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Mineral Wealth and Offshore Accounts: Evidence from the Panama Papers

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Mineral Wealth and Offshore Accounts: Evidence from the Panama Papers

Archana Subramaniam[*]

Abstract

This paper studies the effect of mineral price shocks on the probability of offshore incorporations in tax-havens. Since offshore accounts are widely tied to rent-seeking and corruption in the natural resource sector, we use these observed effects to gain insight into patterns of rent-seeking in mineral dependent countries. We construct a novel dataset that combines monthly data on the incorporation of offshore accounts from the Panama Papers with information about a country's mineral endowments and monthly world mineral prices. Using a fixed-effects linear probability model, we find that that a large price increase has a positive effect on probability of offshore incorporations in subsequent months, in mineral dependent countries. This effect is stronger in countries with weak institutional quality and higher levels of foreign ownership of mines. We deviate from previous work through our focus on the effects of mineral rents rather than petroleum rents and through our introduction of ownership structure as a key variable of importance.

Keywords: Resource curse; Mining; Offshore entities; Panama papers; Corruption.

JEL classifications: D72, D73, O13, Q32, Q33

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Online appendix: https://github.com/sodalabsio/mining_panama_papers/blob/main/Appendix/Appendix%20-%20Subramaniam%20-%20WSP-ESP%20series.docx

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1. Introduction

Countries that are rich in natural resources often experience low levels of long-term growth, despite their natural endowments (Ades & di Tella, 1999; Leite & Weidmann, 1999; Sachs & Warner, 1995). Known in academic literature as the 'resource curse', this paradoxical negative relationship between growth and resource abundance goes against conventional economic wisdom that has held that natural resources can form the basis for long-term economic growth (Badeeb et al., 2017). The proposed curse has been linked to several causal mechanisms including the effect of resource dependence on other forms of capital, the link between resource dependence and de-industrialization and the effect of high resource rents on rent-seeking (see Van der Ploeg (2011) for a summary of the different explanations of the resource curse).

The rent-seeking channel in particular is one that is difficult to empirically observe due to the inherently secretive nature of rent-seeking activities. Studies that look at the effect of resource abundance on corruption and rent-seeking largely use subjective indicators of corruption, usually based on survey data which are affected by cognitive biases (Ades & di Tella, 1999; Bhattacharyya & Hodler, 2010; Leite & Weidmann, 1999; Vicente, 2010). Others use micro-level data, but these focus on the effects of resource windfalls within a single country and lack external validity (Brollo et al., 2013; Vogel, 2020).

As an alternative to traditional indicators of rent-seeking, we exploit one of the largest data leaks in history, the Panama Papers, to gain insight into the effect of mineral windfalls on rent-seeking behaviour. The Panama Papers consists of leaked information on offshore incorporations created in tax-havens globally and includes details on the month and year of incorporation and the country of beneficiaries of these accounts. Investigative studies and a growing body of empirical work have established the role of offshore accounts as key organisational structures that support government corruption and elite capture of resource wealth globally (Andersen et al., 2022; Jancsics, 2017; O'Donovan et al., 2019; Villamil et al., 2022). We combine monthly data on offshore incorporations with data on mineral prices to investigate the effect of mineral windfalls, captured by the exogenous monthly fluctuation in world mineral prices, on the probability of offshore incorporations in countries that produce these minerals. Studies on world mineral prices have shown that fluctuations in mineral prices are largely determined by global demand shocks and since these prices are determined in the world market, they should be exogenous to local factors that might influence the probability of offshore incorporations within countries (Álvarez et al., 2017; M. H. Chen, 2010; Slade, 1982; Stuermer, 2018). In a sample of mineral dependent countries, we find that a mineral price shock increases the probability of offshore incorporations by 2.3 percentage points, six months after the mineral windfall. We calculate the long-run effect of a mineral windfall and find that a mineral windfall increases the probability of offshore incorporations by 6.4 percentage points in the year after a price shock[1].

We investigate how this effect differs across countries with different levels of institutional quality and foreign ownership of mines. We find that in mineral-dependent countries with lower levels of institutional quality, measured using World Bank indicators of rule of law, control of corruption and political stability, mineral windfalls increase the probability of offshore incorporations in that year by 12.2, 10.6 and 12.1 percentage points respectively. In countries with high levels of institutional quality, the effects of mineral windfalls on the probability of offshore incorporations are small and statistically insignificant. We find that in countries with a high level of foreign ownership, a mineral windfall increases the probability of offshore incorporations by 9.5 percentage points in the year after the mineral windfall. In countries with low levels of foreign ownership, there is no statistically significant effect of a mineral windfall on the probability of offshore incorporations in the subsequent months.

2. Background

2.1 Rent-Seeking, Corruption, and the Mining Sector

The term 'rent-seeking' coined by Krueger (1974), refers to a type of behavior first described by Tullock (1967), where resources are used in an unproductive manner to contend for private benefits rather than to generate economic gains. Rent-seeking is closely tied with corruption and although the terms are often used interchangeably in economic literature (Coolidge & Rose-Ackerman, 1995), traditional rent-seeking theory tends to see corruption as a subset of rent-seeking behavior which involves the use of public power to capture private gain (Lambsdorff 2002). There are several models that attempt to explain rent-seeking in the resource sector. The voracity model, put forward by Lane and Tornell (1996) suggests that rent-seeking manifests when the government manipulates the economy to funnel wealth away from the private sector and into the hands of political elite. This can occur through several methods including bribe demands, expropriation, theft, and taxation(Lane & Tornell, 1996).

[1] The unconditional likelihood of at least one offshore incorporation occurring in a month, in the sample of mineral dependent countries (excluding tax-havens and countries with no data on mineral rents) is 0.164. For a sample of all countries in the Panama dataset (excluding tax-havens and countries with no data on mineral rents), this value is 0.179.

The voracity model predicts that if a positive shock impacts the resource sector (e.g. resource price boom), then the rate of return in this sector increases which incentivizes elites to try appropriate gains from this sector (Lane and Tornell 1996). As the loss caused by elites extracting wealth from the resource sector eclipses the wealth initially generated by the positive shock, capital shifts away from the productive resource sector to unproductive sectors, thus resulting in a decline in growth (Deacon & Rode, 2015; Lane & Tornell, 1996). The proposed relationship between rent-seeking and lower GDP growth has been supported by empirical studies that have found that corrupt countries tend to experience lower growth (Aidt et al., 2008; Leite & Weidmann, 1999; Mauro, 1995; Ugur, 2014).

The relationship between natural resource wealth and rent-seeking is believed to be more apparent in, the mining sector compared to other resource sectors (Asher & Novosad, 2021; Vogel, 2020). Revenues from mines generate unusually high rents relative to other resources, which increases politicians' return to rent-seeking in these sectors (Auty, 2002; Vogel, 2020). Since these revenues are "point-source" or concentrated within specific locations, they are further easier to appropriate (Leite & Weidmann 1999, p. 180). Moreover, mines generate fiscal windfalls, independent of any form of taxation, and this increase in government budget makes it easier for political elite to grab rents without displeasing voters (Asher & Novosad, 2021; Brollo et al., 2013; Vogel, 2020).

2.2. Institutional Quality

Economies with strong institutional barriers to rent seeking should not experience the voracity effect to the same extent that economies with weak institutions do (Deacon & Rode, 2015; Lane & Tornell, 1996). In countries with a strong rule of law that punishes corruption, we can expect rent-seeking to be a much costlier endeavor and as a result these countries are likely to exhibit a weaker link between increases in resource wealth and rent-seeking activities (Deacon and Rode 2015; Lane and Tornell 1996). The importance of institutional quality in determining the existence of the resource curse has been backed by empirical evidence. Sala-i-Martin and Subramanian (2003) find that the negative effect of resource abundance on economic growth disappears when the effect of political institutions, proxied by the rule of law index, is controlled for. Mehlum, Moene, and Torvik (2006) find that countries with an Index of Institutional Quality rating of 0.93 or higher, do not seem to experience the resource curse, while countries with lower levels of institutional quality do.

2.3. Foreign Ownership of Mines

The role of foreign or local ownership of resources in determining the extent of rent-seeking activities is not widely studied in the existing resource curse literature. There has been mixed evidence on the effect of large foreign firms on corruption more generally. A portion of the literature suggests that presence of foreign firms in a market should reduce corruption since the increased competition that will ensue as a result will reduce rents received by individual firms in the sector and thus reduce incentives for rent-seeking (Ades & Di Tella 1999). Moreover, as foreign firms enter a domestic market, they may contribute to the spread of norms such as rule of law, property rights protection and democracy that reduce the prevalence of corruption (Sandholtz & Gray, 2003).

Others argue that large foreign firms, especially multinational corporations (MNC) might be able to extract more rents under certain conditions, compared with locally owned firms, and thus contribute to higher levels of corruption (Zhu 2017; Wright and Zhu 2018). A large segment of markets in developing countries are characterised by high-entry barriers and are underexploited since local firms do not have access to the technology or economies of scale to engage in profitable production (Wright & Zhu, 2018). Large MNCs however are able to circumvent these barriers due to their size, capital endowments and expertise and are able to extract oligopolistic profits due to the lack of competition they face (Wright & Zhu, 2018). In corrupt countries, MNCs often work in liaison with local corrupt officials who benefit from access to the high rents received by MNCs. Zhu (2017) finds that provinces in China with more MNC activity tend to be more associated with corruption. Malesky, Gueorguiev, and Jensen (2015) find that foreign firms in Vietnam are more likely to pay bribes in restricted high-rent industries, compared to local firms. Thus, the literature gives ambiguous evidence on the effect of foreign ownership on the relationship between mineral wealth and rent-seeking behaviour.

2.4. Offshore Accounts

Datasets based on offshore accounts are a useful alternative to subjective corruption indexes as they can provide a more objective indication of political rents (Kertiesz et al. 2022; Marcolongo and Zambiasi 2022). Offshore entities are funds, trusts or companies that are registered in tax-havens or jurisdictions with low taxes for foreign investors, typically found in small island countries such as the Cayman Islands or Panama (Köbis & Starke, 2017). Offshore entities in tax havens operate under secrecy and although they can be opened for legal reasons, investigative studies indicate that they are commonly used for the facilitation of embezzlement, money laundering and bribery. (Jancsics, 2017; O'Donovan et al., 2019; Sayne et al., 2017).

Investigative studies conducted by the International Consortium of Investigative Journalists have found strong ties between offshore accounts registered in Panama and corruption in natural resource sectors in Africa (Fitzgibbon, 2016). More than 1400 companies listed in the Panama papers refer to mining, petrol, gas or oil in their names and many of these accounts have been linked back to politicians and those with family or business ties to politicians (Fitzgibbon, 2016). Moreover, thirty-seven companies created by Mossack Fonseca (the firm at the center of the Panama papers data leak) have been involved in either government investigations or court actions linked with natural resources in Africa alone (Fitzgibbon, 2016).

While data on offshore accounts have been used to observe corruption in the oil sector (Andersen et al., 2017; Marcolongo & Zambiasi, 2022), these papers assume oil prices to be exogenous which is questionable since world oil prices is correlated with political risk in OPEC countries (Chen et al., 2016). Moreover, world oil prices tend to be correlated with GDP (Hamilton, 2003), which may introduce endogeneity into these models. World mineral prices on the other hand are less likely to be correlated with GDP and are historically pushed up by global demand (Álvarez et al., 2017; Slade, 1982; Stuermer, 2018). Moreover, unlike studies based on oil, our identification strategy allows us to exploit exogenous variation that does not only vary by time but also by mineral resource.

As far as we are aware, Andersen et al. (2017) are the closest to our approach as they look at the effect of mineral wealth on wealth stored in offshore accounts in a subsection of their paper which primarily focuses on the effects of oil rents on offshore deposits. Instead of the Panama Papers, they use data on cross-border deposits from the Bank of International Settlements (BIS) to investigate how deposits in tax-havens fluctuate in response to resource price booms and how this effect differs in countries with different levels of institutional quality. We differ from their work in that we add an additional layer of heterogeneity analysis and focus on the effect of ownership structure on the relationship between mineral wealth and offshore incorporations.

3. Methodology

3.1. Data and Construction of Key Variables

3.1.1. Offshore Incorporations

We obtain data on offshore incorporations from the 2016 Panama Paper leak provided by the International Consortium of Journalism. This dataset includes information on accounts with beneficiaries in 160 countries, between 1990-2012. The Panama Papers data leak occurred at Mossack-Fonseca, a law firm that was at its peak, the fourth-largest provider of offshore financial services (Alstadsæter et al., 2019). Whilst, the Panama papers is not indicative of all offshore accounts created globally during our period of study, it nevertheless provides a useful insight into a sizeable portion of these entities. A concern noted by others who have worked with the Panama papers and tax-haven related data more generally (Andersen et al., 2017; Bayer et al., 2020; Marcolongo & Zambiasi, 2022) is that offshore accounts may be incorrectly listed as having a beneficiary in a tax haven if these accounts were created by agents in tax-havens on behalf of foreign clients. These accounts may appear to be linked to tax-haven countries, but their true beneficiaries would reside elsewhere which prevents us from being able to accurately ascertain the country from which an offshore account was opened. To remedy this, we follow the convention in existing literature (Andersen et al., 2017; Bayer et al., 2020; Marcolongo & Zambiasi, 2022) and exclude offshore entities that are registered by agents in tax havens from our regression analysis. We consider countries to be tax-havens if they are classified as such by either Hines (2010) or Johannesen & Zucman (2014). This reduces the number of countries in the Panama dataset from 170 to 106 and the number of mineral dependent countries[2] from 32 to 29.

[2] Description of how countries are defined as mineral dependent is included in Section 3.2.

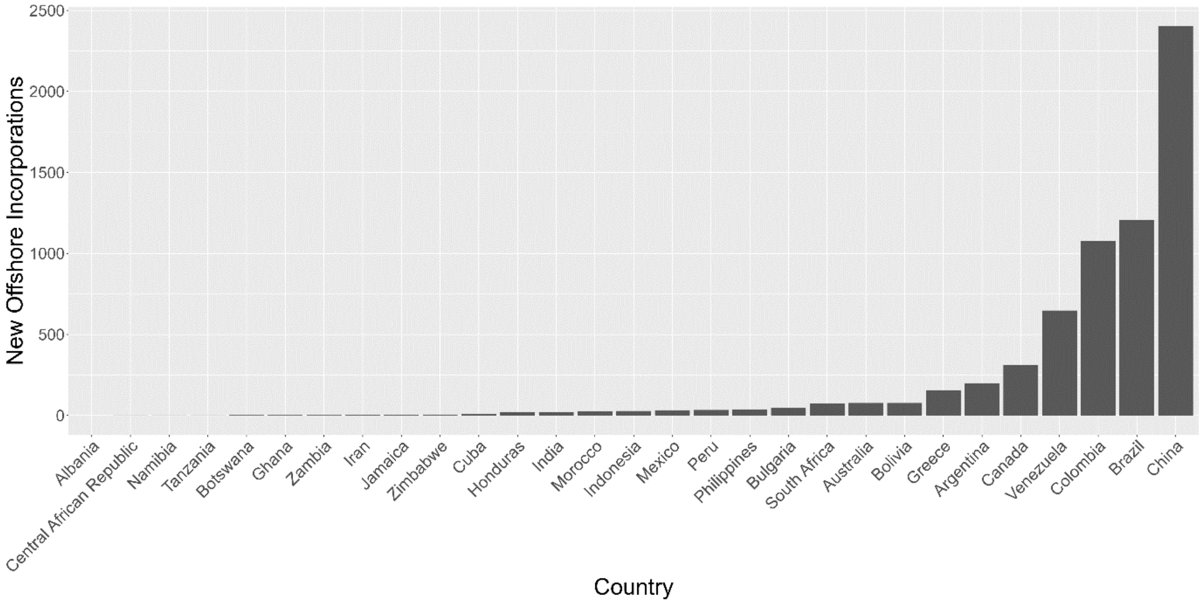


FIGURE 3. New offshore entities incorporated between 1990-2012 in mineral dependent countries. *Note:* Countries classified as tax-havens by Hines (2010) or Johannesen & Zucman (2014) are excluded. Countries that lack data on mineral rents for specific minerals are also excluded. [3]

Figure 3 shows the total number of new offshore entities that were incorporated in each mineral dependent country in our dataset, excluding tax-havens. We see that the number of new offshore incorporations tends to be highly skewed. At the higher end, 2403 new entities were incorporated between 1990-2012 with beneficiaries in China and towards the lower end, Albania had zero new entities in this time period.

3.1.2. Construction of Dependent Variable

Due to the skewness of our data on offshore accounts, we follow Bayer et al. (2020) in using a binary variable, $Offshore_{it}$, that takes the value of one if at least one offshore entity is created in month *t* with a beneficiary in country *i*.

[3] Discussed further in Section 3.1.5

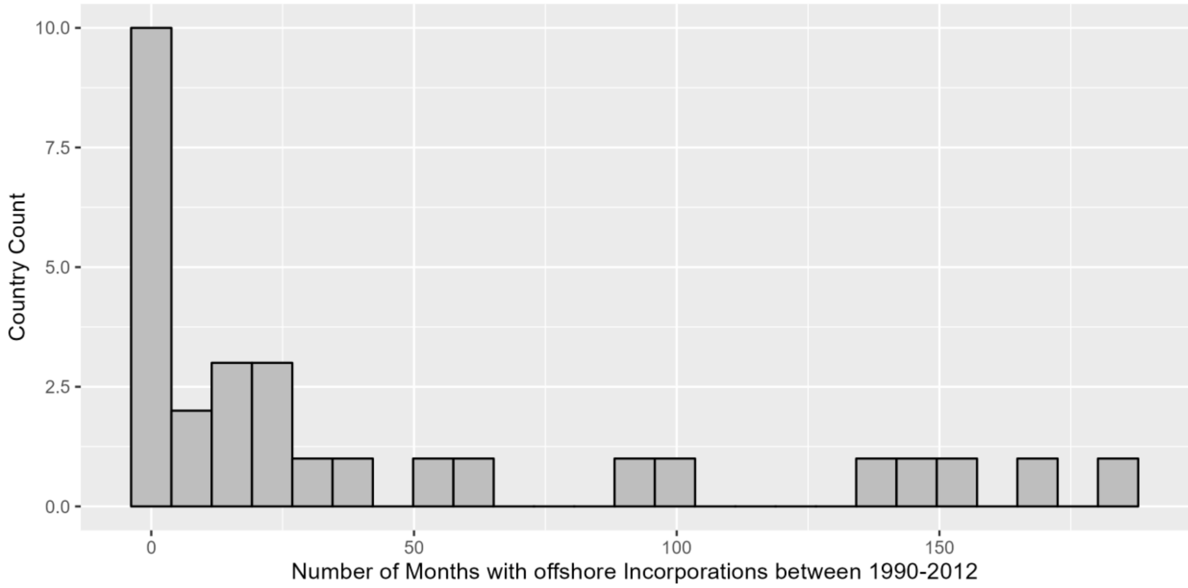


FIGURE 4. Histogram of number of months with offshore incorporations, by country, between 1990-2012. *Note:* Only countries that are mineral dependent and not classified as tax-havens by Hines (2010) and Johannesen & Zucman (2014) are included. Countries that lack data on mineral rents for all minerals and all years are also excluded, since we exclude these countries from our later regression analysis.

Figure 4 shows the distribution of number of months with offshore incorporations between 1990-2012 across mineral-dependent countries. There is still considerable variation in months with new offshore entities across the sample of mineral dependent countries. For ten countries, there are less than five months during which new offshore entities were incorporated by individuals in each of these countries. At the opposite end, for six countries, there are more than 100 months during which new entities were incorporated by individuals in each of these countries.

3.1.3. World Mineral Prices

We obtain data on monthly prices for zinc, tin, silver, phosphate rock, lead, nickel, iron ore, gold, copper and aluminium from the World Bank commodity price data. We convert these prices from nominal to real using a Manufactures Unit Value (MUV) deflator provided by the World Bank and standardize all prices to $USD per metric tonne. Figure 3 shows fluctuations in world mineral prices over time for each mineral.

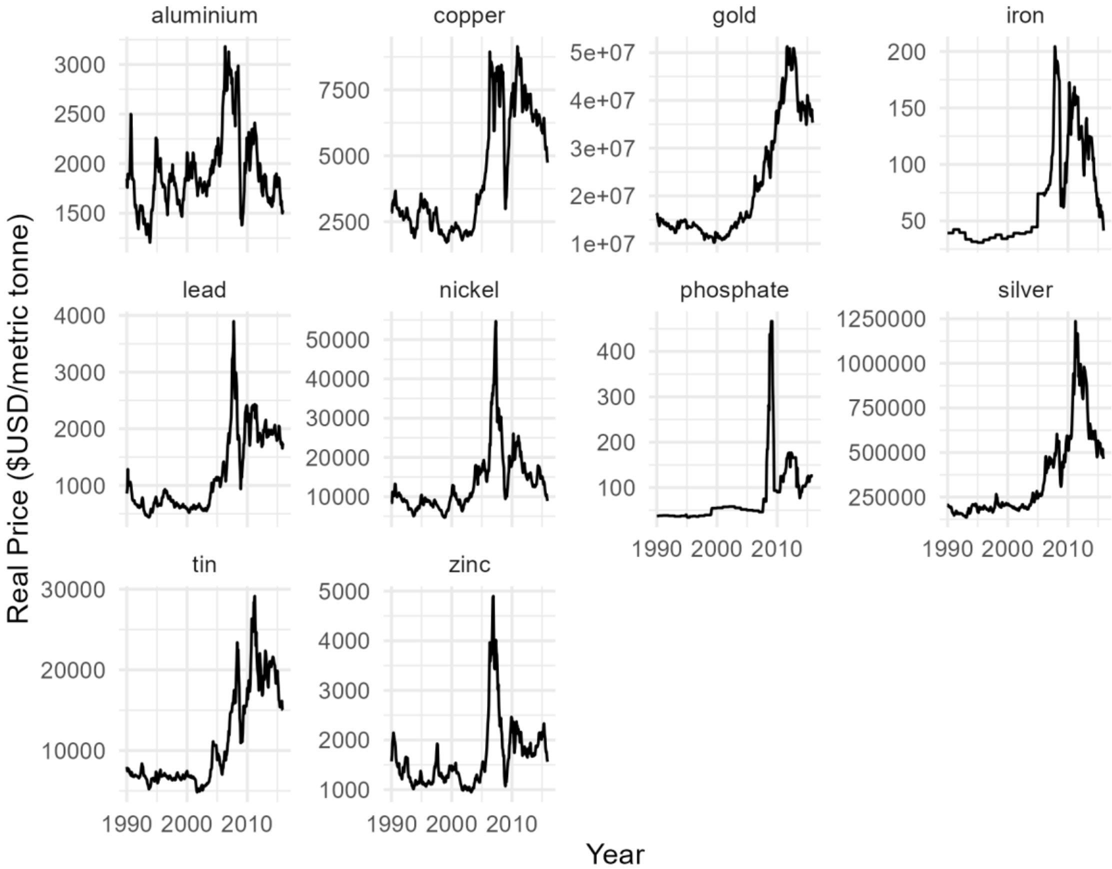


FIGURE 5. Price trends for minerals between 1990-2012. *Note:* Prices are given in $USD per metric tonne and converted from nominal to real using a Manufacturer Unit Value deflator. Data on prices and deflator is taken from the World Bank Commodity Prices dataset.

The graphs indicate that there is heterogeneity in price trends over time and across different mineral groups which we can exploit in our identification strategy. We restrict our analysis to these ten minerals due to a lack of available data on mineral rents[4], for other minerals. Moreover, we follow Berman et al. (2017) and Axbard et al. (2021) in excluding diamonds from our analysis since there is significant variation in the quality and prices of diamonds and a lack of data on these differing price trends for different qualities of diamonds.

3.1.4. Mineral Rents

We calculate mineral rents based on data provided in the Adjusted Net Savings dataset from the World Bank which includes information on rents from all ten minerals for 149 countries between 1970-2001. We calculate total mineral rents for specific minerals by multiplying the

[4] We require data on mineral rents for each mineral in order to construct weights for our regression. Discussed further in Section 3.1.5.

unit rent value with production quantity. Of the 106 countries in the Panama dataset (excluding tax-havens), 64 have a positive value of mineral rents for at least one year in our time period of interest.

3.1.5. Construction of Explanatory Variable

We calculate the monthly natural log difference in prices for each mineral as an approximate for the monthly percentage change in prices. Our empirical strategy is only concerned with the effect of positive price fluctuations on offshore incorporations as our dataset does not include information on closure of offshore accounts. As a result, we replace negative price movements with zero. Thus, the monthly price change variable is defined as:

$$\Delta \ln (P_t^R) = \begin{cases} \ln (P_t^R) - \ln (P_{t-1}^R) & \text{if } P_t^R > P_{t-1}^R \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

where P_t^R is the price of mineral *R* at month *t*.

Following Andersen et al. (2017) and Arezki & Brückner (2012), we construct a singular variable that captures the exogenous price fluctuations across all minerals, weighting these price fluctuations by the revenue share of GDP for each mineral. To capture the importance of each mineral to the GDP of individual countries, we weight the log difference values by the mineral's average percentage contribution to GDP between 1980-1989. We use a time-invariant measure of the mineral's contribution to GDP in the decade that precedes the time period of our study (1990-2012). If time-variant weights are used or if the weight are calculated using data on mineral contribution to GDP during the time period of study, these weights may be correlated with the general wealth in a country and thus be correlated with offshore incorporations, thereby introducing endogeneity into our model. The weighted percentage price change is summed across all minerals to create the following variable defined for country *i* and month *t*:

$$\pi_{it} = \sum_R (\theta_{i(1980-1989)}^R \Delta \ln (P_t^R)) \quad (2)$$

where $\theta_{i(1980-1989)}^R$ is the average percentage contribution of mineral *R* to the GDP of country *i* between 1980-1989. Following Andersen et al. (2017), we assume that mineral rents are zero when this data is missing since only a limited number of countries have a complete set of data for all ten minerals in all years. We remove any countries that have a zero value of π_{it} for all months in the time period as this indicates they had missing or zero values for mineral rents for all minerals in all years. Of the 106 countries in our dataset that are not tax-havens, 64 have at least one positive value of π_{it} between 1990-2012.

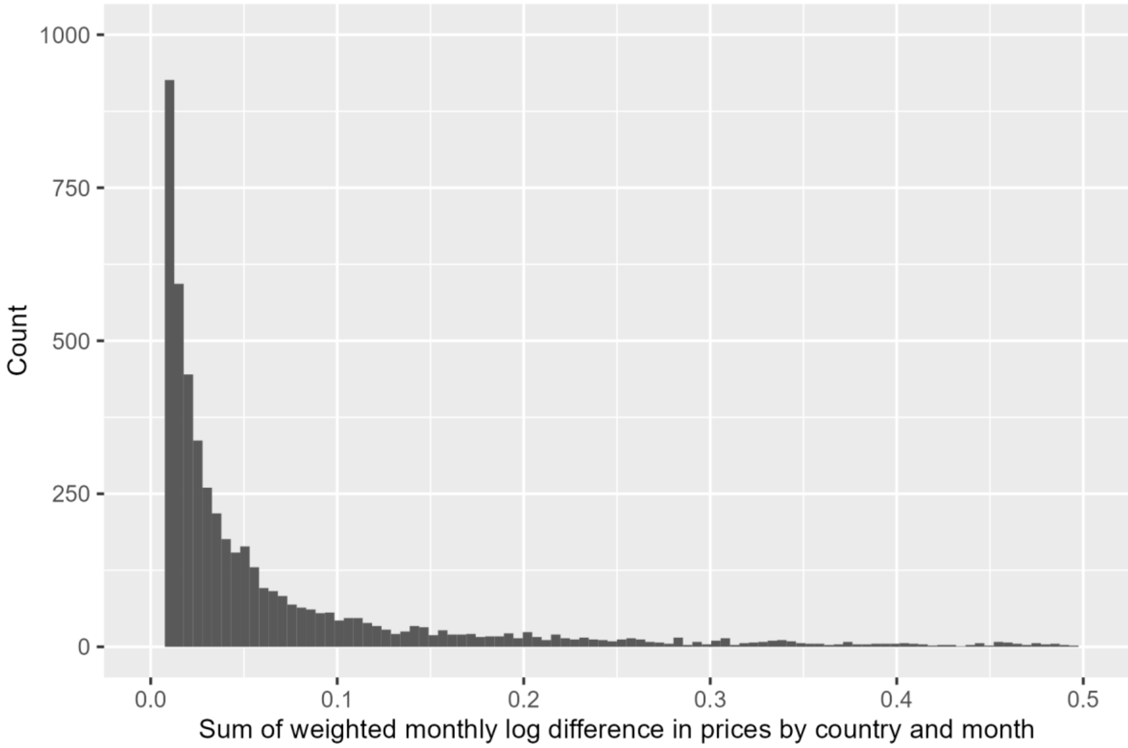


FIGURE 6. Distribution of π_{it} by country and month. *Note:* Countries with no positive values of π_{it} for any month between 1990-2012 have been excluded. Countries that are classified as tax-havens by Hines (2010) or Johannesen & Zucman (2014) have also been excluded. Sum of weighted monthly log difference in prices is calculated by finding the monthly log difference in prices for each mineral, weighting these values by the contribution of the specific mineral to the GDP of a country between 1980-1989 and summing these weighted price differences for all minerals.

Even when countries that have no positive values of π_{it} are removed, the distribution of π_{it} remains heavily skewed. Due to the skewed distribution of π_{it} and since we expect that price fluctuations that are too small in magnitude may not influence the probability offshore incorporations; we do not use π_{it} as our explanatory variable in our baseline regression. Instead, we construct a dummy variable D_{it}^{70} that take the value of one if the value of π_{it} is greater than the 70^{th} percentile cutoff, calculated for values of π_{it} across all years and all countries in the Panama dataset that have at least one positive value of π_{it} in our time period of study.[5] We discuss the sensitivity of our results to varying cutoffs in our robustness section.

[5] This is a uniform cut-off that does not vary by country or year.

3.1.6. Ownership

We obtain data on ownership of mines from the SNL Mining & Metals database. The database provides information on the nationality of ownership of 29188 mines globally across 109 countries between the years 2002 and 2018. Using a time-variant measure of foreign ownership would result in our ownership variable being correlated with time-variant unobservable variables (e.g., unobserved conflict) that may also be correlated with offshore incorporations. To reduce the effect of omitted variable bias, we construct a time-invariant measure of foreign ownership[6]. For each country, we calculate the percentage of all mines that were active at any point between 2002-2012 which were foreign owned. We exclude mines that produce any minerals that are not included in our analysis.

Percentile Rank	Percentage of mines in a country that are foreign owned
0	54.5%
25	33.0%
50	91.9%
75	100%
100	100%

TABLE 1. Percentile values of the percentage of all active mines that are foreign owned in each country between 2002-2012. *Note*. Dataset is composed of mineral dependent countries with tax-havens and countries that have no positive value of π_{it} excluded. Only mines that produce tin, zinc, copper, aluminium, gold, nickel, phosphate, lead, iron ore or silver are included.

Table 1 reports the 25th, 50th, 75th and 100th percentile values of the percentage of mines that are foreign owned in each country during our period of study. A sample of mineral-dependent countries, excluding tax-havens, is used to calculate the percentile values. These figures indicate that a large portion of countries in our dataset have mining industries that are predominantly foreign owned.

3.1.7. Other data

We obtain data on GDP for all countries from the World Bank. Indicators of institutional quality are taken from the World Bank Worldwide Governance Indicators (WGI), measured in 2006. We also use data on mineral contribution to exports from UNCTAD and mineral rents

[6] By calculating a mean time-invariant ownership variable, we eliminate the omitted variable bias caused by time-variant unobservable variables. There may still be time-invariant factors that are correlated with ownership which bias our results. We discuss this in further detail in Section 4.1.4.

to GDP from the World Bank to separate countries in our sample into mineral dependent and mineral non-dependent.

3.2.Empirical Strategy

We exploit exogenous variation in world mineral prices to estimate the effect of mineral windfalls on the probability of an offshore account being opened in the months following a mineral windfall. Due to the high volatility and unpredictability of mineral prices (Chen, 2010), we may consider large increases in these prices to result in unanticipated income shocks that result in an exogenous increase in mineral wealth. The assumption of exogenous world mineral prices has been used by others in the literature to study the effects of mineral wealth on a range of dependent variables including conflict, electability of criminal politicians and crime (Asher & Novosad, 2021; Axbard et al., 2021; Berman et al., 2017). World mineral prices are determined in the global market and historical price shocks have largely been determined by demand side fluctuations caused by rapid industrialisation or economic downturns (Alvarez & Skudelny, 2017; Slade, 1982; Stuermer, 2018). Thus, it seems reasonable to assume that mineral prices are exogenous to local factors that contribute to the opening of offshore accounts within individual countries. The few exceptions to this assumption may occur in countries that own a very large share of production of a mineral. In these cases, a single country may have the market power to influence prices on the world market and thus internal conditions within the country that are correlated with offshore incorporations may also affect world mineral prices. To alleviate these concerns, we drop countries that contribute to a very high share of the production of individual minerals in our robustness section and show that our results are robust to this test. We use a linear probability model to estimate the following regression:

$$Offshore_{it} = \sum_{n=0}^{12} \beta_n D_{i(t-n)}^{70} + \boldsymbol{\gamma}_{iy} + \boldsymbol{\gamma}_t + \varepsilon_{it} \quad (3)$$

where $Offshore_{it}$ is a dummy variable that takes the value of one if at least one offshore entity is created in country *i* in month *t*, D_{it}^{70} is a dummy variable that takes the value of one if the sum of weighted monthly log difference in mineral prices for country *i* and month *t* is greater than the 70th percentile cut off value (π_{it} > 70th percentile cut off value), $\boldsymbol{\gamma}_{iy}$ represents a vector of country-year fixed effects and $\boldsymbol{\gamma}_t$ represents a vector of month fixed effects. The country-year fixed effects should control for any unobserved shocks that are specific to a country and year including conflicts, yearly fluctuations in GDP and macroeconomic shocks that may affect offshore incorporations. The month fixed effects should control for any seasonal patterns in offshore incorporations or mineral prices. We add twelve lagged values of D_{it}^{70} to the regression to capture the effects of a mineral windfall on the probability of offshore incorporations twelve months after the windfall. Standard errors are clustered at the country level.

We first estimate this regression for all countries in the Panama dataset that are not tax-havens and have a positive value of π_{it} for at least one month in our time period, to reduce the effects of non-availability of mineral rents data for certain countries. We then restrict our sample to those that are mineral dependent. Mineral dependent countries have larger mineral reserves, and thus an exogenous increase in prices should lead to a larger income shock and increase in mineral wealth in these countries. If this increase in mineral wealth is being captured by elite via bribes or embezzlement of profits, we should expect that the effect of mineral windfalls on offshore incorporations should be larger in mineral dependent countries where the return to rent seeking is higher due to larger mineral reserves. Existing definitions of mineral dependence found in the literature either use a measure of mineral rents to GDP ratio or mineral contribution to exports, or a combination of both, but an exact application of existing definitions to the Panama dataset results in sample sizes that are far too small (Auty, 2002; Haglund, 2011; International Council of Mining & Metals, 2018). Similar to prior definitions we define mineral dependence using data on mineral share of exports sourced from UNCTAD and mineral rents to GDP ratio provided by the World Bank. Countries are considered to be mineral dependent if they are in the top 25th percentile for either measure in 2006[7]. In our robustness section, we show that our results do not have significant variations if mineral dependence is calculated using data from 2012 or using data from multiple years during the time period.

3.3. Main Results

Table A.1 in the appendix reports our main results. We include a graphical representation of these results in Figure 7. There seems to be a statistically significant positive effect on the probability of offshore incorporations that occurs six months after a mineral windfall across both samples. Column (1) in Table A.1 reports the results for all countries in the Panama dataset, excluding tax-havens and any countries that have no positive values of π_{it} for the entire

[7] Mineral dependent countries are first calculated for the full Panama dataset and countries with no positive values of π_{it} are subsequently removed from this list.

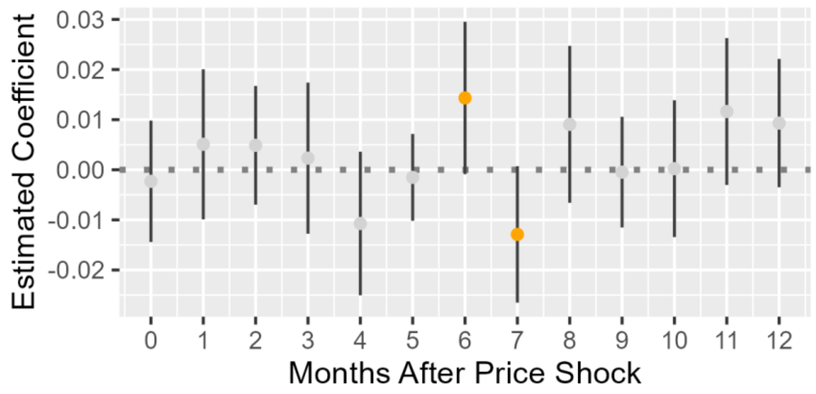
time period. We see that a mineral windfall increases the probability of an offshore account being opened six months later by 1.4 percentage points. However, there seems to be a counteracting negative effect that occurs in the following month. Both effects are statistically significant only at the 10 percent level. In column (2), we see that when our sample is restricted to mineral dependent countries, the estimated coefficient of the effect six months after the mineral windfall increases to 2.3 percentage points and becomes statistically significant at the 5 percent level. There are no statistically significant negative effects for this sample. A full list of countries that are classified as mineral dependent are included in Table A.2 in the Appendix.

3.3.1. Aggregated Effects Over a Year

To find the aggregate effect of a mineral windfall on increases in the probability of offshore incorporations over the subsequent twelve months after the windfall, we find the sum of coefficients of current and lagged values of D_{it}^{70}. We test whether the linear sum of these coefficients is greater than zero and calculate standard errors using the delta method[8] (see King et al. (2000) for a description of the delta method and its use in regression analysis). The results are presented in Table A.3 in the Appendix and a coefficient plot of these results is presented in Figure 8. The new summed coefficients capture the the long-run effect of a mineral windfall on the probability of offshore accounts being opened in the year after the mineral windfall. Using a sample of all countries in the Panama dataset, excluding tax-havens and countries with no positive value of ρ_{it} between 1990-2012, we find the long-run effect over a year is positive but statistically insignifcant, with an estimated coefficient of 2.9 percentage points. When the sample is restricted to mineral dependent countries, this effect increases in magnitude to 6.4 percentage points and becomes statistically significant at the 10% level. The stronger effect in mineral dependent countries is in line with our initial prediction that mineral dependent countries should see a greater increase in the probability of offshore incorporations after a mineral windfall since they experience a larger change in mineral wealth which should incentivise a greater degree of rent-seeking.

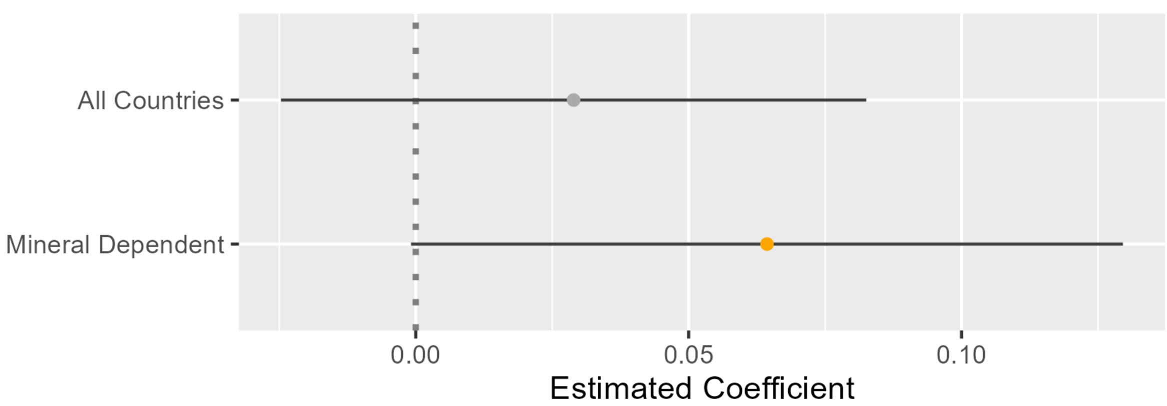
[8] The delta method uses a first-order Taylor approximation to estimate standard errors of transformations of regression coefficients.

(a) All countries



(b) Mineral Dependent Countries

FIGURE 7. (a) All countries in Panama dataset (excluding tax-havens and those without at least one positive value of ρ_{it}). (b) Mineral dependent countries. *Note:* This graph plots estimated coefficients and 95% confidence intervals of the baseline regression (Standard errors are clustered at the country level). Tax-havens, countries that are not mineral-dependent and countries with no positive value of π_{it} are excluded from all samples. Countries are defined as mineral dependent if they have values of mineral contribution to exports or mineral contribution to GDP that are in the 25th percentile, relative to other countries in the Panama dataset in 2006.



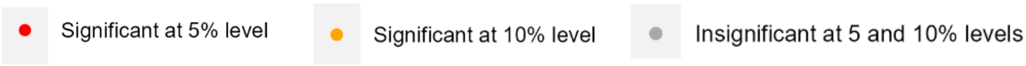


FIGURE 8. Coefficient Plot of Sum of Current and Lagged Coefficients. *Note:* Estimated coefficients show sum of coefficients of current and lagged values of D_{it}^{70} and 95% confidence intervals are estimated using the delta method. Tax-havens and countries with no positive value of π_{it} are excluded from all samples. Countries are defined as mineral dependent if they have values of mineral contribution to exports or mineral contribution to GDP that are in the 25[th] percentile, relative to other countries in the Panama dataset in 2006.

3.3.2. Robustness

We now discuss the robustness of our main results to different specifications and definitions of key variables and sample compositions. First, we run a placebo test for our baseline regression and incorporate twelve leads of D_{it}^{70} into our model. If our regression picks up an effect on the probability of offshore incorporations prior to the mineral windfall, then this would suggest that either that our regression specification is picking up spurious correlations or that there may be an omitted variable that causes both variables to increase. We show our results in Table A.4 in the Appendix. For both the full sample of countries and mineral-dependent countries, we show that a mineral windfall only has correlations that are statistically significant with lagged values of D_{it}^{70}, and not leads.

We also run our baseline regression using a sample of countries that are not mineral dependent. Since mineral dependent countries on average tend to have smaller mineral reserves and experience a smaller income shock as a result of mineral price booms, we expect the effect in these countries to be smaller or insignificant. These results are displayed in Table A.5 in the appendix. The only positive effect we observe with this sample that is statistically significant at the 10% level occurs one month after a price shock and this effect is smaller in magnitude compared the positive effect we observe with a sample of mineral dependent countries. We also display the sum of the coefficients of current and lagged values of the explanatory variable and re-calculated standard errors in table A.6 in the Appendix. In countries that are not mineral dependent, the long-run effect over across twelve months is not statistically different to zero.

To test that our results are not being driven by countries that own very large shares of mineral production, we drop any country in our subset of mineral dependent countries that is the top producer of any mineral included in our study in 2006 (Benham et al., 2008). Table A.7 in our Appendix includes a list of top producers of each mineral in 2006 and the share of production they own. The results are presented in Table A.8 in the Appendix, and we show that our results are robust to this modification.

Next, we test our results against varying definitions of mineral dependence. First, we reclassify mineral dependent countries as those that either have values of mineral contribution to GDP or mineral contribution to exports that are in the top 25th percentile in 2012, relative to other countries in the Panama dataset. Secondly, we consider countries to be mineral dependent if they have values of either indicator in the top 25th percentile for at least eleven years between 1990-2012. Both sets of results are shown in Table A.9 in the Appendix. We see that a positive effect six months after a mineral windfall is still statistically significant at the 10% level for countries that are mineral dependent in 2012 and statistically significant at the 5% level for countries that are mineral dependent for more than eleven years. Using these new sample specifications, we also see additional positive effects that occur eleven months after a mineral windfall.

We further test the robustness of our results to different definitions of our explanatory variable: D_{it}^{70}. We construct dummy variables that take the value of one when our weighted price change variable, ρ_{it}, is greater than the 50th, 60th, 80th and 90th percentile values in contrast to the 70th percentile cutoff we use for our baseline regression and main results. These results are displayed in Tables A.10, A.11, A.12 and A.13 in the appendix. When lower cutoffs are implemented, the magnitude of the positive effect at six months decreases slightly but additional positive effects in other months are also picked up using these specifications. When larger cutoffs are used, there is a positive effect six months after a mineral windfall, but this effect is smaller in magnitude and no longer statistically significant. One potential explanation for this could be due the fact very high monthly price changes tend to be isolated to few minerals[9] and thus setting a cutoff that is too high may exclude certain minerals and countries from our analysis.

Lastly, we text for the sensitivity of our results to an alternative dependent variable defined at the intensive margin – the natural log of new offshore incorporations (plus one). These results are presented in Table A.14 in the Appendix. Under this specification, we see that a mineral windfall has positive effects on the log of offshore incorporations, seven months, and eleven months after the windfall. Although the months during which we observe the effect changes, the main finding of positive effects that are larger in mineral dependent countries compared to all countries holds true with the alternative dependent variable. The coefficient

[9] This phenomenon is demonstrated in Figure A.1 in the Appendix.

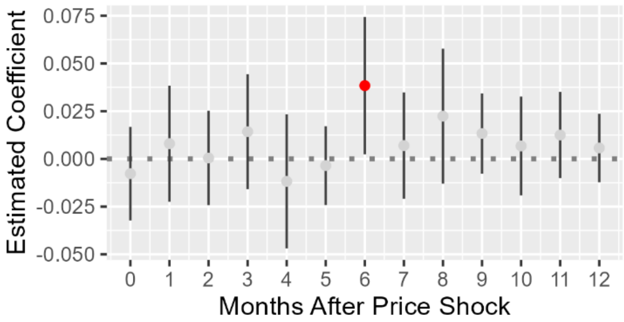
we observe at seven months with the new dependent variable, (0.022) is similar in magnitude to the coefficient we observe at six months using the old dependent variable (0.023).

Overall, we conclude the main implications of our results are generally robust to different placebo tests and methods of defining variables, although the specific months during which we observe these effects are sometimes sensitive to these alternative specifications.

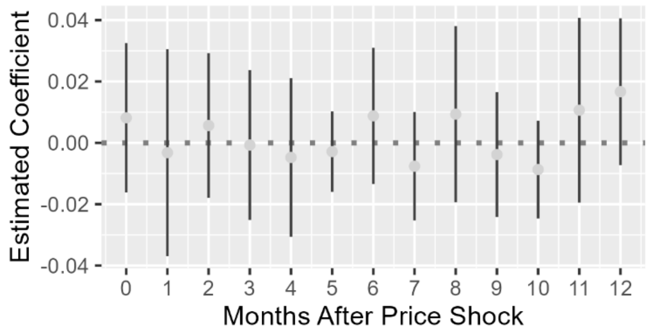
4. Effect Heterogeneity

4.1.1. Institutional Quality

We investigate how the effect of a mineral windfall on probability of offshore incorporations differs between countries with different levels of institutional quality. We use three indicators of institutional quality; control of corruption, political stability and rule of law provided by the 2006 World Bank series of Worldwide Governance Indicators (WGI) for our main results. For each indicator, we split our sample of mineral dependent countries into two groups and assign countries a "High" status if their score for a specific indicator is greater than or equal to the median score of the sample and a "Low" status otherwise. A full list of countries in each subset is provided in Table A.15 in the appendix and the results are presented in Table A.16. These results are also visually presented using coefficient plot in Figure 9. Overall, across all three indicators of institutional quality, we see that the positive effect between mineral windfalls and the probability of offshore incorporations occurs only in mineral dependent countries with WGI scores that imply a low level of institutional quality. We see the largest single-month effect in terms of magnitude when the sample is restricted to mineral dependent countries with low control of corruption scores. In these countries, a mineral windfall results in an increase in the probability of an offshore incorporation by 3.8 percentage points, six months after the windfall occurred. We see a similarly strong effect in the sample of mineral dependent countries with low political stability scores where a mineral windfall increases the probability of offshore incorporations by 2.5 percentage points six months later, and by 2.3 percentage points eleven months later. Countries that are characterised by a weak rule of law have positive effects that occur three and eleven months after a mineral windfall, but these effects are only statistically significant at the 10% level. These effects disappear when our samples are composed of mineral dependent countries with high institutional quality. We show that these results are robust to

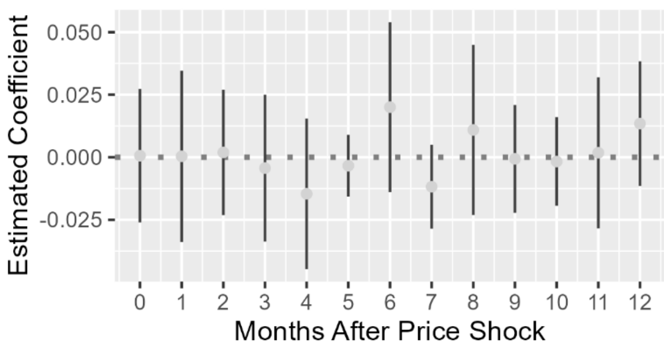


(a) Low Control of Corruption



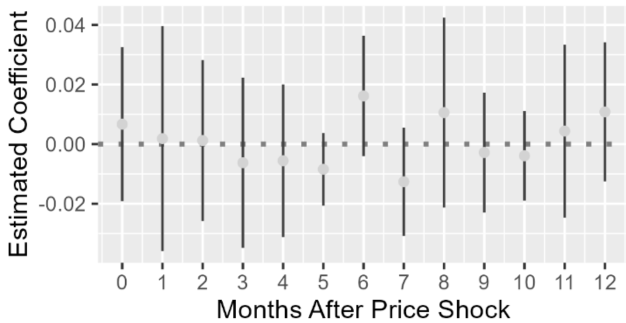
(b) High Control of Corruption

(c) Low Political Stability



(d) High Political Stability

(e) Weak Rule of Law



(e) Strong Rule of Law

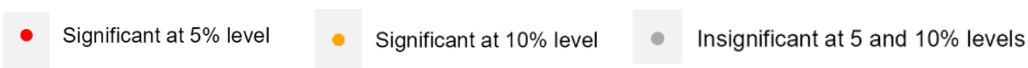


FIGURE 9. Effect heterogeneity by different indicators of institutional quality. Note: These coefficient plots show the estimated coefficients and 95% confidence intervals that are produced when the baseline regression is applied to different samples of countries, split based on their WGI indicator scores. Standard errors are clustered at the country level. Tax-havens, countries that are not mineral-dependent and countries with no positive value of π_{it} are excluded from all samples. Countries are classified as having low control of corruption, weak rule of law and low political stability if their WGI for these respective indicators are below the median value in 2006.

the use of Transparency International's 2006 Corruptions Perception Index as an alternative indicator of institutional quality in Table A.17 in the Appendix.

4.1.2. Aggregated Effect Over a Year

We compare how the long-run effect of a mineral windfall on offshore entities over a year differs between countries with high and low levels of control of corruption, rule of law and political stability. Using an identical method to section 3.3.1, we use a linear sum of coefficients of current and lagged values of D_{it}^{70} to capture this long-run effect.

The results are presented in Table A.18 in the Appendix and a coefficient plot of these results is presented in Figure 9. We see that the long-run effect is strongest in mineral dependent countries with indicators that suggest weak institutional quality. The strongest effect occurs in mineral dependent countries with weak rule of law, where a mineral windfall increases the probability of an offshore account being opened in the next twelve months by 12.2 percentage points. The effect in mineral dependent countries with low political stability is almost identical with an estimated effect of 12.1 percentage points. Both results are statistically significant at the 5% level. In countries with low control of corruption, there is similarly a positive effect with an estimated coefficient of 10.6 and this effect is statistically significant at the 10% level. These three effects are all stronger than the long-run effect in mineral dependent countries in general which had an estimated coefficient of 6.4 percentage points which was signficiant at the 10% level. Mineral dependent countries with high control of corruption, strong rule of law and high political stability all report statistically insignificant long-run effects.

These results are highly suggestive. Firstly the fact that a mineral windfall only causes an increase in the probability of offshore incorproations in countries that have weak institutions strengthens our proposition that the increase in offshore incorproations we observe is linked with a rise in illicit activiites such as transaction of bribes and embezzlement of mineral profits by political elite. If the higher probability of offshore incorporations was simply a result of a short-term increase in overall wealth of the country, this effect should occur equally in mineral dependent countries with weak and strong institutions[10]. Secondly, in agreeance with the wider resource curse literature our results emphasise the importance of institutional quality in determining the relationship between mineral wealth and rent-seeking.

[10] Our fixed effects specification should control for increases in wealth between years within a country. Only short-run fluctuations in wealth within a year for a specific country would be left uncontrolled for.

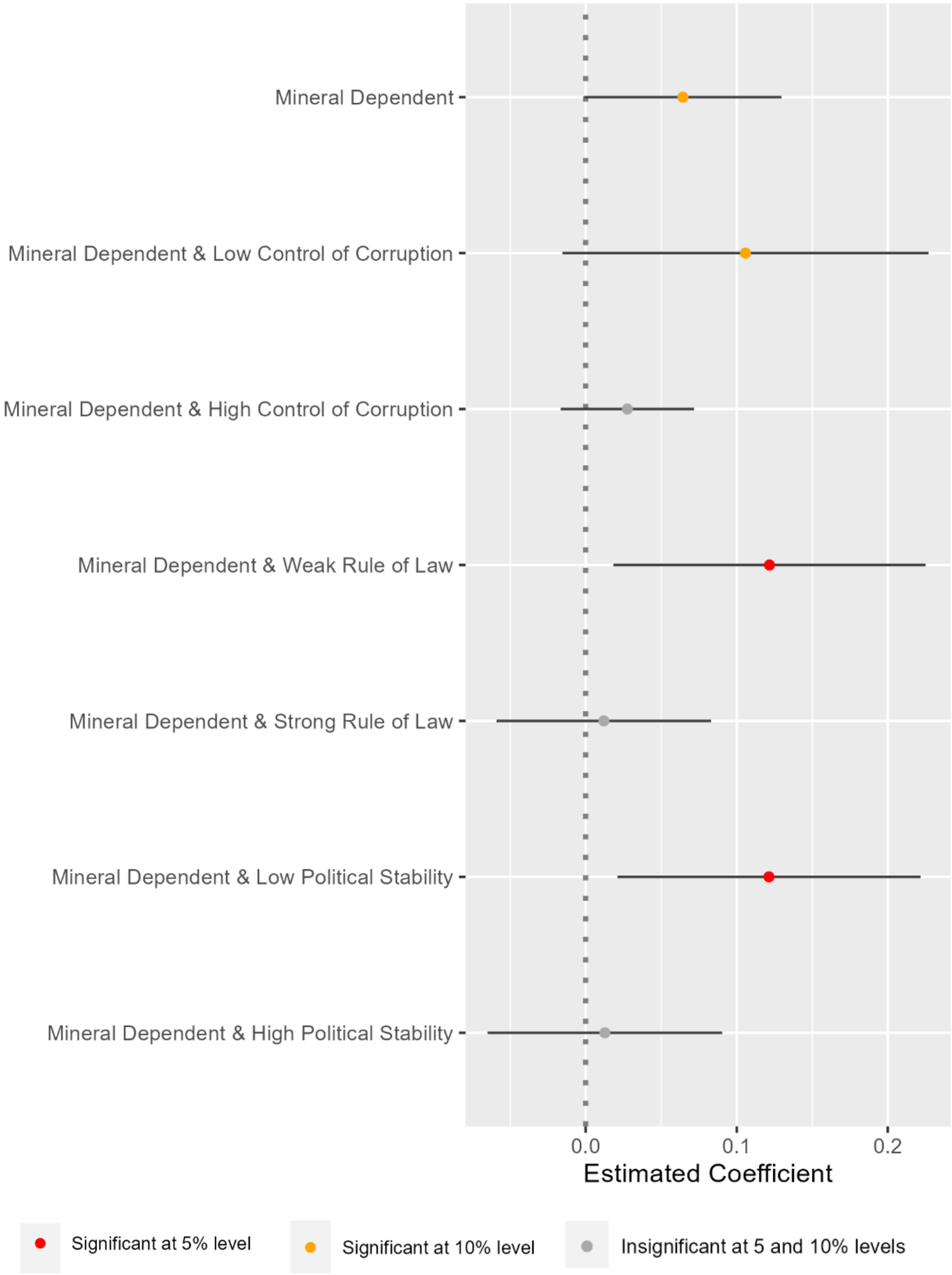


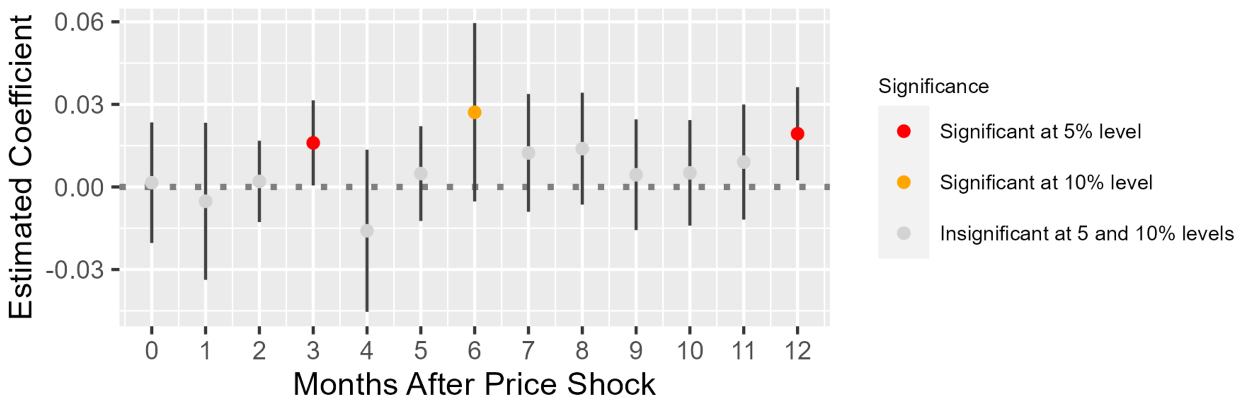
FIGURE 9. Coefficient Plot of Sum of Lagged Coefficients for Different Levels and Indicators of Institutional Quality. *Note:* Plotted coefficients show the sum of coefficients of current and lagged values of D_{it}^{70} and 95% confidence intervals are estimated using the delta method. Tax-havens, countries that are not mineral-dependent and countries with no positive value of π_{it} are excluded from all samples. Countries are classified as having low control of corruption, weak rule of law and low political stability if their WGI score for these respective indicators are below the median value in 2006.

4.1.3. Foreign Ownership of Mines

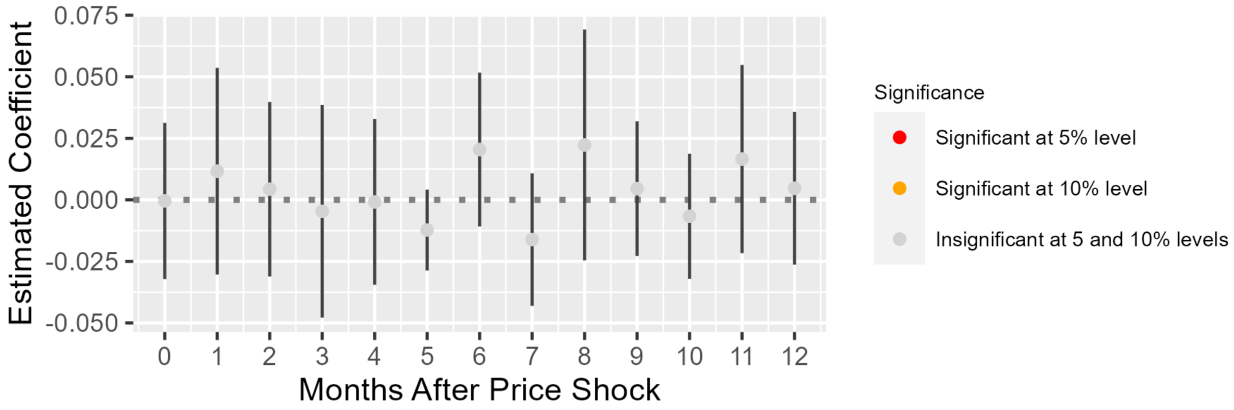
A factor that is omitted in analysis of rent-seeking in the mineral sector is the ownership structure of the mineral industry in question and specifically if mines are predominantly locally or foreign owned. Since our dataset contains information on the country of ownership of mines, we are able to exploit this information to add a novel additional layer of analysis to existing literature which has conventionally mainly focused on the effect of institutional quality on the relationship between resource rents and indicators of rent-seeking (Andersen et al., 2022; Leite & Weidmann, 1999; Marcolongo & Zambiasi, 2022; Mehlum et al., 2006). We split our sample of mineral-dependent countries, excluding tax-havens, into two groups and classify those that have more than 80% of mines being foreign owned as possessing "High Foreign Ownership" while the remainder are classified into the "Low Foreign Ownership" category. A full list of countries in each grouping is included in Table A.19 in the Appendix. This cut-off gives us roughly equal sample sizes for both groups with fifteen countries falling into the high foreign ownership subset and thirteen into the low foreign ownership subset.

We run our baseline regression for both samples and display the results visually in Figure 10 and as a table in Table A.20 in the Appendix. In countries with a high level of foreign ownership, a mineral windfall increases the probability of an offshore account being opened after three months, six months and twelve months by 1.6, 2.7 and 1.9 percentage points respectively. While the effect at three and twelve months are statistically significant the 5% level, the effect at 6 months is only statistically significant at the 10% level. Countries with a low level of foreign ownership on the other hand report no statistically significant relationship between a mineral windfall and the probability of an offshore entity being opened in any of the twelve months after the mineral windfall. We show that these results are robust to alternative definitions of high and low foreign ownership[11] in Table A.21 in our Appendix.

[11] We redefine countries as having high foreign ownership if the percentage of foreign owned mines in the country is greater than 70% and 90%.



(a) High Foreign Ownership



(b) Low Foreign Ownership

FIGURE 10. Heterogenous Effects by Level of Foreign Ownership. (a). Countries with high foreign ownership (b) Countries with low foreign ownership. *Note:* These coefficient plots show the estimated coefficients and 95% confidence intervals that are produced when the baseline regression is applied to different samples of countries, split based the level of foreign ownership of mines. Standard errors are clustered at the country level. Tax-havens, countries that are not mineral-dependent and countries with no positive value of π_{it} are excluded from all samples. Countries are considered to have a high level of foreign ownership if more than 80% of active mines between 2002-2012 were foreign owned.

4.1.4. Aggregate Effects Over a Year

We present the sum of coefficients of the current and lagged values of D_{it}^{70} in Table A.22 in the appendix and graphically present these summed coefficients and standard errors in Figure 11.

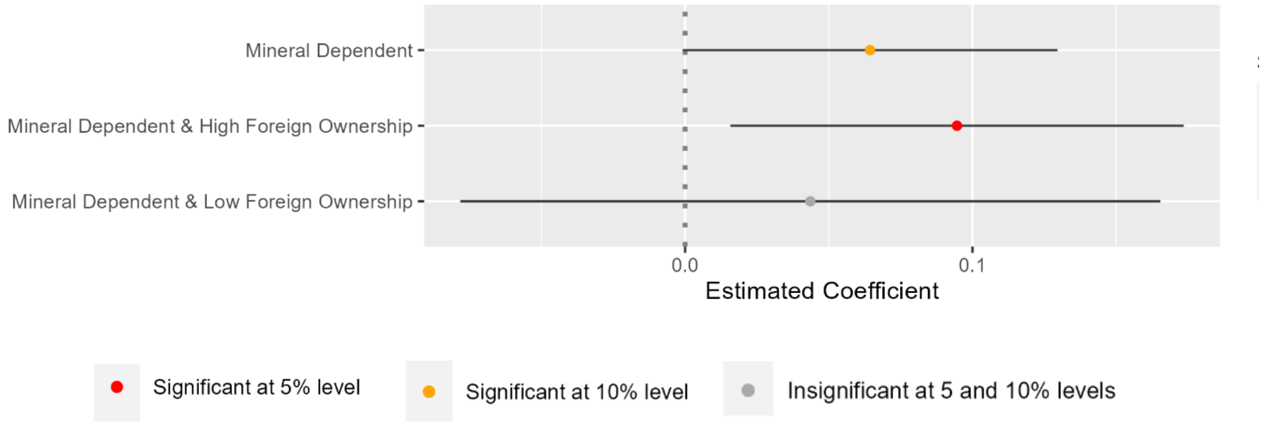


FIGURE 11. Coefficient Plot of Sum of Lag Coefficients for Different Levels of Foreign Ownership. *Note:* Estimated coefficients show sum of coefficients of current and lagged values of D_{it}^{70} and 95% confidence intervals are estimated using the delta method. Tax-havens, countries that are not mineral-dependent and countries with no positive value of π_{it} are excluded from all samples. Countries are considered to have a high level of foreign ownership if more than 80% of active mines between 2002-2012 were foreign owned.

Figure 11 show that the long-run effect of a mineral windfall on the probability of offshore incorporations over a year is higher in countries with a greater level of foreign ownership of mines. In the subset of countries with more than 80% of mines that are foreign owned, we see that a mineral windfall increases the probability of offshore incorporations in the next twelve months by 9.5 percentage points. This estimated coefficient is larger and more statistically significant than the coefficient estimated using a sample of all mineral dependent countries. In countries with less than 80% of mines that are foreign owned, this effect is both smaller and statistically insignificant. Thus, our results suggest that the link between mineral windfalls and offshore incorproations is stronger where there is greater foreign ownership of mines. This finding aligns well with the idea that foreign companies, especially multinational corporations, tend to exacerbate corruption in the areas they operate in (Zhu, 2017).

One potential concern is that countries with high levels of foreign ownership may also be countries that generate large mineral rents. Foreign companies may be more likely to invest in certain countries if their mineral deposits are large and profitable, and thus the difference we find between countries with high levels of foreign ownership and low levels of foreign ownership may actually be capturing the difference between countries that receive more mineral rents and those that receive lower mineral rents. To investigate this, we look at how the level of foreign ownership of mines in a country, changes with the total mineral rents received by a country between 1990-2001[12]. Figure A.2 in the Appendix uses a bar plot to show the total mineral rents received by the mineral dependent countries in our dataset between 1990-2001. We use colour to indicate if countries have high or low levels of foreign ownership. There seems to be no correlation between higher levels of average mineral rents and level of foreign ownership.

We cannot however exclude the possibility that the larger effect we observe in countries with foreign owned mines is due to the fact that foreign companies use offshore accounts to a greater degree than local companies. If this were true, then the different effects we observe in countries with low and high foreign ownership may not reflect differences in the extent of rent-seeking activities between both samples. This does not affect our main finding which holds that the effect of mineral windfalls on the likelihood of offshore incorporations is higher when a country has relatively higher levels of foreign ownership. It only prevents us from being able to make judgements on overall differences in rent-seeking activity between both groups of countries.

5. Limitations

This study has three potential limitations that we are aware of. Firstly, our identifications strategy hinges on the premise that an increase in mineral rents should result in an increase in offshore incorporations since we expect elites who capture the mineral wealth to use offshore accounts as conduits for bribes or as a safe store for illegally acquired wealth. However, if individuals use existing offshore accounts for these purposes, we will not observe an increase in new accounts being opened. Thus, data on offshore incorporations does not give us an insight into the full magnitude of the use of offshore accounts for rent-seeking purposes. Instead, our results likely provide an underestimation of the true effect of mineral windfalls on offshore financial activity. Nevertheless, given that it is precisely the lack of knowledge surrounding corruption that drives the motivation for our study, the Panama papers still provide a useful glimpse into the otherwise largely unobservable patterns of rent-seeking that occur in mineral dependent countries.

Secondly, the variability in mineral rents received by countries poses challenges in defining our explanatory variable. While our current method of using a dummy variable as our explanatory variable helps us reduce the skewedness of our weighted exogenous price change

[12] The World Bank only provides data on mineral rents for individual minerals (used to calculate total mineral rents) until 2001.

variable (π_{it}), this also means our analysis only occurs at the extensive margin. Moreover, even at the extensive margin, our explanatory variable is still skewed, albeit to a lesser extent. Namibia for instance experiences 235 shocks during the time period of our study while France and Vietnam only experience one shock during this period. Restricting our sample to mineral dependent, non-tax haven country does reduce this issue to some extent. Still, that fact that some countries tend to experience price shocks for a majority of months during the time period of our study may increase our chance of picking up spurious correlations. To rule the possibility of spurious correlations, we conduct a placebo test with leads of the explanatory variable included. Nevertheless, alternative ways of specifying the explanatory variable may be an area to experiment with in future research.

Thirdly, our heterogeneity analysis may be affected by confounding factors that are correlated with our outcome variable and with institutional quality or foreign ownership. We have shown that one of the main potential sources of omitted variable bias in our foreign ownership heterogeneity analysis, a correlation between countries with high mineral rents and high foreign ownership, is inconsistent with our data. Given more time, collecting data on additional potential confounding factors (if they are available) and testing for their correlation with foreign ownership or corruption may allow us to reduce the possibility of omitted variable bias in our heterogeneity analysis

6. Conclusion

This paper studies the effect of large exogenous increases in mineral prices on the probability of offshore incorporations in the countries that produce these minerals. We construct a novel dataset that combines information on monthly offshore incorporations with information on price trends for ten minerals between 1990-2012. In a sample of 29 mineral dependent countries, we find that a large exogenous increase in mineral prices leads to an increase in the probability of offshore incorporations, six months after the price shock. We also find that the long-run effect of a mineral windfall on the probability of offshore incorporations over the subsequent twelve months is positive and statistically significant.

The patterns we observe regarding the effect of mineral windfalls on the probability of offshore incorporations provide preliminary evidence for the hypothesised link between offshore accounts and rent-seeking activities. If the increased likelihood of offshore incorporations after a mineral windfall was simply the result of a short-term increase in wealth, we should see a similar effect across mineral dependent countries with high and low levels of institutional quality. Instead, we find that this effect is larger and more statistically significant in countries with weak institutional quality and becomes statistically insignificant in countries with strong levels of institutional quality. Differences in the level of rent-seeking activity between countries of different institutional qualities seems to provide the most obvious explanation for this pattern. Moreover, when we incorporate leads into the main regression, we find that mineral windfalls only affect the probability of offshore incorporations after the windfall and not before, thus reducing the possibility that there may be some omitted variable that causes co-movements in both variables. When combined with existing investigative and empirical evidence on the role of offshore accounts in facilitating rent-seeking activities, our results support the narrative that mineral wealth leads to an increase in rent-seeking activities, which occurs through the use of offshore accounts in tax-havens.

Additionally, the effect of mineral windfall on the probability of offshore incorporations is also large and significant in countries with high levels of foreign ownership of mines and statistically insignificant for countries with low levels of foreign ownership of mines. We rule out that this effect is driven by differences in total mineral rents received countries and thus our results suggest that foreign firms may participate more actively in rent-seeking using offshore incorporations compared to local firms.

Our paper has three main policy implications. Firstly, our study highlights the role that offshore accounts in tax-havens play in enabling rent-seeking and thus provides backing for larger international regulations of tax-havens. Secondly, our research highlights the role of institutional quality in determining the extent of rent-seeking that occurs in the mining sector. Policies aimed at strengthening existing institutions such as those that promote greater transparency surrounding the awarding of mining licenses should help reduce the prevalence of rent-seeking. Thirdly, we provide evidence that indicates that foreign owned mines are more likely to use offshore incorporations to facilitate rent-seeking activities, in comparison with locally owned mines. Countries may benefit from targeting regulation of offshore activity towards mines that are foreign owned.

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