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► **To cite this version:**

Rabah Arezki, Youssef Camara, Frederick van Der Ploeg, Grégoire Rota-Graziosi. BAD SAMARITANS IN FOREIGN AID: EVIDENCE FROM MAJOR MINERAL DISCOVERIES. 2024. hal-04789791

**HAL Id: hal-04789791**

**<https://hal.science/hal-04789791v1>**

Preprint submitted on 18 Nov 2024

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BAD SAMARITANS IN FOREIGN AID:  
EVIDENCE FROM MAJOR MINERAL DISCOVERIES\*

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This paper explores whether foreign aid is self-interested, exploiting the timing and size of major mineral discoveries. We first analyze the effect a resource discovery in a two-by-two donor-recipient model with conflict about natural resources, using a contest success function. We then estimate the effects of major discoveries using a gravity model for a large panel of countries. Our empirical estimates are consistent with the predictions of the theoretical model. Results show that recipient countries that experience major discoveries receive more, not less, bilateral aid, all else equal. Our benchmark result is that following a mineral discovery, a recipient country receives 36% more aid compared to a country without such a discovery. That is a paradox considering that major discoveries are associated with an effective relaxation of international borrowing constraints.

**Keywords:** bilateral aid, self-interested donors, mineral discoveries, contests

**JEL codes:** E00, F3, O1, O2

October 2024

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## I. INTRODUCTION

Critics of foreign aid have argued that donors are driven by self-interest.<sup>1</sup> The criticism is especially salient in the case of bilateral aid as donors stand to benefit from a potential quid pro quo with recipients. Such equivocation may center around access to markets but perhaps more importantly around access to natural resources especially in developing countries. Indeed, developing countries are less industrialized and tend to consume fewer natural resources than they produce. That situation lends itself to influence over these resources by foreign economic powers given (known) reserves. Yet, there have been little systematic exploration of the self-interest motive of foreign aid donors. Our objective is to explore whether foreign aid is self-interested, exploiting the timing and size of major mineral discoveries.<sup>2</sup>

Throughout the 19<sup>th</sup> century, Western European powers have competed to secure access to natural resources such as cotton, copper, iron and rubber which were critical for their industries. These colonial enterprises were undertaken through coercion and military might. In the modern era, a new race between major economic powers to secure critical resources for their industries is at play. That race between these economic powers is especially acute nowadays given the two technological transformations namely decarbonization and digitalization. To dominate the new industries emanating from these transformations, it has become vital for major powers to secure access to critical minerals such as lithium, cobalt and rare earth.

The Democratic Republic of Congo (DRC) is rich in mineral resources with the world's largest reserves of cobalt and accounts for 68 percent of world's production is a case in point—cobalt is a critical component for battery technology of electric vehicles. It is no surprise that DRC has become the darling of major economic powers such as China, the United States and the European

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<sup>1</sup> Bauer (1972) offers an early and prescient criticism of aid, where he famously argues that aid is a transfer from taxpayers in rich countries to governments in poor countries (cf. Bauer, 1984; Shleifer, 2009). Bauer also argued that government aid was neither necessary nor sufficient for development, and may hinder it via increasing corruption, misallocation of resources and erosion of civil society. Another early criticism is by Hirschman and Bird (1968) who interestingly stated: “it [aid] is an instrument of national policy which can be used by the rich to acquire influence and to increase their power.” More recently, Deaton (2016) also highlighted the paradox of aid. A contemporaneous and prolific author criticizing foreign aid is Bill Easterly whose work we reference (partially) below. For example, Easterly (2024) states that “where aid is needed, it does not work; where aid works, it is not needed”. The title of this paper is inspired by the Matthew effect and Buchanan (1975). Aid effectiveness is also an issue as recipient governments can exploit fungibility, sanctions by donors are not credible (Samaritan dilemma), competition among donors frustrates matters, and monitoring aid is costly (Bourguignon and Sundberg, 2007; Bourguignon and Gunning, 2017).

<sup>2</sup> The paradox we have highlighted is different from tied aid. Tied aid works mainly through imports of goods and services financed directly by aid while our paradox is about aid against the recipients' own resources.

Union. The latter are simultaneously committing to and signing major mineral contracts. Other anecdotal evidence of that concomitance between foreign aid and natural resource abundance plays out in Guyana, Mozambique, Mongolia, Namibia, and Papua New Guinea. Rather than use coercion as was the case in the 19<sup>th</sup> century, foreign aid could be seen as “greasing the wheels” to the signing of lucrative mining contracts for exploration, extraction and ultimately trade flows. In other words, traditional donors as well as non-traditional donors such as China are in a contest to secure natural resources located in developing countries and boost bilateral trade by granting aid.

To identify elements of self-interest motive in donors’ decision to allocate foreign aid, we exploit the timing and size of major discoveries. Whether they relate to minerals or hydrocarbons, major discoveries are salient shocks. Here we will primarily rely on mineral discoveries because then the sample period spans to most recent years namely 2023. It is also noteworthy that the original mineral dataset obtained from MINEX, a consultancy, contain estimates of the value of mineral deposits which are not per se net present values (NPVs) but values of mine sites.<sup>3</sup> The median discovery in the sample is 29.81 percent of GDP for minerals. We further complement our analysis with hydrocarbon discoveries obtained from the late Mike Horn, former President of the American Petroleum Geologist Association, noting that this dataset ends in 2014.<sup>4</sup>

Major mineral discoveries are also frequent and widespread. Over the past decades there have been hundreds of discoveries of mineral and hydrocarbon resources all around the world including South Asia, Latin America and most notably Sub-Saharan African countries. In many of these countries property rights are with the state, rather than with the private sector as in the United States. The consequences of major discoveries are to immediately increase the (known) wealth of a nation. It thus raises the value of the collateral that countries can use to borrow internationally, thus alleviating potential external borrowing constraints—in principle, even before the resource is extracted. Considering the above, countries experiencing major discoveries should receive less aid.

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<sup>3</sup> Richard Schodde, the Managing Director of MINEX, states that the value available in the dataset is: “the dollar value of the various metals in the deposit (after adjusting for the likely recovery rate, treatment & refining charges, etcetera). As a rule, the prices used are based on the average monthly price (as reported by the London Metal Exchange or equivalent) realized over the preceding 3 years. This pricing methodology is consistent with the guidelines used in the US Security Exchange Commission for valuing mining projects”.

<sup>4</sup> The NPV for so-called giant hydrocarbon discoveries is 2.97 percent of GDP. The computation differs from the computation of the values of mineral discoveries and hence the two are not directly comparable. We therefore use dummies to combine the two discoveries.

Take a mental experiment where donors are given the choice to provide aid to two otherwise identical countries that differ only on one dimension, namely the occurrence of a discovery. If donors are exclusively “altruistic”, the choice of aid allocation should be directed toward the country without a discovery because poverty reduction is more acute there than in the country who has received a windfall of natural resource wealth. If donors are motivated by “self-interest”, aid may go toward the country which discovered resources. Indeed, self-interest donors will attempt to secure access to the newly discovered resources. We present a simple theoretical two-by-two donor-recipient model with a contest success function to analyze rent capture and conflict between donors and recipients. We test the resulting insights with an empirical analysis of the effects of resource discoveries on bilateral aid.

An alternative explanation to the self-interest motive driving aid to countries which discovered resources could be that donors want to be associated with “economic success” stories. Indeed, a booming economy following a major discovery in a recipient country could make donors willing to be associated with such apparent success, albeit at the expense of the relatively “poorer” countries not having discovered resources. Mozambique which discovered giant oil and gas reserves is a case in point. Mozambique experienced large foreign direct investment inflows with (initial but) sizable local spillovers in turn leading to job creation including outside the resource sectors (Toews et al., 2022). Such apparent success can lead donors to “bet on the success” of countries like Mozambique to showcase that foreign aid is effective.

From that perspective, donors would be enticed to give more aid in the form of loans rather than grants to the country which has just discovered resources with the hope that they could repay in the next few years — major discoveries typically take on average 5 to 7 years between discovery and first production. We will directly test whether the loan rather the grant component of aid responds more to major discoveries to verify whether that alternative explanation is supported by the data. One important conceptual caveat with this alternative explanation for why aid flows to discovery country is that the odd for success is effectively low for countries that have abundant natural resources. Notwithstanding the Toews et al. (2022) results for Mozambique, the so-called resource curse literature has abundantly documented the weaker performance of countries dependent in natural resources. Indeed, a myriad of factors drive the resource curse ranging from Dutch disease to excessive macroeconomic and political instability and conflicts as surveyed by van der Ploeg (2011).

We thus explore the paradox that as developing countries become (relatively) “richer” due to major resource discoveries they tend to receive, not less, but more foreign aid. Foreign aid, as recorded by the Development Assistance Committee, is a drop in the bucket for traditional donor countries, about 214.4 billion of US dollars or 0.37 percent of their combined Gross National Income (GNI) in 2023.<sup>5</sup> But foreign aid is a major source of funding for most developing economies. Furthermore, exporters of mineral resources such as DRC, Mongolia and Zambia have remained aid recipient with historical peaks reaching respectively 67.2, 17.2 and 57 percent of respective GNI.

Our empirical estimates are consistent with the predictions of our theoretical model for self-interest donors. Results show that recipient countries that discover major resources receive more, and faster, aid everything else equal. That is indeed a paradox considering that major resource discoveries imply an immediate increase in (known) wealth and are associated with an effective relaxation of international borrowing constraints. We verify that grant and not just loan components of aid increase following a discovery and that the flow of bilateral aid increases more from the country of nationality of the discoverer. Results are robust to a wide array of checks including accounting for the nature of discovery, the heterogeneity of donors and recipients, and using different estimators.

Our results are related to the abundant strand of the literature on aid allocation.<sup>6</sup> A notable paper by Burnside and Dollar (2000) argues that aid allocation is only weakly going to countries with good policies. In turn, the authors argue that this needs to change to increase the effectiveness of foreign aid.<sup>7</sup> <sup>8</sup> Easterly (2024) finds that US and other aid donors shifted toward badly governed countries, worsening the so-called “paradox of aid”: lowest income countries where aid is most needed are often the ones with the worst governance.<sup>9</sup> <sup>10</sup> Our paper is related to that strand of

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<sup>5</sup> See data at the following URL link: <https://www.oecd.org/en/topics/sub-issues/oda-trends-and-statistics.html>

<sup>6</sup> Alesina and Dollar (2000), Alesina and Weder (2002) and Knack (2001) are among the early contribution to the strand of literature on aid allocation. The authors find that foreign aid tends to flow more to democratic and less to corrupt countries — prior to the early 2000s.

<sup>7</sup> Andersen et al. (2022) show evidence of outright aid capture in low-income countries. They find that aid disbursements to highly aid-dependent countries coincide with sharp increases in bank deposits in offshore financial centers known for bank secrecy and private wealth management, but not in other financial centers.

<sup>8</sup> Djankov et al. (2008) find that aid has a negative impact on institutions and that aid is a bigger “curse” than oil.

<sup>9</sup> Easterly (2007) suggests that empirical evidence for the impact of aid on growth is inconclusive and depends on a variety of factors including policies.

<sup>10</sup> Eisensee and Stromberg (2007) document that the public opinion in the United States is influenced by media coverage of global events and disasters and in turn affects U.S. aid decisions.

literature in that it unveils a new paradox of foreign aid namely that (relatively) richer countries on account of major mineral discoveries receive not less but more aid.

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Natural experiments have also been used to dissect the effect of shocks on aid allocation.<sup>11</sup> Notably, Faye and Niehaus (2012) document the existence of “aid cycle”, where donors strategically use bilateral aid to sway the outcome of elections. The authors exploit the timing of (predetermined) elections to explore whether donors behave strategically during elections. We follow a similar empirical approach using a gravity model combined with the timing and size of major mineral discoveries to explore the change in donors’ allocation of aid to recipient countries.

Our paper is also related to the strand of literature on natural resources. Natural resource dependence subjects developing and emerging market economies to macroeconomic challenges.<sup>12</sup> One challenge traditionally emphasized in the literature is rent seeking, wherein natural resources increase the return to state capture, potentially leading to inefficient policy choices in the absence of strong political institutions.<sup>13</sup> Another is the so-called Dutch disease wherein a natural resource discovery or price appreciation is accompanied by an overvalued real exchange rate, which in turn shrinks the non-resource export sector.<sup>14</sup> Arezki, Ramey and Shang (2017) explores the effect of news shocks in open economies using giant oil and gas discoveries as a directly observable measure of news shocks about future output—the delay between a discovery and production is on average four to six years. Consistent with the predictions of the theoretical model, estimates show that after an oil or gas discovery, the current account and saving rate decline for the first five years and then rise sharply during the ensuing years. These results suggest that countries experiencing giant discoveries borrow from the rest of the world well before extraction starts. In this paper, we document that major mineral discoveries lead to a deterioration of the current account implying

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<sup>11</sup> Werker et al. (2009) utilize oil price fluctuations as an exogenous source of variation to examine the macroeconomic implications of foreign aid from the Organization of Petroleum Exporting Countries (OPEC). The study reveals that aid substitutes for domestic savings, does not significantly impact the financial account, and leads to substantial unaccounted capital flight, thus challenging conventional assumptions about the economic benefits of aid.

<sup>12</sup> See van der Ploeg (2011) for a survey of the literature on the so-called resource curse.

<sup>13</sup> Tornell and Lane (1999) describe a “voracity effect” in which a terms of trade windfall leads to state capture by powerful groups. Robinson, Torvik, and Verdier (2014) provide a similar model in which incentives for state capture increase with natural resources exports. See Ross (2012) for examples of rent seeking in the oil industry.

<sup>14</sup> Eastwood and Venables (1982) show how in the standard neoclassical model, an oil discovery will lead to an appreciation of the real exchange rate, operating through an increase in the relative price of non-tradables. Torvik (2001) shows that the Dutch disease can be avoided in a more sophisticated model by allowing for learning-by-doing in the non-tradable sector and knowledge spillovers from the non-tradable to tradable sector. See Arezki and Ismail (2013) and references therein for discussion of the mixed empirical evidence in favor of the Dutch disease.

the country borrows from the rest of the world. Mineral discoveries imply that a country is richer than previously thought and should relax external borrowing constraints. Further, we document that foreign aid tends to flow significantly more to countries experiencing positive wealth shocks in the form of a major mineral discoveries, which suggests that donors may be self-interested.

Section 2 present a simple theory of aid allocation in presence of natural resource discoveries. Section 3 describes the data and empirical strategy. Section 4 presents the main results. Section 6 lays out extensions and robustness checks. Section 7 concludes.

## II. AID ALLOCATION AND RENT SEEKING WITH RESOURCE DISCOVERIES

We put forward a simple analytical model to show the difference between benevolent and non-benevolent donors. Recipients attempt to divert revenues from foreign aid or natural resources. Benevolent donors maximize payoffs from aid to various recipient countries duly taking account of the fact that part of foreign or resource income gets diverted by the recipient governments and other political and business elites. Non-benevolent donors also care about the boom associated with resource discoveries. Our key result will be that donors then allocate more aid to countries with resource discoveries than to countries without. This is an example of the aid paradox.

Consider two aid donor countries denoted by  $A$  and  $B$ , and two aid recipient countries denoted by 1 and 2. Donor countries maximize their payoff function by choosing an allocation scheme of their aid to recipients. Each donor country allocates its total aid budget,  $T_i, i = A, B$  to recipient countries. Denoting aid of donor country  $j$  to recipient  $i$  by  $a_{ji}, j = 1, 2, i = A, B$ , we have

$$(1) \quad a_{1i} + a_{2i} \leq T_i, i = A, B.$$

Elites in recipient countries may capture a share of the aid,  $x_j, j = 1, 2$ . So, only  $(1 - x_j)a_{ji}$  of aid  $a_{ji}, i = A, B$  reaches the target population in recipient country  $j = 1, 2$ .

### II.A. BENEVOLENT DONORS

The payoff of a donor country increases in the aid it gives to each recipient country but decreases in the share of aid that is diverted. The payoffs for donor countries are

$$(2) \quad W_i = \sum_{j=1,2} f_j(a_{ji}; x_j), i = A, B$$



where  $f_j(a_{ji}; x_j)$  is the recipient-specific impact function of aid to country  $j$ . This function is increasing and concave in  $a_{ij}$  and decreasing in  $x_j$ . Donors have no self-interest but simply maximize the aid impact on the population (e.g., poverty reduction). If donors are uninterested in securing access to natural resources, they are “benevolent” donors. Later we explore “non-benevolent” donors, where self-interested donors try to secure access to resources (and benefit from the ensuing booms of a mineral discovery) as well as cut poverty in recipient countries.

Country 1 has a mineral windfall of value  $R_1 = R > 0$ . We suppose that the government and elites of this country maximize their share of rents from resources and aid. The degree of rent diversion depends on how deficient institutions and corrupt governments are in the recipient countries. Adding an altruistic motive or a redistributive component will not alter our main results. Country 2 has no resources,  $R_2 = 0$  (or if it does have resources, they are not diverted).

The payoff of the decision makers (government or elite) in the recipient countries are

$$(3) \quad U_j(x_j; a_{jA}, a_{jB}) = x_j(a_{jA} + a_{jB} + \beta_j R_j) - \frac{1}{2} c_j x_j^2, j = 1, 2,$$

where  $x_j(a_{jA} + a_{jB} + \beta_j R_j)$  is the share of diverted rents and  $\beta_j > 0$  captures that resource rents may be more (or less) easily diverted relative to aid depending on whether  $\beta_j < 1$  (or  $> 1$ ). The function  $\frac{1}{2} c_j x_j^2$  with  $c_j > 0$  reflects expenditures necessary to stay in power or divert rents.

Donors determine their aid allocation  $(a_{1i}, a_{2i}, i = A, B)$ , and recipients decide on rent seeking  $(x_j, j = 1, 2)$ . We consider a two-stage game: in stage one, donors decide their allocation of aid; in stage two, recipients  $j = 1, 2$  choose their diversion rate  $x_j$  to maximize  $U_j(x_j; a_{jA}, a_{jB})$  given levels of foreign aid  $a_{jA}$  and  $a_{jB}$ . Optimality requires that the marginal cost of diverting rents must equal the size of resource rents and aid. This gives the best response functions

$$(4) \quad x_1^r = \frac{1}{c_1} (a_{1A} + a_{1B} + \beta R) \text{ and } x_2^r = \frac{1}{c_2} (T_A - a_{1A} + T_B - a_{1B}).$$

Hence, aid to one country increases rent-seeking behavior in that country but leads to less aid to the other country (from the budget constraint) and less rent seeking in the other country. Given aid allocations and budgets, resources increase rent seeking in country 1 with no effects in country 2.

Given the best response functions (4), the first-stage maximization program is for donors to allocate their aids by maximizing their payoffs (2) subject to the budget constraints (1). The first-order optimality condition for giving to country 1 by donor country  $A$  gives

$$(5) \quad \frac{\partial f(a_{1A}; x_1^r)}{\partial a_{1A}} + \frac{\partial f(a_{1A}; x_1^r)}{\partial x_1^r} \frac{1}{c_1} = \frac{\partial f(a_{2A}; x_2^r)}{\partial a_{2A}} + \frac{\partial f(a_{2A}; x_2^r)}{\partial x_2^r} \frac{1}{c_2},$$

taking  $a_{1B}$  and  $a_{2B}$  as given, and similarly for giving aid from country  $B$  (and to country 2) taking  $a_{1A}$  and  $a_{2A}$  as given. Donors thus take aid of other donor countries as given, since we assume that donors do not coordinate. The resulting equilibrium is a non-cooperative Nash equilibrium.

Equation (5) indicates that the marginal benefit of aid, net of the marginal cost of rent seeking in country  $A$ , is set to the net marginal benefit of aid to country  $B$ . To get a tractable solution, we assume symmetry so  $f_1(\cdot) = f_2(\cdot)$ ,  $c_1 = c_2 \equiv c > 0$  and  $T_A = T_B \equiv T$ , and  $f_j(a_{ji}; x_j) = a_j - \frac{1}{2}\phi a_j^2 - \frac{1}{2}\omega x_j^2$  with  $\phi, \omega > 0$ . We then have  $a_{jA} = a_{jB} \equiv a_j, j = 1, 2$ . With these assumptions equations (1), (4) and (5) give<sup>15</sup>

$$(6) \quad a_1 = \frac{1}{2} \left( T - \frac{\omega}{\phi c^2 + 2\omega} \beta R \right) < a_2 = \frac{1}{2} \left( T + \frac{\omega}{\phi c^2 + 2\omega} \beta R \right), \text{ and}$$

$$(7) \quad x_1 = \frac{1}{c} \left( T + \frac{\phi c^2 + \omega}{\phi c^2 + 2\omega} \beta R \right) > x_2 = \frac{1}{c} \left( T - \frac{\omega}{\phi c^2 + 2\omega} \beta R \right).$$

Hence, even with rent diversion in recipient countries, donors decrease aid to the developing country with resources and thus (given a fixed budget for aid) increase aid to the country without resources, especially so if the donor attaches a high cost to diverting rents in recipient countries while recipient countries attach little cost to diverting rents (high  $\omega$  and low  $c$ ); see equation (6). Note that a resource discovery in country 1 increases rent diversion in that country by more than in the recipient country with resources; see equation (7).

## II.B. NON-BENEVOLENT DONORS

We now consider non-benevolent donors to capture that donors may be self-interested by trying to use their aid policy to secure a privileged access to natural resource. To capture this, we modify the donors' objective function by adding the expected gain from capturing resource rents.

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<sup>15</sup> Note  $a_1 + a_2 = T$ ,  $x_1 = \frac{1}{c}(2a_1 + \beta R)$ ,  $x_2 = \frac{2}{c}(T - a_1)$  and  $1 - \phi a_1 - \frac{\omega}{c} x_1 = 1 - \phi a_2 - \frac{\omega}{c} x_2$ . Substituting the first three equations into the last one, we get  $\phi a_1 + \frac{\omega}{c^2}(2a_1 + \beta R) = \phi(T - a_1) + \frac{2\omega}{c^2}(T - a_1)$ , which gives (6).

Donor countries  $A$  and  $B$  are fighting over access to natural resources. We model this with a contest success function, where the probability of access to resources (via a right or license),  $p(a_{1A}, a_{1B}) = a_{1A}/(a_{1A} + a_{1B})$ , increases in its own level of aid but decreases in the level of aid by the rival donor to country 1 with the resource discovery.<sup>16</sup> The objective function of the donor countries becomes

$$(8) \quad V_A(a_{1A}; x_1^r, x_2^r) = f(a_{1A}; x_1^r) + f(a_{2A}; x_2^r) + \alpha_A p(a_{1A}, a_{1B})R,$$

and similarly for donor  $B$ , where the coefficients  $\alpha_i \geq 0, i = A, B$  denote how self-interested donors are. Donors thus give aid to curb poverty in recipient countries (altruistic motive), but also to obtain access to potential resource benefits in recipient countries (self-interest motive). Under the assumption of a Nash equilibrium between the donors, equation (5) becomes

$$(5^*) \quad \frac{\partial f(a_{1A}; x_1^r)}{\partial a_{1A}} + \frac{\partial f(a_{1A}; x_1^r)}{\partial x_1^r} \frac{1}{c_1} + \alpha_A \frac{\partial p(a_{1A}, a_{1B})}{\partial a_1^A} R = \frac{\partial f(a_{2A}; x_2^r)}{\partial a_{2A}} + \frac{\partial f(a_{2A}; x_2^r)}{\partial x_2^r} \frac{1}{c_2},$$

with  $\frac{\partial p}{\partial a_{1A}} = \frac{a_{1B}}{(a_{1A} + a_{1B})^2} > 0$ , and similarly for donor  $B$ . Higher aid thus increases the chance of capturing more of the benefits from the resource discovery. For simplicity, we set  $\alpha_A = \alpha_B \equiv \alpha$  and get a symmetric equilibrium with  $a_{jA} = a_{jB} \equiv a_j, j = 1, 2$  and solve for  $a_1$  from the quadratic<sup>17</sup>

$$(9) \quad 2a_1^2 + (\omega\beta R^* - T)a_1 - \alpha \frac{c^2}{4} R^* = 0 \quad \text{with} \quad R^* \equiv \frac{R}{\phi c^2 + 2\omega}.$$

This gives

$$(9^*) \quad a_1 = \frac{1}{4}(T - \omega\beta R^*) + \frac{1}{4}\sqrt{(T - \omega\beta R^*)^2 + 2\alpha c^2 R^*}.$$

Note that (9') boils down to equation (6) if  $\alpha = 0$ . We can see from (9') that if donors become more self-interested, they increase aid to countries with resources and cut aid to countries without ( $\partial a_1/\partial \alpha = -\partial a_2/\partial \alpha > 0$ ). These effects are stronger the size of resources in country 1. The effect of more self-interested donors on the rent diversion rate is positive in the country with resources and negative in the country without ( $\frac{\partial x_1}{\partial \alpha} = -\frac{\partial x_2}{\partial \alpha} = \frac{2}{c} \frac{\partial a_1}{\partial \alpha} > 0$ ), and again these effects are stronger if the resource windfall in country 1 is larger. Total differentiation of (9) yields

<sup>16</sup> See Tullock (1967) and Hirschleifer (1991) for early contributions to the contest function approach. See Konrad (2008) for an overview with applications in many different fields.

<sup>17</sup> The last equation in footnote 15 becomes  $1 - \phi a_1 - \frac{\omega}{c} x_1 + \frac{\alpha R}{4a_1} = 1 - \phi a_2 - \frac{\omega}{c} x_2$ , which gives

$1 - \phi a_1 - \frac{\omega}{c} \frac{1}{c} (2a_1 + \beta R) + \frac{\alpha R}{4a_1} = 1 - \phi(T - a_1) - \frac{\omega^2}{c^2} (T - a_1)$ . Hence,  $a_1$  follows from equation (9).

$$(9) \quad da_1 = \frac{a_1 dT + \left(\frac{\alpha}{4}c^2 - \omega\beta a_1\right) dR^* + \frac{c^2}{4}R^* d\alpha}{4a_1 + \omega\beta R^* - T}.$$

We thus see that the effect of resources in country 1 is to reallocate aid from the resource-rich country 1 to the resource-poor country 2 if self-interest of donors is not too large (i.e.,  $\alpha < 4\omega\beta a_1/c^2$ ), as in section II.A for benevolent donors (with  $\alpha = 0$ ). However, if self-interest of donors is large enough ( $\alpha > 4\omega\beta a_1/c^2$ ), a resource discovery in country 1 leads donors to increase aid to the resource-rich country 1 at the expense of aid to the resource-poor country (“bad Samaritans”). The resource-poor developing country is hurt by resource discoveries in other recipient countries. To test whether donors are sufficiently self-interested, we must test whether resource discoveries lead donors to increase aid. It is easy to verify that in that case rent diversion rates in the country with resources increases while it decreases in the country without.

### III. DATA AND EMPIRICAL STRATEGY

Here, we present our dataset for aid, resource discoveries and our control variables. Tables A.1 and A.2 present a summary of the data sources and descriptive statistics.

We obtain aid or Official Development Assistance (ODA) data from the Development Cooperation Directorate (DAC) database of the Organization for Economic Cooperation and Development (OECD).<sup>18</sup> We use ODA commitments from 1975 to 2017, deflated to constant 2017 US dollars as our main dependent variable. Using changes in commitments, as opposed to changes in disbursement, allows us to limit the potential endogeneity associated with discoveries. Indeed, aid once disbursed could (directly) facilitate investment in exploration (and further extraction), and hence influence the timing of discoveries of minerals. The change in commitment, however, is unlikely to affect the timing of the discovery. This allows to assert that the relationship we uncover between the timing of discovery and aid commitment is plausibly causal.

To account for the rise of China as a major non-traditional donor (not included in OECD’s DAC database), we incorporate data from the Aid Data’s Chinese Official Finance to Africa Dataset.<sup>19</sup> China’s collateralized lending (e.g., infrastructure against natural resources) can be seen

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<sup>18</sup> OECD, Aid (ODA) commitments to countries and regions (DAC3a).

<sup>19</sup> We verify that our main result that aid increases following a mineral discovery holds when excluding China from the sample (see Table B.4). We also show that our main result appears to hold for China alone, but results are not

as an example of quid pro quo between donor and recipient. While traditional donors do not explicitly use collateralized lending/aid, the evidence presented in this suggest that implicitly their aid commitments are linked to the presence of natural resources in recipient countries.

We consider bilateral aid flows. These capture more directly the potential quid pro quo between donors and recipients. We exclude multilateral aid from our main analysis, since it can potentially limit national interest motives.<sup>20</sup> We focus on the 20 largest (bilateral) donors which together accounted for 99 percent of aid commitments.<sup>21</sup> That results in a 47-year panel dataset, featuring 189 recipients in total, with an average of 165 recipients per donor-year.

ODA, as defined by the OECD Glossary, includes grants and loans directed to countries and territories classified as “developing” based on criteria such as being official sector undertakings with economic development and welfare enhancement as primary objectives and featuring concessional financial terms. The dataset also incorporates technical cooperation as part of aid, while excluding grants, loans, and credits for military purposes. The ODA data thus excludes military aid.

Major mineral discoveries are our main explanatory variable in the empirical analysis. The proprietary raw data on mineral deposit discoveries are from MinEx. The list of minerals included in the dataset is comprehensive and includes precious metals and rare earths. MinEX constructed the data from company public reports (Annual Reports, press releases, NR 43–101 studies, etcetera), technical and trade journals (such as Economic Geology, Northern Miner and Mining Journal) and Government Files (from the various Geological Surveys).

There are caveats associated with the Minex data. First, there is likely to still be a certain measurement bias towards larger deposits as they tend to be better documented. Second, data for countries such as Russia and China may be under-estimated considering the less accessible nature of the data. Last, our dataset excludes iron ore and bauxite. These metals are more abundant and visible than other metals and hence are less subject to a discovery process. Exploitation decisions

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robust and are statistically insignificant (see Supplementary Appendix Table B.5). Inconsistency between datasets may render the comparison between China and DAC countries difficult, hence we leave further analysis of the role of China for further research.

<sup>20</sup> We also verify more systematically that the hypothesis that multilateral aid is less sensitive to discovery relative to bilateral aid cannot be rejected (see Supplementary Appendix Table B.6).

<sup>21</sup> We also verify that our main result holds with different donor groupings (see Supplementary Appendix Table B.7).

tend to be based more on proximity to port facilities for iron ore and substantial energy availability for bauxite than other factors.<sup>22</sup> MinEX thus does not report “discoveries” for iron and bauxite.

Market value for mineral discoveries is straightforward, since MinEX provides Tier information for each mineral deposit (see Table A.3). Deposits are assigned to Tier 1 to Tier 4 by their estimated revenue using long-run commodity prices. For example, Tier 1 deposits are “large, long life, and low cost”, while Tier 4 deposits are “uneconomic deposits”. Following Tier’s definitions, and to simplify calculations, we assign a value of \$750 million USD for Tier 1 discoveries, \$100 million USD for Tier 2 discoveries, \$20 million USD for Tier 3 discoveries, and 0 for Tier 4 discoveries.

In addition to mineral discoveries, we also conduct supplementary analysis with data for oil and gas discoveries from Horn (2014) which reports discoveries of giant oil (including condensate) and gas fields which we interchangeably refer to jointly as hydrocarbon, oil and gas, or simply oil discoveries. A giant discovery is defined as a discovery of an oil and/or gas field that contains at least 500 million barrels of ultimately recoverable oil equivalent. Ultimately recoverable reserves refer to the amount that is technically recoverable given existing technology, from which, we were able to construct a net present value (NPV)<sup>23</sup> for oil discoveries at the time of the discovery.<sup>24</sup>

Demographic and economic variables are used as controls and are from the World Bank’s World Development Indicators database.

### III.A. EMPIRICAL STRATEGY

The empirical strategy to explore the effects of mineral (and further oil) discoveries on foreign aid commitments exploits the specific timing of discoveries in recipient countries to test whether the response of donors is self-interested. We follow the reduced-form specification used by Faye

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<sup>22</sup> Discoveries that are located and discovered by a firm from the same country are excluded from the sample.

<sup>23</sup> For oil discoveries we use the NPV constructed by Arezki et al. (2017), assuming 5 percent risk discount rate and realistic projected production profile.

<sup>24</sup> A measure of the NPV of a giant oil discovery is  $NPV_{i,t} = \sum_{j=5}^{j=J} \frac{q_{i,t+j} * oilprice_t}{(1+r)^j}$  (cf. Arezki et al., 2017). The NPV for a given country,  $i$ , at the time the discovery is made,  $t$ , is the discounted sum of gross revenue derived from an approximated oil production profile,  $q_{i,t+j}$ , from the fifth year following the discovery to the exhaustion year,  $J$ , valued at the oil price prevailing at the time of the discovery. The approximated production profile follows a piece-wise process in the form of reserve-specific-plateau production followed by exponential decline (Höök et al., 2014; Robelius, 2007).

and Niehaus (2012). In all our specifications, we incorporate donor-recipient fixed effects, allowing us to estimate the effects of discoveries by relying solely on the time variation within donor-recipient pairs. This eliminates any time-invariant characteristics associated with recipients and their specific bilateral relationships with donors. Our approach is akin to a difference-in-difference estimation using aid inflows (outcomes) for countries who were exposed to discoveries (treated) and countries which were not (not treated), both before and after discoveries. To account for the potential effect of trends in aid flows coinciding with mineral discoveries, we introduce time-varying controls such as population and GDP. That helps mitigate the risk of confounding variables and ensures a robust examination of the effects of discoveries on bilateral aid.

Let  $d$  denote donor countries,  $r$  recipient countries, and  $t$  years. We estimate the direct relationship between bilateral aid commitment and the timing of discoveries within a country pair:

$$(10) \quad \text{Log}(ODA_{drt}) = \theta \text{DISC}_{rt} + X'_{drt}\beta + \alpha_{dr} + \epsilon_{drt},$$

where  $\text{Log}(ODA_{drt})$  is the logarithm of ODA from donor  $d$  to recipient  $r$  at time  $t$ ,  $\text{DISC}_{rt}$  is the dummy that takes 1 if country  $r$  has any mineral (or further oil) discovered in year  $t$  and 0 otherwise,  $X_{drt}$  is a vector of time-varying donor or recipient specific control variables such as population and GDP, and  $\alpha_{dr}$  represents a vector of donor-recipient country pair fixed effects.

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Further, we explore the mechanisms driving aid allocation following discoveries, exploring the role of political systems. E.g., democracy is expected to interact with discoveries to drive further aid commitments following discovery on account of the presence of check and balances and other constraints to the executive—potentially restricting rent and resource capture. To explore these mechanisms, we augment (10) with an interaction between conflicts and democracy

$$(11) \quad \text{Log}(ODA_{drt}) = \theta_1 \text{DISC}_{rt} + \theta_2 \text{DISC}_{rt} \times \text{DEMO}_r + X'_{drt}\beta + \alpha_{dr} + \epsilon_{drt}$$

Here  $\text{DEMO}_r$  is the measure of democracy of the recipient country, indexed by simple average of polity2 score of the recipient country. Intuitively,  $\theta_2$  estimates the difference-in-difference between discovery effects for higher or lower democracy level compared to neutral polity score of 0. If the donors favor democracy when allocating aid following a discovery, then democracy helps to strengthen the link between resource discovery and aid, and thus the estimate of  $\theta_2$  should be statistically significant and positive.

Bilateral aid flows between a specific donor and recipient over time involve numerous instances of zero values. Most empirical studies typically adopt a straightforward approach of excluding pairs with zero aid from the dataset and using ordinary least square (OLS) to estimate the logarithmic linear form. In contrast, we do not drop the zeros in this paper. We assign the value of 1 if ODA is equal to zero and take the natural logarithm of ODA commitments. Given the prevalence of zeros and the potential heteroskedasticity of errors, OLS results may exhibit biases and inconsistency. To ensure consistent estimators and address zero-value observations effectively, robust estimators such as the Poisson Pseudo-Maximum Likelihood (PPML) estimator, Zero-Inflated Poisson, Heckman selection model, and the Probit model (Silva and Tenreyro, 2006; Herrera, 2010; Martin and Hall, 2017) can be used. We exploit these alternative estimators to assess the robustness of our estimates.

A statistical concern is the potential correlation between discoveries and unobserved characteristics of recipient countries. For example, poor countries may exhibit both higher rent capture and a higher propensity to receive aid. To address this concern, we incorporate donor-recipient fixed effects (denoted as  $\alpha_{dr}$ ) into equation (10). This adjustment effectively removes time-invariant attributes of recipients and their specific bilateral relationships with donors, thus allowing us to focus on estimating the impact of discoveries by considering only the time variation within donor-recipient pairs. Another issue to contend with is the potential alignment between trends in aid and the frequency of discoveries. To mitigate this concern, we introduce controls in the form of time-varying variables such as population and GDP. This approach helps account for any concurrent trends in aid allocation and the occurrence of discoveries, enabling a proper identification of the effects of discoveries on aid allocation. A concluding methodological consideration pertains to inference. Even upon the elimination of donor-recipient and time varying effects, achieving conditional uncorrelation of error terms within the panel dimensions in equation (10), a requisite for the consistency of conventional OLS standard errors, remains unlikely. Given the various dimensions available for clustering, we adopt a robust approach by clustering on donor-recipient pairs, which is both the most general and restrictive method (Bertrand et al., 2004).



## IV. RESULTS

### IV.A. DOES FOREIGN AID INCREASE FOLLOWING MINERAL DISCOVERIES?

We first test whether the occurrence of a mineral discovery leads to an increase in aid commitment in recipient countries. Columns I-III of Table 1 report estimates of equation (10), where the occurrence of a mineral discovery is captured by a dummy as a predictor of bilateral aid commitment. The results suggest a statistically significant and positive direct relationship between aid commitment and mineral discovery. This is true whether we control for time-varying influences such as year fixed effects (column I), donor-year fixed effects (column II), or macroeconomic controls (column III). Using column III as our benchmark, we find that the occurrence of a mineral discovery increases bilateral aid commitment by about 36 percent.<sup>25</sup> Hence, the average difference in aid between countries experiencing a mineral discovery and those which do not is 36 percent.

When substituting the use of dummy by a measure of the net present value (evaluated in US dollars) associated with mineral discovery (columns IV-VI in Table 2), the results remain statistically significant. Quantitatively, the interpretation of the results using column VI estimates as a benchmark implies that a 1 percent increase in values associated mineral discovery increase bilateral by about 0.015 percent all else being equal. For example, if the value of a discovery goes from Tier 2 (20 million USD) to Tier 4 (750 million USD) bilateral commitment could increase by about 50 percent. The effect of mineral discoveries on aid commitment appears rather large. Our empirical estimates are consistent with the predictions of section II.B with a self-interest motive for donors. The self-interest motive in our model is associated with the securing of access to mineral resources in recipient countries. The results confirm that the occurrence of a mineral discovery causes new bilateral commitment on impact of the news of the discovery.

To allay the potential concern stemming from staggered treatment concerns, we also use the local projection difference-in-difference (LP-DiD) estimation method proposed by Dube et al (2023) as an alternative estimation method. Our results are robust to whether we consider that once a unit is treated, the unit remains treated (see Figure 1). Note that the dynamic effect of the mineral discovery on foreign aid commitment uncovered by the local projection method is concentrated at

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<sup>25</sup> To interpret this, we exponentiate the coefficient associated with the discovery dummy and subtract 1 to get the percentage change.

the onset of the discovery. Also, there is no evidence of an anticipation effect of aid commitment prior to the discovery. These results justify our focus on the impact effect of discoveries on aid.

Our empirical results thus indicate that recipient countries that experience major discoveries receive more bilateral aid all else equal despite that major discoveries imply an immediate increase in national wealth and suggest a relaxation of international borrowing constraints. To verify that, we explore the effect of mineral discoveries on macroeconomic aggregates replicating the analysis of Arezki et al. (2017) but using mineral rather than giant oil discoveries.

We generated impulse response functions following a mineral discovery shock for the current account, saving and investment using the so-called local-projection method (Jorda', 2005). Results presented in Panel A of Figure C1 points to “swinging” current account balances following mineral discoveries. That is the current account first deteriorates before it improves. The country borrows from the rest of the world following the news of a discovery. Saving also decreases before starting to increase (Panel B of Figure B.1). Investment increases first become it declines (see Panel C of Figure B.1). The anticipation effect of these macroeconomic variable is the result of the delay between the announcement of the discovery and the start of production. That is akin to a so-called news shock—a shock you learn about today but materialize in the future. That delay is typically 5 to 7 years from the discovery date. Anticipating the mineral revenues, the country experiencing a discovery starts to borrow from the rest of the world well before the production start. That suggests that countries experiencing a discovery enjoy the relaxation of potential borrowing constraints.

We also test whether a country more open to capital markets receives more aid following a mineral discovery. We thus generate impulse responses distinguishing the behavior of countries with higher financial openness from those with lower openness using the measure of capital openness of Chinn and Ito (2006). Following a mineral discovery, countries that are less open financially experience higher investment, and a deterioration of saving and the current account, barely distinguishable from financially open countries (see panels A, B and C of Figure B.2). The flow of aid following a mineral discovery, points to inefficiency in aid allocation. Given the stated goals of poverty reduction of aid, one would expect less, not more, aid in recipient countries that experience a discovery compared to recipient countries without such discoveries. After all, one could argue that countries experiencing a discovery should need less aid, not more aid.

TABLE 1

## EFFECT OF MINERAL DISCOVERIES IN RECIPIENT COUNTRIES ON BILATERAL AID

	(I)	(II)	(III)	(IV)	(V)	(VI)
	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid
Mineral discovery	0.239*** (0.055)	0.235*** (0.049)	0.307*** (0.052)			
Mineral discovery (NPV)				0.012*** (0.003)	0.012*** (0.002)	0.015*** (0.002)
Recipient GDP			-1.328*** (0.083)			-1.328*** (0.083)
Donor GDP			2.911*** (0.117)			2.910*** (0.117)
Recipient population			1.451*** (0.301)			1.451*** (0.301)
Donor population			-1.251*** (0.155)			-1.250*** (0.155)
Fixed effects	DR,Y	DR,DY	DR	DR,Y	DR,DY	DR
Observations	151,076	151,076	126,810	151,076	151,076	126,810
R-squared	0.591	0.647	0.610	0.591	0.647	0.610

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country. Each column reports a separate regression. The dependent variable in all columns is log of bilateral ODA. All control variables are in logarithms. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources, and 0 otherwise. Mineral discovery (NPV) is log of net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair, Y for year, and DY for donor-year pair. The number of observations in column (3) and (6) are smaller, since these regressions include macroeconomic indicators that are not available for all countries and all years (see Appendix for details). Constant terms are included in all regressions but are not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\*, and \*\*\* denote 10%, 5%, and 1% significance level, respectively.

TABLE 2

TEST OF SPEED OF DISBURSEMENT OF AID COMMITMENT FOLLOWING MINERAL DISCOVERIES

Model 1 (with DR-Y Fixed Effects):  $Disbursement_{dr,t} = \sum_{h=1}^H \beta_h Commitment_{dr,t-h} * NoDiscovery_{r,h} + \sum_{h=1}^H \theta_h Commitment_{dr,t-h} * Discovery_{r,h} + \gamma_{dr} + \gamma_t + \epsilon_{dr,t}$

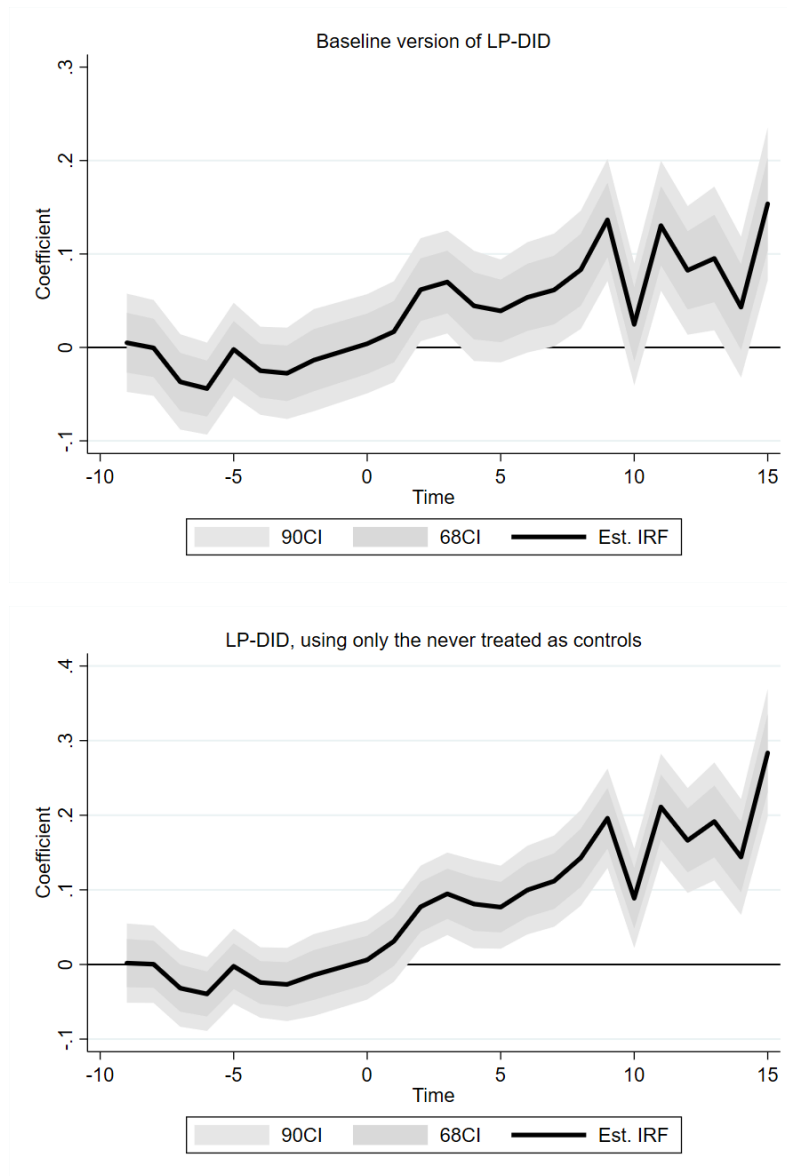
Model 2 (with DR-DY Fixed Effects):  $Disbursement_{dr,t} = \sum_{h=1}^H \beta_h Commitment_{dr,t-h} * NoDiscovery_{r,h} + \sum_{h=1}^H \theta_h Commitment_{dr,t-h} * Discovery_{r,h} + \gamma_{dr} + \gamma_{dt} + \epsilon_{dr,t}$

Model 3 (with DR Fixed Effect and GDP and Population):  $Disbursement_{dr,t} = \sum_{h=1}^H \beta_h Commitment_{dr,t-h} * NoDiscovery_{r,h} + \sum_{h=1}^H \theta_h Commitment_{dr,t-h} * Discovery_{r,h} + \gamma_{dr} + \delta * GDP/Population + \epsilon_{dr,t}$

	Theoretical prediction for alternative hypothesis H1	Hypothesis test	P-value
Model 1 (with DR-Y FE)			.01
Model 2 (with DR-DY FE)	More disbursement in presence of discoveries at horizon 1	$H_0: \sum_{h=1}^1 \theta_h - \beta_h \leq 0$ vs $H_1: \sum_{h=1}^1 \theta_h - \beta_h > 0$	.01
Model 3 (with DR FE/GDP)			.39
Model 1 (with DR-Y FE)			.00
Model 2 (with DR-DY FE)	More disbursement in presence of discoveries at horizon 2	$H_0: \sum_{h=1}^2 \theta_h - \beta_h \leq 0$ vs $H_1: \sum_{h=1}^2 \theta_h - \beta_h > 0$	.00
Model 3 (with DR FE/GDP)			.06
Model 1 (with DR-Y FE)			.00
Model 2 (with DR-DY FE)	More disbursement in presence of discoveries at horizon 3	$H_0: \sum_{h=1}^3 \theta_h - \beta_h \leq 0$ vs $H_1: \sum_{h=1}^3 \theta_h - \beta_h > 0$	.00
Model 3 (with DR FE/GDP)			.05
Model 1 (with DR-Y FE)			.00
Model 2 (with DR-DY FE)	More disbursement in presence of discoveries at horizon 4	$H_0: \sum_{h=1}^4 \theta_h - \beta_h \leq 0$ vs $H_1: \sum_{h=1}^4 \theta_h - \beta_h > 0$	.00
Model 3 (with DR FE/GDP)			.04
Model 1 (with DR-Y FE)			.03
Model 2 (with DR-DY FE)	More disbursement in presence of discoveries at horizon 5	$H_0: \sum_{h=1}^5 \theta_h - \beta_h \leq 0$ vs $H_1: \sum_{h=1}^5 \theta_h - \beta_h > 0$	.02
Model 3 (with DR FE/GDP)			.11

*Notes.* The table presents the results of the test as to whether at different horizons of the discoveries, the increase in aid commitments on impact materializes in terms of disbursements. It shows the hypothesis tests for the relevant integrals for different models with different fixed effects and for different temporal horizons. Model 1 includes the donor-recipient pair and year (DR-Y) fixed effects. Model 2 includes donor-recipient pair and donor-year pair (DR-DY) fixed effects. Model 3 includes donor-recipient pair (DR) fixed effect as well as GDP and population variables as controls. For each of these models and at horizons ranging from 1 to 5 years after the discovery, we test the null hypothesis that aid disbursement is less than or equal to zero against our theoretical prediction (that committed aid disbursement is greater in the presence of a discovery shock). The reported p-values shows that at standard levels of statistical significance and for most econometric specifications, we reject the null hypothesis in favor of our hypothesis that committed aid disbursement is greater in the presence of a discovery shock.

FIGURE 1: IMPULSE RESPONSE FUNCTIONS FOR OVERSEAS DEVELOPMENT AID FOLLOWING MINERAL DISCOVERIES



*Notes.* The figure shows the estimated impulse response functions for the logarithm of commitments of official development assistance following a mineral discovery. The method of estimation is local projections difference-in-difference (LP-DID) based on Dube et al. (2023). Panel A uses LP-DID with the base specification, estimating a variance-weighted average effect with strictly positive weights. Panel B applies LP-DID with the same specification but uses only never-treated countries as controls. The line indicates point estimates, and grey areas are 90% and 68% confidence intervals, respectively.

#### IV.B. IS AID DISBURSED FASTER FOLLOWING MINERAL DISCOVERIES?

Here we test whether recipient countries benefit from not only larger but also faster aid disbursements following discoveries. We thus test whether at different horizons, the increase in commitments on impact materializes in terms of disbursements. In other words, we test whether the increase in commitment on impact following a discovery could be “cheap talk”. Table 2 shows the hypothesis tests for the relevant integrals for different models with different fixed effects and for different temporal horizons. For example, we test the null hypothesis that aid disbursement is less than or equal to zero against our theoretical prediction (that committed aid disbursement is greater in the presence of a discovery shock), i.e., we test whether it is positive in the first year. We also test the null hypothesis that the response is less than or equal to zero against our theoretical prediction that it is positive for horizons of zero to 5 years.

The results show that for most econometric specifications, we reject the null hypothesis in favor our theoretical prediction at standard levels of statistical significance. For example, the response of aid disbursement is significantly positive between the year of the discovery and the following year (with a p-value of 0.01), indicating a significant effect at one-year horizon. The results are similar for periods with two or five-year horizons. The response of aid disbursement is different from zero in the first five years when there is a discovery shock.

These results point to potential further inefficiency in the allocation of aid. Given the stated goals of poverty reduction of aid, one would expect not only less aid but also that aid commitment should be less expeditiously disbursed in the countries experiencing a discovery compared to the country not experiencing a discovery. Indeed, countries experiencing a discovery need less aid and the speed of disbursement should not be of the essence in that context.

The statistical significance and large average effect of mineral discovery on aid flows could however hide heterogeneity. In other words, there could be a differential effect, depending on donor-recipient and recipient characteristics, which we explore further below.

#### IV.C. HOW IS THE COMPOSITION OF AID AFFECTED BY MINERAL DISCOVERIES?

Here, we test whether the occurrence of a mineral discoveries affects the composition of bilateral aid commitment in recipient countries. Columns I-III of Table 3a report estimates of

TABLE 3a

## EFFECT OF MINERAL DISCOVERIES PROXIED BY DUMMY VARIABLES ON GRANTS &amp; LOANS COMPONENTS OF BILATERAL AID

	(I)	(II)	(III)	(IV)	(V)	(VI)
	Bilateral grants	Bilateral grants	Bilateral grants	Bilateral loans	Bilateral loans	Bilateral loans
Mineral discovery (dummy)	0.217*** (0.054)	0.214*** (0.048)	0.287*** (0.051)	0.090** (0.043)	0.087** (0.040)	0.145*** (0.046)
Recipient GDP			-1.277*** (0.083)			-0.189*** (0.050)
Donor GDP			2.831*** (0.114)			0.449*** (0.073)
Recipient population			1.646*** (0.301)			-1.278*** (0.154)
Donor population			-1.357*** (0.149)			-0.053 (0.100)
Fixed effects	DR,Y	DR,DY	DR	DR,Y	DR,DY	DR
Observations	151,076	151,076	126,810	151,076	151,076	126,810
R-squared	0.596	0.657	0.618	0.359	0.395	0.371

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral grants and loans committed by the donor country to the recipient country. Each column reports a separate regression. The dependent variable in columns (1) - (3) is log of bilateral grants, and in columns (4) - (6) it is log of bilateral loans. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources, and 0 otherwise. Mineral discovery (NPV) is log of net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair, Y for year, and DY for donor-year pair. The number of observations in column (3) and (6) are smaller, since these regressions include macroeconomic indicators that are not available for all countries and all years. Constant terms are included in all regressions but not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5%, and 1% significance level, respectively.

TABLE 3b  
EFFECT OF VALUES OF MINERAL DISCOVERIES ON GRANTS & LOANS  
COMPONENTS OF BILATERAL AID

	(I)	(II)	(III)	(IV)	(V)	(VI)
	Bilateral grants	Bilateral grants	Bilateral grants	Bilateral loans	Bilateral loans	Bilateral loans
Mineral discovery (NPV)	0.011*** (0.002)	0.011*** (0.002)	0.014*** (0.002)	0.004** (0.002)	0.004** (0.002)	0.007*** (0.002)
Recipient GDP			-1.277*** (0.083)			-0.189*** (0.050)
Donor GDP			2.829*** (0.114)			0.448*** (0.073)
Recipient population			1.646*** (0.301)			-1.278*** (0.154)
Donor population			-1.356*** (0.149)			-0.052 (0.100)
Fixed effects	DR,Y	DR,DY	DR	DR,Y	DR,DY	DR
Observations	151,076	151,076	126,810	151,076	151,076	126,810
R-squared	0.596	0.657	0.618	0.359	0.395	0.371

*Notes.* The table shows the results of regressions of natural resource discoveries (in terms of NPV) by the recipient country on bilateral grants and loans committed by the donor country to the recipient country. Each column reports a separate regression. The dependent variable in columns (1) - (3) is log of bilateral grants, and in columns (4) - (6) it is log of bilateral loans. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources, and zero otherwise. Mineral discovery (NPV) is log of net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair, Y for year, and DY for donor-year pair. The number of observations in column (3) and (6) are smaller, since these regressions include macroeconomic indicators that are not available for all countries and all years (see appendix for details). Constant terms are included in all regressions but are not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*10%, \*\*5%, and \*\*\*1% significance level.



TABLE 4

## EFFECT OF “BILATERAL” MINERAL DISCOVERIES ON BILATERAL AID

	(I)	(II)	(III)	(IV)	(V)	(VI)
	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid
Bilateral mineral discovery (dummy)	0.373 (0.256)	0.788*** (0.258)	0.521** (0.255)			
Bilateral mineral discovery (NPV)				0.023 (0.015)	0.049*** (0.014)	0.035** (0.014)
Recipient GDP			-0.852*** (0.087)			-0.852*** (0.087)
Donor GDP			2.842*** (0.132)			2.842*** (0.132)
Recipient population			0.350 (0.361)			0.350 (0.361)
Donor population			-0.744*** (0.176)			-0.744*** (0.176)
Fixed effects	DR,Y	DR,DY	DR	DR,Y	DR,DY	DR
Observations	103,854	103,854	89,285	103,854	103,854	89,285
R-squared	0.612	0.675	0.628	0.612	0.675	0.628

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country through a company from the donor country on bilateral aid committed by the donor country in the recipient country (equation 1). Each column reports a separate regression. The dependent variable in all columns is log of bilateral ODA. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources, and zero otherwise. *Bilateral mineral discovery (dummy)* is a dummy variable that takes 1 for a recipient country has any natural resources discovered by a firm from donor country, and zero otherwise. Fixed effects are denoted DR for donor-recipient pair, Y for year, and DY for donor-year pair. The number of observations in column (3) and (6) are smaller since these regressions include macroeconomic indicators that are not available for all countries and all years (see Appendix for details). Constant terms are included in all regressions but not reported. Standard errors in parentheses are clustered by donor, recipient, and year. \*, \*\* and \*\*\* denote 10%, 5%, and 1% significance level, respectively.

equation (10) for the grant component of aid commitments. The results suggest a statistically significant and positive direct relationship between grants and mineral discoveries. This is true whether we control for time-varying influence in the form of year fixed effects (column I), specific to donors using donor-year fixed effects (column II), or macroeconomic controls (column III). Using the column III estimates as our benchmark, we interpret results as a discovery increasing the grant component of bilateral aid commitment by about 0.3 percent. In other words, the average difference in grant component between countries experiencing a mineral discovery and those which do not is 35 percent. When considering loan component as the dependent variable (columns IV-VI), the results remain statistically significant, but the point estimate becomes much smaller (about 16 percent). Interestingly, the results presented in Table 3b using the NPV of mineral discoveries are very similar and also support the notion that following a mineral discovery aid is relocated from countries without to countries with resources.

The results suggest that the loan component of aid flows does not exclusively drive our aggregate aid results presented in the earlier sub-section. Instead, the relative change in the grant component following discovery is not only statistically significant but also quantitatively much larger than the change in the loan component. The result suggests that the self-interest motive drives aid allocation in country experiencing a discovery. The alternative explanation positing that donors are betting on growth in country experiencing a discovery should have led to a more exclusive and smaller increase of the loan component.

#### IV.D. DOES THE COUNTRY OF NATIONALITY OF THE DISCOVERER MATTER?

We now test whether the occurrence of a mineral discovery leads to an increase in aid from the nationality of the discoverer of minerals. The measure of the mineral discovery is now associated with a donor-recipient pair and no longer associated solely with the recipient country. Note that the data collected from industry reports to match the discoverer nationality with the discovery is limited. The link between the bilateral aid agency and the firm discovering the resource may be more complex than just the nationality. Columns I-III of Table 4 report estimates of equation (10) with “bilateral” discoveries using a dummy as a predictor of bilateral aid commitment. The results suggest a statistically significant and positive direct relationship between aid commitment from the country of nationality of the discoverer and mineral discoveries. This is true for columns II and III but not for column I where we use non-donor specific year-fixed effects.

When using NPV for the bilateral discovery, the results presented in columns IV to VI are qualitatively similar. Notwithstanding data limitations, our results seem to be robust to allowing for the nationality of the discoverer.

## V. EXTENSIONS AND ROBUSTNESS CHECKS

We now offer a variety of robustness checks and extensions. First, we complement our analysis based on major mineral discovery with giant oil discovery (see Table B.1). Our main results are robust to using as shocks giant oil discoveries separately or when combining them with mineral discoveries. Discoveries in minerals and/or oil cause an increase in bilateral aid commitments.

Second, we test whether our main results are heterogeneous along respectively the donor dimension (see Table B.2) and recipient dimension (see Table B.3). To test the potential heterogeneity in donor behavior, we split donors alongside legal origin using data from Glaeser and Shleifer (2002). We are motivated by the fact that colonization has created “legal families” of laws which reverberate till today on relationship between donors and recipients. Results show that our results are robust across the different legal families of donors based on their legal origins (see Table B.2). Quantitatively, aid commitments from donors of the Scandinavian family respond the most to mineral discoveries. They are followed by respectively the French, English and German. The results hold when using NPV measures instead of dummies to proxy the occurrence of discovery. When splitting the sample alongside recipient geographic grouping (see Table B.3), we find that our main results are driven by respectively sub-Saharan Africa, European and Central Asia and Latin America.

Third, we test whether our results are robust to using different estimators to account for the presence of too many zeros. Table B.4 presents the results from the estimation of (10) using OLS which is our benchmark as well as alternative estimators, namely the Poisson Pseudo-Maximum Likelihood, Zero-Inflated Poisson, Heckman selection model, and Probit estimators. The coefficient associated with Columns (I-V) suggests that the coefficients associated with mineral discovery on bilateral aid is statistically significant across the different estimators. Our main results are robust to using different estimators accounting for the presence of too many zero observations.

We also test whether our results on the effect of mineral discovery on bilateral aid is robust to a wide array of further checks. Table B.5 presents the results from the estimation of (10) excluding

China. The coefficient associated with columns (I-VI in Table B.5) suggests that the coefficient associated with mineral discovery irrespective as to whether we use dummy or NPV, on bilateral aid is statistically significant across the board. When isolating China as donor as presented in Table B.6, the main results are positive and statically significant when using dummies as a proxy for discovery. The results are much less statistically significant when using NPV as a proxy.

We further explore the relative sensitivity of bilateral relative to multilateral aid in response to discovery (see Table B.7). To do so, we use the ratio of bilateral aid to total bilateral and multilateral aid. Multilateral donors such as the International Monetary Fund and World Bank have multiple stakeholders, the donor-recipient tie is less apparent, and hence multilateral aid should be less sensitive to a discovery than bilateral aid. The results largely confirm that bilateral aid is more sensitive to mineral discoveries than multilateral aid. This suggests that the governance of multilateral institutions tends to limit the quid pro quo between donors and recipients.

We also explore the robustness of our results across the number of top donors in our sample. The results presented in Table B.8 show that our main results are not driven by the choice of the twenty top donors. Whether we use all donors or only the top five donors our results remain robust. We also explore whether our results are driven by any sub-period (see Table B.9). Performing a simple sample split indicates that the results are driven by the second half of the sample period.

Finally, we explore the potential role of interactive effects between mineral discoveries and political systems in explaining bilateral aid commitments (see Table B.10). To do so, we introduce a democracy indicator as in equation (11). The results point to a statistically significant and negative interactive term while the default term associated with the discovery is positive and significant. This suggest that democracies are less subject to the quid pro quo between donor and recipient in the context of a mineral discovery; controlling for the low-income status of recipient countries does not alter the result. This is true whether we use a dummy or the NPV as a proxy for mineral discoveries or whether we control for time-varying influences using year fixed effects, donor-year fixed effects, or macroeconomic controls.

## VI. CONCLUSION

We have examined the effect of major mineral discoveries on bilateral aid as test of donors' self-interest. We first analyzed the effect of a resource discovery in a two-by-two donor-recipient

model with a contest success function. We then estimated the effects of major discoveries using a gravity model for a large panel of countries. Our empirical estimates are consistent with the predictions of our contest function analysis for self-interested, non-benevolent donors. Our empirical results show that recipient countries that experience major discoveries receive more, and faster, bilateral aid, all else equal. Our benchmark result is that following a mineral discovery, a recipient country receives 36% more aid compared to a country without such a discovery. This result is noteworthy since mineral discoveries imply an immediate increase in national wealth and are associated with external borrowing suggesting an effective relaxation of international borrowing constraints. We verify that the grant components of aid, and not just the loan components, increase bilateral aid. This allows us to reject the alternative explanation that donors may rely on the improved financial health of the discovery country so showcase aid effectiveness. Furthermore, the flow of bilateral aid increases more from the country of nationality of the discoverer providing further evidence of a quid pro quo between aid and mineral resources. Results are robust to a wide array of checks including accounting for the nature of discovery, for the heterogeneity of donors and recipients and to using different estimators.

Our simple model suggests complex interactions between and within different groups of agents. Donors enter a contest to gain influence over the surpluses of minerals in would-be recipient countries. These two levels of interaction may hide another layer of interaction. Indeed, multinational corporations operating in the mineral sector may also interact with respectively donors and recipients. Multinational corporations' interests may be at odds with that of taxpayers and would-be aid recipients in respectively donor and recipient countries. Even without the use of foreign aid to gain influence, the interaction between multinational corporations and governments in mineral-rich but otherwise poor countries is asymmetric. It is plagued by asymmetries of information and in capacity, thus resulting in unbalanced relationships. The nature of the strategic relations between multinational corporations and governments in donor and recipient countries and what it entails in terms of welfare for individuals in recipient is a promising area of research.

Our results have important policy implications. Although several traditional donors in advanced economies have announced that they would limit the amount of aid, it is likely that aid could continue to play a key role in helping securing access to critical minerals. The extraordinary growth in demand for critical minerals is putting upward pressure on prices and stimulating new critical mineral discoveries all around the world. The new geopolitical environment could further

exacerbate the self-interest motive of donors desperate to secure access to minerals (and the ensuing boom in suppliers) critical for their domestic industries. In developing countries, this new bonanza presents opportunities but also important risks. The rush for critical minerals could create a “new curse of critical minerals”.

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## APPENDIX A: DATA

### TABLE A.1: DATA SOURCES

Variable	Source
Bilateral aid/grants/loans	Organization for Economic Co-operation and Development (OECD) Development Co-operation Directorate (DAC) database
Aid from China	Strange, Dreher, Fuchs, Parks, Tierney (2017)
Natural resources discoveries per year and country	Horn and Myron (2014) for oil and gas, MinEx (2014) for Mineral
GDP, population	World Bank, World Development Indicators
Polity II score	Marshall, Gurr, Jaggers (2016)

### TABLE A.2: DESCRIPTIVE STATISTICS

Variable	N	Mean	SD	Unit
<i>Donor/Recipient/Year level</i>				
Bilateral aid	203,452	10,900,000	91,000,000	Constant 2017 USD
Bilateral grants	203,452	7,134,921	67,700,000	Constant 2017 USD
Bilateral loans	203,452	3,763,484	50,700,000	Constant 2017 USD
Discovery (dummy)	203,452	0.003	0.054	-
Mineral discovery (dummy)	203,452	0.002	0.048	-
Oil discovery (dummy)	203,452	0.001	0.026	-
Discovery (NPV)	203,452	22,400,000	1,600,000,000	Constant 2017 USD
Mineral discovery (NPV)	203,452	509,962	32,800,000	Constant 2017 USD
Oil discovery (NPV)	203,452	21,900,000	1,600,000,000	Constant 2017 USD
<i>Recipient/Year level</i>				
Recipient total official aid	8,015	433,000,000	974,000,000	Constant 2017 USD
Recipient average Polity II score	6,229	-0.52	5.34	-
Recipient GDP	6,549	0.20	1.06	Trillions of constant 2017 USD
Recipient population	7,916	27.89	112.86	Millions
<i>Donor/Year level</i>				
Donor GDP	1,455	1.01	2.28	Trillions of constant 2017 USD
Donor population	1,595	28.46	47.87	Millions

*Note.* Total official aid is the sum of total bilateral aid received by the recipient country, and total multilateral aid, such as aid from World Bank and International Monetary Fund, received by the same recipient country.

TABLE A.3: DEFINITION OF TIERS IN MINEX

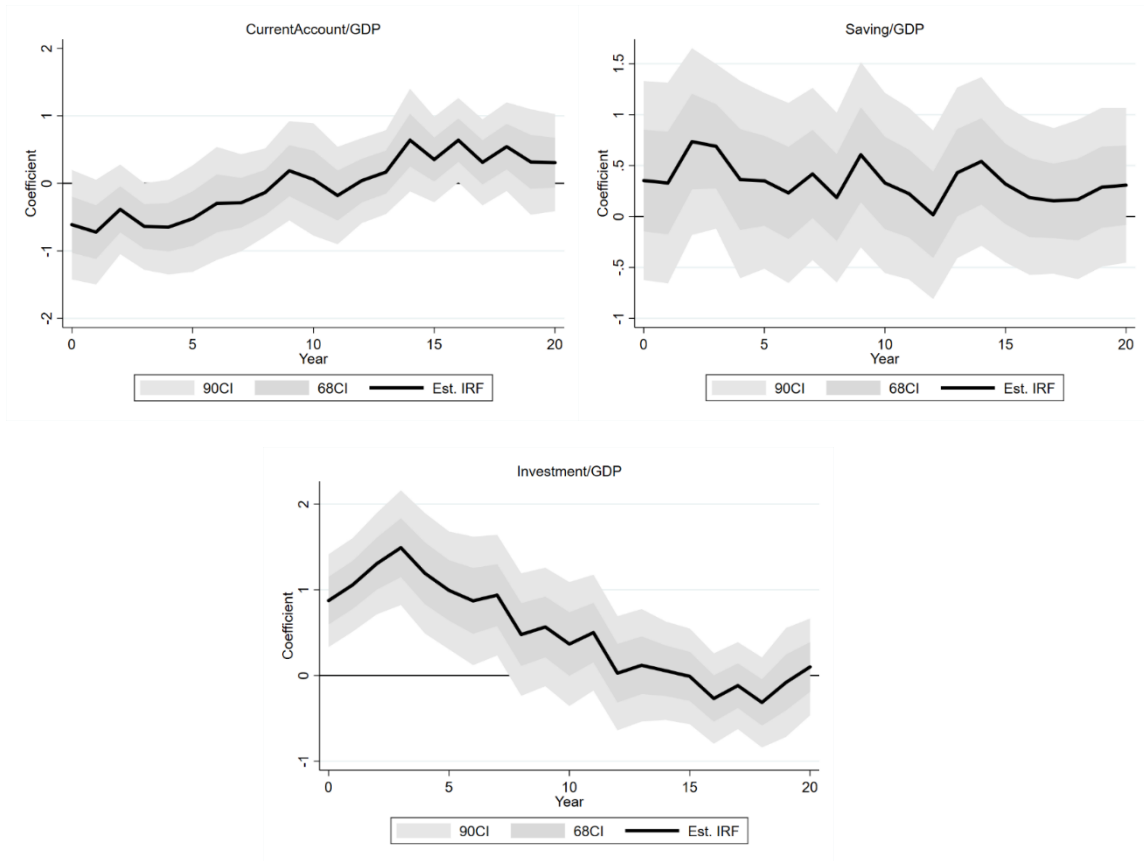
- Tier 1 Tier 1 deposits' are "company making" mines. They are large, long-lived and low-cost.
- Using long run commodity prices it generates >\$500-1000m pa of revenue (i.e. >200 ktpa Cu or >800 kt Zn+Pb or >5ktpa of U<sub>3</sub>O<sub>8</sub> or >250 kozpa Au) for >20 years and is in the bottom quartile of the cost curve. It has very robust economics and will be developed irrespective of where we currently are in the business cycle and whether the deposit has been fully drilled out. The resource is of a size/quality that it creates multiple opportunities for expansion.
- Tier 2 'Tier 2 deposits' are "significant" deposits - but are not quite as large or long life or as profitable as Tier 1 deposits. i.e., it only meets some of the Tier 1 criteria.
- Typically, Tier 2 deposits are economically attractive/profitable in all but the bottom of the business-cycle but has limited "optionality" because of modest size and life of the mine.
- It is noted that over time, through additional delineation and/or changes in costs or business risk some Tier 2 deposits may ultimately become Tier 1 deposits.
- Tier 3 'Tier 3 deposits' are small / marginal deposits (most deposits found fall into this category) While they can be profitable – at best they don't meet more than one of the Tier 1 criteria.
- Typically, these projects only get developed during the top of the business cycle and/or developed only if they are satellite operations to an existing business (i.e. they would never be developed as a stand-alone mine). Using long run price forecasts have NPV's between \$0-\$50m at the decision-to-build stage.
- Tier 4 'Tier 4 deposits' are uneconomic deposits. Using long run price forecasts, the deposit has a negative NPV at the decision-to-build stage and is unlikely to be developed (even at the top of the business cycle).

Source: Richard Schodde, MINEX Consulting

APPENDIX B: SUPPLEMENTARY RESULTS

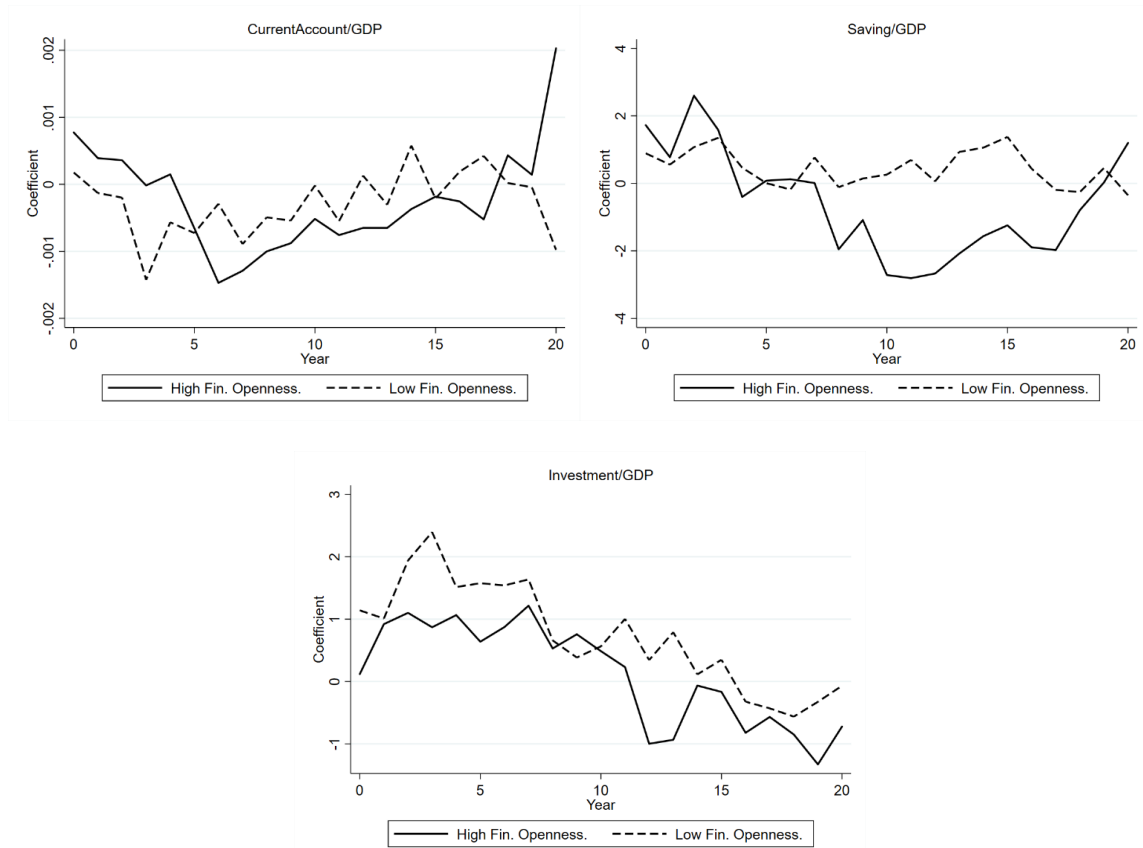
FIGURE B.1:

IMPULSE RESPONSE FUNCTIONS FOR THE CURRENT ACCOUNT, NATIONAL SAVING AND INVESTMENT FOLLOWING A MINERAL DISCOVERY



*Notes.* The figure presents the impulse response of a mineral discovery on current account, national saving and investment, all as a percentage of GDP. The line with circles indicates point estimates, and grey areas are 90% and 68% confidence intervals, respectively.

FIGURE B.2  
FINANCIAL OPENNESS AND IMPULSE RESPONSE FUNCTIONS



*Notes.* The figure presents the impulse response of a mineral discovery for countries with high and low financial openness, respectively. The line with circles indicates point estimates, and grey areas are 90% and 68% confidence intervals, respectively. The vertical axis shows percentage changes.

TABLE B.1

## EFFECT OF MINERAL &amp; OIL DISCOVERIES IN RECIPIENT COUNTRIES ON BILATERAL AID

	(I)	(II)	(III)	(IV)	(V)	(VI)
	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid
Mineral and oil discovery (dummy)	0.152*** (0.059)	0.152*** (0.051)	0.224*** (0.056)			
Mineral discovery (dummy)				0.117** (0.060)	0.120** (0.052)	0.197*** (0.056)
Oil discovery (dummy)				0.293** (0.128)	0.282*** (0.107)	0.437*** (0.127)
Recipient GDP			-0.852*** (0.087)			-0.852*** (0.087)
Donor GDP			2.837*** (0.132)			2.837*** (0.132)
Recipient population			0.333 (0.361)			0.330 (0.360)
Donor population			-0.747*** (0.176)			-0.747*** (0.176)
Fixed effects	DR,Y	DR,DY	DR	DR,Y	DR,DY	DR
Observations	103,854	103,854	88,487	103,854	103,854	88,487
R-squared	0.612	0.675	0.631	0.612	0.675	0.631

*Notes.* The table shows the results of regressions of natural resource (both mineral and oil) discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country. Each column reports a separate regression. The dependent variable in all columns is log of bilateral ODA. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. Mineral discovery (NPV) is the logarithm of the net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair. The number of observations in column (3) and (6) are smaller, since these regressions include macroeconomic indicators that are not available for all countries and all years (see Appendix for details). Constant terms are included in all regressions but are not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.

TABLE B.2  
EFFECT OF MINERAL DISCOVERIES ON BILATERAL AID FOR DIFFERENT LEGAL  
ORIGINS OF DONORS

	(I) Baseline	(II) English	(III) French	(IV) German	(V) Scandinavian	(VI) Baseline	(VII) English	(VIII) French	(IX) German	(X) Scandinavian
Mineral discovery (dummy)	0.307*** (0.052)	0.279*** (0.088)	0.358*** (0.105)	0.265*** (0.089)	0.491*** (0.144)					
Mineral discovery (NPV)						0.015*** (0.002)	0.013*** (0.004)	0.017*** (0.005)	0.013*** (0.004)	0.024*** (0.007)
Recipient GDP	-1.328*** (0.083)	-1.027*** (0.155)	-1.222*** (0.154)	-1.483*** (0.147)	-1.085*** (0.262)	-1.328*** (0.083)	-1.027*** (0.155)	-1.222*** (0.154)	-1.484*** (0.147)	-1.086*** (0.262)
Donor GDP	2.911*** (0.117)	1.696*** (0.250)	2.562*** (0.242)	3.227*** (0.184)	1.666*** (0.323)	2.910*** (0.117)	1.694*** (0.250)	2.560*** (0.242)	3.226*** (0.184)	1.657*** (0.323)
Recipient population	1.451*** (0.301)	1.328*** (0.490)	1.965*** (0.563)	-0.173 (0.525)	4.964*** (0.848)	1.451*** (0.301)	1.328*** (0.490)	1.965*** (0.563)	-0.174 (0.524)	4.963*** (0.848)
Donor population	-1.251*** (0.155)	0.387* (0.233)	-3.427*** (0.442)	8.404*** (2.099)	2.100 (2.614)	-1.250*** (0.155)	0.387* (0.233)	-3.423*** (0.442)	8.414*** (2.099)	2.174 (2.614)
Observations	126,810	33,571	38,711	35,931	18,597	126,810	33,571	38,711	35,931	18,597
R-squared	0.610	0.671	0.555	0.649	0.512	0.610	0.671	0.555	0.649	0.512
Fixed effects	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country using alternative specifications. The dependent variable in all columns is log of bilateral ODA. Each column reports a separate regression with a sample defined by the legal origin of the donor countries (English common law, French civil law, German civil law, and Scandinavian civil law). All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. Mineral discovery (NPV) is log of net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair. Constant terms are included in all regressions but not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.

TABLE B.3

## EFFECT OF MINERAL DISCOVERIES ON BILATERAL AID FOR DIFFERENT GEOGRAPHIC REGIONS

	(I) Baseline	(II) SSA	(III) MENA	(IV) EAP	(V) ECA	(VI) SA	(VII) LAC
Mineral discovery (dummy)	0.307*** (0.052)	0.200*** (0.076)	-0.349 (0.236)	0.057 (0.159)	0.887*** (0.168)	0.124 (0.213)	0.811*** (0.205)
Recipient GDP	-1.328*** (0.083)	-0.422*** (0.160)	-1.139*** (0.247)	-0.489** (0.228)	-2.576*** (0.349)	-0.834** (0.408)	-0.760*** (0.247)
Donor GDP	2.911*** (0.117)	2.287*** (0.276)	2.181*** (0.442)	1.076*** (0.359)	0.250 (0.702)	2.140*** (0.689)	2.599*** (0.423)
Recipient population	1.451*** (0.301)	-1.358** (0.537)	-2.638*** (0.861)	-2.389** (1.210)	11.910*** (1.559)	-0.148 (1.928)	-4.797*** (1.283)
Donor population	-1.251*** (0.155)	2.238*** (0.519)	5.578*** (1.412)	2.075*** (0.595)	3.206*** (1.000)	3.418** (1.393)	1.019* (0.597)
Fixed effects	DR	DR	DR	DR	DR	DR	DR
Observations	126,810	19,158	7,340	10,397	11,955	3,270	12,941
R-squared	0.610	0.702	0.723	0.810	0.668	0.743	0.734

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country, by region. Each column reports a separate regression for each region (SSA: Sub-Saharan African, MENA: Middle East and North Africa, EAP: East Asia and Pacific, ECA: Europe and Central Asia, SA: South Asia, LAC: Latin America and Caribbean). The dependent variable in all columns is log of bilateral ODA. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. Mineral discovery (NPV) is log of net present value of Mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair. Constant terms are included in all regressions but not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.

TABLE B.4

## EFFECT OF MINERAL DISCOVERIES ON BILATERAL AID WITH DIFFERENT ESTIMATORS TO ACCOUNT FOR “TOO MANY ZEROS”

	(I) Baseline	(II) Poisson	(III) ZIP	(IV) Heckman	(V) Probit	(VI) Baseline	(VII) Poisson	(VIII) ZIP	(IX) Heckman	(X) Probit
Mineral discovery (dummy)	0.307*** (0.052)	0.025*** (0.005)	0.004*** (0.001)	0.072*** (0.019)	0.112*** (0.020)					
Mineral discovery (NPV)						0.015*** (0.002)	0.001*** (0.000)	0.0002*** (0.0001)	0.003*** (0.001)	0.005*** (0.001)
Recipient GDP	-1.328*** (0.083)	-0.151*** (0.010)	-0.018*** (0.002)	-0.290*** (0.035)	-0.415*** (0.028)	-1.328*** (0.083)	-0.151*** (0.010)	-0.01810*** (0.00231)	-0.290*** (0.035)	-0.415*** (0.028)
Donor GDP	2.911*** (0.117)	0.329*** (0.017)	0.073*** (0.003)	1.091*** (0.053)	0.809*** (0.040)	2.910*** (0.117)	0.328*** (0.017)	0.07249*** (0.00347)	1.091*** (0.053)	0.808*** (0.040)
Recipient population	1.451*** (0.301)	0.023 (0.038)	0.016** (0.008)	0.298*** (0.114)	0.448*** (0.109)	1.451*** (0.301)	0.023 (0.038)	0.01570** (0.00766)	0.298*** (0.114)	0.448*** (0.109)
Donor population	-1.251*** (0.155)	0.378*** (0.065)	-0.075*** (0.011)	-1.112*** (0.173)	-0.078 (0.067)	-1.250*** (0.155)	0.378*** (0.065)	-0.07460*** (0.01122)	-1.112*** (0.173)	-0.078 (0.067)
Fixed effects	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
Observations	126,810	125,972	126,810	126,810	101,832	126,810	125,972	126,810	126,810	101,832

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country using alternative specifications. Each column reports a separate regression for each alternative specification including Poisson regression, Zero Inflated Poisson (ZIP), Heckman model, and Probit regression. The dependent variable in all columns is log of bilateral ODA. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. Mineral discovery (NPV) is log of net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair. Constant terms are included in all regressions but not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.



TABLE B.5

## EFFECT OF MINERAL DISCOVERIES ON BILATERAL AID EXCLUDING AID FROM CHINA

	(I)	(III)	(III)	(IV)	(V)	(VI)
	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid
Mineral discovery (dummy)	0.233*** (0.055)	0.229*** (0.050)	0.303*** (0.053)			
Mineral discovery (NPV)				0.012*** (0.003)	0.011*** (0.002)	0.015*** (0.002)
Recipient GDP			-1.318*** (0.084)			-1.318*** (0.084)
Donor GDP			2.849*** (0.123)			2.847*** (0.123)
Recipient population			1.528*** (0.305)			1.527*** (0.305)
Donor population			-1.196*** (0.158)			-1.194*** (0.158)
Fixed effects	DR,Y	DR,DY	DR	DR,Y	DR,DY	DR
Observations	148,520	148,520	124,353	148,520	148,520	124,353
R-squared	0.592	0.647	0.611	0.592	0.647	0.611

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country, excluding China. Each column reports a separate regression. The dependent variable in all columns is log of bilateral ODA. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. Mineral discovery (NPV) is the log of net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair, Y for year, and DY for donor-year pair. The number of observations in column (3) and (6) are smaller, since these regressions include macroeconomic indicators that are not available for all countries and all years. Constant terms are included in all regressions but not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.

TABLE B.6  
EFFECT OF MINERAL DISCOVERIES ON BILATERAL AID FROM CHINA

	(I)	(III)	(III)	(IV)	(V)	(VI)
	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid
Mineral discovery (dummy)	0.612*	0.612*	0.758**			
	(0.351)	(0.351)	(0.345)			
Mineral discovery (NPV)				0.024	0.024	0.031*
				(0.016)	(0.016)	(0.016)
Recipient GDP			-0.690			-0.693
			(0.672)			(0.673)
Donor GDP			0.986			0.995
			(1.236)			(1.237)
Recipient population			-0.754			-0.738
			(2.819)			(2.822)
Donor population			66.818**			66.574**
			(27.510)			(27.510)
Fixed effects	DR,Y	DR,DY	DR	DR,Y	DR,DY	DR
Observations	2,556	2,556	2,457	2,556	2,556	2,457
R-squared	0.509	0.509	0.506	0.509	0.509	0.506

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by China to the recipient country. Each column reports a separate regression. The dependent variable in all columns is log of bilateral ODA. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. Mineral discovery (NPV) is the log of the net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair, Y for year, and DY for donor-year pair. The number of observations in column (3) and (6) are smaller, since these regressions include macroeconomic indicators that are not available for all countries and all years. Constant terms are included in all regressions and not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.

TABLE B.7

## EFFECT OF MINERAL DISCOVERY ON BILATERAL AID AS A RATIO OF TOTAL (BILATERAL AND MULTILATERAL) AID

	(I)	(III)	(III)	(IV)	(V)	(VI)
	Bilateral aid in total aid	Bilateral aid in total aid	Bilateral aid in total aid	Bilateral aid in total aid	Bilateral aid in total aid	Bilateral aid in total aid
Mineral discovery (dummy)	0.105** (0.052)	0.105** (0.047)	-0.028 (0.047)			
Mineral discovery (NPV)				0.005** (0.002)	0.005** (0.002)	-0.001 (0.002)
Recipient GDP			-0.091 (0.072)			-0.091 (0.072)
Donor GDP			2.163*** (0.112)			2.163*** (0.112)
Recipient population			-0.825*** (0.281)			-0.825*** (0.281)
Donor population			-1.784*** (0.196)			-1.784*** (0.196)
Fixed effects	DR,Y	DR,DY	DR	DR,Y	DR,DY	DR
Observations	151,076	151,076	126,810	151,076	151,076	126,810
R-squared	0.479	0.541	0.530	0.479	0.541	0.530

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country, as the ratio of the bilateral aid to total official aid received by the recipient. Each column reports a separate regression. The dependent variable in all columns is the log of ratio of committed bilateral aid in total official aid committed for the recipient country. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. Mineral discovery (NPV) is the log of the net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair, Y for year, and DY for donor-year pair. The number of observations in column (3) and (6) are smaller since these regressions include macroeconomic indicators that are not available for all countries and all years. Constant terms are included in all regressions but not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.

TABLE B.8  
EFFECT OF MINERAL DISCOVERIES ON BILATERAL AID FOR DIFFERENT GROUPS  
OF TOP DONORS

	(I)	(III)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(9)	(10)
	Baseline (Top 20 donors)	All donors	Top 15 donors	Top 10 donors	Top 5 donors	Baseline (20 donors)	All donors	Top 15 donors	Top 10 donors	Top 5 donors
Mineral discovery (dummy)	0.307*** (0.052)	0.083** (0.038)	0.301*** (0.059)	0.310*** (0.073)	0.333*** (0.094)					
Mineral discovery (NPV)						0.015*** (0.002)	0.004** (0.002)	0.015*** (0.003)	0.015*** (0.003)	0.015*** (0.004)
Recipient GDP	-1.328*** (0.083)	-0.795*** (0.062)	-1.428*** (0.098)	-1.492*** (0.125)	-1.237*** (0.167)	-1.328*** (0.083)	-0.795*** (0.062)	-1.427*** (0.098)	-1.492*** (0.125)	-1.237*** (0.167)
Donor GDP	2.911*** (0.117)	2.192*** (0.076)	3.083*** (0.133)	2.168*** (0.180)	2.616*** (0.218)	2.910*** (0.117)	2.192*** (0.076)	3.082*** (0.133)	2.166*** (0.180)	2.615*** (0.219)
Recipient population	1.451*** (0.301)	2.129*** (0.221)	1.369*** (0.359)	0.908** (0.451)	-0.489 (0.611)	1.451*** (0.301)	2.129*** (0.221)	1.368*** (0.359)	0.907** (0.451)	-0.490 (0.611)
Donor population	-1.251*** (0.155)	-1.797*** (0.139)	-0.806*** (0.165)	5.012*** (1.080)	5.093** (2.204)	-1.250*** (0.155)	-1.797*** (0.139)	-0.806*** (0.165)	5.019*** (1.080)	5.094** (2.204)
Fixed effects	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
Observations	126,810	212,536	96,528	64,762	30,461	126,810	212,536	96,528	64,762	30,461
R-squared	0.610	0.644	0.617	0.602	0.583	0.610	0.644	0.617	0.602	0.583

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country, by top donors' group. Each column reports a separate regression for each top donors' group (identified based on the periods 2000-2017). The dependent variable in all columns is log of bilateral ODA. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. Mineral discovery (NPV) is the log of the net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair. Constant terms are included in all regressions but not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.

TABLE B.9  
EFFECT OF MINERAL DISCOVERIES ON BILATERAL AID  
FOR DIFFERENT SUB-SAMPLE PERIODS

	(I) Baseline	(III) 1975-1999	(III) 2000-2021	(IV) Baseline	(V) 1975-1999	(VI) 2000-2021
Mineral discovery (dummy)	0.307*** (0.052)	0.037 (0.061)	0.487*** (0.067)			
Mineral discovery (NPV)				0.015*** (0.002)	0.001 (0.003)	0.022*** (0.003)
Recipient GDP	-1.328*** (0.083)	-0.747*** (0.102)	-1.642*** (0.115)	-1.328*** (0.083)	-0.747*** (0.102)	-1.641*** (0.115)
Donor GDP	2.911*** (0.117)	3.047*** (0.127)	1.712*** (0.178)	2.910*** (0.117)	3.047*** (0.127)	1.709*** (0.179)
Recipient population	1.451*** (0.301)	0.323 (0.432)	2.599*** (0.447)	1.451*** (0.301)	0.323 (0.432)	2.601*** (0.447)
Donor population	-1.251*** (0.155)	-1.314*** (0.243)	2.043*** (0.330)	-1.250*** (0.155)	-1.314*** (0.243)	2.049*** (0.330)
Fixed effects	DR	DR	DR	DR	DR	DR
Observations	126,810	58,514	68,296	126,810	58,514	68,296
R-squared	0.610	0.680	0.725	0.610	0.680	0.725

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country, by sub-period. Each column reports a separate regression for each sub-period. The dependent variable in all columns is log of bilateral ODA. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. Mineral discovery (NPV) is the log of the net present value of mineral discoveries at the time of discovery by the recipient country. Fixed effects are denoted DR for donor-recipient pair. Constants terms are included in all regressions but not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.

TABLE B.10

EFFECT OF MINERAL DISCOVERY IN RECIPIENT COUNTRIES WITH INTERACTION  
WITH DEMOCRACY AND LOW-INCOME GROUPING ON BILATERAL AID

	(I)	(III)	(III)	(IV)	(V)	(VI)
	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid	Bilateral aid
Mineral discovery (dummy)	0.529*** (0.087)	0.527*** (0.080)	0.732*** (0.086)			
Mineral discovery (dummy) x Democracy	-0.878*** (0.149)	-0.873*** (0.136)	-1.014*** (0.135)			
Mineral discovery (dummy) x Low income	-0.428*** (0.116)	-0.419*** (0.103)	-0.734*** (0.116)			
Mineral discovery (dummy) x Democracy x Low income	0.156 (0.255)	0.148 (0.290)	0.930*** (0.257)			
Mineral discovery (NPV)				0.024*** (0.004)	0.024*** (0.004)	0.034*** (0.004)
Mineral discovery (NPV) x Democracy				-0.040*** (0.007)	-0.040*** (0.006)	-0.047*** (0.006)
Mineral discovery (NPV) x Low income				-0.018*** (0.005)	-0.018*** (0.005)	-0.034*** (0.005)
Mineral discovery (NPV) x Democracy x Low income				0.006 (0.012)	0.006 (0.013)	0.043*** (0.012)
Recipient GDP			-1.252*** (0.087)			-1.253*** (0.087)
Donor GDP			3.318*** (0.126)			3.316*** (0.126)
Recipient population			0.841** (0.330)			0.843** (0.330)
Donor population			-1.598*** (0.164)			-1.596*** (0.164)
Observations	125,441	125,441	108,602	125,441	125,441	108,602
R-squared	0.589	0.652	0.593	0.589	0.652	0.593
Fixed effects	DR-Y	DR-DY	DR	DR-Y	DR-DY	DR

*Notes.* The table shows the results of regressions of natural resource discoveries by the recipient country on bilateral aid committed by the donor country to the recipient country, depending on recipient country's average democracy level across all sample years. Each column reports a separate regression. The dependent variable in all columns is log of bilateral ODA. All control variables are in logs. Mineral discovery (dummy) is a dummy variable which takes the value 1 if the recipient country has discovered natural resources and zero otherwise. *Democracy* in interaction terms is a dummy variable that takes 1 if the average of the Polity score across all years (1975-2018) for the recipient country is greater than or equal to 6, and zero otherwise. *Low income* in the interaction terms is a dummy variable which takes the value 1 if the recipient country is a low-income country (defined as a country whose average GDP per capita is below the first quartile), and zero otherwise. Fixed effects are denoted DR for donor-recipient pair, Y for year, and DY for donor-year pair. The number of observations in column (3) and (6) are smaller, since these regressions include macroeconomic indicators that are not available for all countries and all years. Constant terms are included in all regressions but not reported. Standard errors in parentheses are clustered at donor-recipient pair level. \*, \*\* and \*\*\* denote 10%, 5% and 1% significance level, respectively.