restructuring debts. It also includes potential costs in the event of legal action by tax authorities, and hence is dependent on the capacity of source countries to enforce tax laws: the more a country can mobilize resources to track its corporate tax base, the more costly it is for firms to shift part of their profits.

There is no clear consensus on the shape of the shifting cost function, but initial work (Huizinga and Laeven, 2008; Devereux et al., 2008; Cristea and Nguyen, 2016) considers that the concealment cost is quadratic and increases proportionally with the share of income shifted. Recent evidence (Davies et al., 2018; Bilicka, 2019; Wier and Erasmus, 2023) also supports the assumption that firms have to incur a fixed cost to engage in profit shifting, such as the expense of hiring accounting or legal services.[7]

We define the cost function as follows:

$$C(s, \pi_a) = \begin{cases} \phi + VC(s, \tau_a, s\pi_a) & \text{if } s > 0 \\ 0 & \text{otherwise} \end{cases}$$

with ϕ representing the fixed cost associated with initiating profit shifting, and $VC(.)$ which depends on τ_a, country a's fiscal capacity and on s and $s\pi_a$. We assume that VC is a positive, increasing, and convex function with respect to s, which models the increasing difficulty for the firm to shift an additional portion of profit, as it may become more challenging to justify legally to the tax authorities. The cost is increasing in the total amount shifted $s\pi_a$.

The MNE chooses to shift a share s of its profit π_a to maximize its global after-tax profit:

$$\Pi(s) = (1 - t_a)(\pi_a - s\pi_a) + (1 - t_b)(\pi_b + s\pi_a) - C(s, \tau_a, s\pi_a)$$

[6]When a company sells its commodity to affiliate b at a lower price than the market price and then sells it at a normal price

[7]Using data on intra-firm transactions in France, Davies et al. (2018) show that about 450 MNFs account for over 90% of intra-firm exports to the ten largest tax havens for France, suggesting a presence of a fixed cost of profit shifting.

Absent profit shifting, the global after-tax profit represents the real after-tax profit of the group: $\Pi(0) = (1 - t_a)\pi_a + (1 - t_b)\pi_b$. With profit shifting, the firm shifts the optimal share s^* that maximises $\Pi(s) = \Pi(0) + (t_a - t_b)s\pi_a - \phi - VC(s, \tau_a, s\pi_a)$.

The first-order condition with respect to s is:

$$\frac{\partial \Pi}{\partial s} = 0 \iff (t_a - t_b)\pi_a - \frac{\partial VC(s, \tau_a, s\pi_a)}{\partial s} - \frac{\partial VC(s, \tau_a, s\pi_a)}{\partial s\pi_a}\pi_a = 0$$

The second-order condition is satisfied since Π is concave with respect to s. In addition, the MNE chooses to engage in profit shifting if in the long run:

$$\Pi(s^*) > \Pi(0) \iff (t_a - t_b)s^*\pi_a - \phi - VC(s^*, \tau_a, \pi_a) > 0$$

So if the tax differential $t_a - t_b$ and the firm's size π_a are large enough to offset the associated costs, ϕ, and the variable cost of optimal shifting. Not all firms engage in profit shifting.

In the short run, when $\pi_a > 0$, i.e. the market price is high enough from the break-even price, the share of profit shifted and the total shifted amount are increasing in the tax differential as:

$$\frac{\partial^2 \Pi}{\partial s \partial (t_a - t_b)} = \pi_a > 0; \quad \frac{\partial^2 \Pi}{\partial s\pi_a \partial (t_a - t_b)} = 1 > 0$$

The amount of profit shifted is increasing as:

$$\frac{\partial^2 \Pi(s)}{\partial s\pi_a \partial \pi_a} = \frac{\partial VC}{\partial s} \frac{1}{\pi_a^2} > 0$$

The share of shifted profit will evolve with π_a depending on this condition:

$$\frac{\partial^2 \Pi}{\partial s \partial \pi_a} = (t_a - t_b) - \frac{\partial VC}{\partial s\pi_a}$$

So it depends on whether the marginal tax gain from shifting offsets the marginal shifting variable cost of the amount shifted. This condition depends further on the relationship between marginal variable cost and the shifted amount. If the last part is sufficiently small, the MNE will have an interest in shifting a large share of profit as π_a.

When $\pi_a < 0$, i.e. when the market price goes below the break-even price, the optimal share of profit shifted will depend on the tax rules in country a versus country b to report losses, and on the technology and associated cost to shift losses. We make no further assumptions on this as of now.

A similar tradeoff can arise for revenue shifting, if the firm wants to avoid royalties r_a in country a. The firm can choose to shift a portion of revenues $k^*(t_a - t_b, r_a, R_a, \tau_a, \phi)$ out of a to avoid taxes on revenues. Shifting revenue will also shift profits and interact with the profit-shifting choice. The remaining shifting of profit will take place through other channels. The choice of s and k will depend on the relative cost of shifting revenues vs profits. We assume that it is such that the firm cannot shift its optimal share of profit only through revenue shifting.

Resource-rent fiscal windfalls and state capacity Extractive windfalls in a are taxed by the state. For the sake of simplicity, we assume for now that the firm produces only one commodity and makes a constant markup over its marginal cost. The state imposes income taxes levied on profit. In the absence of profit shifting, this tax would raise:

$$T_i = t_a \times \pi_a = t_a(pq - C_m(q))$$

With q the volume of the commodity produced and C_m the extraction cost. When the commodity price p increases due to an economic shock, the derivative of income tax windfalls is:

$$\frac{\partial T_i}{\partial p} = t_a(pq' + q - C'(q)q')$$

This derivative is positive if the marginal revenue caused by a price increase is greater than the change in cost caused by the adjustment in production. By definition, everything else being equal, the firm will adjust production only if $p - C'(q) > 0$, which implies that this derivative is positive. Otherwise, it is equal to q, which is positive.

The elasticity of income tax fiscal windfalls to commodity prices, when production adjusts, is:

$$\varepsilon_{T_i/p} = \frac{p(q + pq' - C'(q)q')}{\pi_a} = \epsilon_{\pi_a/p} = \frac{1}{1 - AC(q)/p} + \frac{pq'(p - C'(q))}{\pi_a}$$

With $AC(q)$ the average cost corresponding to the break-even price. If p is close to the break-even price, this elasticity will be large.

If the firm shifts a portion $s^*(t_a - t_b, \pi_a, \tau_a, \phi)$ of its profits to a low-tax affiliate, income tax windfalls become:

$$T_i = t_a(1 - s^*)\pi_a = t_a(1 - s^*)(pq - C_m(q))$$

And the elasticity of windfalls to commodity prices:

$$\varepsilon_{T_i/p} = \frac{p(q + pq' - C'(q)q')}{\pi_a} = \epsilon_{\pi_a/p} - \frac{s^*}{1 - s^*}\varepsilon_{s^*/p}$$

The price elasticity of profit shifting will depend on the sign of $\frac{\partial s^*}{\partial \pi_a}$. If the share of profit shifted increases with profit, $\varepsilon_{s^*/p} > 0$ and the fiscal windfall price elasticity is reduced by the share of profit shifted. In this case, when s^* increases, $\varepsilon_{T_i/p}$ is reduced. Any change in parameters of s^*, everything else being equal, should reduce fiscal windfall price elasticity. This implies that if the share of profit shifted increases when prices increase, countries with a lower state capacity should have a lower fiscal windfall price elasticity for income tax revenues.

Extractive states also raise fiscal windfalls via royalties on revenues. In the absence of revenue shifting, fiscal windfalls from royalties are:

$$T_r = r_a(R_a) = r_a pq$$

With r_a the royalties rate. When the commodity price p increases due to an economic shock, the derivative of income tax windfalls is:

$$\frac{\partial T_r}{\partial p} = r_a(pq' + q)$$

Which is always positive if p increases. The fiscal windfall elasticity is:

$$\varepsilon_{T_r/p} = 1 + \varepsilon_{q^*/p}$$

Which is positive and superior to one. If the firm shifts part of its revenues $k^*(r_a, R_a, \tau_a, \phi)$ abroad, the fiscal windfall becomes:

$$T_r = r_a(R_a) = r_a(pq)(1 - k^*)$$

And the elasticity:

$$\varepsilon_{T_r/p} = 1 + \varepsilon_{q/p} - \frac{k^*}{1 - k^*}\varepsilon_{k^*/p}$$

Again, the price elasticity of fiscal windfalls will change because of shifting depending on the sign of $\varepsilon_{k^*/p}$, i.e., whether the share of income shifted increases or decreases with R_a. If this share is constant, the elasticity of fiscal windfalls to commodity prices will not be affected. If the share increases with market prices, then an increase in k^* will decrease the fiscal windfall price elasticity. This implies that if the share of revenue shifted increases when prices increase, countries with a lower state capacity should have a lower fiscal windfall price elasticity for royalties revenues.

Testable hypothesis Based on this simple model, we will test empirically for the following hypothesis:

1. At the group level, a change in the price of the commodity extracted should increase the total amount shifted to low-tax affiliates, by creating a windfall (profit increase) in extractive affiliates. This increase in the shifted amount will be observed even if the share of shifted profits diminishes with the size of total extractive profits.

2. At the project level, fiscal revenues from taxes and royalties increase with the price of the commodity extracted (fiscal windfalls).

3. Profit/revenue shifting will lower the price elasticity of fiscal revenues if the share of profit/revenue

shifted increases with total extractive profits/revenues, everything else being equal.

4. Fiscal capacity will increase fiscal revenues price elasticity if shifting increases with total extractive profits/revenues.

3 Data & Descriptive Evidence

This section describes our four main data sources: Country-by-country reports data, mine/oil field-level production data, consolidated financial data, and our Project-by-project dataset that we use in the last section (Section 5) of the paper. All the cleaning procedures are described in the Appendix Section E. It then provides descriptive evidence on effective tax rates and profitability in each country and on the distribution of activity along the different types of affiliates.

3.1 Data

Country-by-Country Reports. Our main source of data is Country-by-Country reports (CbCR). CbCR was implemented in 2016 as part of Action 13 of the OECD/G20 BEPS Project to give tax administrations the information needed to address tax base erosion and profit shifting (BEPS) related risks. Reporting is mandatory for multinational companies with worldwide consolidated revenues of more than €750 million in the previous year. Currently, reporting does not entail public disclosure and CbCRs are submitted to the respective tax authority and made available to researchers on a confidential basis. Data is at the MNE $\times$ country-year level and includes information on related party revenues,[8] unrelated party revenues,[9] total revenues,[10] profits before income taxes, income tax paid, income tax accrued, stated capital, accumulated earnings, number of employees, and tangible assets other than cash and cash equivalents. MNEs must also provide qualitative information on the business activities performed in each country, along with the list of their subsidiaries.

We have access on a confidential basis to all CbCRs of MNEs having a subsidiary in France,

[8] Revenue generated from transactions between subsidiaries of the multinational group.
[9] Revenue generated from trade with extra-group firms.
[10] Related plus unrelated party revenues.

including foreign MNEs, from 2016 to 2019, and from 2016 to 2022 for French MNEs. We complement these confidential CbCRs with available public CbCRs, which are voluntarily disclosed by 24 extractive MNEs.[11] The combination of these three groups of firms is an unbalanced panel from 2016 to 2023.

We select MNEs that are specialized in extractive activity by first matching our CbCR dataset to oil and mining production data. In particular, we remove banks, investment funds or conglomerates that might have interests in extractive projects. We further remove state-owned corporations that are predominantly producing in their headquarter country because their incentives to shift profits might be different.

We correct CbCR data from double counting of intra-group dividends, which inflate profits of some MNEs, including intra-group dividends received in a procedure described in Appendix Section E.[12] Table C11 in the Appendix shows the number of MNEs we correct each year and the total amount of correction.

Our final dataset comprises 73 MNEs active in 198 countries, and a total number of firm × country × year observations of 10,336. Appendix Table B1 shows descriptive statistics on our final CbCR dataset on a yearly basis.

Table 1 gives information on the coverage of our data. Comparing our dataset to data on global oil and mining production and the activity of extractive firms, we find that our sample covers 30% of mining[13] production, 37% of oil & gas production made by MNEs, and a third of global profits made by extractive listed firms between 2016 and 2023.[14] Our coverage is larger between 2016 and 2019, when we cover more than a third of oil production, 40% of mining production, and 41% of global profits made by extractive listed firms. The geographic distribution of activity is detailed in Table B2 in the Appendix. It shows in particular that the top countries in our sample are resource-rich countries.

[11] Publicly reported CbCRs were collected by Aliprandi and Borders 2023 and made available on the website of the EUTax Observatory.

[12] See Aliprandi et al. (2025) for more details on how intra-group dividends affect CbCR data.

[13] Coal production is not included in our analysis.

[14] Publicly listed firms with NAICS3 211 or 212 and which are not State-owned.

Table 1: Coverage of CBCR

Year	Oil Production			Mining Production			Global Profits		
	Sample ($bn)	World ($bn)	Share (%)	Sample ($bn)	World ($bn)	Share (%)	Sample ($bn)	World ($bn)	Share (%)
2016	261.3	586.9	44.5	74.0	329.6	22.5	35.7	68.9	51.8
2017	364.5	717.6	50.8	109.3	375.4	29.1	134.9	343.0	39.3
2018	430.4	911.1	47.2	118.1	396.6	29.8	194.8	482.2	40.4
2019	339.6	845.3	40.1	138.3	364.2	38.0	95.9	281.3	34.1
2020	152.3	542.2	28.1	110.2	392.8	28.1	-38.9	-155.3	25.0
2021	267.3	952.2	28.0	177.0	520.7	34.0	212.4	734.0	28.9
2022	401.8	1,379.0	29.1	148.3	473.5	31.3	322.1	1,067.3	30.2
2023	275.6	1,059.3	26.0	128.6	432.7	29.7	188.9	752.4	25.1
2016-2023	**311.6**	**874.2**	**36.7**	**125.5**	**410.7**	**30.3**	**143.2**	**446.7**	**34.4**

Sources: Rystad Upstream for oil & gas production, S&P Metals and Mining for mining production, Compustat Northam and Global for global profits.
Lecture: In 2016, MNEs in our sample produced around $261.3bn worth of oil, gas & NGL, which makes up 34.2% of global production.
Notes: Since our sample excludes corporations specialized in coal and large state-owned corporations, we excluded them from our benchmarks. The benchmark sample only includes non-state owned multinational firms. The last line displays the average across all years, and the average shares the ratio between the sum of all production/profits made by MNEs in our sample and the sum of global production/profits.

Extractive production data. We use the two most exhaustive proprietary data sources to recover information on multinational firms extractive activity on a country-by-country basis.[15] Rystad Upstream database is one of the most comprehensive databases on oil & gas fields, covering most of the worldwide production from the end of the 20th century to 2023. For each project, it provides volumes of production, revenues, and cash costs at the year-product level. S&P Metals and Mining is a proprietary database on precious metal mining. It gives information for each firm on its ownership of mines, the type of products extracted, its location, and, in many cases, the amounts of production. Mine and oil production data serve two purposes for our analysis. Matching CbCR data with these production datasets first allows us to define the product specialization of the MNEs in our sample very accurately using MNE and commodity-level information on production and production value pre-period. Table 2 shows how MNEs in our sample are distributed along the different commodities.

Second, it allows us to identify countries in which each MNE has an extractive activity, which is crucial for our identification strategy. We expect the profitability of extractive subsidiaries to be closely linked to commodity prices, and we thus need to exclude them from our control group. Figure 4 shows the location of all the mines and oil fields that are owned by the extractive

[15] Both sources were previously widely used in the literature (Berman et al., 2017; Coulomb et al., 2021).

Table 2: Commodities Breakdown

Commodity	CbCR No. MNEs	CbCR Profits ($bn)	Compustat No. MNEs	Compustat Profits ($bn)
Oil	25	741.5	277	2,305.9
Gas	11	48.4	77	354.0
Uranium, Nickel & Zinc	8	6.5	22	19.7
Iron	7	140.0	29	467.3
Manganese, Phosphate & Potash	6	30.8	9	10.2
Copper	6	28.7	36	164.0
Gold & Platinum	5	41.2	159	151.5
Aluminum, Chromium & Lithium	5	9.9	1	0.0
Diamonds	0	0	16	52.7
Silver	0	0	16	3.1
Lead	0	0	3	1.3
Molybdenum	0	0	3	6.4
Tungsten	0	0	3	-0.1
Tin	0	0	2	3.7
Titanium	0	0	1	0.0
All	**73**	**1,047.0**	**650**	**3,539.7**

Notes: The number of MNEs is the number of MNEs appearing at least once in the sample. Profits are the sum of profits over the period (2016-2023). Some commodities are pooled together to satisfy confidentiality rules.

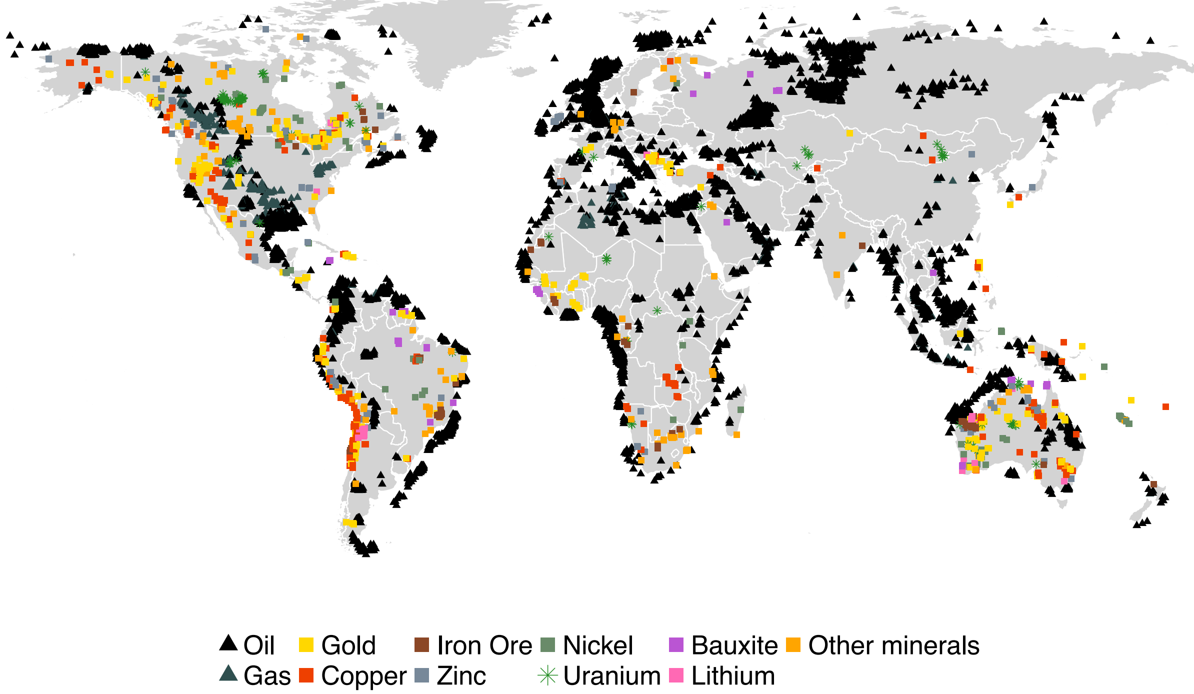
MNEs in our final sample, while Table B2 shows how much each country represents in terms of profits, taxes, etc. They show that almost all extractive countries are covered in our sample, with the notable exception of China, in which we only cover a small number of oil fields and almost no mines.

Consolidated financial data. To have a complete picture of the extractive sector, we use Compustat (both Global and North America), which gathers financial information (profits, sales, number of employees, assets, etc.) on publicly listed firms. We restrict the sample to the mining and the oil & gas sector.[16] Matching Compustat data with production data previously described, we find that Compustat covers at least 75% of global oil, gas and mining production made by non-state-owned MNEs. Table B5 shows the coverage of Compustat in global mining and oil & gas production over the years.

This dataset serves two purposes. It first allows us to confirm our CBCR results at the consolidated level, and make sure that our price shocks are strongly relevant for firms financials.

[16]NAICS 211 for "Oil and Gas Extraction" & NAICS 212 "Mining (except Oil and Gas) and Quarrying".

Figure 4: Extractive activity of MNEs in our CbCR sample



Sources: Rystad Upstream (oil & gas) & S&P Metals and Mining.

Notes: This graph shows the location of all extractive projects majority-owned by MNEs in our CbCR sample. Mines and oil/gas fields can be at either the exploration or production stage.

Second, and more importantly, it allows us to estimate the amounts of windfall profits over the period, and thus to give a global estimation of the amounts of shifted windfall profits. It further allows us to estimate a semi-elasticity of tax revenue with respect to windfall profits in Section 5.

We also use both Orbis and Compustat consolidated data to clean CbCR data from double counting, in a procedure described in Section E in the Appendix.

Project-level tax payments. To have a complete view of payments made by firms to resource-rich countries, including production taxes not present in CbCR data, we compiled a new database of extractive payments compiled in project-by-project reports (PbPR), which we only use in the last section (Section 5) of the paper. From 2015 onwards, extractive groups listed on a stock exchange market located either in Canada, the United Kingdom, the European Union, Norway, or in the United States since 2023, are required to publicly disclose all payments made to governments that reach the threshold of 100,000 euros (respectively made above 100,000 Canadian dollars or USD) in publicly accessible reports. Figure A3 in the Appendix shows an example of such a report.

Compared to CbCR data, PbPR includes all payments made to governments, and not only income tax payments. This is a key improvement since taxes based on production, either in the form of royalties or production sharing agreements are common in the extractive sector. Based on existing data on payments made to governments, we can estimate that taxes on income make up less than half of total payments (excluding customs taxes and social security contributions).[17] Types of taxes present in PBPR include production entitlements, which are taxes on profit collected in kind; taxes levied on the income, production, or profits of companies; royalties, mainly levied on production; dividends; signature, discovery, and production bonuses; license fees, rental fees, entry fees, and other considerations for licenses and/or concessions; payments for infrastructure improvements.

PbPRs have to be reported publicly by firms, regardless of the country of operation. To construct this dataset, we compiled all the mandatory reports made by subject firms using various sources (government websites, company websites, etc.).[18] All the steps in the construction of this dataset are detailed in the data appendix, and in more detailed in a companion paper (Blanc et al., 2025). Our final PBPR dataset includes 1,200 firms operating 12,178 projects, making total payments of 226.1$bn each year, as shown in the summary statistics table in Appendix (see Table B3). PBPR covers 63% of global oil production made by non-state-owned MNEs, 60% of global mining production, and 54% of global profits of extractive listed firms, as shown in Table B4 in Appendix. Even though our data is at the extractive project level, we aggregate it at the country $\times$ firm level to account for payments that can not be directly attributed to a specific project, which is often the case for corporate income taxes.

Table 3 presents the four main data sources we combine on extractive MNEs.

[17] This computation is made using EITI (Extractive Industries Transparency Initiative) data, which decomposes payments by type of tax for a limited number of voluntary countries.

[18] We greatly benefited from the work of the NGO NRGI (Natural Resource Governance Institute), which compiled those reports from 2015 to 2019.

Table 3: Main data sources

Source	Unit of obs.	Years	Variables	Coverage
CbCR	MNE×Country	2016-2023	Profit, Sales, Assets	>$750M Global Sales
Compustat	MNE	2015-2023	Profit, Sales, Assets	Listed firms
Rystad	Oil & Gas field	1920-2022	Production (volume), Cash-flow, Costs estimates	Global (exhaustive)
S&P Metals and Mining	Mine	1990-2024	Production (volume), Cash-flow, Costs estimates	Global
PbPR	Extractive project (aggregated at MNE×Country)	2016-2023	All payments to governments, 7 types of payments	Large groups listed on Canadian, EU and UK stock exchanges. Exhaustive coverage of large projects.

Price data and list of commodities. We use yearly commodity world prices as reference prices for commodities extracted by firms in our database. We use time series from 2016 to 2023 from IMF Commodity prices, the World Bank Pink Sheets, and the US Geological Survey (USGS) Price Series. We cover 20 commodities: oil, gas, aluminum, chromium, cobalt, copper, gold, iron, manganese, molybdenum, nickel, niobium, palladium, silver, tin, titanium, tungsten, uranium, vanadium and zinc. We convert all prices to per ton prices. The list of commodities is the following: condensate, oil, gas, natural gas liquids (from the Rystad dataset), alumina, aluminum, antimony, bauxite, chromite, chromium, cobalt, copper, diamonds, gold, iron ores, lithium, manganese, molybdenum, nickel, niobium, palladium, phosphate, platinum, potash, silver, tantalum, tin, titanium, uranium, zinc (from the S&P Metals and Mining dataset). Table 2 shows the distribution of MNEs and activities along the different commodities covered in both CBCR and Compustat, while Figure 3 shows the evolution of the prices of all the commodities included in our CbCR sample.

Country-level data. We use common lists of tax havens in the international public finance literature, provided by Tørsløv et al. (2023).[19] These lists identify countries and jurisdictions

[19] Five OECD countries (Belgium, Ireland, Luxembourg, Netherlands, and Switzerland) and 36 non-OECD countries (Andorra, Anguilla, Antigua and Barbuda, Aruba, The Bahamas, Bahrain, Barbados, Belize, Bermuda, the British Virgin Islands, the Cayman Islands, Curaçao, Cyprus, Gibraltar, Grenada, Guernsey, Hong Kong, the Isle of Man, Jersey, Lebanon, Liechtenstein, Macau, Malta, Marshall Islands, Mauritius, Monaco, Panama, Puerto Rico, Samoa, Seychelles, Singapore, St. Kitts and Nevis, St. Lucia, St. Marteen, St. Vincent & Grenadines, Turks and

with preferential tax treatment and financial secrecy.

3.2 Descriptive evidence

Geography of extractive MNEs. We take advantage of the granularity of our CbCR data to draw new stylized facts on the geographical distribution of activity of extractive MNEs. Figure 5a shows the distribution of the main variables included in CbCR broken down by type of country. We differentiate between extractive countries, identified as countries in which the MNE has at least one extractive project (oil, gas or mining), tax havens, and other countries. To be conservative, extractive MNE × countries observations include cases that are both extractive and located in tax havens.

It shows that the global activity of extractive firms is clearly dominated by the upstream sector, which makes up more than 60% of all employees, sales, profits, and tangible assets. Since our CbCR data is at the MNE × country level, we can not distinguish within MNE × countries observations the share that is solely due to extractive activity. The orange shares in Figure 5a, linked to extractive activity, should thus be interpreted as higher bounds. Interestingly, we can also see a clear disconnection between the share of profits that is located in tax havens (18%) and the share of employees and tangible assets in tax havens (4 and 6%).

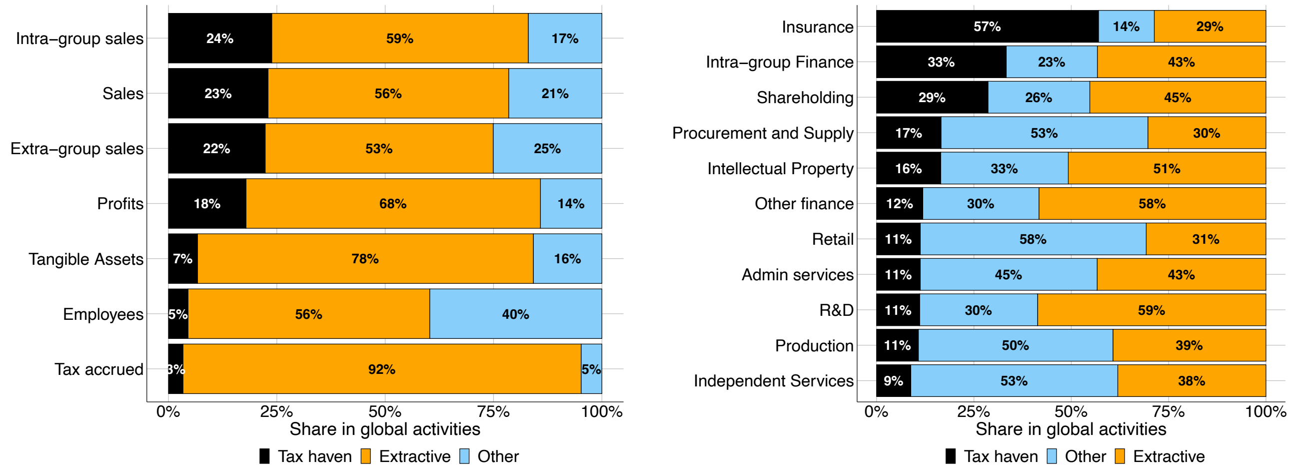
Using the information provided in CbCRs on the specialization of each subsidiary of the MNEs in our sample, we can look at where each type of activity is carried out. Figure 5b shows the share of subsidiaries in each business activity that are located in tax havens, extractive affiliates, and other MNE × countries observations. The majority of subsidiaries specialized in insurance, and a third of subsidiaries specialized in intra-group financing are located in a tax haven. Since the category "Production" includes both upstream (extraction) and midstream (refining) activities, it is balanced between extractive affiliates and other observations.

ETR and profitability. In Figure 6, we display the profit-to-employees ratio and the effective tax rate of extractive multinationals per country of operation. It shows that profitability displays a U-shaped curve along the distribution of ETRs: low-tax countries display high profitability on

Caicos, Vanuatu).

Figure 5: Geography of extractive MNEs

(a) Distribution of Main Variables (b) Distribution of Business Activities



Lecture: 61 % of employees of extractive multinationals are employed in a country where the group conducts an extractive activity (Figure 5a). 57% of subsidiaries specialized in insurance are located in a tax haven (Figure 5b). *Notes:* This figure shows the distribution of our main variables and business activities along our three groups of MNE×country pairs: tax havens, extractive and non-extractive non-TH. When an affiliate is both located in a tax haven and extractive, we place it in the extractive category. The share in profits only includes positive profits. We only included in both graphs observations coming from administrative data, and excluded voluntarily disclosed reports, in which the distribution of activity by sector, and sometimes on sales and taxes paid is not available.

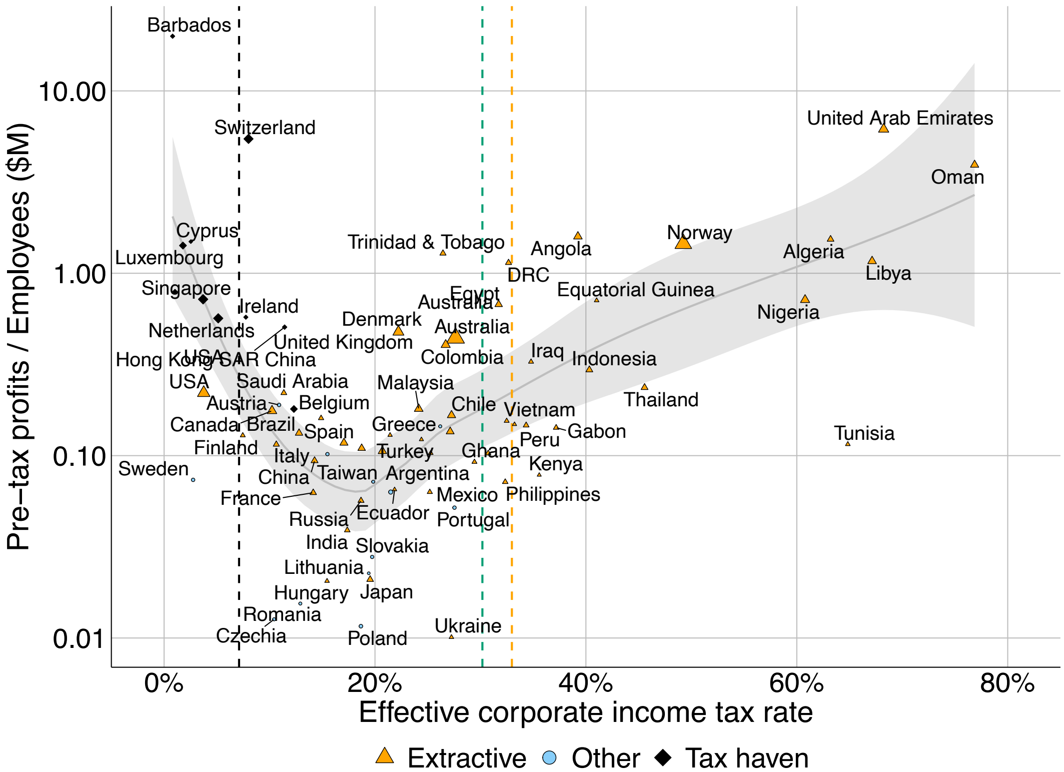
the left-hand side, while the effective tax rate is increasing with the level of profitability on the right-hand side of the graph, where extractive affiliates appear predominantly. This might be indicative of countries setting their tax rates depending on the expected profitability of extractive projects. This reason might explain why mining countries impose lower rates compared to oil & gas countries.

Figure B3 shows the effective tax rate of extractive affiliates specifically by country. It shows a very large heterogeneity within resource-rich countries, with ETR being lower than 5% in the United States[20], and as high as 75% in Oman.

Prices and share of profits in tax haven. Descriptively, we find in Appendix Figure B2 that the share of tax havens in positive non-extractive profits increases during price booms, especially in 2018 and 2022, while it does not necessarily decrease during large price downturns such as in

[20]Extractive firms in the United States benefit from accommodating policies, in particular the deduction for Intangible Drilling Costs, which allows firms operating in the US to deduct a large portion of their capital expenditures.

Figure 6: Profitability and Effective Tax Rates by country



Notes: The Y axis is the log-scaled pretax profit-to-number of employees ratio, in millions $US. The size of the points is a function of the amount of total profits in the country. The black vertical dashed line indicates the average effective tax rate of tax haven countries, the orange vertical line indicates the average effective tax rate in extractive countries, and the green vertical line indicates the global effective tax rate. Effective tax rates are computed as the ratio between positive tax paid and positive profits booked across the whole period (2016-2023). Countries are broken down by extractive and non-extractive countries. A country is defined as extractive when at least one MNE has an extractive activity in the country. We only included observations with positive profits and tax accrued, as well as countries in which at least five companies are operating.

2016 and 2020.

4 Within-Group Allocation of Windfalls

4.1 Group specialization and windfalls

Group-level Price Shocks. For each MNE, we have information on the value of its yearly production volume and value per commodity. We define the MNE's primary commodity as the commodity from which the MNE generated the highest cumulative revenue during the six-year period (2010–2015) preceding the beginning of our panel. Taking into account a large number of years pre-period allows us to smooth any temporary commodity shock in revenue. We compute specialization on our pre-sample period to avoid endogeneity concerns linked to the fact that firms might specialize in commodities with higher prices during our period of interest. We also chose to take the value of each commodity instead of the volume to find a common metric between different types of commodities.

MNEs vary in their product specialization, as shown in Table 2 showing the distribution of MNEs and activity along the different commodities covered in our sample.

Out of our 73 MNEs, 35 are either specialized in oil, gas, or NGLs, and 38 are mining MNEs. In a robustness test, we check our results using an alternative definition of our price shocks, defined as the average of commodity prices weighted by the share of each commodity in the production value of the MNE (Section C of Appendix).

Correlation with consolidated results. To test whether MNEs profits and revenues at the group level are correlated with commodity price shocks, we run a non-causal regression based on the following specification:

$$y_{g(p)t} = \alpha + \beta \ln P_{g(p)t} + \theta_K \ln Asset_{gt} + \theta_L \ln Employees_{gt} + \mu_t + \mu_g + \varepsilon_{gt} \qquad (1)$$

With $y_{g(p)t}$ the logarithm of consolidated profits, sales or taxes paid of MNE g at time t, $P_{g(p)t}$ the MNEs main commodity p market price at time t, μ_g group fixed effects and μ_t time fixed-effects. We control for the MNEs consolidated assets and number of employees. The coefficient β captures the correlation between the price index and total consolidated pretax profits, sales and corporate income tax accrued (CIT), and should be interpreted as an elasticity. It will capture variation across time and within MNEs, for price changes that are metal specific. We do not claim that this coefficient captures the causal effect of a commodity price change on the profit made by an extractive MNE. It rather captures the conditional correlation within MNEs of prices with consolidated profits, sales and CIT.

Table 4: Consolidated Results

	Profits (log)		Taxes (log)		Sales (log)	
	(1)	(2)	(3)	(4)	(5)	(6)
$P_{g(p)t}$ (log)	1.62***	1.63***	1.77***	1.72***	0.432***	0.434***
	(0.505)	(0.528)	(0.277)	(0.271)	(0.112)	(0.099)
Employees (log)		0.016		-0.020		0.064
		(0.116)		(0.086)		(0.067)
Tang Assets (log)		0.087		0.080		0.055
		(0.101)		(0.106)		(0.101)
Observations	194	168	210	186	218	212
R^2	0.89904	0.90262	0.93697	0.94312	0.97633	0.97421
Within R^2	0.07660	0.09698	0.15050	0.17749	0.03565	0.07462
MNE fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on the log of consolidated profits, sales and taxes in US$. Standard errors are clustered at the MNE level.

Table 4 shows that profits, sales and CIT strongly correlate with our MNE price indexes. In column (1) and column (3), the price index is associated positively with consolidated profits and turnover. Columns (2) and (4) show that, conditional on total assets and employees, a 1% increase in the main commodity price is associated with a 1.63% increase in consolidated profits, a 1.7% increase in global taxes paid, and a 0.43% increase in consolidated turnover. All these results are very strongly significant. Given that costs of production are not as elastic with respect to commodity prices as sales, it is natural that the pretax profits and the tax variables respond more to prices compared to sales. Commodity price changes explain a significant part of the variation in group profits and taxes: respectively 7.6 and 15 percents. We check that results hold with a larger number of MNEs and number of years in Table C1, using Compustat. The strong positive correlation holds, although coefficients on profit are smaller (1.3), albeit similar for sales.

4.2 Empirical strategy: within-group windfalls and profit shifting

We exploit the fact that group specialization in extractive commodities is associated with group specific profit shocks to study how an extractive MNE allocates windfall profits across countries and affiliates, in particular in low-tax countries. Our empirical strategy uses group-specific commodity price shocks to generate variation in extractive profit and compares within each group the differential profit price elasticity of tax haven affiliates versus the rest of the group.

This strategy has the flavor of a Bartik instrument within a triple difference setting (Goldsmith-Pinkham et al., 2020). The change in MNEs extractive revenues and profitability is determined by initial specialization in commodities (the shares, here 0 or 1). In the previous subsection, we showed that changes in the price of these commodities correlate strongly with changes in profits (the shift). In this approach, the shares act as a treatment intensity, and matter for exogeneity, and the shifts as relevant changes affecting the outcome. On top of price changes across time, and differences in commodity specialization across multinational groups, we exploit differences within the multinational group between MNE $\times$ country units. In particular, we compare within the group, profits booked in tax havens to profits booked in countries where no extraction is undertaken. The underlying assumption is that in the absence of haven-specific characteristics, the profits of subsidiaries in tax havens would have reacted to prices, such as in the rest of the group, to the group-specific shock in commodity prices.[21]

Validity Assumptions. To causally identify profit shifting, our approach relies on several assumptions. First, as explained by Goldsmith-Pinkham et al. (2020), shares should be exogenous and shifts only have to be relevant. In our case, it implies product specialization should be exogenous with respect to the price elasticity of havens affiliates financials relative to the rest of the group. In other terms, MNEs specialization in some commodities should not be correlated with a different trend in the share of profit shifted across time. As we selected only minerals

[21]Our empirical strategy is also close to the one from Dharmapala and Riedel (2013) who study different types of group-level income shocks.

and oil and gas sectors for which a large body of profit-shifting anecdotal evidence is available, this hypothesis is plausible.[22] To support this assumption, we compared the average share of tax havens in total profits depending on the commodity specialization of our MNEs. Figure B1 in the Appendix shows that this share does not significantly differ from one commodity to the other, suggesting that being able to shift more profits is not determinant in the specialization decisions of MNEs. The shift should be relevant for affiliates financials, which we showed in the previous Subsection 4.1 applies to our case. This approach does not require the shift to be exogenous to profit shifting to identify the relative shift of windfalls in tax havens.

Second, there should be no spillovers in the outcome of interest from one group to another. Our triple difference structure allows us to avoid this concern: we compare tax haven affiliates to the rest of the group, so we control for changes at the scale of the group caused by price evolution. While it is implausible that there are no spillovers from one multinational group to another in this sector, our empirical strategy only requires that there are no spillovers in profit-shifting choices from one group to another when prices change. Third, each data point should be close to a steady state equilibrium.

Estimation. We estimate the following equation:

$$\begin{aligned} y_{g(p)it} = &\alpha + \beta_H \ln P_{g(p)t} \times Haven_i + \beta_M \ln P_{g(p)t} \times Extract_{gi} + \beta_m \ln P_{g(p)t} \\ &+ \nu \ln a_{git} + \theta' X_{it} + \mu_g + \mu_t + \varepsilon_{git} \end{aligned} \tag{2}$$

The outcome variable y_{git} is the logarithm of financials of MNE g we are interested in, in country i in year t. Our main outcome of interest is MNE $\times$ country profit, which is the sum of profit affiliates of group g in country i. In the baseline specification, we only include observations with positive profits, for which the log of profit is defined. This sample choice is also motivated by our theoretical model, which provides clear implications when affiliates profits in A and B are positive, but not for losses.[23] We further explore other outcome variables. In particular,

[22] We exclude commodities such as coal, construction stones, or other minerals, for which cases of profit shifting have been less salient.

[23] We test in subsection 4.4 allocation of losses.

comparing the effect of prices on both intra-group and extra-group sales provides additional information on the origin of our windfall profits.

The variable $P_{g(p)t}$ is the price of the main commodity p extracted by group g. The indicator variable $Haven_i$ takes the value one if i is a tax haven. We include the price both on its own and interacted with the tax haven dummy. The first term will control for the commodity price shock common to all the affiliates of the same group: β_m is the average price elasticity in the group to a commodity price boom. The interaction term and its coefficient β_H is our coefficient of interest and captures the supplementary price elasticity of tax haven affiliates compared to the rest of the group. Under the assumption that tax haven affiliates should have benefited from the same spillovers from extractive activity within the group, this coefficient captures the supplementary profit change generated by profit-shifting services.

We want to compare non-extractive tax havens affiliates to other non-extractive affiliates benefiting from windfall spillovers within the firm. We thus exclude extractive affiliates from the control group, which face first-order effects of commodity price changes. We add an interaction term of $\ln P_{g(p)t}$ with the indicator $Extract_{gi}$, which takes the value one if the group g undertakes extractive activity in country i.

Our baseline specification includes standard two-way fixed effect μ_{gi} and μ_t for MNE $\times$ country and year. Controlling for time fixed-effects is especially crucial in our setting, since macroeconomic common shocks are a substantial source of commodity price volatility.

The inclusion of year fixed effect will wash out changes in commodity markets that are common to all commodities: $P_{g(p)t}$. Group-country fixed effect will adjust for the within-group analysis and control for the unbalanced panel. We control for the number of employees and the value of assets for each MNE $\times$ country. We use an IHS transformation to deal with zeros in the reported value. The model is estimated by OLS, clustering standard errors at the MNE level. In some specifications, we use MNE-year fixed effects, which control for any time change affecting the average group profitability.

4.3 Baseline results

Table 5 presents the baseline results on subsidiaries unconsolidated profit. In column (1), we regress on the average price effect with our control variables. The coefficient associated with variable $Price_{gt}$ is positive and significant. The magnitude is lower than for consolidated profit: 0.65. The average profit price elasticity is lower than the price elasticity of the total profit. This points to composition effects, with the biggest affiliates in terms of profit reacting more to price changes. Moreover our sample does not aggregate to consolidated results, since we limit ourselves to positive profits due to the log transformation.

In column (2), we introduce all the interaction terms of our specification. The coefficient associated with extractive activity is close to the consolidated results and highly statistically significant. The coefficient associated with the interaction term of interest, with the tax haven dummy, is positive and statistically significant. Column (2) indicates that for a 1% group commodity price increase, the profit allocated to tax haven affiliates increases by 0.53pp more compared to other non-extractive affiliates in the same group. The magnitude of this elasticity is substantial.[24] The other non-extractive affiliates in the group display an average increase of 0.19, which is not statistically significant. Most of the group profit change seems to be driven by extractive and tax haven affiliates. We find that the non-causal elasticity between commodity prices and extractive profit is between 1.45 and 1.56.

In column (3), we verify that our results are not driven by observations that are both defined as extractive and tax havens, such as affiliates of oil and gas groups in the Netherlands. We find that the interaction term of the two is negative and not statistically significant. All other results remain. In columns (4) and (5), we introduce group-year fixed effects, which capture all common group-level shocks. Results for extractive subsidiaries remain. The magnitude of the coefficient for tax haven affiliates is slightly higher, and the coefficient is even more precisely identified.

In Figure 7, we unconditionally decompose the price elasticity of MNE $\times$ country profit per

[24] Around 10 times the elasticity of affiliates profit to imputed parent profit estimated by Dharmapala and Riedel (2013).

Table 5: Baseline Results

	Profits (log)				
	(1)	(2)	(3)	(4)	(5)
$P_{g(p)t}$ (log)	0.648***	0.190	0.182		
	(0.226)	(0.239)	(0.239)		
$\text{Extract}_{gi} \times P_{g(p)t}$ (log)		1.45***	1.47***	1.53***	1.56***
		(0.266)	(0.278)	(0.254)	(0.267)
$\text{Haven}_i \times P_{g(p)t}$ (log)		0.528**	0.558**	0.711***	0.751***
		(0.256)	(0.266)	(0.213)	(0.221)
$\text{Haven}_i \times \text{Extract}_{gi} \times P_{g(p)t}$ (log)			-0.651		-0.842
			(0.547)		(0.572)
Employees (IHS)	0.230***	0.226***	0.226***	0.237***	0.237***
	(0.067)	(0.068)	(0.068)	(0.061)	(0.061)
Tang Assets (IHS)	0.066**	0.069**	0.069**	0.045***	0.045***
	(0.032)	(0.032)	(0.032)	(0.016)	(0.016)
Observations	5,209	5,209	5,209	5,209	5,209
R^2	0.92796	0.92922	0.92923	0.94101	0.94103
Within R^2	0.06043	0.07690	0.07700	0.06470	0.06490
MNE-Country fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓		
MNE-Year fixed effects				✓	✓

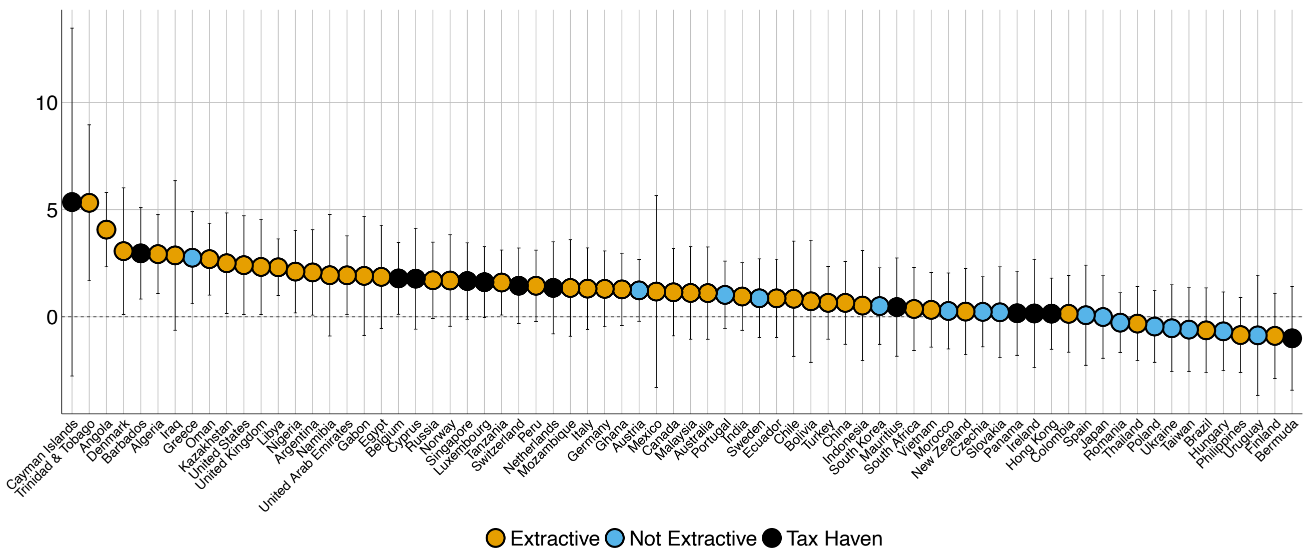
Notes: This table summarizes our estimates of the effects of commodity prices on unconsolidated profits. The outcome variable is the log of profits in US$. Standard Errors are clustered at the MNE level.

country in our sample:

$$y_{git} = \alpha + \beta_i Country \times logP_{g(p)t} + \theta' Controls_{git} + \mu_{gi} + \mu_{gt} + \varepsilon_{gt} \tag{3}$$

The Figure plots each coefficient β_i and confidence intervals at the 95% level. Countries displaying the largest reaction to price changes are both extractive subsidiaries and tax haven subsidiaries. In contrast, non-extractive-non-haven subsidiaries display lower windfall profits.

Figure 7: Result: Profit price-elasticity per country



Notes: This graph shows the coefficients associated with each country dummy interacted by our price variable in the equation detailed in Equation 3. Countries are defined as extractive if at least one MNE is carrying out an extractive activity there. The reference country is France. Includes countries in which at least 10 MNEs have an activity and for which we have at least 50 observations. Standard errors are clustered at the MNE level.

4.4 Mechanisms

Intra-group and extra-group sales. In Table C4, we study the change in sales within MNEs. In column (3), we find that the coefficient associated with $P_{g(p)t}$ is positive and slightly significant. The coefficient associated with the interaction with subsidiaries operating in the extractive sectors is positive and slightly significant. The coefficient on the interaction term with subsidiaries in tax havens is positive albeit not statistically significant. When the group windfall increases, we cannot claim that sales of haven subsidiaries vary in a different way than the rest of the group. Most of the extractive groups in our sample are integrated downstream and include refining, transformation, and distribution activities, which are part of our control group. In times of commodity price booms, these subsidiaries will experience a mechanical increase in sales value through price effects (as well as in input costs, reducing profit). As these firms constitute our control group, we find that tax haven affiliates increase their sales *as much as* other subsidiaries directly subject to price effect. If the costs of services sold by these subsidiaries do not increase as fast as in the rest of the group, which is the case for profit-shifting phantom activity, it generates excess profits.

CbCRs allow us to decompose sales between intra-group and extra-group sales. Intra-group sales will typically include sales linked to intra-group services, or the sale of raw commodities to refining and distribution affiliates, while extra-group sales will include sales to final consumers as well as sales of raw commodities to refineries outside the MNE. Tables C5 and C6 show the results for both intra-group and extra-group sales. We find that the coefficients associated with the extractive dummy are both positive and slightly significant. Interestingly, even though not significant, the coefficients associated with the haven dummy are close to zero for extra-group sales, but positive (0.2) for intra-group sales, which could indicate that the increases in profits are driven by intra-group activity.

Location of losses in Tax Havens. Commodity price volatility creates high windfalls and can generate large losses if it drops below break-even price. In our final sample, around a third of our observations are losses. We study the allocation of these losses. An MNE could have incentives to allocate more profits to low-tax countries when their total profits increase, and to allocate the losses linked to a decrease in commodity prices in high-tax countries to reduce its tax burden.

In a first approach, we first use as a dependent variable the Inverse Hyperbolic Sine Transformation of pretax profits. To compare the relative effects of prices in tax haven subsidiaries making losses to those making gains, we interact our independent variable of interest by a dummy variable equal to one when a given subsidiary makes gains in a given year, and zero if it makes losses. This transformation allows for including negative profits but is sensitive to scale transformation (Aihounton and Henningsen, 2021). Alternatively, we split the sample in two groups between losses in absolute value and positive profits. Results are displayed in Table C7.

In column (1), we still find that tax haven affiliates have an excess price elasticity compared to other affiliates from their group, although less precisely estimated. Column (2) shows that the price effects are positive and strongly significant in subsidiaries making gains, and negative in subsidiaries making losses in tax havens, displaying a relationship going in the opposite direction, which was expected: an increase in commodity prices is expected to reduce the losses. However, interestingly, we find that the coefficient for losses is negative and strongly significant for non-haven countries, while it is closer to zero in tax havens. This might be explained by the fact that a decrease in prices, which is more likely to be the case in times of losses, is more strongly associated with an increase in losses in non-haven countries, while losses in haven countries do not increase as much.

In columns (3) and (4), we split the sample in two: the first sample used to obtain the regression results of column (3) includes only positive observations (*i.e.* gains), while the second sample (column (4)) only includes negative observations (*i.e.* losses). We find that the relative effect of prices on profits in tax havens is only significant in our first (gains-only) sample (see column (3) line 2), and becomes insignificant when only including losses (column (4) line 6). In comparison, the coefficient for extractive is statistically significant in both cases. We find that when the main commodity price increase by 1%, the absolute value of losses decrease by 0.5 percent. Extractive MNEs do not locate the losses linked to low prices in tax havens more than in other countries, while the opposite is true in the case of gains.

Symmetry between price increases and decreases. We further test interacting our price variable with a dummy indicating whether prices are increasing or decreasing compared to the past year. The results are displayed in Table C8 in the Appendix. We don't find any asymmetric effect of prices during price increases compared to price decreases, meaning that during price downturns, when profits are still positive, profits decrease in tax havens as much as they increase during price upturns. This tends to confirm the results of Becker et al. (2020b) which show that MNEs strategically locate their risky activities in low-tax countries to justify high levels of profitability without real economic substance.

Business activity. Using the information on the business activities of the subsidiaries belonging to the MNEs in our sample, we investigate whether some types of activities are driving our results more than others. For each MNE $\times$ country, we define primary activity as the activity in which the MNE has the largest number of affiliate. We then regress our profit variable on the interaction of a set of dummy for each primary activity, interacted with our MNE-level price shocks. The equation estimated is the following:

$$y_{g(p)it} = \alpha + \sum_{s} \beta_s lnP_{g(p)t} \times \mathbb{1}BusinessActivity_{s,gi} + \mu_g + \mu_t + \epsilon_{git} \tag{4}$$

With $y_{g(p)it}$ the profits of MNE g at times t in country i and $BusinessActivity_{s,gi}$ an indicator variable if the main business activity of MNE g in country i is s.

Figure C1 shows the associated coefficients. Because each MNE $\times$ country can have multiple activities in each country, the identification is challenging, and our coefficients are not precisely estimated. Figure C1 however shows that MNE $\times$ country specialized more in intra-group finance seem to react the most to commodity price changes, predominantly located in tax havens (Figure 5b).

4.5 Robustness

As a robustness check, we estimate equation 2 using a PPML estimator in order to include zero profit and account for any heteroskedasticity bias created by the log transformation (Silva and Tenreyro, 2006). Columns (2) to (5) in Table C9 show that tax havens book more profits than the non-extractive rest of the group when commodity price increases. Coefficients are higher than with the OLS estimator as larger observations are weighted more by PPML (Breinlich et al., 2024).

We further check that our results are not driven by extreme values by using as an outcome variable a winsorized version of our profit variable, each year at the 1% level. We also run our regression on the group of MNEs that we observe every year between 2016 and 2019. Table C10 shows that our results are unchanged.

4.6 Magnitude of profit shifting

We use an alternative two stage least squares approach to quantify the excess increase identified in the previous subsection in dollar terms. We instrument consolidated profits with the price of the commodity in which the MNE specializes in. Consolidated profits are strongly linked to price shocks. If tax havens windfalls result from profit shifting, prices only affect tax havens profits through its effect on consolidated profits. They are thus a valid instrument for our purpose.

The specification is, for the first stage:

$$\pi_{g(p)t} = \alpha_0 + \beta_0 \ln P_{g(p)t} + \mu_g + \mu_t + \varepsilon_{gt} \tag{5}$$

With $\pi_{g(p)t}$ MNE consolidated profits. We run this specification in levels to predict profits in dollars. We then use the fitted values to run the following regression:

$$\pi^{TH}_{g(p)t} = \alpha_1 + \beta_{IV}\hat{y}_{gt} + \nu_g + \nu_t + \epsilon_{gt} \tag{6}$$

With π^{TH}_{gt} being the total profits booked in tax havens by MNE g at time t, Asset^{TH}_{gt} the amounts of tangible assets in tax havens, and $\text{Employees}^{TH}_{gt}$ the number of employees in tax havens. Table C2 in the Appendix gives the results for the first stage, indicating a strong relevance of our price shocks. Table 6 shows the results of the second stage. Columns (1) and (2) show the results with profits in tax havens as an outcome. The results show that a $1 increase in consolidated profits leads to around $0.2 booked in tax havens.

We estimate the same regression on the financial results of other affiliates to benchmark our results, although the instrument for extractive affiliates is not exogenous. We find a $0.8 increase in affiliates located in tax havens, and no increase in other affiliates of the group.

To translate these results in global estimates of shifted windfalls, we use our large sample of firms from Compustat. We showed earlier that the profit elasticity to the main commodity was

Table 6: Instrumental Variable Results

	Profits in TH (1)	Extractive Profits (2)	Other Profits (3)
Consolidated Profits$_{gt}$	0.198***	0.883***	-0.052
	(0.071)	(0.075)	(0.055)
F-test (1st stage)	12.570	12.570	12.570
Observations	248	248	248
MNE fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓

Notes: Standard errors are clustered at the MNE level.

similar to our smaller sample of CbCR firms. We run the same model as Equation 5, estimated coefficients are presented in Table C2. Using these results, we predict windfall profits:

$$\widehat{\pi_{g(p)t}}^{W} = \pi_{g(p)t-1} \times \widehat{\beta}_0 \times \frac{\Delta P_{pt}}{P_{pt-1}} \tag{7}$$

For each MNE and year such that $\frac{\Delta P_{pt}}{P_{pt-1}} > 0$ and $\widehat{\pi_{g(p)t}}^{W} > 0$.

Table 7 provides, for each year, the total amount of positive profits, the total of MNE-level positive profit changes, and the predicted positive windfall profits. Our estimation of windfall profits is strongly correlated with profit changes at the MNE-year level, with a correlation of 0.8. Predicted global windfalls represent 67% of positive profit changes between 2015 and 2023. Figure C2 shows the time change in positive profits across time, and the share of our estimated windfall profits. We find that a $1 increase in consolidated profits from commodity price change leads to a $0.2 increase in profits in tax havens. We hence estimate that on average, each year, $22.7 billion in profits were shifted to tax havens during commodity price increases, or around 13.4% of total positive profits growth.

Table 7: Windfall Profits Estimation and Global Profits

Year	Profits	Profits Growth	Windfall Profits		Windfall Profits in TH	
			Amount	Share	Amount	Share
	($bn)	($bn)	($bn)	(%)	($bn)	(%)
2016	49.1	75.9	7.5	10	1.5	2
2017	240.3	191.5	142.2	74	34.5	18
2018	303.4	152.4	143.7	94	31.0	20
2019	77.0	30.2	23.9	79	5.0	17
2020	101.3	35.1	22.3	64	4.5	13
2021	483.0	590.9	320.8	54	107.5	18
2022	601.3	323.6	262.9	81	53.9	17
2023	34.9	8.1	2.2	27	0.5	6
2016-2023	**210.0**	**156.4**	**102.8**	**66**	**26.5**	**17**

Sources: Compustat North America and Global & authors computation.
Notes: This table presents our global estimates of windfall profits. The last line shows the yearly average.

5 Fiscal Windfalls

In this section, we study how government revenues in extractive countries respond to changes in commodity prices and windfall profits using our new PbPR dataset. These results allow us to ultimately estimate government revenue losses for extractive countries under some hypothesis on the distribution of windfall profits losses.

5.1 Effects of commodity prices on government revenues

In this subsection, we estimate how government revenues change with commodity price changes. We estimate the following model:

$$\ln(Payment_{git}) = \alpha + \beta_T \ln P_{git} + \gamma X'_{it} + \mu_{gi} + \mu_t + \varepsilon_{git} \quad (8)$$

We regress total payments made by each firm g in each country i on P_{git}, the price in year t of the main commodity extracted by firm g in country i.[25] Coefficient β_T captures the non-causal change in extractive tax payments linked to a commodity price change. It should be interpreted as an elasticity. We introduce firm $\times$ country (μ_{gi}) and year (μ_t) fixed effects to capture average

[25]We define the main commodity extracted as the one with the largest production value between 2016 and 2023.

differences in firm productivity in each country, and common yearly changes in the extractive sector. The vector X_{it} captures country-level control variables. We control for changes in GDP per capita, the statutory income tax rate, and the Government Effectiveness measure from the World Governance Indicators. We cluster standard errors at the firm × country level. The results are presented in Table 8.

Table 8: Effects of commodity prices on extractive government payments

	Payments to Government (log)			
	(1)	(2)	(3)	(4)
P_{git} (log)	1.01***	1.00***		
	(0.100)	(0.095)		
Prod Volume$_{git}$ (log)		0.471***		
		(0.051)		
P_{git} (log) × Mining$_g$			1.21***	1.16***
			(0.169)	(0.168)
P_{git} (log) × Oil & Gas$_g$			0.939***	0.705***
			(0.103)	(0.109)
Prod Volume$_{git}$ (log) × Mining$_g$			0.395***	0.396***
			(0.075)	(0.076)
Prod Volume$_{git}$ (log) × Oil & Gas$_g$			0.524***	0.526***
			(0.068)	(0.068)
P_{git} (log) × Mining$_g$ × Gov Effectiveness$_{it}$				0.053**
				(0.026)
P_{git} (log) × Oil & Gas$_g$ × Gov Effectiveness$_{it}$				0.256***
				(0.058)
Gov Effectiveness$_{it}$	-0.101	-0.134	-0.091	-0.870***
	(0.257)	(0.220)	(0.216)	(0.313)
Statutory Tax Rate$_{it}$ (log)	0.180	-0.015	0.019	0.056
	(0.213)	(0.215)	(0.215)	(0.215)
GDP per cap$_{it}$ (log)	0.008	-0.211	-0.210	-0.263
	(0.283)	(0.274)	(0.272)	(0.267)
Observations	4,419	4,232	4,232	4,232
R^2	0.89503	0.91121	0.91150	0.91216
Within R^2	0.04591	0.13474	0.13757	0.14392
Firm-Country fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓

Notes: The outcome variable is the sum of all payments to governments as reported in PBPR in US$ by firm × country. The independent variable is the log of commodity prices in US$ per metric ton. Standard Errors are clustered at the firm $imes$ country level.

In the first column, we find a proportional relationship between prices and government payments: a 1% increase in commodity prices leads to a 1% increase in extractive payments made to governments. The coefficient is significantly estimated. This elasticity is high, but below what should be expected. For tax payments based on production value, the elasticity should be around one, since production value will have a one-to-one relationship with commodity prices. But the elasticity should be above for tax payments based on profits, since costs of production are not expected to increase as much as prices. Our results could be driven by to be partly driven by losses carry-forward reducing the tax base.

The coefficient on price in column (1) could encompass changes in the tax base, both driven by an increase in unit profit and in production volume. In column (2), we control for firms production of its main commodity in the country. The coefficient is positive: when production volume increases by 1% in country i, tax payments change by 0.47%. The log price elasticity is unchanged.

In column (3), we explore the heterogeneities between the mining and oil and gas sectors. We find in particular that payments by mining firms respond more strongly to commodity price changes, although the difference is not statistically significant (p-value=0.13). In column (4), we explore whether countries with a better state capacity benefit from larger windfall revenues during commodity price booms. Our results indicate that it is the case, in particular for oil & gas extraction. This could be a sign that these countries either have more progressive tax systems, being more likely to adopt taxes on income rather than taxes on revenue. It could also be indicative of their higher capacity to capture windfall profits.

5.2 Link between profits and government revenues

To estimate the effects of profit shifting on government revenues, we explore the relationship between profits and taxes. To assess the effect of a $1 increase in consolidated profits on payments to government, we run a simple regression of taxes paid in extractive affiliates on consolidated profits at the MNE level:

$$Payments_{gt}^{Extr} = \alpha + \gamma_T \pi_{gt} + \mu_g + \mu_t + \varepsilon_{git} \tag{9}$$

With $Payments_{gt}^{Extr} = \sum_i Payments_{git}$ the amount of payments made by MNE g in year t linked to its extractive activity, π_{gt} the group consolidated profits, including extractive profits, and μ_g,

μ_t group and time fixed effects. To compare our results from those of Subsection 4.6 we use the same strategy of instrumenting consolidated profits with the price of MNE g's main commodity.

The results are displayed in Table 9. Column (1) presents the OLS results. Our main result of interest is the instrumental variable result in column (2). A $1 increase in consolidated profits leads to a $0.4 increase in tax payments linked to extractive activity.

Table 9: Effects of consolidated profits on extractive government payments

	Government Payments ($)	
	OLS	IV
	(1)	(2)
Profit ($)	0.266***	0.408***
	(0.069)	(0.080)
R^2	0.88238	0.85985
Within R^2	0.37809	0.26515
F-test (1st stage), Profit ($)		36.135
Observations	2,230	1,342
Group fixed effects	✓	✓
Year fixed effects	✓	✓

Notes: This table summarizes our estimates of the effects of consolidated profits on payments to governments linked to an extractive activity. The outcome variable is the sum of all payments to governments as reported in PBPR in US $. The independent variables are consolidated profits in US $ as reported in Compustat (1), estimated windfall profits (2) and consolidated profits instrumented by the log of prices (3). Standard Errors are clustered at the MNE level.

5.3 Losses in fiscal windfalls for extractive countries

How are fiscal losses due to profit shifting allocated across countries? To answer this question, we allocate the firm-level shifted windfall profits computed in Section 4.6. We then allocate these shifted windfalls to extractive countries in proportion to the share of total production value that each country represents for each firm. Say, if firm A has half of its commodity production value in Angola and half in Canada, each country will receive half of the shifted windfalls generated by this firm. To compute fiscal losses from these shifted windfalls, we use the effective tax rates of each extractive country using our CbCR data (Figure B3). This measure displays a lot of cross-country variation, from close to 5% in the United States to more than 75% in Oman. In future

Table 10: Windfalls and losses by country in 2021

Country	Windfall Profits ($bn)	Tax base loss ($bn)	Revenue loss ($bn)	Share of loss in gov revenues (%)
United Arab Emirates	16.8	3.4	2.2	1.80
Australia	39.1	7.8	2.2	0.37
Norway	19.6	3.9	1.9	0.77
Nigeria	12.1	2.4	1.5	4.57
Oman	8.8	1.8	1.4	4.70
United States	176.8	35.4	1.3	0.02
Canada	53.0	10.6	1.1	0.15
Libya	7.4	1.5	1.0	3.95
Iraq	13.0	2.6	0.9	X
Angola	11.0	2.2	0.9	5.75
Indonesia	10.1	2.0	0.8	0.59
Peru	9.5	1.9	0.7	4.28
Brazil	24.3	4.9	0.6	0.41
Kazakhstan	15.1	3.0	0.6	1.90
Algeria	4.7	0.9	0.6	1.07
United Kingdom	12.9	2.6	0.6	0.05
Egypt	9.0	1.8	0.6	X
Chile	10.3	2.1	0.6	0.77
Russia	14.8	3.0	0.6	X
Colombia	7.7	1.5	0.4	X
Total	**540.0**	**108.0**	**48.6**	**X**

Notes: This table shows the distribution of windfall profit losses and the associated estimated losses in revenues. The last columns is the ratio between our estimates of tax losses and total government revenues excluding social securities contributions as reported in the Government Revenues Dataset (UNU Wider). This figure is missing for some countries.

analysis, we plan to reconstruct comprehensive tax rates, including extractive tax regimes using PbPR.

This approach relies on the assumption that windfalls should be re-allocated to extractive affiliates only, and not to the rest of the group. In Subsection 4.6, we showed that the profits of non-extractives non-haven affiliates do not respond to windfall profit. Midstream affiliates real profits are likely to be more loosely linked to commodity prices changes: costs are inflated through the price of raw materials. Yet mark-ups and mark-downs could adjust, and increased volumes could compensate for some fixed costs. In this case, our estimate would constitute a higher bond for extractive states.

We use 2021 as a benchmark year, in which there was a large commodity boom in gas, oil, and some minerals. The results are displayed in Table 10 for the top 20 countries in terms of revenue loss. The top-ranked countries are the United Arab Emirates, Australia, Norway, and Nigeria. This reflects both their economic size in extractive activity, potentially high tax rates, and specialization in commodities facing a price increase in 2021. The United States and Canada display a large tax base loss thanks to their size, and a small revenue loss due to a small ETR on extractives. The last column compares the estimated revenue losses to the total extractive revenues of each country, as reported by the Government Revenues Dataset. We find that revenue loss could be particularly important for developing countries, such as Peru, Angola, Nigeria, and Oman.

6 Conclusion

Using variations in commodity prices and relying on a new cross-country firm database matched with firm-level production data, we find that the profits of subsidiaries located in tax havens are more sensitive to commodity price changes than other non-extractive subsidiaries. A $1 increase in consolidated profits of extractive MNEs leads to a $0.2 increase in profits in tax havens, a $0.88 increase in extractive affiliates, and to a non-significant decrease in other affiliates. This result suggests that extractive MNEs shift more profit in times of price booms.

Our results have important policy implications for source countries. Because windfalls co-move with prices, anti-avoidance enforcement should be counter-cyclical, with enhanced monitoring during price upswings. In terms of tax instruments, while production taxes are more distortive for production and investment decisions, they could be less sensitive to profit shifting. This paper offers useful orders of magnitude of how much can be lost for resource-rich countries in terms of income tax. A solution already implemented in Alberta, Canada, would be the implementation of a progressive production tax, whose rate would increase with the market price of this commodity. Such an instrument could reduce base erosion risks while being less distortive than a regular production tax.

These results are particularly important today in the wake of policy debates around excess profit taxes after the 2022 surge in gas prices. Many resource-rich countries have implemented progressive taxation on corporate income of extractive firms to capture a higher share of the extractive rent in times of high commodity prices - among others, the Democratic Republic of the Congo, Colombia, Chile, Peru, South Africa, and the United Kingdom. Shifting of windfall profits might undermine these initiatives.

Future research could take advantage of the availability of new administrative microdata in developing countries to analyze the revenue effects of windfall taxes in a context of imperfect enforcement, and analyze in more depth the specific mechanisms linked to profit shifting in the extractive sector.

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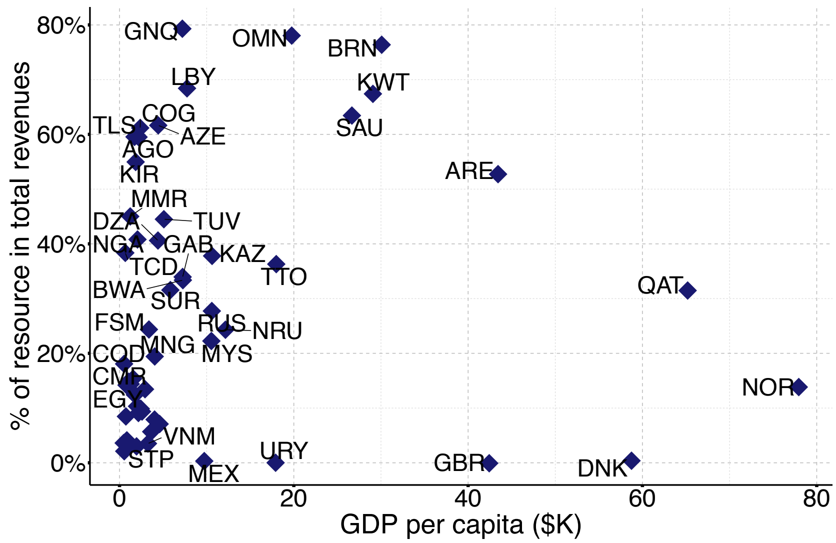
Appendix

A Extractive sectors: context

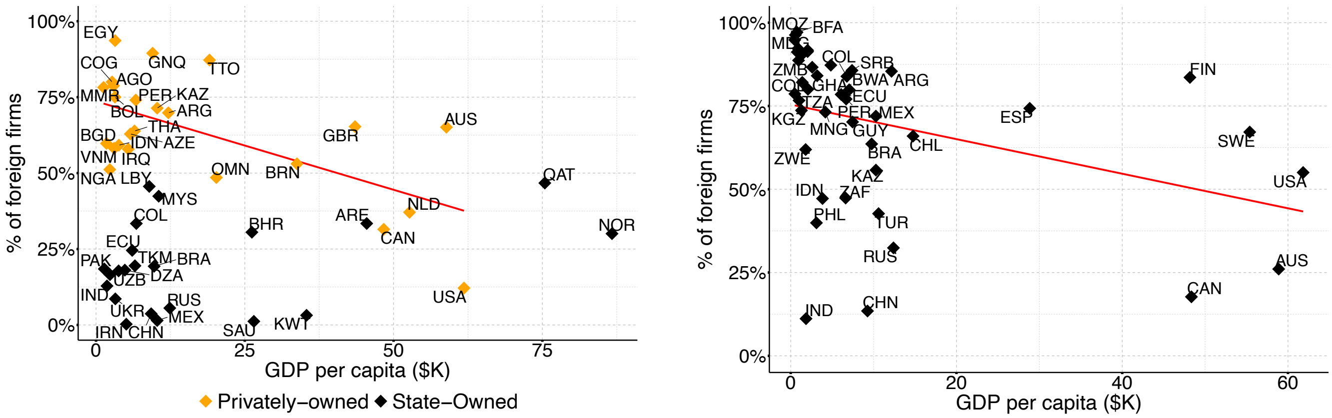
Figure A1: Share of resource revenues in total revenues and GDP per capita



Sources: World Bank (GDP per capita) & UNU Wider Government Revenues Dataset. Revenues exclude social security contributions.
Notes: Between 2016 and 2022, payments from the extractive sectors made up 60% of total tax revenues of the country, excluding social security contributions.

Figure A2: Production ownership and GDP per capita

(a) Oil & gas (b) Mining



Sources: Rystad Upstream & S&P Metals and Mining.

Notes: Selection of countries producing more than 500M barrels per year or having more than 50 mines. Countries falling under the category "National Companies" have more than 50% of their production made by state-owned companies. .

Figure A3: Project-by-Project Report - An example

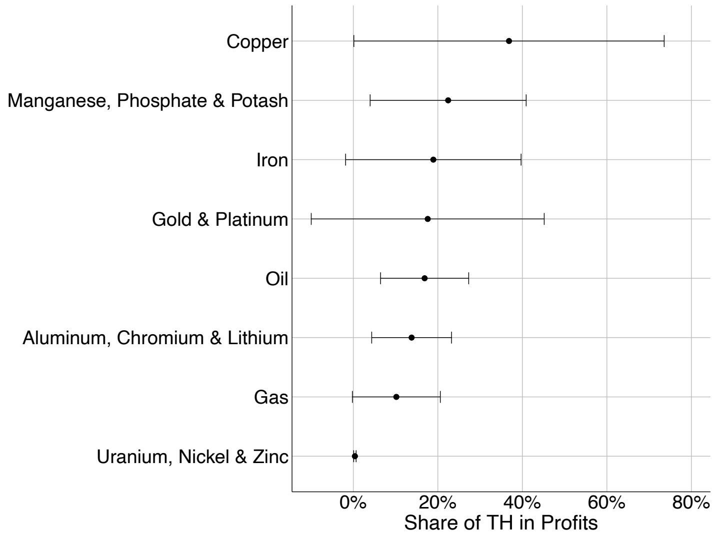
In application of the regulation imposing a disclosure of the value of the total Payments, the table presented herebelow shows the sum of payments done in cash and in kind valuated as indicated in the footnotes

	Income taxes	Other Taxes	Taxes (Total)	Royalties	License fees	License bonuses	Dividends	Infrastructure improvements	Production entitlements	Total of Payments
Nigeria (all payments (kusd) - including valuation of in-kind payments)										
Payments per Project										
OML58 (joint venture with NNPC, operated)	*43,382*	–	43,382	–	–	–	–	–	–	43,382
OML99 (joint venture with NNPC, operated)	*106,952*	–	106,952	–	–	–	–	–	–	106,952
OML100 (joint venture with NNPC, operated)	*20,519*	–	20,519	–	–	–	–	–	–	20,519
OML102 (joint venture with NNPC, operated)	*148,049*	–	148,049	–	–	–	–	–	–	148,049
OML118 (Bonga)	*73,650*[a]	*55,335*[b]	128,985	–	217[c]	–	–	3,775	94,107[d]	227,084
OML130 PSA (Akpo & Egina)	*446,226*	*63,624*	509,850	–	2,006	63,991	–	8,399	–	584,246
OML138 (Usan)	*6,077*	*25,279*[e]	31,356	–	1,735[f]	–	–	1,466	19,115[g]	53,672
Joint ventures with NNPC, operated - Non-attributable	–	–	–	–	4,215	–	–	10,241	–	14,456
Joint ventures with NNPC, non operated - Non-attributable	*90,369*	–	90,369	–	1,926	–	–	10,273	–	102,568
Non-attributable	*251,528*[h]	–	251,528	–	–	–	–	–	–	251,528
Total	***1,186,752***	***144,238***	**1,330,990**	**–**	**10,099**	**63,991**	**–**	**34,154**	**113,222**	**1,552,456**

Notes: This example is taken from Totalenergies report of 2022 published on the company website.

B Descriptive statistics

Figure B1: Average share of tax haven in non-extractive profits



Lecture: This graph shows the average share of tax havens in total profits by specialization and confidence intervals.

Notes: Some commodities are grouped for confidentiality reasons.

Figure B2: Average share of tax haven in non-extractive profits

Lecture: This graph shows the evolution of the share of tax havens in non-extractive positive profits of MNEs specialized in oil and the price of crude oil.

Notes: The correlation at the MNE level between the share of tax havens in positive profits and crude oil prices is 0.13.

Table B1: Summary Statistics - CBCR data

Year	MNEs (Nb)	Countries (Nb)	MNE×Country	Sales ($bn)	Profits ($bn)	Employees (th)
2016	38	194	1,700	1,465.1	-5.0	1,559.2
2017	46	198	2,000	1,885.5	145.8	2,023.7
2018	39	196	1,700	1,915.5	211.1	1,704.7
2019	46	189	1,800	1,930.2	117.7	1,727.9
2020	22	171	800	692.9	-39.4	755.4
2021	24	168	800	994.6	221.0	760.1
2022	22	167	800	1,254.3	286.2	714.3
2023	19	151	700	1,070.6	223.0	691.7
2016-2023	73	198	1,300	1,401.1	145.0	1,242.1

Notes: This table shows the distribution of the main variables in our CbCR sample.
Lecture: in 2016, there are 38 MNEs in our sample, present in 194 countries, generating 1,465.1 billion US$ in sales, -5 in profits, and have in total 1,559.2 employees in full-time equivalent.

Table B2: Summary Statistics by Country

	Profits		Taxes		Sales		Employees		MNEs	
	($bn)	(%)	($bn)	(%)	($bn)	(%)	(th)	(%)	(Nb)	(%)
Australia	234.6	23.2	68.4	17.6	815.6	3.6	624.4	6.8	55	2.7
Norway	205.4	20.3	103.4	26.6	610.7	2.7	158.0	1.7	36	1.7
United Arab Emirates	55.1	5.4	43.2	11.1	335.3	1.5	13.7	0.1	27	1.3
Singapore	48.5	4.8	1.8	0.5	2,306.8	10.3	94.0	1.0	52	2.5
Switzerland	47.9	4.7	3.7	1.0	1,061.4	4.7	18.2	0.2	38	1.8
Colombia	43.5	4.3	11.7	3.0	136.1	0.6	113.2	1.2	30	1.4
Chile	37.5	3.7	6.5	1.7	119.0	0.5	209.0	2.3	27	1.3
Nigeria	35.8	3.5	22.8	5.9	125.9	0.6	67.6	0.7	19	0.9
United States	35.0	3.5	-1.7	-0.4	4,604.4	20.5	1,151.4	12.5	61	2.9
South Africa	31.9	3.1	5.6	1.4	274.3	1.2	529.6	5.7	36	1.7
Netherlands	29.8	2.9	4.9	1.2	1,032.6	4.6	165.9	1.8	56	2.7
Malaysia	28.6	2.8	7.6	2.0	184.0	0.8	184.1	2.0	33	1.6
Spain	24.8	2.4	4.0	1.0	1,046.4	4.7	275.3	3.0	36	1.7
Kazakhstan	19.6	1.9	3.6	0.9	64.5	0.3	228.6	2.5	20	1.0
Denmark	17.7	1.7	4.5	1.2	122.6	0.5	53.6	0.6	27	1.3
Egypt	16.3	1.6	6.8	1.7	67.6	0.3	30.6	0.3	18	0.9
Thailand	14.2	1.4	5.2	1.3	124.7	0.6	61.3	0.7	27	1.3
Belgium	12.4	1.2	1.6	0.4	530.3	2.4	186.8	2.0	37	1.8
Indonesia	12.3	1.2	5.5	1.4	58.5	0.3	65.0	0.7	36	1.7
China	11.1	1.1	2.0	0.5	146.8	0.7	165.5	1.8	47	2.3
Japan	10.5	1.0	2.5	0.6	343.3	1.5	539.0	5.8	41	2.0
Germany	8.7	0.9	6.1	1.6	1,046.3	4.7	308.7	3.3	46	2.2
United Kingdom	8.2	0.8	20.4	5.2	2,616.9	11.6	457.3	5.0	56	2.7
Bermuda	5.7	0.6	0.2	0.0	19.1	0.1	0.2	0.0	26	1.3
South Korea	4.3	0.4	1.0	0.2	92.0	0.4	72.4	0.8	36	1.7
Russia	3.8	0.4	1.4	0.4	62.3	0.3	130.2	1.4	32	1.5
Philippines	3.6	0.4	1.3	0.3	45.3	0.2	81.8	0.9	28	1.4
Gabon	3.4	0.3	2.2	0.6	26.6	0.1	35.3	0.4	20	1.0
Ghana	3.2	0.3	1.2	0.3	22.5	0.1	35.6	0.4	16	0.8
World	1,160.4	100.0	472.4	100.0	23,678.1	100.0	9,937.0	100.0	73	100.0

Notes: This table shows for each country the amounts of total profits, taxes, sales, employees and MNEs in our sample for each country, as well as the share in the whole sample.
Lecture: MNEs in our sample have generated $234.6bn of profits over 2016-2023, which amounts to 23.2% of all the profits in our dataset.

Table B3: Summary Statistics - PbPR data

Year	Nb Firms	Nb Countries	Nb Projects	Payments			
				Royalties ($bn)	Taxes ($bn)	Other ($bn)	Total ($bn)
2016	583	140	4,430	24.0	77.0	67.0	144.0
2017	637	142	4,775	29.8	114.5	84.6	199.1
2018	680	137	5,075	37.8	163.2	111.1	274.3
2019	628	141	4,912	33.6	156.5	86.4	242.9
2020	639	135	4,362	19.3	87.7	55.0	142.7
2021	634	128	3,968	28.8	82.7	76.1	158.7
2022	648	124	3,913	49.7	192.3	119.1	311.4
2023	686	119	4,112	66.7	198.7	137.3	336.1
2016-2023	**1,200**	**157**	**12,178**	**36.2**	**134.1**	**92.1**	**226.1**

Notes: This table describes the information contained in our PBPR dataset each year. The last line shows the total number of firms, countries and extractive projects appearing in our sample, and the yearly average payments made by firms in our sample.

Table B4: Coverage of PBPR

Year	Oil Production			Mining Production			Global Profits		
	Sample ($bn)	World ($bn)	Share (%)	Sample ($bn)	World ($bn)	Share (%)	Sample ($bn)	World ($bn)	Share (%)
2016	336	485	69.3	187	320	58.3	2,219	4,248	52.2
2017	418	600	69.7	216	365	59.0	2,775	5,308	52.3
2018	523	762	68.6	220	390	56.5	4,904	7,985	61.4
2019	485	721	67.4	227	386	58.8	4,575	7,450	61.4
2020	290	467	62.0	253	415	60.8	3,482	5,674	61.4
2021	468	812	57.6	332	554	60.0	3,083	6,696	46.0
2022	666	1,149	58.0	300	505	59.5	4,223	8,878	47.6
2023	530	909	58.3	302	463	65.2	4,273	8,294	51.5
2016-2023	**464**	**738**	**62.9**	**255**	**425**	**59.9**	**3,692**	**6,817**	**54.2**

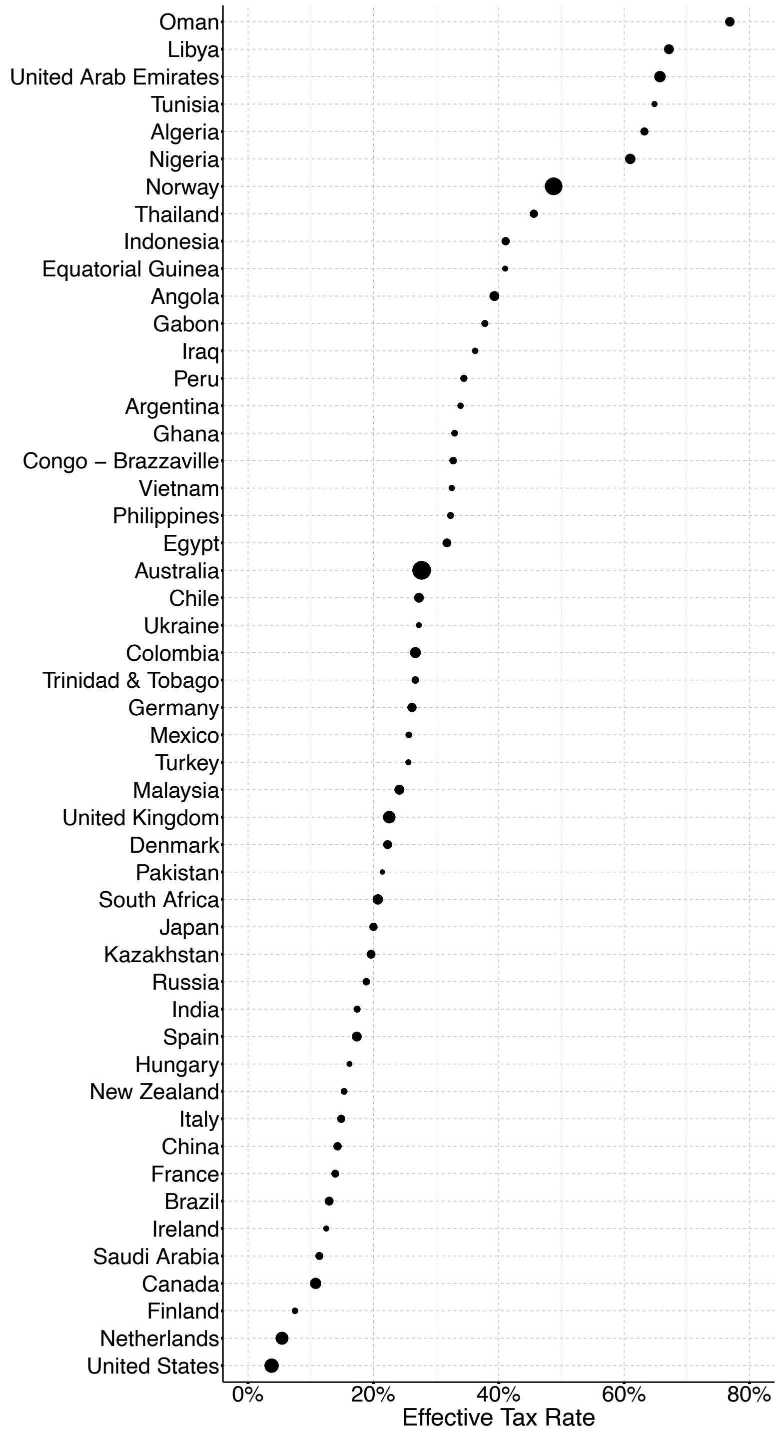
Sources: Rystad Upstream for oil & gas production, S&P Metals and Mining for mining production, Compustat Northam and Global for global profits.
Lecture: In 2016, MNEs in our sample produced $619bn worth of oil, gas & NGL, which makes up 35.3% of global production.
Notes: The benchark includes all production of oil, gas and minerals, including production made by state-owned corporations and non-MNEs.

Table B5: Coverage of Compustat

Year	**Oil Production**		**Mining Production**		**Total Production**	
	World ($bn)	Share (%)	World ($bn)	Share (%)	World ($bn)	Share (%)
2016	371.4	72	483.5	75	855.0	74
2017	433.1	73	598.2	76	1,031.2	75
2018	465.0	73	759.2	76	1,224.2	75
2019	448.8	74	717.9	76	1,166.7	75
2020	461.4	76	465.7	75	927.1	75
2021	611.4	76	809.3	74	1,420.6	75
2022	605.1	75	1,144.2	74	1,749.3	75
2023	541.2	76	904.3	74	1,445.5	75
2016-2023	**735.3**	**75**	**492.2**	**75**	**1,227.5**	**75**

Lecture: In 2016, non state-owned MNEs produced $371bn worth of minerals, of which Compustat covers 72%.
Notes: The benchark includes all production of oil, gas and minerals, made by non state-owned MNEs.

Figure B3: Effective tax rates of extractive affiliates by country



Notes: This figure shows the effective tax rates by country for the top 50 countries in our sample in terms of aggregate profits. The effective tax rate is computed as the ratio between the sum of tax accrued and the sum of profits generated in the country in extractive affiliates only. Extractive affiliates are defined at the MNE × country level and can thus include non-extractive activity. The size of the points is proportional to the sum of profits generated in each country over the period in our dataset. It excludes observations with negative profits or negative tax accrued. We also removed countries with fewer than 5 MNEs operating due to confidentiality reasons.

C Robustness and other results

Table C1: Elasticity of consolidated profits to commodity prices

	Profit (log)		Sales (log)	
	(1)	(2)	(3)	(4)
$P_{g(p)t}$ (log)	1.38***	1.28***	0.488***	0.439***
	(0.143)	(0.155)	(0.101)	(0.072)
Employees (log)		0.071		0.389***
		(0.179)		(0.070)
Assets (log)		0.512***		0.571***
		(0.146)		(0.093)
Observations	2,228	1,752	3,752	2,886
R^2	0.90489	0.90797	0.95808	0.97890
Within R^2	0.06539	0.09986	0.01790	0.33303
Year fixed effects	✓	✓	✓	✓
Group fixed effects	✓	✓	✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on consolidated profits using Compustat data. The outcome variables are consolidated profits and consolidated sales in US dollars. Standard Errors are clustered at the MNE level.

Alternative price shock definition

To take into account the fact that firms might specialize in different commodities, we use alternative measures of shocks. In particular, we compute a weighted index taking into account the share of each commodity in total production as follows:

$$P_{g(p)t} = \sum_p \log(P_{p,t}) \times \omega_{g,p} \tag{10}$$

Where P_{pt} represents the price in USD per ton of product p. The weight $\omega_{g,p}$ represents the share of the commodity p in total production volume for the years 2008-2012 for the oil & gas sector.[26] For groups specialized in mining, we use the number of mines extracting commodity p in total mines of the group, as we have only partial information on production. The results are displayed in C3. It shows that our results hold, even though they are less precisely estimated.

[26] All production is converted into barrel equivalents.

Table C2: Instrumental Variable Regression - First Stage

	Consolidated Profits	
	(1)	(2)
$P_{g(p)t}$ (log)	$1.27 \times 10^{10***}$	$1.2 \times 10^{10**}$
	(0.1)	(0.0)
Firm Controls		✓
Observations	248	248
R^2	0.63575	0.63975
Within R^2	0.04997	0.06039
MNE fixed effects	✓	✓
Year fixed effects	✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on the level of consolidated MNEs profits. Prices are log transformed. Standard errors are clustered at the MNE level. Firm controls include the log of the number of employees and the log of tangible assets.

Table C3: Baseline Results with Weighted Average Prices

	Profits (log)				
	(1)	(2)	(3)	(4)	(5)
$P_{g(p)t}$ (log)	0.663***	0.253	0.241		
	(0.223)	(0.251)	(0.250)		
$Extract_{gi} \times P_{g(p)t}$ (log)		1.38***	1.41***	1.43***	1.46***
		(0.266)	(0.275)	(0.257)	(0.268)
$Haven_i \times P_{g(p)t}$ (log)		0.420*	0.471**	0.532**	0.580**
		(0.238)	(0.235)	(0.225)	(0.225)
$Haven_i \times Extract_{gi} \times P_{g(p)t}$ (log)			-0.982*		-0.885*
			(0.507)		(0.517)
Employees (IHS)	0.242***	0.240***	0.240***	0.249***	0.249***
	(0.069)	(0.070)	(0.070)	(0.062)	(0.062)
Tang Assets (IHS)	0.072**	0.076**	0.076**	0.050***	0.050***
	(0.032)	(0.032)	(0.032)	(0.017)	(0.017)
Observations	5,237	5,237	5,237	5,237	5,237
R^2	0.92724	0.92844	0.92846	0.94033	0.94035
Within R^2	0.06875	0.08411	0.08438	0.06815	0.06841
MNE-Country fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓		
MNE-Year fixed effects				✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on unconsolidated profits, using an alternative measure of price shocks, here defined as the average commodity price weighted by the share of total production value of the MNE pre-period. Prices and the outcome variable are log transformed. Standard errors are clustered at the MNE level.

Table C4: Baseline - Total Sales

	Sales (log)				
	(1)	(2)	(3)	(4)	(5)
$P_{g(p)t}$ (log)	0.358*	0.248	0.231		
	(0.206)	(0.223)	(0.218)		
$Extract_{gi} \times P_{g(p)t}$ (log)		0.283	0.324*	0.157	0.205
		(0.192)	(0.194)	(0.197)	(0.194)
$Haven_i \times P_{g(p)t}$ (log)		0.159	0.231	0.073	0.153
		(0.161)	(0.173)	(0.166)	(0.173)
$Haven_i \times Extract_{gi} \times P_{g(p)t}$ (log)			-1.40		-1.50*
			(0.900)		(0.859)
Employees (IHS)	0.438***	0.438***	0.438***	0.410***	0.409***
	(0.106)	(0.106)	(0.106)	(0.112)	(0.111)
Tang Assets (IHS)	0.076***	0.076***	0.076***	0.064***	0.063***
	(0.028)	(0.028)	(0.029)	(0.021)	(0.021)
Observations	7,670	7,670	7,670	7,670	7,670
R^2	0.93089	0.93094	0.93097	0.93960	0.93964
Within R^2	0.13366	0.13421	0.13458	0.11431	0.11480
MNE-Country fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓		
MNE-Year fixed effects				✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on unconsolidated total sales, including both intra-group and intra-group sales. Prices and the outcome variable are log transformed. Standard errors are clustered at the MNE level.

Table C5: Baseline - Intra-Group Sales

	Intra-Group Sales (log)				
	(1)	(2)	(3)	(4)	(5)
$P_{g(p)t}$ (log)	0.427*	0.226	0.216		
	(0.224)	(0.302)	(0.299)		
$Extract_{gi} \times P_{g(p)t}$ (log)		0.500*	0.523*	0.510*	0.534*
		(0.268)	(0.272)	(0.291)	(0.294)
$Haven_i \times P_{g(p)t}$ (log)		0.244	0.282	0.196	0.236
		(0.380)	(0.366)	(0.383)	(0.371)
$Haven_i \times Extract_{gi} \times P_{g(p)t}$ (log)			-0.666		-0.663
			(0.709)		(0.729)
Employees (IHS)	0.382***	0.381***	0.380***	0.366***	0.365***
	(0.122)	(0.124)	(0.123)	(0.130)	(0.129)
Tang Assets (IHS)	0.044*	0.045*	0.045*	0.035*	0.035*
	(0.024)	(0.024)	(0.024)	(0.018)	(0.018)
Observations	6,125	6,125	6,125	6,125	6,125
R^2	0.92701	0.92716	0.92717	0.93501	0.93502
Within R^2	0.07581	0.07766	0.07777	0.06490	0.06502
MNE-Country fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓		
MNE-Year fixed effects				✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on unconsolidated intra-group sales. Prices and the outcome variable are log transformed. Standard errors are clustered at the MNE level.

Table C6: Baseline - Extra-Group Sales

	Extra-Group Sales (log)				
	(1)	(2)	(3)	(4)	(5)
$P_{g(p)t}$ (log)	0.140	0.040	0.037		
	(0.231)	(0.251)	(0.255)		
$Extract_{gi} \times P_{g(p)t}$ (log)		0.304^{*}	0.312^{*}	0.247	0.256
		(0.173)	(0.183)	(0.178)	(0.188)
$Haven_i \times P_{g(p)t}$ (log)		-0.005	0.010	-0.124	-0.107
		(0.275)	(0.291)	(0.287)	(0.305)
$Haven_i \times Extract_{gi} \times P_{g(p)t}$ (log)			-0.266		-0.282
			(0.717)		(0.580)
Employees (IHS)	0.436^{***}	0.436^{***}	0.436^{***}	0.391^{***}	0.391^{***}
	(0.117)	(0.118)	(0.118)	(0.112)	(0.112)
Tang Assets (IHS)	0.096^{***}	0.096^{***}	0.096^{***}	0.083^{***}	0.083^{***}
	(0.032)	(0.032)	(0.032)	(0.023)	(0.023)
Observations	6,891	6,891	6,891	6,891	6,891
R^2	0.93256	0.93260	0.93260	0.94081	0.94081
Within R^2	0.13016	0.13071	0.13073	0.10746	0.10747
MNE-Country fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓		
MNE-Year fixed effects				✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on unconsolidated extra-group sales. Prices and the outcome variable are log transformed. Standard errors are clustered at the MNE level.

Table C7: Gains versus Losses

	Profits (log)	|Losses| (log)	Profit-to-Employee		Profit (IHS)	
	(1)	(2)	(3)	(4)	(5)	(6)
$P_{g(p)t}$ (log)	0.171	0.187	-169,684.0	1,570.4	-0.767*	-0.790**
	(0.231)	(0.379)	(1,529,628.1)	(1,450,696.7)	(0.443)	(0.368)
$P_{g(p)t}$ (log) $\times$ Gains_{git}				119,756.7**		0.495***
				(58,674.6)		(0.091)
Extract_{gi} $\times$ $P_{g(p)t}$ (log)	1.47***	-0.418	8,751,232.7***	7,072,696.1***	4.42***	2.65***
	(0.255)	(0.297)	(2,877,812.3)	(2,447,768.3)	(0.823)	(0.523)
Extract_{gi} $\times$ $P_{g(p)t}$ (log) $\times$ Gains_{git}				854,520.0*		0.663***
				(463,747.2)		(0.197)
Haven_i $\times$ $P_{g(p)t}$ (log)	0.532**	-0.019	6,464,012.2	4,936,825.4	0.672	0.552*
	(0.255)	(0.507)	(6,668,326.5)	(6,247,002.2)	(0.498)	(0.319)
Haven_i $\times$ $P_{g(p)t}$ (log) $\times$ Gains_{git}				1,862,683.8**		0.137**
				(738,144.4)		(0.061)
Employees (IHS)	0.225***	0.397***	-4,055,761.9	-4,132,929.7	0.069*	-0.071
	(0.068)	(0.083)	(3,640,659.8)	(3,654,886.5)	(0.037)	(0.069)
Tang Assets (IHS)	0.069**	0.049**	228,041.5	223,098.5	-0.010	-0.019*
	(0.032)	(0.019)	(318,078.7)	(313,597.8)	(0.013)	(0.010)
Observations	5,287	3,458	7,087	7,087	9,371	9,371
R^2	0.92905	0.88449	0.45394	0.45888	0.61347	0.77908
Within R^2	0.07724	0.09272	0.01585	0.02475	0.03025	0.44574
MNE-Country fixed effects	✓	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓	✓	✓

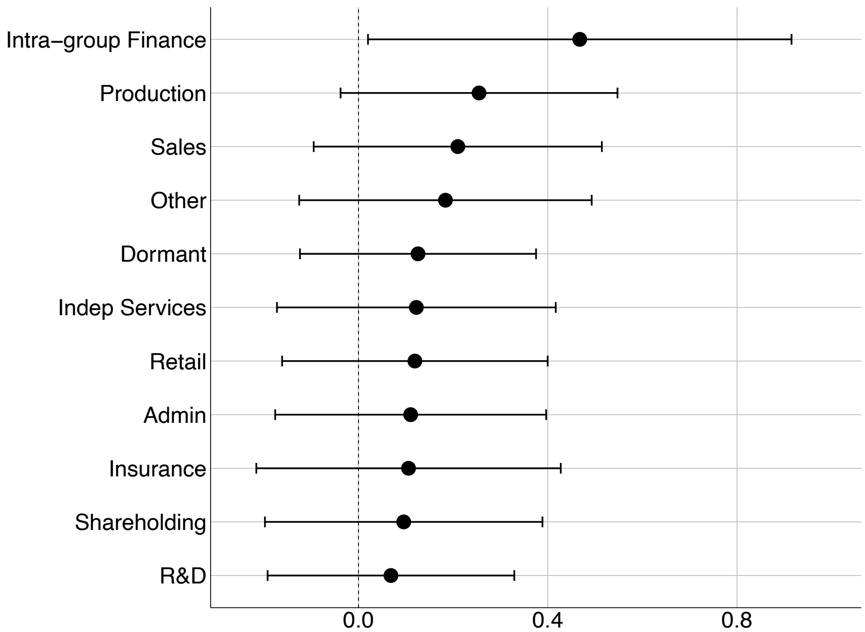
Notes: This table summarizes our estimates of the effects of commodity prices on unconsolidated profits in times of positive profits and in times of losses. Prices and the outcome variable are log transformed. Standard errors are clustered at the MNE level.

Table C8: Effects of prices during price increases/decreases

	Profits (log)			
	(1)	(2)	(3)	(4)
$P_{g(p)t}$ (log)	0.648***	0.058		
	(0.226)	(0.196)		
$P_{g(p)t}$ (log) $\times$ Increase_t		0.005		-0.064
		(0.011)		(0.306)
Extract_{gi} $\times$ $P_{g(p)t}$ (log)		1.50***	1.53***	1.49***
		(0.277)	(0.254)	(0.317)
Extract_{gi} $\times$ $P_{g(p)t}$ (log) $\times$ Increase_t		-0.007		-0.069
		(0.017)		(0.312)
Haven_i $\times$ $P_{g(p)t}$ (log)		0.690***	0.711***	0.762***
		(0.252)	(0.213)	(0.221)
Haven_i $\times$ $P_{g(p)t}$ (log) $\times$ Increase_t		-0.006		-0.002
		(0.013)		(0.013)
Employees (IHS)	0.230***	0.262***	0.237***	0.239**
	(0.067)	(0.096)	(0.061)	(0.103)
Tang Assets (IHS)	0.066**	0.047**	0.045***	0.044**
	(0.032)	(0.022)	(0.016)	(0.021)
Observations	5,209	3,790	5,209	3,790
R^2	0.92796	0.94431	0.94101	0.94734
Within R^2	0.06043	0.07589	0.06470	0.06220
MNE-Country fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓		
MNE-Year fixed effects			✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on unconsolidated profits in times of price increases and decreases. Prices and the outcome variable are log transformed. Standard errors are clustered at the MNE level.

Figure C1: Profit price-elasticity by primary activity



Notes: Each coefficient is the coefficient associated with the interaction of the MNE-specific commodity price with a set of dummy variables indicating primary activity of the MNE × country. Primary activity is defined as the activity with the largest number of subsidiaries. The reference point is intellectual property leasing. Regression includes controls for the IHS of the number of employees and assets, fixed effects at the group-country and group-year level. Standard errors clustered at the group level.

Table C9: Robustness - PPML estimator

	Profits				
	(1)	(2)	(3)	(4)	(5)
$P_{g(p)t}$ (log)	0.992***	-0.198	-0.661		
	(0.218)	(0.474)	(0.410)		
$\text{Extract}_{gi} \times P_{g(p)t}$ (log)		1.30***	1.78***	1.18***	1.80***
		(0.431)	(0.429)	(0.332)	(0.251)
$\text{Haven}_i \times P_{g(p)t}$ (log)		1.18*	1.84***	0.828	1.61***
		(0.651)	(0.488)	(0.613)	(0.341)
$\text{Haven}_i \times \text{Extract}_{gi} \times P_{g(p)t}$ (log)			-2.66***		-2.99***
			(0.684)		(0.636)
Employees (IHS)	-0.034	-0.037	-0.040	0.026	0.024
	(0.038)	(0.039)	(0.038)	(0.081)	(0.080)
Tang Assets (IHS)	0.072**	0.073**	0.074**	0.053**	0.054**
	(0.032)	(0.032)	(0.032)	(0.022)	(0.022)
Observations	5,389	5,389	5,389	5,389	5,389
Pseudo R^2	0.93773	0.93899	0.93976	0.95970	0.96061
MNE-Country fixed effects	✓	✓	✓	✓	✓
Year fixed effects	✓	✓	✓		
MNE-Year fixed effects				✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on unconsolidated profits using a poisson estimator. Standard errors are clustered at the MNE level.

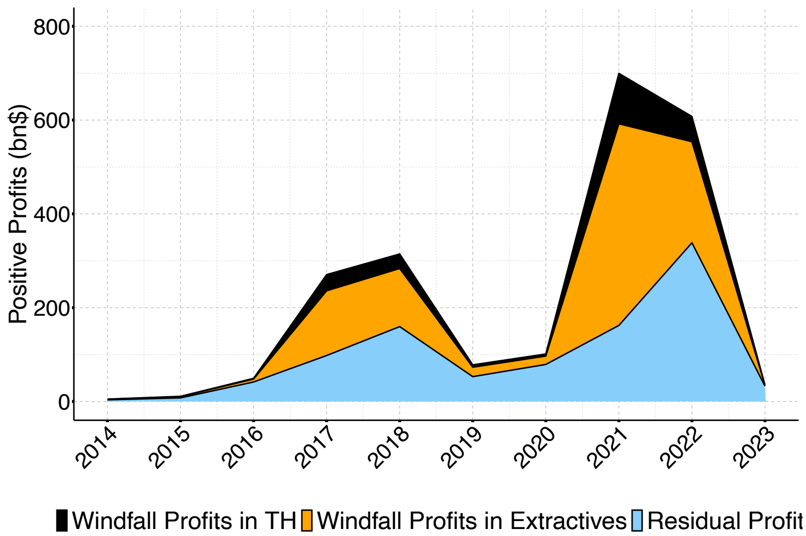
Table C10: Winsorized and Balanced Sample

	Winsorized Profits (log)		Balanced Sample Profits (log)	
	(1)	(2)	(3)	(4)
$P_{g(p)t}$ (log)	0.621***	0.160	0.522*	-0.066
	(0.228)	(0.243)	(0.275)	(0.286)
$\text{Extract}_{gi} \times P_{g(p)t}$ (log)		1.46***		1.82***
		(0.262)		(0.334)
$\text{Haven}_{i} \times P_{g(p)t}$ (log)		0.526**		0.971**
		(0.257)		(0.366)
Employees (IHS)	0.232***	0.228***	0.312***	0.306***
	(0.067)	(0.067)	(0.066)	(0.070)
Tang Assets (IHS)	0.066**	0.068**	0.002	0.004
	(0.032)	(0.032)	(0.025)	(0.026)
Observations	5,209	5,209	2,787	2,787
R^2	0.92778	0.92909	0.93569	0.93705
Within R^2	0.06087	0.07781	0.04736	0.06744
MNE-Country fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓

Notes: This table summarizes our estimates of the effects of commodity prices on unconsolidated profits with a sample winsorized at the 1% level each year, and a balanced sample (with the same number of MNEs throughout the period). Standard errors are clustered at the MNE level.

D Magnitudes

Figure C2: Windfall Profits Estimation



Notes: This graph shows the evolution of global positive profits of extractive firms worldwide split between our windfall profits estimation and the residual profits.

E Data Appendix

Cleaning of double counting in CbCR data

Due to the initial unclear guidance of the OECD between 2016 and 2020, intra-firm payments of dividends are not always eliminated from country-by-country reports. As an illustration, income from a subsidiary located in Germany that is distributed to a holding company in Switzerland could be counted both in the profit measures of the German and the Swiss subsidiaries. This double-counting of dividends can distort key indicators of profit shifting, artificially inflating reported profits and leading to underestimations of effective tax rates, as dividends are generally not taxed under corporate income tax. Therefore, it is crucial to correct this double-counting of equity income, which might be particularly salient for fiscal years prior to 2020 (Delpeuch et al., 2019; Horst and Curatolo, 2020; Blouin and Robinson, 2023). We correct our data by matching CbCR data to consolidated financial statements from Orbis and Compustat. The amount of double-counted profits is then defined as the difference between profits reported in CbCRs and consolidated data for each MNE. Table C11 shows the number of MNEs we correct each year and the amounts involved.

To allocate double-counting within MNEs, we use the information they disclose on the business activities of their subsidiaries. From this data, we know where MNEs locate their holding companies, and hence where dividends are susceptible to being sent. For each MNE, we select countries in which MNEs have a holding company as well as the headquarter countries, where dividends are usually repatriated, and remove a share of double-counted dividends for each MNE $\times$ country equal to the share of profits in this country in all profits of all countries having a holding company or hosting the headquarters.

Table C11: Double Counting per year

Year	MNEs (Nb)	Intra-Group Dividends ($bn)	Uncorrected Profits ($bn)	Corrected Profits ($bn)	Dividends/Uncorrected Profits (%)
2016	7	39.4	343.5	-50.3	11.5
2017	15	44.6	1,904.4	1,458.3	2.3
2018	11	67.4	2,785.1	2,110.8	2.4
2019	8	48.1	1,657.9	1,177.0	2.9
2020	0	0.0	-393.6	-393.6	0.0
2021	0	0.0	2,241.7	2,241.7	0.0
2022	0	0.0	2,861.7	2,861.7	0.0
2023	0	0.0	2,230.2	2,230.2	0.0

Lecture: In 2016, 7 MNEs double counted their intra-group dividends. Intra-group dividends represented $39.4bn in total, or 11.5% of total reported profits.

Project-by-Project data construction

Our main source of data is Resource Project, an open platform gathering the data of extractive CbCR filings publicly available, produced by the Natural Resource Governance Institute.The platform provides per-project payment details, as well as complementary information on the firm and project: headquarters location, filing jurisdiction, and product extracted. The actualization of this platform stopped after 2020: the resulting database covers the years 2016-2019 with a partial coverage of the last year. To complement this dataset, we gather filings provided online by the Canadian and the United Kingdom's administrations.[27] For the remaining firms not filing under these two jurisdictions, we collected and standardized their extractive CbCR filings, publicly available on their websites. To harmonize all sources, we fuzzily matched the names of firms and matched the remaining ones by hand. We do the same for extractive projects within each firm. We check the project match by allowing for limited differences in reported payment between Resource Project and the complementary sources. The administrative sources and the firms' reports do not provide information on the extracted product. For projects and firms not included in the Resource Project database, we deduced information on the product either from group specialization or the project name when possible. A companion paper (Blanc et al., 2025) gives more details on the construction and harmonization of the different sources, as well as more descriptive statistics on extractive tax payments.

[27] Source data available here and here.

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