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Investigating the fiscal resource curse

What's China got to do with it?

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Abstract: The term *fiscal resource curse* refers to countries' inability to raise taxes from a broad base in the presence of natural resources. We employ a novel instrumental variable strategy to estimate the causal effect of resource revenues on non-resource tax effort by exploiting the so-called 'China shock'. Since its 2001 accession to the World Trade Organization, China's non-renewable resource trade has driven up commodity prices, raising resource revenues among exporting countries. Exporting countries benefit from infrastructure projects rather than just liquid capital flows. Our results provide no consistent evidence for a fiscal resource curse. On the contrary, a one-percentage-point increase in resource revenues as a percentage of GDP leads to about a 0.3-percentage-point increase in non-resource taxes as a percentage of GDP. China's non-resource trade model might be easing binding constraints to expanding the non-resource sector and presenting an opportunity to diversify the domestic revenue base in developing countries.

Key words: China, infrastructure, natural resources, tax effort, trade

JEL classification: H2, H41, Q32, Q37

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1 Introduction

Estimates of the cost of meeting infrastructure deficits in developing countries are in the trillions. Meanwhile, development aid lags far behind. Goal 17.1 of the Sustainable Development Goals rightly marks an important shift from the previous Millennium Development Goals in its emphasis on domestic revenue mobilization rather than development aid as a means of financing sustainable development. Countries with abundant natural resources are seen as having an advantage, including having an opportunity to raise revenues and thus develop their fiscal capacity. However, the evidence is complicated. The literature on the natural resource curse is well known—countries with abundant natural resources fail to transform that advantage into favourable development outcomes. However, a related term, *fiscal resource curse*, is relatively less explored. The term refers to the inability of resource-rich countries to mobilize taxes from a broad base, particularly outside the natural resource sector (Jensen 2011; Knack 2009; Masi et al. 2018; Mohtadi et al. 2016).

For instance, during the pre-financial crisis period between 1980 and 2005, natural resource revenues increased significantly across Sub-Saharan Africa by about seven percentage points. Non-resource revenue, however, grew by less than 1 per cent (Gupta and Tareq 2008). The importance of diversifying revenue sources stems from the fact that natural resources are subject to the Prebisch–Singer hypothesis. Commodities suffer from inferior terms of trade over time compared with manufactured products. Moreover, they are subject to price volatilities, which destabilizes national budgets and undermines planning. The global revolution underway in the adoption of alternative energy sources as part of efforts to fight climate change means that the future of hydrocarbon fuels, for example, looms large. While maximizing revenues from the resource sector is desirable, extending such effort to the non-resource sector becomes even more important with respect to securing an expanded and sustainable revenue base.

This paper uses the new Government Revenue Database on non-renewable resource revenues developed by the ICTD (International Centre for Tax and Development) and UNU-WIDER (henceforth ICTD-GRD) to estimate a causal relationship between resource revenues and non-resource tax effort. Our preference for non-resource tax rather than non-resource revenues as an outcome variable allows us to shed light on fiscal capacity outside the resource sector. Thus, our outcome variable of interest does not include other non-tax sources such as fees, fines, returns on public investments, or divestiture receipts. We employ conventional panel econometric techniques, including a novel instrumental variable strategy which allows us to look at the impact of external factors that mediate in the relationship but have been largely ignored in earlier literature. Previous studies have tended to focus on local mechanisms such as the level of informality, tax administration, corruption, and other institutional bottlenecks, without much attention to external factors. To the best of our knowledge, none of the studies in this area has accounted for China's increased role in the natural resource trade since its accession to the World Trade Organization (WTO) in 2001 and how that impacts on the relationship between resource revenues and non-resource tax effort. Since 2001, China's engagement in the non-renewable resource trade has increased several-fold, driving up commodity prices and raising resource revenues among exporting countries. China's model of resource trade with developing countries has also been increasingly characterized by so-called 'resource-for-infrastructure' deals, which means that exporting countries benefit from infrastructure projects rather than just liquid capital flows. We exploit this exogenous variation in China's non-renewable resource trade to examine the causal effect of resource revenues on non-resource tax effect using a two-stage least squares (2SLS) approach. Our identification strategy is inspired by the fact that China's scaled-up demand for non-renewable resources after 2001 was unrelated to non-resource tax effort across the globe.

We do not find consistent evidence for a negative relationship between resource revenues and non-resource taxes. On the contrary, we find that, once we account for China's role in the global non-renewable resource trade, a one-percentage-point increase in resource revenues as a percentage of GDP leads to about a 0.3-percentage-point increase in non-resource taxes as a percentage of GDP in some specifications. China's provisioning of energy and transport infrastructure in developing countries in lieu of export revenues may be easing the binding constraints to expanding the non-resource sector. The latter becomes the basis for increasing output in the sector and therefore increasing non-resource tax revenues.

The rest of the paper is structured as follows. Section 2 reviews the empirical and theoretical literature. We discuss the empirical strategy in Section 3. This is followed by a discussion of the results in Section 4. We conclude in Section 5 with plausible policy implications.

2 Review of the empirical and theoretical literature

2.1 Review of key empirical literature

Using longitudinal data covering a global sample of 30 oil-producing countries for the period 1992 to 2005, Bornhorst et al. (2009) employed fixed-effects and generalized method of moments (GMM) estimators to investigate the relationship between hydrocarbon revenues and non-hydrocarbon revenues. They find that a one-percentage-point increase in hydrocarbon revenues displaces non- hydrocarbon revenues by about 0.2 percentage points. The authors could be described as part of the avant-garde in this line of work, as previous literature had paid little attention to such cross-country studies. Furthermore, the required revenue data for such cross-country analysis were only then emerging, largely spearheaded by a few institutions—notably the International Monetary Fund (IMF), the Organization for Economic Co-operation and Development (OECD), and the ICTD. Using a panel of 20 African countries and 15 Latin American countries respectively, Thomas and Treviño (2013) and Ossowski and Gonzales (2012) engage in a similar analysis to Bornhorst et al. (2009), albeit on a regional basis. They confirm a negative and statistically significant relationship between resource and non-resource revenues.

In the case of Latin American countries, Ossowski and Gonzales (2012) look not only at non-resource revenue performance in resource-exporting countries but also at disaggregated components such as value-added tax (VAT) and non-resource income tax. They use a combination of statistical and panel econometric techniques, principally relying on a Driscoll and Kraay estimator due to the presence of serial correlation and cross-sectional dependence in the data. The choice of the estimator also stems from the large time series relative to the number of observational units. Using a panel of 15 countries for the period 1994 to 2010, the authors confirm a displacement effect of a magnitude of about 0.2 percentage points in non-resource revenues for a one-percentage-point increase in resource revenues, similar to Bornhorst et al. (2009). In general, the performance of VAT, excise duty, and non-resource income tax in resource-exporting countries was inferior to that of comparator natural-resource-poor countries in the region.

Thomas and Treviño (2013) first examine the determinants of non-resource revenues among 42 Sub-Saharan African countries over the period 2000 to 2011. Following Bornhorst et al. (2009), they investigate the relationship between resource and non-resource revenues using panel econometric techniques including an Arellano and Bond estimator. They find an offset of about 0.15 percentage points for a one-percentage-point increase in resource revenues. This is a long-run estimate. The contemporaneous effect is, however, lower and is sensitive to the inclusion of additional regressors. They also find that the offset in non-resource revenues in resource-rich countries is better explained by corruption than by the level of statutory tax rates.

Similarly, Crivelli and Gupta (2014) use a global sample of 35 developing and emerging economies over the period 1992 to 2009 to investigate the effect of resource revenues on non-resource revenue effort. With regard to the latter, they explore both direct taxes (personal income taxes and corporate taxes) and indirect taxes (taxes on goods and services/VAT and trade taxes). Using fixed effects and a two-step GMM estimator, they confirm an eviction effect in non-resource taxes of a magnitude of 0.3 percentage points for a one-percentage-point increase in resource tax revenues. Indirect taxes such as VAT were found to be most vulnerable.

Evidence suggests that the relationship between resource and non-resource revenues need not be negative. For instance, Venables (2016) finds that resource revenues could serve as a means of transferring funds from the public sector to the private sector. This transfer could be through either investment in public goods or direct support through targeted subsidies and other incentives. Such action could propel the private sector as the 'engine of growth' and boost employment in the non-resource sector. This could be expected to impact positively on non-resource revenues over time. Bjornland and Thorsrud (2016) provide further evidence of the plausibility of such positive spillovers from the resource to the non-resource sector. More recent evidence on this is highlighted by Knebelmann (2017). In a global sample of 22 developing and emerging countries for the period 1998 to 2012, Knebelmann (2017) does not find consistent evidence to support the eviction effect or a fiscal resource curse. Using a pooled ordinary least squares (OLS) methodology for variations in non-oil and oil taxes, she finds a 'weak synergy effect' in some specifications, albeit sensitive to evolution in the oil economy. The synergy effect suggests that improvements in revenue effort in the oil sector could extend positive externalities to non-oil revenue mobilization efforts.

2. 2 Theoretical literature

The theoretical framework for this paper is largely based on theories that attempt to explain the natural resource curse. Two strands are prominent: market-based theories and political economy theories (Deacon 2011). These strands have been consolidated in other works to provide a comprehensive view on the theoretical relationship between resource dependence and fiscal capacity (Besley and Persson 2013, 2014; Jensen, 2011).

Market-based and political economy models of the resource curse

The theory of the Dutch disease, also referred to as the 'booming sector model', fits market-based models of the resource curse. It conveys the idea of a trade-off between a vibrant or well-performing natural resource sector and a diminished or non-performing non-resource sector, often resulting from exchange rate movements which lead to de-industrialization. The reasons given generally relate to negative spillover effects inflicted on the non-resource sector for tradeable and non-tradeable goods. For instance, price volatility in the resource sector is transferred to the non-resource sector through pro-cyclical spending decisions by the public sector, leading to fluctuations in economic activity (Villafuerte and Lopez-Murphy 2010). Both government and private investors respond accordingly to economic volatility. For instance, adverse price shocks mean less public investment in the non-resource sector, depriving the sector of critical enablers of state capacity to drive expansion, such as infrastructure and energy. Using international trade theory, Corden (1984), Corden and Neary (1982), and Neary and van Wijnbergen (1985) discuss static and dynamic models and their predictions for the manifestation of the Dutch disease.

In their base model, Corden and Neary (1982) define a small, open economy producing two tradeable goods whose prices are determined exogenously. Then there is a third good, non-tradeable, whose price is determined by local market forces. The two tradeable goods are energy goods and manufactures respectively, while the third good represents services. A host of assumptions include the fact that the relative price of the traded goods does not change while the price of non-traded goods relative to traded goods is defined as the real exchange rate and subject to change.[1] In accordance with the Heckscher–Ohlin model, Cordon and Neary's model allows for intersectoral mobility of at least one factor of production. The effect of a boom in the energy sector is modelled to yield two results: a spending effect and a resource movement effect. In the case of the latter, a boom in the energy sector increases the marginal productivity of factors employed there. This attracts mobile factors from other (source) sectors, leading to equilibrium readjustment in the economy. This readjustment is to the detriment of the source sectors. Indeed, the movement of labour from the manufacturing sector to the booming sector is one direct effect leading to de-industrialization. Also, the movement of labour out of the services sector results in a fall in output, which creates an excess demand for services. Prices must rise to restore equilibrium. The resulting change in relative prices means an appreciation of the real exchange rate.

In a situation where the rate of absorption of resources (as a result of the resource movement effect) from the source sectors into the booming energy sector is low, the impact described above becomes limited. Consequently, a spending effect kicks in. The expectation of increases in real income from the boom triggers increases in the consumption of services. A direct consequence is an increase in relative prices, leading to a real exchange rate appreciation, in addition to other adjustments. The spending effect, however, is conditional on the marginal propensity to spend on services in the economy. The upshot of these effects is a decline in the manufacturing sector. However, in further extensions to their model, Corden and Neary (1982) demonstrate that these effects need not necessarily lead to de-industrialization of the economy. In the context of a long run, the free mobility of capital can be assumed across the manufacturing and services sectors. Then, there is still excess labour based on the fact that the amount in use by the energy sector is only a portion of the total. The authors demonstrate that a boom in the energy sector could actually provide a boost to the manufacturing sector. Assuming a muted spending effect due to a zero-income elasticity of demand for services, the authors postulate that a resource boom triggers a resource movement effect. That is, the boom increases the demand for labour, which reduces the amount available to the labour-intensive sector. On the basis of the Rybczynski theorem, output increases in the sector that uses capital intensively while output in the services sector reduces. The theorem, therefore, suggests a boost to the manufacturing sector.

Our theoretical framework also reflects the models developed by Besley and Persson (2009, 2010) and extended by Jensen (2011). These models provide insights into determinants of fiscal capacity. Jensen (2011) demonstrates how fiscal capacity is impacted on account of a positive shock to the non-resource sector. The incumbent social planner is incentivized to mobilize taxes from the non-resource sector as resources become available to develop the required administrative infrastructure. In effect, the cost of investing in developing fiscal capacity today is weighed against the benefit of a potentially higher tax take in the future. The decision reflects forward-looking behaviour on the part of a rational social planner who cares about the size of the tax take, irrespective of the intended use. A corollary to a revamped non-resource sector is presented in the model as a diminished level of resource dependence. While this view of reduced resource dependence in the face of an improved non-resource sector cannot be interpreted as automatic,

[1] Output in the manufacturing sector is taken as the numeraire.

the model adds to our understanding of what factors drive fiscal capacity in resource-rich contexts. A key model prediction is that investment in developing fiscal capacity decreases with increasing resource intensity (Jensen 2011).

The Besley–Persson model on the relationship between resource revenues and non-resource tax effort

In further extensions to their earlier models (Besley and Persson 2009, 2010), Besley and Persson (2013) present useful features for exploring the relationship between resource revenues and non-resource taxes. They provide insights into the role of both economic and institutional factors in explaining fiscal outcomes in the presence of a natural resource sector. They also incorporate insights from the literature on the theory of optimal taxation—in particular, Pigou's question on how to maximize taxes on different types of commodities while keeping the distortions and disutility generated to the barest minimum.[2] Their focus on internal factors (i.e. interplay of variables within a country) opens up space for further exploration of relevant external factors that affect the ability of open economies to improve fiscal capacity in the presence of natural resources. While the model accounts for the role of aid in some extensions, other external factors remain less explored in explaining fiscal capacity. We take advantage of the strengths of the model to examine the impact of increased global trade in natural resources.

We present salient features of Besley and Persson's (2013) model, henceforth B–P model, below. Improvement in the statutory tax take is modelled as a forward-looking investment by a state to increase its fiscal capacity (Besley and Persson, 2010). The authors consider two time periods denoted by S, where $S = 1{,}2$ for the first and second periods respectively. There exist two main groups in the population, $J \in \{I_s, O_s\}$. I_s and O_s represent the incumbent group and opposition group respectively. To accommodate a distinction between sectors, we define an economy, $k_i \geq 0$, for all $i = 1{,}2$, with k_1 representing a natural resource sector and k_2 representing a non-resource sector. The natural resource sector is mainly characterized by the production of non-renewable resources (hydrocarbons and minerals), while the non-resource sector forms the base of the economy outside the natural resource sector.[3] The natural resource sector may form a significant base of the export sector; however, the non-resource sector is much larger by employment size, as well as more sophisticated in terms of types and quantities of products.

Moreover, the non-resource sector has a larger tax base than the resource sector. The economy produces $N + 1$ consumption goods, where $n \in \{0,1, \dots N\}$. Let $x^J_{n,s}$ represent consumption of commodity n by group J at period s. We explicitly define government provision of public goods, g_s, which is funded through taxation and borrowing. Variants of the latter would include resource-for-infrastructure deals, where a foreign government provides public goods upfront in period 1 in lieu of payments through non-renewable commodity exports in period 2. In this case, we define public goods provision as $g_s = g_o(1 + \rho)$, where g_o captures government spending on public goods funded through domestic revenues while ρ measures the proportion of government spending on public goods provided for by foreign governments (principally defined by resource-for-infrastructure deals). The explicit discussion on how government funds public goods is an important addition which the B–P model implicitly assumes. Labour supply from the population

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[2] One of Ramsey's key theoretical conclusions in response to this question is to maximize revenues from the commodity with the least price elasticity of demand (Ramsey 1927).

[3] Our definition of 'natural resource sector' in the model remains consistent as used in the rest of the paper. The distinction between sectors does not impact substantively on the model, noting that Besley and Persson generalize the sectors to be defined by multiple goods and services.

is given by L_s^J at a cost of ω_s^J to the government.[4] Tax rates are defined by $t = \{t_{1,s}, t_{2,s}, \dots, t_{N,s}, t_{L,s}\}$, so that after-tax price levels and wage levels are $p_{n,s}(1 + t_{n,s}), n = 1,2, \dots, N$ and $\omega_s^J(1 - t_{L,s})$ respectively.

The B–P model defines tax evasion and other forms of non-compliance with statutory tax policy. There is also an informal sector characterized by non-payment of taxes. These features are defined by a parameter $\varepsilon_{n,s}$, the total amount of undisclosed consumption or income, which is decreasing in the level of investment in fiscal capacity of the state, $\tau = \{\tau_{1,s}, \tau_{2,s}, \dots, \tau_{N,s}, \tau_{L,s}\}$. Proxies used in capturing the concept of fiscal capacity include the ratios of tax to GDP, income tax to total tax, non-trade tax to total tax, and non-resource tax to GDP (Ricciuti et al. 2018). Here, we make use of the latter (i.e. non-resource tax as a percentage of GDP) as it remains consistent with Besley and Persson (2013) and thus captures a broader tax base (including income taxes) outside the natural resource sector. This base is usually more difficult to tax, as it requires a minimum level of administrative infrastructure (Besley and Persson 2011; Ricciuti et al. 2018). This definition of fiscal capacity is similar to that of Jensen (2011) and provides the opportunity to obtain theoretical insights into the relationship with resource revenues, which is our goal.

The total cost of investing in fiscal capacity is denoted by $C = \{F^{k_i}(\tau_{k_i,2} - \tau_{k_1,1}) + f_s^{k_i}\}$, where $f_s^{k_i}$ captures the cost of existing fiscal capacity, $(f_s^{k_i} \geq 0)$. What the B–P model defines as existing administrative capacity includes records management, trained staff, and other basic logistics. Note that the decision to invest in fiscal capacity occurs in period 1. The cost of non-compliance is given by a function $c(\tau_{n,s}, \varepsilon_{n,s})$. Investment in fiscal capacity will, therefore, drive up non-compliance costs and render tax evasion more difficult. Total tax payments due to government from consumption of commodities then become $t_{n,s}[p_{n,s}x_{n,s}^J - \varepsilon_{n,s}]$ while total tax payments from labour income are $t_{L,s}[\omega_s^J L_s - \varepsilon_{L,s}]$. Having defined the basic building blocks, the indirect utility for group J is given by:

$$V^J(t_s, \tau_s, \omega_s^J, \xi_s^J) = v\left(p_{1,s}(1 + t_{1,s}), \dots p_{N,s}(1 + t_{N,s})\right) + v^J\left(\omega_s^J(1 - t_{L,s})\right) + \pi(t_s, \tau_s) + \alpha_s^J H(g_s(\rho)) + \xi_s^J \tag{1}$$

Where α_s^J and ξ_s^J are, respectively, the value which a group in the population places on public goods and the level of cash transfer to a group. Note that the first two terms in Equation 1 represent the gains from consumption and labour supply. The third term could be looked at in terms of the profit from tax evasion or non-compliance, or simply tax reductions. Meanwhile, the revenue objective function of government is given by:

$$R(t_s, \tau_s) = \sum_{n=1}^{N} \mathrm{t}_{n,s}\left(p_{n,s}x_{n,s} - \varepsilon_{n,s}\right) + \sum_{J=1}^{2} \delta^J\, t_{L,s}(\omega_s^J L_s - \varepsilon_{L,s}) + rr_s \tag{2}$$

Government seeks to maximize tax revenue from commodities and labour income as well as revenues from the natural resource sector (rr_s). The term rr_s is assumed to be stochastic (Besley and Persson, 2011). Note δ^J as a weighing parameter that informs government transfers to a group.[5] Total government revenues then go to providing public goods, meeting transfer payments,

[4] Following Besley and Persson (2013), we leave out firms in order to simplify the model but without sacrificing the main insights.

[5] The assumption here is that the incumbent and opposition groups place a similar value on public goods that is higher than the value they place on government transfers.

and investing in fiscal capacity. Besley and Persson (2013) define how these revenues are allocated across the expenditure areas as the 'public policy problem'. The government budget constraint is expressed as:

$$R(t_s, \tau_s) \geq g_s(\rho) + \sum_{J=1}^{2} \delta^J \xi_s^J + k_s \tag{3}$$

Where

$$k_s = \begin{cases} c^k(\tau_2, \tau_1) \; if \; s = 1 \\ 0 \; if \; s = 2 \end{cases} \tag{4}$$

Assuming a weighted government social objective function, where government assigns fixed weights ψ^J to each group (and $\delta^J \psi^J$ can be normalized to 1). Government maximizes

$$\sum_{J=1}^{2} \delta^J \psi^J V^J \left(t_s, \tau_s, g_s, \rho, \omega_s, \varepsilon_s^J\right)$$

subject to Equation 3 above. Take

$$M(\tau_s, rr_s - k_s; \{\delta^J\}) = \max_{g_s, t_s, \varepsilon_s^J} \left\{\sum_{J=1}^{2} \delta^J \psi^J V\left(t_s, \tau_s, g_s, \rho, \omega_s, \varepsilon_s^J\right) subject\ to\ (3)\right\} \tag{5}$$

as the maximum value of government pay-off. To arrive at the optimal level of investment in fiscal capacity, government chooses τ_2 to maximize

$$M(\boldsymbol{\tau}_1, rr_1 - C(\boldsymbol{\tau}_2, \tau_1); \{\delta^J\}) + M(\boldsymbol{\tau}_2, rr_2; \{\delta^J\}) \tag{6}$$

Besley and Persson (2013) obtain their first-order conditions, using envelope theorem to eliminate optimal government and private choices. Their resulting equation is given as:

$$\lambda_2 \frac{\partial R(\boldsymbol{\tau}_2^*, \boldsymbol{\tau}_2)}{\partial \tau_{k,2}} + \frac{\partial \pi(\boldsymbol{\tau}_2^*, \boldsymbol{\tau}_2)}{\partial \tau_{k,2}} - \lambda_1 \frac{\partial C^k(\boldsymbol{\tau}_1, \boldsymbol{\tau}_2)}{\partial \tau_{k,2}} = 0 \; for \; k = 1,2 \tag{7}$$

where $\boldsymbol{\lambda}_2$ is defined as the marginal value of public funds.

The first term in Equation 7 suggests that the marginal revenue (future benefit) of investment in fiscal capacity is driven by two key factors: the marginal value of public funds $\boldsymbol{\lambda}_2$ and the revenue function R (see Equation 2). The second term shows how investment in fiscal capacity varies positively with the cost of non-compliance. In other words, individual benefits (profit) from non-payment of taxes diminish when there is investment in fiscal capacity. This is also the marginal cost to individuals when the state invests in fiscal capacity. From the perspective of government, the second term could also be seen as the marginal benefit of investing in fiscal capacity. The final term represents the marginal cost to the state of investing in fiscal capacity adjusted by the marginal value of public funds in period 1. Here, the cost of investing in fiscal capacity increases with both the marginal value of public funds in period 1 and the cost function (as in Equation 4).

(i) Model predictions with implications for empirical analysis

Among all the predictions of the B–P model, we focus on the effect of natural resources on the fiscal capacity of a resource-rich country. Based on Equation 7, Besley and Person (2013) predict a negative relationship between resource revenues and investment in fiscal capacity. In their view, a discovery of a natural resource, say oil, in period 1 reduces the incentive to invest in fiscal capacity in the next period in anticipation of revenue inflows in that period. In other words, the prospect of earning windfalls in the next period relaxes the need to follow through with commitments to investing in fiscal capacity, which carries real costs. They argue that the discovery of a natural resource, which creates opportunity for earning additional revenue in the next period, reduces the marginal value of public fundsλ_2(that is, tax revenues in the next period). This incentive effect invariably undermines commitment to investing in fiscal capacity. They cite the empirical work of Jensen (2011) to support their prediction. Jensen (2011) finds that a 1 per cent increase in natural resource rents reduces fiscal capacity by 1.4 per cent. Notwithstanding this conclusion, it is important to note that Besley and Persson (2013) acknowledge that resource revenues may be beneficial to the effort of building capacity, although they do not provide a formal treatment of this possibility. They also acknowledge that countries under foreign debt obligations are more likely to place a higher value on tax revenues in the next period (λ_2). We combine these two important insights as follows.

First, we must restate the fact that the provision of public goods can be funded by domestic resources and with support from development partners. This introduces an important dynamic to the predictions of the model. Consistent with what pertains in most countries, governments depend on a mix of internal and external revenue sources to fund public goods. This suggests that $0 \leq \rho \leq 1$. External support could also be perceived as coming in the form of in-kind support (equipment purchases, provision of public goods, etc.) in exchange for export of natural resources. In effect, resource-rich countries could leverage on their resource wealth to secure financing for public goods provision. One such form of financing is through resource-for-infrastructure deals. The empirical literature suggests that resource-for-infrastructure deals have long existed as a form of borrowing and are being used increasingly to fund public goods in many countries (Alemayehu 2018; Halland et al. 2014; Lin and Wang, 2016). The need to pay back external funders in the future for the provision of public goods through either resource revenues or non-resource tax revenues implies that the marginal value of public funds (λ_2) would be high.[6] This should provide incentives for investing in fiscal capacity. The incentive to invest in non-resource tax effort is triggered by the high value citizens place on public goods. Furthermore, as argued by Besley and Persson (2013), there would be the need to make payments for the cost of infrastructure provided, together with the accompanying interest. The volatility of commodity prices suggests that resource-for-infrastructure deals would require an additional buffer. The latter should provide governments with a further incentive to keep tax revenues flowing in, over time, in order to compensate for commodity price shocks. A possible prediction from the B–P model, therefore, is that the discovery of natural resources or inflow of resource revenues need not undermine investment in fiscal capacity. In fact, there could be a positive effect when one takes into account financing arrangements such as resource-for-infrastructure deals. The provision of appropriate infrastructure through such deals (for example, transport, energy, and technology) could also reduce the future cost of investing in fiscal capacity and therefore potentially bring in more revenue per unit cost of investment (Pomeranz and Vila-Belda 2019). Thus, there could be plausible reasons for why the relationship between resource revenues and investment in fiscal capacity could be positive.

A policy of building capacity to optimize revenue mobilization in the resource sector should invariably affect revenue collection in the non-resource sector—barring or limiting the resource movement effect earlier discussed. This is especially the case if the fiscal regime and institutional set-up for revenue mobilization in the resource sector is not different from that in the non-

[6] Also accounting for the cost of these external funds (for example interest payments).

resource sector (Knebelmann 2017). In addition, an increase in resource revenues could suggest increases in direct income which should affect consumption and investment decisions by individuals and firms. The spending decisions could benefit the non-resource sector (Cordon and Neary 1982; Ossowski and Gonzales 2012). The concern here, though, is the relatively capital-intensive nature of the resource sector, and hence the size of this spending effect is not expected to be large, especially for individuals. The exception is the lagged wealth effect discussed by Ossowski and Gonzales (2012). This refers to increases in private consumption, investment, and general economic activity in the non-resource sector caused by the expectation that resource booms are likely to linger. Another plausible element in sustaining economic activity in the non-resource sector is the expectation that incomes are likely to increase in the future due to favourable commodity prices. These possibilities could impact positively on non-resource tax effort and therefore the levels of revenue mobilized from the non-resource sector. We test these arguments within an empirical framework.

3 Empirical strategy and data

3.1 Model specification: Relationship between resource revenues and non-resource tax effort

This section proposes an empirical strategy which explores the relationship between resource revenues and non-resource tax effort using a variety of panel econometric techniques. Our approach provides a consistent way of checking the robustness of the results. The choice of the econometric model specifications is informed by the theory on the determinants of fiscal capacity and the empirical literature on determinants of domestic revenue mobilization. The B–P model shows how factors such as income, the structure of the economy, institutional factors, and aid impact on fiscal capacity. We are also guided by the empirical work of Bornhorst et al. (2009) and Gupta (2007) on the determination of fiscal capacity, which then informs our econometric specification. The base econometric model specification is given as:

$$\left(\frac{R^{NR}}{Y}\right)_{it} = \beta_0 + \beta_1 \left(\frac{R^{R}}{Y}\right)_{it} + \omega' \, controls_{it} + \varphi_i + \tau_t + u_{it} \tag{8}$$

where u_{it} is the error term; ω' is a vector of coefficients for the list of control variables (controls);

τ_t represents the time dummies from 1980 to 2015; φ_i represents the country fixed effects; i is the cross-sectional unit (i.e. country); and t is the time dimension.

The main explanatory variable $\left(\frac{R^{R}}{Y}\right)_{it}$ is resource revenue[7] as a percentage of GDP for country i at time t. The explained variable is $\left(\frac{R^{NR}}{Y}\right)_{it}$ non-resource tax revenues as a percentage of GDP for country i at time t. The vector of control variables includes trade as a percentage of GDP, agriculture value-added as a percentage of GDP, a natural log of GDP per capita, and control of corruption. The country-specific effects (φ_i) allow for unique intercepts for each country and thus capture unobserved country differences that might be correlated with our main explanatory variable as well as the dependent variable. The period dummies (τ_t) capture globalization issues

[7] Used interchangeably with natural resource revenues. Includes revenue from hydrocarbons and minerals.

and other macro shocks or policies that are likely to be correlated with both resource revenues and non-resource taxes. The error term (u_{it}) is assumed to exhibit white-noise characteristics. It is independently and identically distributed with zero mean and constant variance. Other control variables are introduced as part of robustness checks. These include the quality of political institutions, constraint of the executive, inflation, and population. Our global sample comprises both developed and developing countries which produce hydrocarbons and minerals.

3.2 Econometric methods and identification strategy

We employ panel data techniques in a systematic fashion, guided by theory as well as the empirical literature. We begin with an assessment of the data using scatter plots and lines of best fit. We complement the correlation analysis with a naïve pooled ordinary least squares (POLS) estimate to explore the relationship between resource revenues and non-resources taxes. Next, we introduce our vector of control variables. The concern with the POLS estimate is that not controlling for unobserved time-invariant differences in country characteristics may bias our parameter estimate and render our interpretations inaccurate. We test for this and employ fixed-effect estimators (FEEs) in response. We apply a Hausman test to evaluate the appropriateness of our choice between an FEE and a random-effects estimator (REE). After examining the contemporaneous or short-term effects, we explore the medium- to long-term effects of resource revenues on non-resource tax effort. First, we transform the data into a five-year non-overlapping series. We reapply the FEEs described earlier within a medium- to long-term framework. We include this treatment to account for the fact that our key variables of interest may take time to evolve. For some, their impact may only be realizable after a year.

In a number of alternative specifications, we use a GMM estimator developed by Holtz-Eakin et al. (1990), Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). The case for a dynamic specification is premised on a plausible argument that in the context of a shock to a country's non-resource tax revenues it may take time for those revenues to adjust, and thus the variable can be persistent over time (Thomas and Treviño 2013; Bornhorst et al. 2009). In using such a specification, we resolve the so-called Nickel bias, where the lagged variable becomes correlated with the country fixed effect. We also apply the Windmeijer correction to account for downward bias of the standard errors (Roodman 2008).

Our data and empirical strategy also allow us to explore the extent to which context matters. Besides evaluating the global evidence, we are able to disaggregate results for the developing world but also for the set of low-income countries (LICs) and lower-middle-income countries (LMICs) in our sample. Again, we explore the effect of other functional forms as we vary the base model as a robustness check. In other robustness checks, we test for the sensitivity of our results to additional covariates such as measures of institutional quality, population, and inflation.

Identification strategy

Our base model specification in Section 3.1 suffers from endogeneity. While we present arguments on how resource revenues might affect non-resource tax effort, there is reason to expect that difficulties with generating non-resource tax revenues could push governments to focus on mobilizing revenues from the natural resource sector. This presents a case of a simultaneity bias, also referred to as reverse causality. We statistically test for the exogeneity of the main explanatory variable using the Hausman test. The null hypothesis that resource revenue as a percentage of GDP is exogenous is rejected at a probability value close to) (P = 0.0014). The result thus confirms our concern about endogeneity. To address this concern, we use a 2SLS approach to obtain exogenous variation in resource revenues as a percentage of GDP. This is achieved through the use of an exogenous instrument. This approach has additional merits, including tackling probable error in variable measurement. This concern is revisited below.

In order to capture the effect of exogenous variations in natural resource revenues on variations in non-resource tax revenue, we construct an instrumental variable. We employ the effect of China's accession to the WTO in 2001 on international trade in natural resources. This was also a period characterized by rising commodity prices and a 'new' version of commodity trade referred to as resource-for-infrastructure deals (Venables 2016). China's policy decision to join WTO increased its role in the global economy, bringing with it a largely positive outcome for the Chinese economy and a rather mixed outcome for other countries (Asquith et al. 2017; Autor et al. 2016; Bloom et al. 2016; Hu and Jefferson 2009). China's trade strategy and its subsequent impact on global trade was different in the period before 2001 compared with the period after 2001. China's demand for metals skyrocketed from a pre-WTO value of 3 per cent of global demand to 40 per cent by the end of 2014 (IMF 2016). Similarly, China's demand for crude oil surged from 1 per cent to 11 per cent over the same period (IMF 2016). It is also noteworthy that a third of China's energy imports and a fourth of her crude oil comes from Africa (Alemayehu 2018).[8]

The reverberations around the world associated with China's entry into the WTO has been referred to as the 'China shock' (Autor et al. 2016; Bloom et al. 2016). For commodity-producing countries, this shock led to an increase in the demand for their natural resource exports to feed China's manufacturing industries. China is currently the largest net importer of oil, having accounted for about 50 per cent of global growth in crude oil consumption in the decade leading to 2015 (Vasquez 2018). Thus, China's demand for natural resources holds consequences for resource revenues, as it affects global commodity prices (Kilian and Hicks 2013).[9] Evidence from the October 2016 edition of the IMF's World Economic Outlook further suggests that the responsiveness of global commodity prices (crude oil and metals) to increases in China's demand has only been statistically significant since it acceded to the WTO and not before.

A source of variation in the instruments and their effect stems from the fact that China's demand for commodities has not been homogeneous across countries and over time. Secondly, although many countries have both oil and base metals, most specialize in the production and export of one, depending on the size of available reserves, technology, quality of products, and pricing. Furthermore, the distance between China and these trading countries is expected to impact on the volume and value of trade and thus on resource revenues. We explore variants of the China shock as instrumental variables—for example, China's ratio of total imports to GDP and its merchandise trade as a share of GDP. However, we focus on China's natural resource imports (fuel, ore, and metals) as a percentage of GDP as our main instrument, as this best satisfies our exclusion restriction. China's natural resource imports are correlated with resource revenues but not with non-resource tax effort around the globe. The higher the demand for imports by China, the higher the resource revenues for a resource-exporting country, *ceteris paribus*. We test for the relevance and strength of our main instrument.

The use of an instrumental variable approach further helps to address our concern with the errors-in-variables bias. Despite improvements in the quality of the Government Revenue Dataset

[8] The seven countries in Africa that provide for most of China's import (natural resource) needs are South Africa, Nigeria, Algeria, Sudan, Congo, the Democratic Republic of the Congo, and Angola.

[9] Other countries, such as Japan, India, and Brazil, contributed to this increased demand, but relatively less so.

(Prichard et al. 2014), we leverage on the instrumental variable approach to reduce the impact of measurement errors in biasing our parameter estimates.

3.3 Data and descriptive statistics

Our choice of panel data stems from the many advantages they possess. First, they allow us to account for unobserved country heterogeneity which is time-invariant or changes very slowly over time. This would include factors such as geography, some aspects of culture, and whether a country is landlocked or not. We are also able to control for time-varying unobserved variables such as the effect of global shocks. The nature of panel data creates room for improving the efficiency of our parameter estimates, as they tackle the incidence of multicollinearity and allow for degrees of freedom. In situations like ours, where there is persistence in the variable of interest, panel data permit a dynamic specification.

The choice of data and sample can potentially drive results obtained in empirical research. In this regard, we closely review the data and sample of countries used in four studies that we deem most closely related to our study. Apart from the differences in the sample of countries used (mostly due to availability of data), we also observe that most of these studies focus on hydrocarbons (mainly oil and gas resources) and, as such, hydrocarbon revenues. Table 1 shows the list of countries used in previous studies. The letter *X* indicates that a country is included while *0* shows that it is excluded in a study.

Two of the studies, Ossowski and Gonzales (2012) and Thomas and Treviño (2013), are regional studies covering Latin America (15 countries) and Sub-Saharan Africa (SSA) (20 countries) respectively. The three other studies in Table 1 attempt to provide a global perspective on non-resource tax effort in hydrocarbon-producing economies. We emphasize this global perspective by employing data on resource revenues covering a larger set of countries for which there are available data. Our sample extends well beyond the total sample covered in the studies cited and, more broadly, those used in the literature. Our data is from the 2017 version of the Government Revenue Database (GRD).

Table 1: Sample of countries used in four related studies

	Country	Bornhorst et al. 2009	Ossowski and Gonzales 2012	Thomas and Treviño 2013	Crivelli and Gupta 2014	Knebelmann 2017
1	Algeria	X	0	0	X	X
2	Angola	X	0	X	X	X
3	Azerbaijan	X	0	0	0	X
4	Bahrain	X	0	0	X	0
5	Brunei	X	0	0	X	X
6	Cameroon	X	0	X	X	X
7	Chad	X	0	X	0	*
8	Congo (Kinshasa)	0	0	X	0	X
9	Ecuador	X	X *HR*	0	0	X
10	Equatorial Guinea	X	0	X	X	*
11	Gabon	X	0	X	X	X
12	Indonesia	X	0	0	X	*
13	Iran	X	0	0	X	X
14	Kazakhstan	X	0	0	X	X
15	Kuwait	X	0	0	0	*
16	Libya	X	0	0	0	X
17	Mexico	X	X *HR*	0	X	X

18	Nigeria	X	0	X	X	*
19	Norway	X	0	0	X	0
20	Oman	X	0	0	X	0
21	Qatar	X	0	0	0	0
22	Russia	X	0	0	X	0
23	Saudi Arabia	X	0	0	X	X
24	Sudan	X	0	0	0	X
25	Syria	X	0	0	X	X
26	Trinidad and Tobago	X	X *HR*	0	X	X
27	United Arab Emirates	X	0	0	X	X
28	Venezuela	X	X *HR*	0	0	0
29	Vietnam	X	0	0	X	*
30	Yemen	X	0	0	X	X
31	Iraq	0	0	0	0	*
32	Timor-Leste	0	0	0	0	X
33	Côte D'Ivoire	0	0	0	X	X
34	Belize	0	0	0	0	X
35	Bolivia	0	X *HR*	0	0	X
36	Egypt	0	0	0	0	*
37	Malaysia	0	0	0	0	*
38	Chile	0	X	0	0	0
39	Colombia	0	X *HR*	0	X	0
40	Peru	0	X	0	X	0
41	Argentina	0	X *NH*	0	X	0
42	Brazil	0	X *NH*	0	0	0
43	Costa Rica	0	X *NH*	0	0	0
44	El Salvador	0	X *NH*	0	0	0
45	Honduras	0	X *NH*	0	0	0
46	Paraguay	0	X *NH*	0	0	0
47	Uruguay	0	X *NH*	0	0	0
48	Guinea	0	0	X	X	0
49	Congo (Brazzaville)	X	0	X	X	0
50	Botswana	0	0	X	X	0
51	Zambia	0	0	X	0	0
52	Sierra Leone	0	0	X	X	0
53	Mali	0	0	X	X	0
54	Namibia	0	0	X	0	0
56	Niger	0	0	X	0	0
57	Zimbabwe	0	0	X	0	0
58	Tanzania	0	0	X	0	0
59	Ghana	0	0	X	X	0
60	Central African Rep.	0	0	X	0	0
61	South Africa	0	0	X	0	0
62	Burkina Faso	0	0	0	0	0
63	Lesotho	0	0	0	0	0
64	Uganda	0	0	0	0	0
65	Senegal	0	0	0	X	0
66	Ethiopia	0	0	0	0	0
67	Mozambique	0	0	0	0	0
68	Kenya	0	0	0	0	0
69	Madagascar	0	0	0	0	0
70	Malawi	0	0	0	0	0
71	Rwanda	0	0	0	0	0

72	Liberia	0	0	0	0	0
73	Cape Verde	0	0	0	0	0
74	Mauritius	0	0	0	0	0
75	Seychelles	0	0	0	0	0
76	Eswatini (formerly Swaziland)	0	0	0	0	0
77	Benin	0	0	0	0	0
78	Burundi	0	0	0	0	0
79	Comoros	0	0	0	0	0
80	Eritrea	0	0	0	0	0
81	Gambia	0	0	0	X	0
82	Guinea-Bissau	0	0	0	X	0
83	São Tomé and Príncipe	0	0	0	0	0
84	Togo	0	0	0	0	0
85	Guyana	0	0	0	X	0
	Country total	30	15	20	35	22

Notes: * indicates countries not included due to lack of disaggregated data (direct and indirect non-oil taxes or sectorial value-added). '0' indicates countries omitted with or without any explanation. NH: countries labelled as having little or no hydrocarbon revenue; HR: countries that are mainly or exclusively hydrocarbon exporters.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

The GRD is a standardized disaggregated dataset on government revenues. For instance, it separates natural resource revenues from other revenues and has subcategories of these. There are variables such as total resource taxes, non-resource taxes, indirect taxes, direct taxes, property taxes, and trade taxes. We choose the merged version of the database, which combines general government revenue data and central government revenue data. General government revenue data include revenue aggregated from all of government and thus include revenue accruing to the central government and decentralized local authorities. These data are obtainable for a limited set of countries. On the other hand, central government revenues take account of revenues accruing to the central government. Use of central government revenue data would, therefore, under-report total revenue for a country, which has significant revenues accruing from its local authorities or decentralized states, for example. The merged data, which are more comprehensive, capture general government revenue for each country where this is available but capture central government revenue data for a country if there is evidence of limited subnational revenue. A drawback to the use of the merged dataset is that it underestimates revenues for countries which do not have consistent series of general government revenue (see UNU-WIDER 2017).

Prior to the emergence of the ICTD-GRD database in 2014, existing data sources on government revenues suffered a myriad of limitations. These were largely related to data coverage (both across countries and over time); quality and consistency; and reporting and comparability (Baunsgaard and Keen 2010; Keen and Mansour 2009; Prichard et al. 2014). There were also challenges regarding the level of government at which the data were aggregated (for example, general government revenue versus central government revenue) and the GDP series used in normalizing revenue data (Prichard et al. 2014). Challenges with previous data also meant a preference for regional level studies, for which data were relatively more comprehensive and consistent. These challenges with previous government revenue databases and their implications for research outcomes have been documented (Clist 2016; Prichard 2016; Prichard et al. 2014).

The new ICTD-GRD database is a significant improvement over previous attempts to compile comprehensive global datasets on government revenues. It combines the existing datasets into a standardized classification system. The rubrics of the system have been transparently documented

(McNabb 2017; Prichard et al. 2014) and are available on the UNU-WIDER website (UNU-WIDER 2019).

List of control variables

Our list of control variables come from the World Development Indicators (WDI) database (World Bank 2017) and the International Country Risk Guide (ICRG) ((Political Risk Services 2015). Table 2 provides the list of variables considered for this empirical section.

Descriptive statistics

Table 2 presents the summary statistics for key variables used in the estimations of the relationship between resource revenues and non-resource tax effort. The sample is based on the POLS estimation of our base model in Equation 8.

Table 2: Summary statistics for key variables: 1980–2015

	(1)	(2)	(3)	(4)	(5)
Variable	Observations	Mean	Standard deviation	Min.	Max.
Total non-resource tax as % of GDP	1,069	16.016	7.823	0.607	37.577
Total resource revenue as % of GDP	1,069	5.592	9.789	0.000	65.569
Grants as % of GDP	1,069	0.808	1.777	0.000	24.713
Corruption index	1,069	2.937	1.281	0.000	6.000
Agriculture value-added as % of GDP	1,069	12.375	11.637	0.050	61.969
Log GDP per capita in constant US$	1,069	8.570	1.489	5.721	11.618
Trade as % of GDP	1,069	93.921	62.798	12.009	455.415
Consumer price index	973	77.447	36.960	0.000	348.992
GDP Deflator	1,069	133.603	259.791	0.000	5,068.098
Exchange rate per US$	996	758.595	2,331.346	0.000	21,697.568
Service value-added as % of GDP	1,069	53.220	14.778	12.872	93.115
Chinese resource imports as % of GDP	1,069	20.392	5.061	9.506	28.444
N	1,069				

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

Column 1 of Table 2 depicts the number of country-year observations in the period 1980 and 2015. Columns 2 to 5 show the period average, standard deviation, minimum value, and maximum value respectively. These are corrected to three decimal places. Total resource revenue as a percentage of GDP ranges from 0 to approximately 66 per cent, with a country-year average of 6 per cent and a standard deviation of about ten percentage points. Non-resource tax as a percentage of GDP ranges from 0.6 per cent to about 38 per cent with a mean and standard deviation of 16 per cent and eight percentage points respectively. The main instrument, China's resource imports as a percentage of GDP, ranges from 9.5 per cent to 28.4 per cent, with a period average of about 20 per cent and standard deviation of about five percentage points.

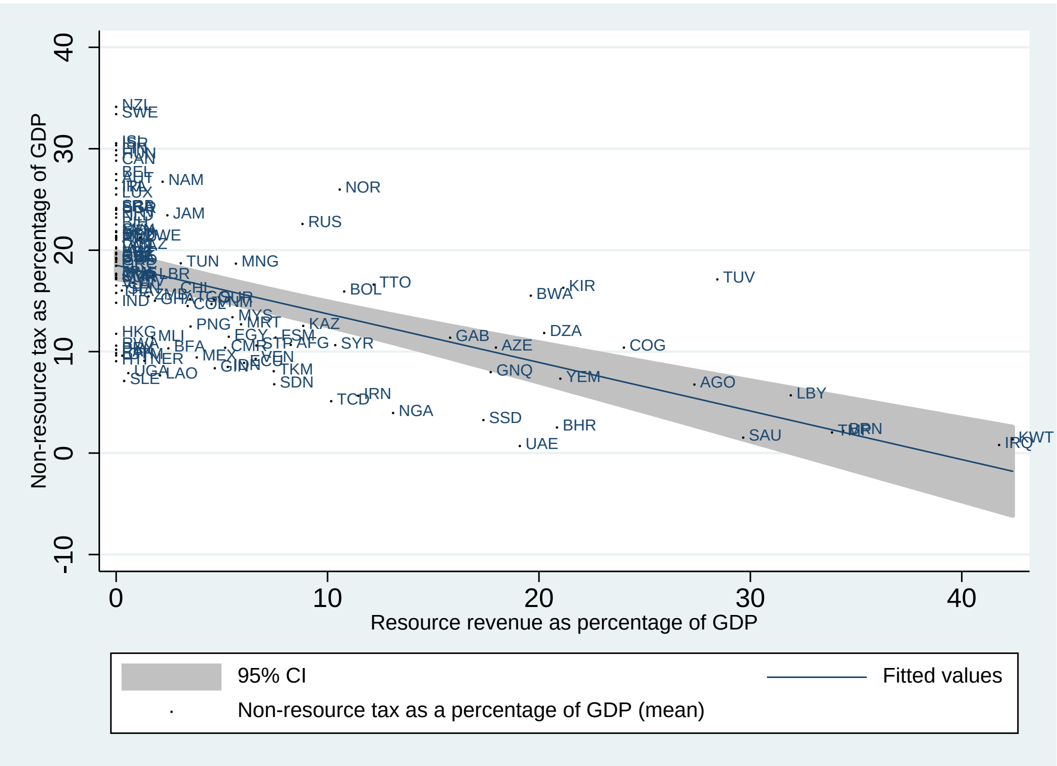
4 Empirical results and discussion

This section begins with a correlation analysis of the two key variables of interest (resource revenues as a percentage of GDP and non-resource tax as a percentage of GDP). Next, we show results from the use of POLS and FEEs. The section then examines medium-term effects by transforming the data into non-overlapping five-year averages, still using FEEs. Having obtained wider N (panels) and shorter time periods as a result of the data transformation, we employ an Arellano and Bond estimator (GMM), assessing the plausibility of a dynamic effect and its implication for the relationship between our variables of interest. Finally, we employ a 2SLS estimator in assessing the effect of a China shock on the relationship between resource revenues and non-resource tax effort.

4.1 The relationship between resource revenues and non-resource tax

Using a scatter plot, we examine the relationship between the two key variables—total resource revenues as a percentage of GDP and total non-resource tax as a percentage of GDP. The scatter plot in Figure 1 shows mean values of non-resource taxes as a percentage of GDP on the y-axis, plotted against resource revenues as a percentage of GDP on the x-axis. The data cover the period from 1980 to 2015. A fitted line is included in the scatter plot. A total of 116 countries are captured using the World Bank's Country Classification Code.

Figure 1: Scatter plot of correlation between resource revenues and non-resource taxes: global sample



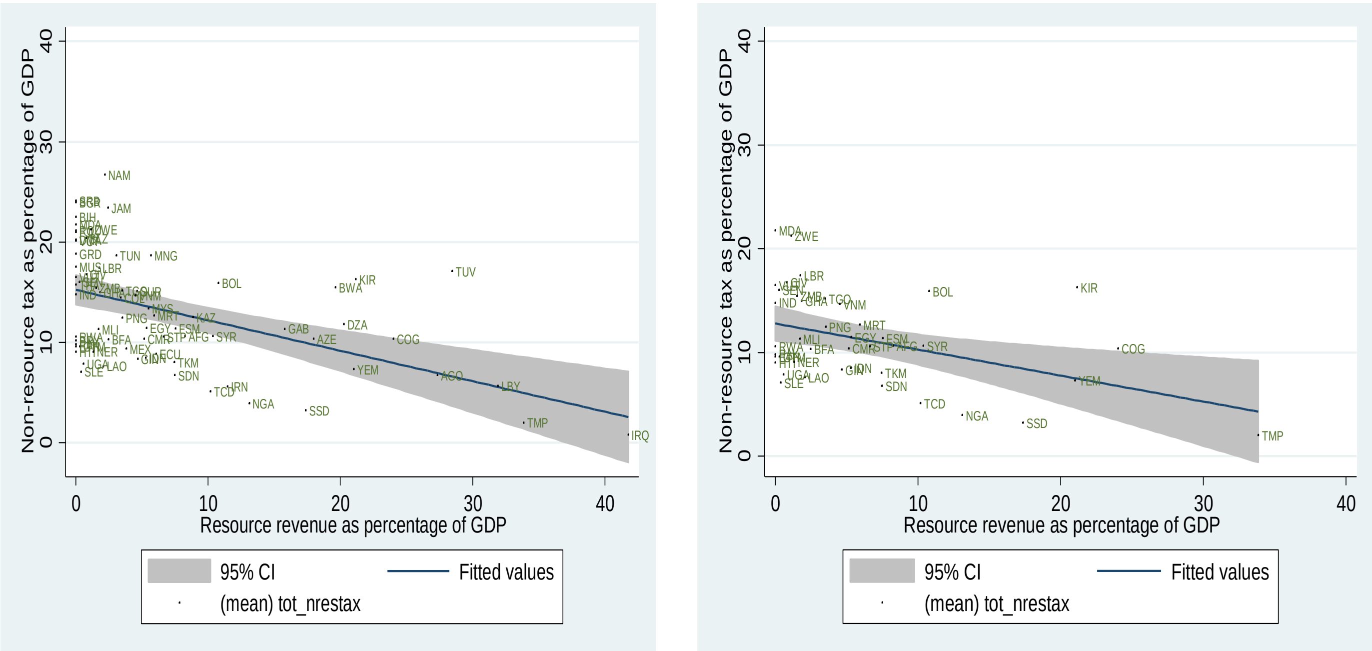
Source: authors' construction based on ICTD-GRD data.

Figure 1 shows a negative relationship between resource revenues and non-resource taxes. The fitted line suggests that on average, a country's non-resource tax as a percentage of GDP is decreasing as resource revenues as a percentage of GDP decrease. Thus, *ceteris paribus*, the higher a country's resource revenue as a percentage of GDP, the lower its non-resource revenue as a percentage of GDP. In the lower right-hand corner of the chart, countries such as Iraq, Kuwait, Saudi Arabia, Brunei, and Timor-Leste have high resource revenues as a percentage of GDP (in excess of 30 per cent) and low non-resource tax revenue shares (mostly less than 5 per cent). At the other extreme are countries such as New Zealand, Sweden, Finland, Israel, and Canada with high non-resource revenues as a percentage of GDP compared with paltry levels of resource revenues as a percentage of GDP (close to zero).[10]

Figure 2: Relationship between resource revenues and non-resource tax effort

a. Developing countries

b. LMICs and LICs



Source: authors' construction based on ICTD-GRD data.

In Figure 2a, we replicate scatter plots for countries in the data that fit the World Bank income classification for developing countries. In keeping with the World Bank's income classification system, we define developing countries as comprising upper-middle-income countries, lower-middle-income countries, and low-income countries. On the basis of 2017 classifications, upper-middle-income countries are defined as having a gross national income (GNI) per capita of between US$4,036 and $12,475.[11] Lower-middle-income countries have a GNI per capita of between $1,026 and $4,035 while low-income countries have a GNI per capita of less than $1,025. Figure 2b represents the sample for low-income and lower-middle-income countries, according to the same method of classification. These plots essentially show that the negative relationship holds even when outliers are dropped. However, the relationship is not statistically robust due to econometric problems such as omitted variables and endogeneity. We explore alternative econometric estimators.

[10] The relationship remains negative (downward-sloping) when we drop all countries with zero levels of both resource revenues as a percentage of GDP and non-resource taxes as a percentage of GDP.

[11] The thresholds in the 2019/20 World Bank income classifications are not significantly different (upper-middle-income: $3,996–$12,375; lower-middle-income :$1,026–$3,995; low income: less than $1,025).

4.2 Pooled ordinary least squares and fixed-effects estimates

Table 3 reports POLS estimates for the effect of resource revenues on non-resource tax effort. The first column provides the coefficient of a bivariate regression. The second column includes grants as an additional control variable in view of the concern that it could potentially undermine non-resource tax effort. The third to fifth columns include an additional set of control variables, following Bornhorst et al. (2009). Column 3 omits fixed effects whereas Column 5 includes country and time fixed effects. Column 4 includes time effects but omits country effects. All specifications have robust standard errors. In Column 1, a negative coefficient on resource revenues is obtained. The offset in non-resource taxes as a result of a one-percentage-point increase in resource revenues is about 0.4 of a percentage point.

Table 3: Results based on POLS and random-effects (REE) model

Dependent variable: Non-resource tax as a percentage of GDP					
	(1)	(2)	(3)	(4)	(5)
Variables	OLS	OLS	OLS	OLS	REE
Tot_resrev	−0.408***	−0.352***	−0.385***	−0.373***	−0.198***
	(0.0123)	(0.0120)	(0.0169)	(0.0152)	(0.0412)
Grants		−0.0295	0.104	−0.0979	−0.00154
		(0.0209)	(0.0859)	(0.0791)	(0.0926)
Corrupt			1.762***	2.637***	0.615
			(0.182)	(0.206)	(0.388)
Agriculture value-added			−0.118***	−0.120***	−0.0137
			(0.0204)	(0.0203)	(0.0691)
Log GDP per capita			1.116***	0.408*	1.698**
			(0.213)	(0.234)	(0.737)
Trade openness			−0.00311	−0.00633*	0.00314
			(0.00346)	(0.00356)	(0.0106)
Country effect	No	No	No	No	Yes
Time effect	No	No	No	Yes	Yes
Observations	2,535	1,830	1,069	1,069	1,069
R-squared	0.284	0.253	0.556	0.597	
Number of id					66

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

The negative offset in non-resource taxes is consistent across all five specifications, although reducing in magnitude. In Columns 2 and 3, we omit both country and time fixed effects. However, our test of the joint significance of time effects (period dummies) suggests that they are statistically significant. Hence, we include time effects in our POLS estimates in Column 4. In Column 5, we allow for country heterogeneity, opting for a random-effects model instead of a least squares dummy variable model, since the former is computationally more efficient (Verbeek 2004). Furthermore, our Lagrange multiplier test (Breusch–Pagan test) for panel (country) heterogeneity suggests that a REE better fits the data than a naïve POLS. Thus, in Column 5, a one-percentage-point increase in resource revenues is associated with an eviction effect of about 0.2 percentage points in non-resource tax effort.

From Columns 3 to 5 of Table 3, only GDP per capita turns out statistically significant across all specifications. GDP per capita is positively correlated with non-resource tax effort. An increase in agriculture value-added is negatively correlated with non-resource tax effort in all three specifications but only statistically significant in Columns 3 and 4. Control of corruption is positively correlated with non-resource tax effort. The coefficient on control of corruption is also statistically significant at the 1 per cent level in Columns 3 and 4. The coefficient on trade openness alternates in sign, although it is only statically significant and negative in Column 4.

Columns 1 and 3 of Table 4 are the results of an REE with and without time effects. Columns 2 and 4 present results of an FEE which allows for correlation between unobserved effects and the right-hand-side variables. The specification in Column 5 of Table 3 is repeated in Column 3 of Table 4 for purposes of comparison of the two specifications for the REE.

Table 4: Random-effects (REE) and fixed-effects (FEE) estimation

Dependent variable: Non-resource tax as a percentage of GDP				
	(1)	(2)	(3)	(4)
Variables	REE	FEE	REE	FEE
tot_resrev	−0.188***	−0.157***	−0.198***	−0.163***
	(0.0487)	(0.0538)	(0.0412)	(0.0469)
grants	0.0373	0.0350	−0.00154	0.00803
	(0.103)	(0.105)	(0.0926)	(0.0916)
corrupt	0.170	0.202	0.615	0.538
	(0.274)	(0.302)	(0.388)	(0.403)
agricval2GDP	−0.0124	0.00347	−0.0137	0.00446
	(0.0677)	(0.0759)	(0.0691)	(0.0792)
Log GDP per capita	2.613***	3.305**	1.698**	1.962
	(0.771)	(1.263)	(0.737)	(1.423)
Trade openness	0.00886	0.00768	0.00314	0.00363
	(0.0105)	(0.0114)	(0.0106)	(0.0121)
Country effect	Yes	Yes	Yes	Yes
Time effect	No	No	Yes	Yes
Observations	1,069	1,069	1,069	1,069
R-squared		0.139		0.187
Number of id	66	66	66	66

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

On the whole, an offset of approximately 0.2 percentage points of GDP in non-resource taxes is associated with a one-percentage-point increase in resource revenues. This result is similar to that of Bornhorst et. al. (2009), who find an offset of similar magnitude for 30 hydrocarbon-producing countries. However, their main outcome variable is non-hydrocarbon revenues as a percentage of GDP, while their main explanatory variable is hydrocarbon revenues. As a robustness check, we test for the inherent assumption associated with the REE that the unobserved effects (country heterogeneity) are exogenous and thus not correlated with the other regressors. A violation of this assumption would render the results inconsistent due to omitted variables. The test provided by Hausman (1978), then, essentially pits a null hypothesis that there is no systematic difference in coefficients between the REE and FEE against the alternative that a systematic difference exists. The Hausman test rejects the null hypothesis of no systematic difference, hence our FEE becomes preferable. This result is maintained with or without the inclusion of period dummies. Thus, for the preferred specification in Column 4, a one-percentage-point increase in resource revenues is associated with a 0.16-percentage-point decline in non-resource taxes.

The next set of specifications accounts for the fact that the impact of natural resource revenues on development outcomes could take time to manifest, at least beyond a calendar year. We allow for persistence of the outcome variable, thereby accommodating the possibility of the effect of shocks lasting for more than a year. For example, it is plausible to expect a shock to non-resource taxes due to an economic crisis that lasts beyond a year. In order to account for these dynamics, the data is transformed into five-year non-overlapping averages (a semi-decadal series). The transformation allows the medium-term effect of resource revenues on non-resource taxes to be assessed. Columns 1 to 5 of Table 5 present the medium-term effects.

Table 5: Medium-term effects: Panel OLS and fixed-effects specification

	(1)	(2)	(3)	(4)	(5)
Dependent variable: Non-resource tax as a percentage of GDP					
Variables	OLS	OLS	OLS	REE	FEE
tot_resrev	−0.426***	−0.370***	−0.419***	−0.295***	−0.171***
	(0.0245)	(0.0236)	(0.0357)	(0.0391)	(0.0611)
grants		−0.00955	−0.0603	0.0824	0.127
		(0.0335)	(0.172)	(0.182)	(0.197)
corrupt			1.997***	0.925**	0.682
			(0.398)	(0.435)	(0.471)
agricval2GDP			−0.141***	−0.0442	0.0222
			(0.0443)	(0.0631)	(0.0937)
Log GDP per capita			0.675	1.326**	1.132
			(0.457)	(0.665)	(1.305)
Trade openness			−0.00112	0.00571	0.0112
			(0.00791)	(0.0103)	(0.0135)
Country effect	No	No	No	Yes	Yes
Time effect	No	No	No	Yes	Yes
Observations	546	409	253	253	253
Number of id			67	67	67

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

Starting from Column 1, the list of control variables is included additively. The specification in Column 2 controls for grants as a percentage of GDP. Column 3 includes the full list of regressors but without fixed effects. The REE and FEE are introduced in Columns 4 and 5 respectively and with time effects. Once again, a Hausman test rejects the null hypothesis of a non-systematic difference between the REE and FEE. The latter becomes the preferred choice. In the medium term, the effect of resource revenues on non-resource taxes appears to be more adverse across all specifications compared with the short-term effect captured in Table 4. The medium-term effect suggests that a one-percentage-point increase in resource revenues offsets non-resource tax effort by about 0.17 percentage points. The effect is statistically significant at the 1 per cent level. The effects of grants and trade openness are not statistically significant across specifications. The coefficient on corruption is positive and statistically significant in the third and fourth columns but not in our preferred specification in Column 5. Similarly, the coefficient on log GDP per capita is positive and significant in the fourth specification but not in the third and fifth specifications. Finally, the effect of agriculture value-added as a percentage of GDP (also a measure of the level of informality) has a negative and statistically significant effect on non-resource tax effort in the third column. This effect, however, is muted in the fourth and fifth columns.

4.3 A causal effect using a GMM estimator

Although applying an FEE on the transformed data (i.e. the non-overlapping five-year series) addresses a potential persistence in the data, it is unable to adequately tackle another potential problem of endogeneity that undermines our model—reverse causation. Countries that have a very low non-resource tax base or deficient (non-resource) tax capacity and therefore low non-resource revenues are more likely to depend on the natural resource sector. Similarly, it is not unreasonable to expect that countries with a poor domestic resource base are more likely to be prone to corruption or to attract grants. Thus, not only is the main explanatory variable (resource revenues as a percentage of GDP) potentially endogenous, but other covariates such as grants and corruption may suffer from the same problem. To correct for this, we apply an Arellano and Bond estimator to the transformed data series, following Bond et al. (2001). The value of applying a GMM estimator lies in its ability to instrument for potentially endogenous variables such as the aforementioned. Columns 1 to 5 in Table 6 feature both a difference GMM (Columns 1 and 2) and a system GMM estimator (Columns 3 to 5). While a difference GMM estimator is sufficient for addressing the concerns enumerated above, a system GMM estimator provides an additional advantage. The systems GMM estimator has better finite sample properties and uses additional instruments within a system of equations to correct for endogeneity (Bond et al. 2001; Roodman 2008). Columns 1 and 2 apply a one-step difference GMM estimator, while Columns 3 to 5 specify a two-step GMM estimator. The specifications in Columns 2, 4, and 5 accommodate time effects as additional exogenous instruments. Besides the lagged dependent variable, corruption is specified as endogenous and thus instrumented for across all specifications. In Column 5, we specify grants as a percentage of GDP as an additional endogenous variable.

Table 6: GMM estimator for a semi-decadal series

Dependent variable: Non-resource tax as a percentage of Gross Domestic Product (GDP)					
	(1)	(2)	(3)	(4)	(5)
Variables	DIFF	DIFF	SYS	SYS	SYS
tot_resrev	−0.123*	−0.134**	−0.171**	−0.116	−0.117**
	(0.0703)	(0.0614)	(0.0667)	(0.0694)	(0.0475)
$(\text{Nonres\_tax})_{t-1}$	−0.0177	0.0275	0.629***	0.762***	0.755***
	(0.215)	(0.266)	(0.168)	(0.193)	(0.132)
grants	0.0692	0.000234	0.0500	0.121	−0.00492
	(0.143)	(0.139)	(0.102)	(0.138)	(0.236)
corrupt	0.0481	0.482	−0.573	−0.482	−0.335
	(0.590)	(1.132)	(0.498)	(0.768)	(0.688)
agricval2GDP	−0.0694	−0.0985	−0.0564	−0.0549	−0.0421
	(0.0599)	(0.0658)	(0.0451)	(0.0404)	(0.0401)
Log GDP per capita	1.699	0.977	0.710	0.350	0.352
	(1.066)	(1.470)	(0.621)	(0.515)	(0.403)
trade2GDP2	0.00980	0.00560	0.00540	0.00317	0.00285
	(0.0101)	(0.0116)	(0.00686)	(0.00427)	(0.00389)
Time effect	No	Yes	No	Yes	Yes
No. of instruments	14	19	24	29	38
Observations	164	164	229	229	229
Number of id	53	53	65	65	65
AR(1) (P-values)	0.62	0.71	0.02	0.04	0.031
Hansen J (P-values)	0.35	0.08	0.22	0.27	0.6
Diff-in-Hansen test	0.36	-	0.51	0.17	0.43

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Lag of non-resource tax and corruption are instrumented for in Columns 1 to 4. In Column 5, we instrument for the grants variable in addition.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

Except in Column 4, the parameter of interest remains negative and statistically significant at conventional levels across all specifications, albeit with caveats for some specifications. The underlying econometric diagnostics for serial correlation for the specifications in Columns 1 and 2 suggest that the test of no first-order autocorrelation was not rejected. Furthermore, the lagged effects of non-resource taxes do not turn out statistically significant at conventional levels. This constitutes a weakness for the first two specifications. In Columns 3 to 5, however, the diagnostics across the specifications appear more credible. The test of no first-order autocorrelation is rejected. The lagged effects are positive and statistically significant. The Hansen J and Difference-in-Hansen test statistics suggest that our overidentifying restrictions are valid. In other words, the set of instruments is credible (Parente and Santos Silva 2012). None of the control variables turn statistically significant. In Column 3, a one-percentage-point increase in resource revenues offsets non-resource taxes by about 0.17 percentage points (similarly to our preferred specification in Column 5 of Table 5). Column 5 is a preferred specification relative to Column 3, given that we account for the possible impact of global shocks in the case of the former. Column 5 shows a reduced eviction effect of resource revenues on non-resource taxes of about 0.12 percentage points in the medium term, while accounting for multiple endogenous variables. Below, we discuss a number of conditions within a country that could drive the observed negative relationship.

First, a government's attempt to take advantage of a new find or commodity boom by introducing new taxes in the form of, say, a windfall tax (Deaton and Miller 1995) or a tax on investment may have unintended consequences. If not properly designed and applied, the tax regime could scare away potential investors and undermine the quest to promote a business-friendly environment. The situation could also cause the private sector to adopt a wait-and-see attitude, thereby discouraging new investments. Such a development not only affects the resource sector but also undermines the expansion of the non-resource sector and therefore the potential for mobilizing non-resource revenues. Furthermore, austere fiscal regimes have a tendency to promote transfer mispricing, tax evasion, and tax avoidance. Another reason that a displacement effect of resource revenues on non-resource tax effort is plausible could be duality in a tax revenue management system. This would be a situation where different fiscal regimes exist between the resource and non-resource sectors. For instance, developing countries may devote more attention to a new resource sector, where an appropriate fiscal regime might be introduced in a bid to get the most out of the sector. The latter may co-exist with a relatively weaker system in the non-resource sector (Venables 2016). Revenue performance may vary between the two sectors as a result, with the non-resource sector getting less attention. In the case of developing countries, this would be partly due to structural challenges relating to informality and productivity in the wider non-resource sector.

Additionally, a boom in natural resource rents could inform a public policy decision to transfer these rents to the private sector through subsidies or generous tax incentives. In some instances, new companies are provided with generous incentives in advance of production in order to recover costs already expended. In the short term, this could dampen non-resource revenues. The situation of low non-resource tax revenues can persist if the binding constraints within the non-resource sector are of a kind that go beyond providing generous tax incentives. Nakyea and Amoh (2018) use Ghana as a case study to demonstrate how generous tax incentives do not necessarily translate into increased flows of foreign direct investment (FDI) while rather reducing the domestic revenue potential of a resource-rich country. An incumbent government might also provide generous tax incentives using resource rents, rather than broadening the tax base, as a way of avoiding citizens' demands for accountability (Fjeldstad and Moore 2008; Moore 2007; Ossowski and Gonzales 2012).

Apart from the tax policy effects described above, there could also be a tax capacity effect. The theoretical argument is articulated by Besley and Persson (2013). In a country with a constrained human resource base, a booming resource sector attracts talent (highly skilled human capital) away from the non-resource sector. This leaves the human resource base in the non-resource sector severely constrained and diminished. Among institutions that suffer from the effect of human resource movement are the state revenue authorities. During resource booms, domestic revenue institutions are sometimes reorganized to suit various purposes. As indicated earlier, one reason could be to maximize resource revenues. There are also instances where resource booms birth a new resource politics. For instance, Chaudhry's work traces Saudi Arabia's development of tax capacity before and after the oil boom in the 1970s (Chaudhry 1997; Knack 2009). The trajectory of improvement in tax capacity between 1930 and 1973 took a different turn when several billions of dollars in oil revenue began to accrue to the government. The boom was triggered by the quadrupling of international oil prices in 1973. As a policy response, most of the offices of the Department of Zakat (religious tithe) and Income Tax were closed during these boom years. The Yemeni government followed a similar path in dismantling a key part of its fiscal infrastructure. When oil prices plummeted in the early 1980s, both governments had to resort to inefficient and austere policies, including retroactive taxation, which could not be sustained (Chaudhry 1997). Lim (1988) also notes that resource-rich countries usually have poor capacity to collect taxes.

However, the explanations so far reveal however only local factors within an economy. This presents only a limited scope to attempts to understand the fiscal resource curse. For instance, Poelhekke and van der Ploeg (2013) find that FDI flows into the natural resource sector of resource-rich countries displace FDI to the non-resource sector. This effect is seen not only when a non-resource country discovers natural resources but also during price booms in countries that already have a natural resource sector (van Der Ploeg and Poelhekke 2017). Thus, in practice, countries are exposed to various geopolitical and economic dynamics, sometimes foreign-born, that impact on what happens to their fiscal capacity within their territories.

In the next section, we explore the role of China's rise in natural resource trade in the aftermath of its accession to the WTO in 2001. This approach accounts for a very important factor in natural resource trade that has not been expressly or adequately accounted for in the fiscal resource curse literature.

4.4 A 2SLS instrumental variable approach: Global sample

We construct and deploy a variant of the China shock as an instrument for the main explanatory variable, resource revenues as a percentage of GDP. China shock represents an interaction term between two variables: China's non-renewable resource imports (fuels, ore, and metals) as a percentage of GDP and a time dummy reflecting China's accession to the WTO. The WTO period dummy takes a value of one for all periods after 2001 and a value of zero otherwise. The variable 'China_Resimp' refers to China's non-renewable resource imports as a percentage of GDP, one of the constituents of the interaction term. Columns 1 to 4 of Table 7 presents the first-stage regression results with the full list of control variables. This includes specification with or without WTO time dummies. Columns 1 and 3 specify China shock as the only instrument for resource revenues as a percentage of GDP, while Columns 2 and 4 include 'China_Resimp' as an additional instrument. We provide the results of validity tests for the instruments.

In the first-stage regression, the coefficients on the instruments turn positive and statistically significant at conventional levels across all four specifications. A test of validity of the instrument for the just-identified restrictions specified in Columns 1 and 3 of Table 4 produces F-values of 4.84 and 19.14 respectively. In Columns 2 and 4, the test for joint validity of instruments yields F-values of 8.26 and 23.43 respectively.

Table 7: First-stage regression: Global sample

Dependent variable: Resource revenues as a percentage of GDP				
	(1)	(2)	(3)	(4)
Variables				
China shock	0.184**	0.741***	0.427***	1.171***
	(0.084)	(0.202)	(0.098)	(0.296)
China_Resimp		−0.680***		−1.325***
		(0.254)		(0.308)
corrupt	−0.289*	−0.097	−0.508***	−0.310*
	(0.168)	(0.190)	(0.184)	(0.187)
Log GDP per capita	−2.439*	−2.144	−2.213*	−1.456
	(0.168)	(1.306)	(1.273)	(1.321)
agricval2GDP	−0.351***	−0.352***	−0.361***	−0.371***
	(0.056)	(0.571)	(0.057)	(0.059)
WTOtime			−1.833***	−3.317***
			(0.505)	(0.635)
[Joint] F-test	4.84	8.26	19.14	23.43
Country effect	Yes	Yes	Yes	Yes
Observations	1,025	1,025	1,025	1,025
R-squared	0.816	0.885	0.920	0.924
No. of countries	66	66	66	66

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Grant and trade variables are 'partialled out' in order to obtain the full covariance matrix of orthogonal conditions necessary for an efficient estimator as well as subsequent overidentification tests. The effect of their inclusion on the coefficients above is preserved.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

In general, specifications with F-values above the benchmark of 10 are preferable, as they are relatively more robust (Stock et al. 2002). This is the case for the specifications in Columns 3 and 4 of Table 7. However, even with positive F-values below 10 in just-identified models, weak instruments need not be dismissed. The conditions that need to be satisfied are as follows: the coefficient of the instrument at the first stage is not zero, is statistically significant at conventional levels, and is of the expected sign (Angrist and Pischke, 2008, 2009). The effect of weak instruments translates to larger standard errors at the second stage. The estimated effect, however, remains unbiased.

The second-stage regression results corresponding to the first-stage regression in Table 7 are displayed in Columns 1 to 4 of Table 8. Like Table 7, Table 8 makes use of the full sample of countries with available data as well as the full list of controls. Except in the fourth column, the second-stage regression estimates show positive coefficients across all specifications on the effect of resource revenues on non-resource taxes, once we account for the China shock. The effects, however, turn out to be statistically insignificant at conventional levels across all four specifications. Thus, the hypothesis that China's resource trade after entry into the WTO might have had a positive impact on resource-exporting countries, on average, through the positive effect on tax revenues from the non-resource sector is not supported by the evidence, using a global sample. While the results may be attributed to the strength of our instrument, a more plausible explanation would be the sample of countries under consideration. Developed countries have diversified their economies away from the traditional natural resource sector. This is also the case for an increasing number of emerging economies. These countries rely less on natural resources for their development and therefore have weak links with China as far as resource trade is concerned. China's influence on the global trade in natural resources is felt much more among developing regions in SSA, Latin America, and Asia (Alemayehu 2018; Lin and Wang 2016;

Vasquez 2018). The resource sector often forms the lion's share of the export sector as well as the total revenue envelope of these economies. China's entry into the WTO and resource imports is thus likely to be felt more in these economies.

Table 8: Second-stage regression: Global sample

Dependent variable: Non-resource tax as a percentage of GDP				
	(1)	(2)	(3)	(4)
Variables				
tot_resrev	0.620	0.307	0.000755	−0.0706
	(0.428)	(0.207)	(0.135)	(0.122)
Corrupt	0.598**	0.439**	0.522***	0.482***
	(0.260)	(0.193)	(0.171)	(0.156)
Log GDP per capita	4.382***	3.959***	2.765***	2.679***
	(0.998)	(0.741)	(0.553)	(0.555)
agricval2GDP	0.290*	0.176*	0.0770	0.0509
	(0.153)	(0.0898)	(0.0625)	(0.0641)
WTOtime			0.859***	0.847***
			(0.276)	(0.263)
Country effect	Yes	Yes	Yes	Yes
China shock1	Yes	Yes	Yes	Yes
China_Resimp	No	Yes	No	Yes
Observations	1,025	1,025	1,025	1,025
R-squared	0.816	0.885	0.920	0.924
No. of countries	66	66	66	66

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Grant and trade variables are 'partialled out' in order to obtain the full covariance matrix of orthogonal conditions necessary for an efficient estimator as well as subsequent overidentification tests. The effect of their inclusion on the coefficients in the model is preserved.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

We test the above hypothesis in the following sections, beginning with the exclusion of a set of outliers. First, we drop a set of developed countries which are classified as among the highest per capita income earners in the global sample used for the estimations in Tables 7 and 8. The list of countries includes USA, Norway, Sweden, Iceland, Netherlands, Luxembourg, Lithuania, and Hong Kong (China).[12]

Columns 1 to 4 of Table 9 present the first-stage regression. Once again, the coefficient on the instruments turns out positive and statistically significant at conventional levels. China's resource imports have a positive effect on resource revenues, holding other factors constant. The F-test for validity of the instruments remain consistently positive and above the benchmark level of 10 for Columns 3 and 4 of Table 10.

[12] Hong Kong is politically part of China; however, the structure of its economy is distinct from that of the mainland. Consequently, several data sources separate data on Hong Kong from those on mainland China.

Table 9: First-stage regression (excluding the set of advanced economies)

Dependent variable: Resource revenues as a percentage of GDP				
	(1)	(2)	(3)	(4)
Variables				
China shock1	0.163*	0.760***	0.473***	1.762***
	(0.095)	(0.218)	(0.116)	(0.3)
China_Resimp		−0.724***		−1.335***
		(0.272)		(0.311)
Corrupt	−0.326**	−0.116	−0.596***	−0.371*
	(0.176)	(0.20)	(0.194)	(0.199)
Log GDP per capita	−2.403**	−2.088	−2.146	−1.410
	(1.355)	(1.383)	(1.340)	(1.380)
agricval2GDP	−0.350***	−0.349***	−0.361***	−0.367***
	(0.056)	(0.057)	(0.057)	(0.059)
WTOtime			−2.311***	−3.70***
			(0.586)	(0.683)
[Joint] F-test	2.92	6.8	16.83	21.99
Country effect	Yes	Yes	Yes	Yes
Observations	882	882	882	882
R-squared	0.816	0.885	0.920	0.924
No. of countries	58	58	58	58

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Grant and trade variables are ‘partialled out’ in order to obtain the full covariance matrix of orthogonal conditions necessary for an efficient estimator as well as subsequent overidentification tests. The effect of their inclusion on the coefficients above is preserved.

Source: authors’ construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

All coefficients in the second stage are positive, although statistical significance is only realized in the second column of Table 10. What becomes obvious, though, is that the negative relationship between resource revenues and non-resource tax effort is not sustained once we account for China’s role in global natural resource trade. Moreover, the fact that there are still several high-income countries in the sample warrants further investigation. In the next section, we consider a more systematic approach by restricting the global sample to the World Bank’s definition of developing countries, as a first step. Next, we examine the role of the China shock for LICs and LMICs. These restricted samples are defined on the basis of the World Bank’s income classification of countries in 2017.

Table 10: Two-stage least squares approach: Second stage (excludes a set of advanced economies)

Dependent variable: Non-resource tax revenue as a percentage of GDP				
	(1)	(2)	(3)	(4)
Variables				
tot_resrev	1.257	0.618**	0.0802	0.0399
	(0.867)	(0.285)	(0.143)	(0.124)
corrupt	0.938**	0.610**	0.721***	0.695***
	(0.449)	(0.259)	(0.185)	(0.170)
Log GDP per capita	5.750***	4.806***	2.765***	2.721***
	(1.670)	(1.022)	(0.609)	(0.607)
agricval2GDP	0.543*	0.312***	0.139**	0.124*
	(0.299)	(0.118)	(0.0655)	(0.0654)
WTOtime			1.419***	1.401***
			(0.315)	(0.285)
Hansen J (P-value)		0.191		0.772
Country effect	Yes	Yes	Yes	Yes
China shock1	Yes	Yes	Yes	Yes
China_Resimp	No	Yes	No	Yes
Observations	882	882	882	882
R-squared	0.415	0.758	0.894	0.898
No. of countries	58	58	58	58

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Grant and trade variables are 'partialled out' in order to obtain the full covariance matrix of orthogonal conditions necessary for an efficient estimator as well as subsequent overidentification tests. The effect of their inclusion on the coefficients above is preserved.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

4.5 A 2SLS instrumental variable approach: Developing countries

Tables 11 to 14 depict results on the role of the China shock in developing economies. Specifically, Tables 11 and 12 explore the case for all developing economies in the sample. The model specifications in Columns 1 through 4 are maintained as previously.

The coefficient on the interaction term between China's resource imports and the WTO time dummy (i.e. China shock) is positive across all specifications, as expected. The effect is statistically significant at conventional levels for the specifications in Column 3 and 4 only. The latter are also characterized by F-values of 14.04 and 14.17 respectively, exceeding the minimum benchmark. The F-values for Columns 1 and 2 are positive but much lower: 0.81 and 1.36 respectively. The result further demonstrates the drawback of restricting the model in Columns 1 and 2.

Table 11: First-stage regression: Developing countries

Dependent variable: Resource revenues as percentage of GDP				
	(1)	(2)	(3)	(4)
Variables				
China shock1	0.101	0.377	0.540***	1.577***
	(0.112)	(0.259)	(0.144)	(0.364)
China_Resimp		−0.338		−1.071***
		(0.332)		(0.379)
corrupt	−0.315	−0.219	−0.771***	−0.633**
	(0.219)	(0.251)	(0.256)	(0.258)
Log GDP per capita	−1.384	−1.235	−1.397	−0.928
	(1.709)	(1.748)	(1.652)	(1.684)
agricval2GDP	−0.334***	−0.333***	−0.354***	−0.358***
	(0.0565)	(0.0570)	(0.0586)	(0.0599)
WTOtime			−3.199***	−4.366***
			(0.727)	(0.847)
[Joint] F-test	0.81	1.36	14.04	14.17
Country effect	Yes	Yes	Yes	Yes
Observations	633	633	633	633
No. of countries	45	45	45	45

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Grant and trade variables are 'partialled out' in order to obtain the full covariance matrix of orthogonal conditions necessary for an efficient estimator as well as subsequent overidentification tests. The effect of their inclusion on the coefficients above is preserved.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

The low F-values in Columns 1 and 2 of Table 11 are mirrored in Table 12, which shows that the coefficients for those specifications are imprecisely estimated. The lack of precision of the model in Columns 1 and 2 of Table 12 is also reflected in the R-squared falling below the zero bound. Thus, the coefficient on resource revenues is positive but not statistically significant at conventional levels for both columns. Despite passing the instrument validity test, the just-identified model in Column 3 of Table 12 retains large standard errors. The coefficient on resource revenues is therefore not statistically significantly different from zero at conventional levels, although it retains a positive sign. The most precisely specified model, in Column 4, of Table 12 passes both the instrument validity test and the Hansen J test of overidentifying restrictions with a P-value of 0.41. The instrumented coefficient of interest turns statistically significant at the 10 per cent level. The result suggests a positive effect of the resource revenues on non-resource tax revenue mobilization effort in developing countries, once the China shock is accounted for.

Table 12: Second-stage regression: Developing countries

Dependent variable: Non-resource tax revenue as a percentage of GDP				
	(1)	(2)	(3)	(4)
Variables				
tot_resrev	1.440	1.422	0.139	0.267*
	(1.818)	(1.040)	(0.159)	(0.158)
corrupt	0.901	0.894	0.628***	0.718***
	(0.751)	(0.610)	(0.208)	(0.227)
Log GDP per capita	4.591**	4.576**	2.794***	2.796***
	(2.170)	(2.185)	(0.720)	(0.854)
agricval2GDP	0.582	0.576	0.153**	0.199***
	(0.589)	(0.353)	(0.0680)	(0.0740)
WTOtime			0.954**	1.089***
			(0.382)	(0.365)
Hansen J (P-value)		0.99		0.41
Country effect	Yes	Yes	Yes	Yes
China shock	Yes	Yes	Yes	Yes
China_Resimp	No	Yes	No	Yes
Observations	633	633	633	633
R-squared	−0.081	−0.060	0.837	0.804
No. of countries	45	45	45	45

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Grant and trade variables are 'partialled out' in order to obtain the full covariance matrix of orthogonal conditions necessary for an efficient estimator as well as subsequent overidentification tests. The effect of their inclusion on the coefficients above is preserved.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

Tables 13 and 14 further restrict the sample of countries to a combination of LMICs and LICs only. Table 13 presents the first-stage regression results. The model specification is consistent with those used in previous tables. Unlike for the full developing-countries sample, the coefficient on the instruments turns out statistically significant at conventional levels across all specifications for the sample of LMICs and LICs. Once again, the validity tests suggest that the models in Columns 3 and 4 of Table 13 are better specified. The F-values are 9.88 and 9.34 respectively.

Table 13: First-stage regression: LMICs and LICs

Dependent variable: Resource revenues as a percentage of GDP				
	(1)	(2)	(3)	(4)
Variables				
China shock	0.275*	0.668**	0.585***	1.459***
	(0.150)	(0.277)	(0.186)	(0.436)
China_Resimp		−0.464		−0.884*
		(0.393)		(0.456)
corrupt	−0.173	−0.0415	−0.419	−0.267
	(0.326)	(0.345)	(0.352)	(0.342)
Log GDP per capita	−5.053***	−5.004***	−4.809***	−4.618**
	(1.816)	(1.825)	(1.797)	(1.814)
agricval2GDP	−0.315***	−0.312***	−0.324***	−0.322***
	(0.0585)	(0.0593)	(0.0600)	(0.0609)
WTOtime			−2.167***	−3.037***
			(0.773)	(0.960)
[Joint] F-test	3.38	5.43	9.88	9.34
Country effect	Yes	Yes	Yes	Yes
Observations	346	346	346	346
No. of countries	26	26	26	26

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Grant and trade variables are ‘partialled out’ in order to obtain the full covariance matrix of orthogonal conditions necessary for an efficient estimator as well as subsequent overidentification tests. The effect of their inclusion on the coefficients above is preserved.

Source: authors’ construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

The corresponding second-stage regression results in Table 14 show a positive coefficient on resource revenues. However, the effect is not statistically significant except in the case of our most preferred specification in the fourth column, where the coefficient on resource revenues turns statistically significant at the 10 per cent level. GDP per capita remains statistically significant at the 1 per cent level across all specifications, indicating that it is an important determinant of non-resource tax effort. The coefficients of the remaining covariates in Table 14 are not statistically significantly distinguishable from zero. The key result suggests that, once we account for the China shock, a one-percentage-point increase in resource revenues augments non-resource tax revenues by about 0.3 percentage points. This effect, however, is statistically modest given its significance at the 10 per cent level. The observed positive relationship between resource revenues and non-resource tax effort on the back of the exogenous shock to the global natural resource trade after year 2001 deserves further deliberation.

The IMF’s (2016) World Economic Outlook aptly summarized the effect of China’s influence on commodity trade following its accession to the WTO. Global commodity prices reacted significantly, leading to higher resource revenues in boom periods. Two key regions that have benefited from China’s natural resource imports are Africa and Latin America, mostly dominated by LMICs and LICs. In these regions, China’s engagement has been characterized by natural resource trade deals that do not necessarily amount to liquid capital flows. The resource trade relationship has evolved to an exchange that compensates for financial market and governance challenges in developing countries, while allowing for real sector diversification in resource-rich countries (Halland et al. 2014; Lin and Wang 2016). This has taken the form of resource-for-infrastructure deals. In essence, China provides for critical infrastructure needs in exchange for natural resources.

Table 14: Second-stage regression for LMICs and LICs

Dependent variable: Non-resource tax revenue as a percentage of GDP				
	(1)	(2)	(3)	(4)
Variables				
tot_resrev	0.0842	0.322	0.100	0.303*
	(0.281)	(0.213)	(0.179)	(0.175)
corrupt	−0.141	−0.0318	−0.142	−0.0579
	(0.205)	(0.248)	(0.210)	(0.241)
Log GDP per capita	2.548***	3.323***	2.633**	3.333**
	(0.930)	(0.870)	(1.051)	(1.289)
agricval2GDP	0.0267	0.107	0.0316	0.0997
	(0.0915)	(0.0702)	(0.0668)	(0.0693)
WTOtime			−0.0309	−0.0673
			(0.386)	(0.444)
Hansen J (P-value)		0.264		0.234
China shock	Yes	Yes	Yes	Yes
China_Resimp	No	Yes	No	Yes
Country effect	Yes	Yes	Yes	Yes
WTO time dummy	No	No	Yes	Yes
Observations	346	346	346	346
R-squared	0.805	0.736	0.802	0.743
No. of countries	26	26	26	26

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Grant and trade variables are 'partialled out' in order to obtain the full covariance matrix of orthogonal conditions necessary for an efficient estimator as well as subsequent overidentification tests. The effect of their inclusion on the coefficients above is preserved.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), and PRS Group (2015).

Conventional FDI from China pales in comparison with credit lines as part of the resource-for-infrastructure deals (Alemayehu 2018). China has offered special 'loans' and projects through its main lending arm, China Exim Bank. These are usually variants of a barter trade which involves exchange of natural resources for infrastructure projects.[13] Since 2007, over US$140 billion in Chinese loans has reached the shores of Latin America to meet investment needs in either transport or energy infrastructure (Vasquez 2018). By 2006, China's investment in Africa's infrastructure had jumped from about US$1 billion per annum to $7 billion per annum, falling slightly to $4.5 billion in 2007 (Foster et al. 2009). Data from the Infrastructure Consortium for Africa (ICA) suggest that China is the leading creditor for infrastructure projects in Africa (ADB Group 2016). These investments cover the areas of energy, transport, water, and information and communication technology. Countries such as Nigeria, Angola, Ethiopia, and Sudan have been the largest beneficiaries. More than 35 countries including the Democratic Republic of the Congo and Ghana continue to benefit from such deals (Foster et al. 2009). The upshot is that China is leveraging its massive capacity in infrastructure provisioning to ease binding constraints facing many developing countries.

[13] Zongwe (2010), however, argues that these natural resource deals bear the features of an investment contract and not trade deals. Per this view, investment contracts depict a long-lasting partnership that could endure for decades.

Lin and Wang (2016) describe resource-for-infrastructure investments as 'bottleneck-releasing' and a means to 'crowd-in funding'. Various studies suggest that infrastructure gaps remain among key binding constraints on firm growth and productivity in developing countries (Abeberese 2019; Akpandjar and Kitchens 2017; Allcott et al. 2016). The provision of transport and energy (electricity) infrastructure releases bottlenecks, significantly driving down transaction costs and potentially increasing revenues. Moreover, countries with better infrastructure are more likely to attract investment, a crowding-in factor that can also trigger a multiplier effect. The tendency towards capital flight is reduced and future decision-makers have a default commitment mechanism for accumulating assets (Halland et al. 2014). Therefore, the resource-for-infrastructure trade model has potential for leveraging infrastructure development as a means of expanding the non-resource sector and the non-resource taxable base and, by extension, improving the level of non-resource taxes mobilized.

Our key result in Table 14 conveys the message that the benefits of a thriving natural resource sector need not displace domestic tax revenues in the non-resource sector. The role of infrastructural development through natural resource trade is key to this result. The modesty that should go with the interpretation of our result lies in the following: first of all, it would be naïve to expect that China's resource trade model would automatically convey positive benefits in terms of non-resource tax outcomes in every case. The Chinese resource trade model is not equal in size and scale among the developing countries in our sample. While the number of countries partnering with China has been increasing, the majority of transactions have been concentrated in a few countries. Moreover, concerns have been raised about the nature of contracts, alongside how they are implemented. Transparency around these contracts is an issue that has been raised by civil society organizations, while some governments have described it as debt-trap diplomacy. The risk to infrastructure projects of opaque contracts is that there is a greater likelihood of their revocation or review if new governments that take over power in these countries feel dissatisfied. Examples of this have already been witnessed in countries such as Malaysia.

Another concern that has emerged is the fact that, in some countries, bidding for contracts is dominated by Chinese companies to the detriment of local content and broader participation. An oft-cited example is the Angola model. A resource-for-infrastructure deal was struck between China and Angola in 2004 following decades of conflict in the latter, which ended in 2002. This was at a time when traditional donors such as the OECD, World Bank, and IMF were hesitant to lend to Angola given its post-conflict status (Zongwe 2010). Angola benefited from about US$4.5 billion in post-conflict infrastructure investment, exporting thousands of barrels of oil per day to China in return (Zongwe 2010). About 30 per cent of the project was subcontracted to local companies, although there are claims that some of these local companies were jointly owned with the Chinese. The cost of borrowing under the resource-for-infrastructure deal has also been raised as important for the borrowing countries. There is a fear that countries risk running into a debt crisis under these deals. Finally, concerns about the quality of some of the infrastructure raises the importance of project monitoring and evaluation towards ensuring the best value for money.

4.6 Further robustness checks for baseline model (Equation 8)

Despite the analysis in the preceding sections, a concern can be raised about the validity of the baseline model specified in Equation 8. A question arises as to whether the relationship between resource revenues and non-resource tax effort can be non-linear. Additionally, one might wonder whether introducing other control variables could affect the results. To check the robustness of the estimates from our base model, first, we investigate whether there is a non-linear relationship between resource revenues and non-resource tax effort. The result is presented in Column 1 of Table 15. From Columns 2 to 5 of Table 15, we include a list of control variables additional to our base model. We examine the sensitivity of our results to the inclusion of these additional control variables: quality of political institutions, constraint of the executive, inflation, and population.

Table 15: Robustness checks with non-linear term and alternative covariates

Dependent variable: Non-resource tax as a percentage of GDP					
	(1)	(2)	(3)	(4)	(5)
Variables	FEE	FEE	FEE	FEE	FEE
tot_resrev	−0.295***	−0.178***	−0.178***	−0.127*	−0.187***
	(0.104)	(0.0514)	(0.0516)	(0.0636)	(0.0436)
c.tot_resrev#c.tot_resrev	0.00287*				
	(0.00166)				
grants	−0.00181	0.00882	−0.000956	0.0530	0.0798
	(0.0934)	(0.0915)	(0.0919)	(0.0995)	(0.0950)
corrupt	0.577	0.443	0.439	0.841**	0.535
	(0.398)	(0.465)	(0.436)	(0.362)	(0.370)
agricval2GDP	−0.00251	−0.0256	−0.0255	−0.00720	−0.00427
	(0.0799)	(0.0754)	(0.0751)	(0.0725)	(0.0748)
Log GDP per capita	2.324	1.878	1.829	3.509**	4.384***
	(1.488)	(1.472)	(1.447)	(1.712)	(1.583)
trade2GDP2	0.00484	−0.0107	−0.0111	0.00480	0.0139
	(0.0120)	(0.00899)	(0.00879)	(0.0126)	(0.0137)
polity2		−0.00771			
		(0.0674)			
exconst			0.00925		
			(0.00785)		
lncpi				−0.577	
				(0.498)	
lnpop					12.69***
					(3.624)
Country effect	Yes	Yes	Yes	Yes	Yes
Time effect	Yes	Yes	Yes	Yes	Yes
Observations	1,069	978	978	973	1,069
R-squared	0.195	0.166	0.168	0.204	0.272
Number of id	66	62	62	65	66

Notes: robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Source: authors' construction based on ICTD-GRD data, World Bank (2017), Marshall et al. (2016), and PRS Group (2015).

The augmented specifications in Columns 1 to 5 of Table 15 compare favourably with the baseline results in Tables 4 and 5, despite the inclusion of a squared term of the explanatory variable as well as the inclusion of additional covariates in Table 15. In Column 1 of Table 15, the squared term of the resource revenue variable turns statistically significant at the 10 per cent level, although the magnitude is close to zero. We evaluate the point at which the effect of resource revenue on non-resource tax effort turns positive. The effect of resource revenues on non-resource tax effort is given by

$$\frac{\partial(R^{NR}/Y)_{it}}{\partial(R^{RR}/Y)_{it}} = -0.295 + 2(0.00287)\left(\frac{R^{RR}}{Y}\right)_{it} \tag{9}$$

The effect of resource revenues on non-resource tax effort at the sample mean (of resource revenues) becomes $-0.295 + 0.00574(6.3) = -0.258$, which is negative. At the turning point, however, Equation 9 turns to zero. Thus,

$$\frac{\partial(R^{NR}/Y)_{it}}{\partial(R^{RR}/Y)_{it}} = -0.295 + 0.00574\left(\frac{R^{RR}}{Y}\right)_{it} = 0 \text{ and } \left(\frac{R^{RR}}{Y}\right)_{it} = 51.39.$$

This result suggests that beyond a resource revenue to GDP level of 51.39 per cent, the effect of resource revenue on non-resource tax effort turns positive. For this level of resource revenue as a percentage of GDP, there are only five countries in the sample that qualify: Saudi Arabia, Libya, Timor-Leste, Kuwait, and Qatar. These countries are also mostly outliers in the sample. Thus, evidence of a non-linear relationship between resource revenues and non-resource tax effort is not robust. Furthermore, the coefficients of resource revenues as captured in Columns 2 to 5 of Table 15 are not qualitatively different from the random-effects and fixed-effects estimates in Table 4. The only additional control variable in the new set of specifications which turns out statistically significant is population, which is positively associated with non-resource tax effort. In effect, a larger population is positively correlated with a higher potential for mobilizing non-resource tax revenues. Thus, we can conclude that the evidence of a non-linear relationship between resource revenues and non-resource tax effort is not strong. Our linear specification in Equation 8 is therefore appropriate (see also Bornhorst et al. 2009).

Next, there is the concern that normalizing non-resource taxes with GDP is problematic. The argument is that changes to GDP arising from, say, increases in natural resource production diminish our dependent variable automatically and thus bias our parameter estimates (Bornhorst et al. 2009; Thomas and Treviño 2013).[14] An approach suggested in the literature is to normalize non-resource taxes and resource revenues with non-resource GDP and resource GDP respectively. There are severe limitations to the suggested approach. First, non-resource GDP, or resource GDP, for that matter, is generally difficult to measure precisely, over time, and across countries. Comparable data across countries is only now emerging. Additionally, normalizing non-resource taxes and resource revenues with non-resource GDP and resource GDP respectively is not consistent with the standard definition of a tax base (Thomas and Treviño 2013). Furthermore, whether this normalization approach is used or not hardly affects the main findings of available studies that consider this issue (Bornhorst et al. 2009; Thomas and Treviño 2013).

5 Conclusion

In this empirical paper, we investigate the validity of a variant of the fiscal resource curse—the idea that countries that have non-renewal natural resources perform poorly in mobilizing non-

[14] It is noteworthy that we normalize both the dependent variable and the explanatory variable by GDP. As a result, if the numerators increase by the same proportion as the denominators, the resulting ratio is unchanged. Furthermore, the base model controls for GDP per capita.

resource taxes. In effect, we examine whether natural resource revenues displace non-resource tax effort. The study uses a new global dataset on resource and non-resource revenues developed by the International Centre for Taxation and Development and currently hosted by UNU-WIDER. With data covering over a hundred countries for the period 1980 to 2015, we test for both static and dynamic relationships between resource revenues and non-resource tax effort using panel econometric techniques. What is novel in this study is that we exploit a variant of the so-called China shock within a 2SLS instrumental variable framework to explore the relationship. We define the China shock as our exogenous instrument, which interacts China's total non-renewable natural resource imports as a percentage of GDP with a time dummy that indicates the country's active participation in global trade after 2001, when the country joined the WTO. China's global resource trade model is characterized by so-called resource-for-infrastructure deals. Basically, China provides infrastructure in lieu of non-renewable natural resource exports from developing countries. Our identification strategy stems from the fact that China's global demand for natural resource imports constituted a global trade shock following its accession to the WTO. This transition has been unrelated to non-resource tax effort in developing countries.

Our results suggest that the evidence of a displacement effect of natural resource revenues on non-resource tax effort is not consistent, conclusive, or a *fait accompli*, once one accounts for the China shock. We find that, after assuming membership of the WTO, China's natural resource trade strategy with developing countries may have conferred some positive benefits on non-resource tax effort. In some specifications, we find that a one-percentage-point increase in non-renewable natural resource revenues leads to a 0.3 percentage point increase in non-resource tax revenues as a percentage of GDP. The evidence is statistically significant only at the 10 per cent level and hence must be interpreted with caution. Through resource-for-infrastructure deals, China's investment in critical social and economic infrastructure may have contributed to improving the environment for doing business and expanding the non-resource tax base in resource-rich developing countries. The effect of these infrastructure investments in LICs and LMICs may be contributing to reversing the fiscal resource curse.

The Hartwick rule suggests that countries should invest a part of their revenues from natural resources in the development of other forms of capital. Such investment should yield returns, as it contributes to diversifying the economy and expanding the tax base. The prospects of maintaining a smooth tax rate and securing expanded revenue base long after the natural resources are depleted should merit the attention of policy makers.

References

Abeberese, A.B. (2019). 'The Effect of Electricity Shortages on Firm Investment: Evidence from Ghana'. *Journal of African Economies*, 29(1): 46–62. https://doi.org/10.1093/jae/ejz013

ADB Group (2016). *African Economic Outlook 2016: Sustainable Cities and Structural Transformation*. Available at: http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/AEO_2016_Report_Full_English.pdf (accessed 20 August 2019).

Akpandjar, G., and C. Kitchens (2017). 'From Darkness to Light: The Effect of Electrification in Ghana, 2000–2010'. *Economic Development and Cultural Change*, 66(1): 31–54. https://doi.org/10.1086/693707

Alemayehu, G. (2018). 'The Emerging Pattern of African Economic Engagement with China and the Rising South: Implications for Africa's Structural Transformation'. *Journal of African Economies*, 27(suppl_1): i52–i90. https://doi.org/10.1093/jae/ejy014

Allcott, H., A. Collard-Wexler, and S.D. O'Connell (2016). 'How Do Electricity Shortages Affect Industry? Evidence from India'. *American Economic Review*, 106(3): 587–624. https://doi.org/10.1257/aer.20140389

Angrist, J.D., and J.-S. Pischke (2008). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton, NJ: Princeton University Press. https://doi.org/10.2307/j.ctvcm4j72

Angrist, J.D., and J.-S. Pischke (2009). 'A Note on Bias in Just Identified IV with Weak Instruments'. London: London School of Economics.

Arellano, M., and S. Bond (1991). 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations'. *Review of Economic Studies*, 58: 277–97. https://doi.org/10.2307/2297968

Arellano, M., and O. Bover (1995). 'Another Look at the Instrumental Variable Estimation of Error-Component Models'. *Journal of Econometrics*, 68: 29–51 https://doi.org/10.1016/0304-4076(94)01642-D

Asquith, B.J., S. Goswami, D. Neumark, and A. Rodriguez-Lopez (2017). 'US Job Flows and the China Shock'. Working Paper 24080. Cambridge, MA: NBER (National Bureau of Economic Research. https://doi.org/10.3386/w24080

Autor, D.H., D. Dorn, and G.H. Hanson (2016). 'The China Shock: Learning from Labor-Market Adjustment to Large Changes in Trade'. *Annual Review of Economics*, 8(1): 205–40. https://doi.org/10.1146/annurev-economics-080315-015041

Baunsgaard, T., and M. Keen (2010). 'Tax Revenue and (or?) Trade Liberalization'. *Journal of Public Economics*, 94(9–10): 563–77. https://doi.org/10.1016/j.jpubeco.2009.11.007

Besley, T., and T. Persson (2009). 'The Origins of State Capacity: Property Rights, Taxation, and Politics'. *American Economic Review*, 99(4): 1218–44. https://doi.org/10.1257/aer.99.4.1218

Besley, T., and T. Persson (2010). 'State Capacity, Conflict, and Development'. *Econometrica*, 78(1): 1–34. https://doi.org/10.3982/ECTA8073

Besley, T., and T. Persson (2011). *Pillars of Prosperity: The Political Economics of Development Clusters*. Princeton, NJ: Princeton University Press. https://doi.org/10.23943/princeton/9780691152684.001.0001

Besley, T., and T. Persson (2013). 'Taxation and Development'. In A.J. Auerbach, R. Chetty, M. Feldstein, and E. Saze (eds), *Handbook of Public Economics, Volume 5*. https://doi.org/10.1016/B978-0-444-53759-1.00002-9

Besley, T., and T. Persson (2014). 'Why Do Developing Countries Tax So Little?' *Journal of Economic Perspectives*, 28(4): 99–120. https://doi.org/10.1257/jep.28.4.99

Bjornland, H.C., and L.A. Thorsrud (2016). 'Boom or Gloom? Examining the Dutch Disease in Two-Speed Economies'. *Economic Journal*, 126(598): 2219–56. https://doi.org/10.1111/ecoj.12302

Bloom, N., M. Draca, and J. Van Reenen (2016). 'Trade Induce Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity'. *Review of Economic Studies*, 83: 87–117. https://doi.org/10.3386/w16717

Blundell, R., and S. Bond. (1998). 'Initial Conditions and Moment Restrictions in Dynamic Panel Data Models'. *Journal of Econometrics*, 87: 11–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Bond, S.S., A. Hoeffler, and J. Temple (2001). 'GMM Estimation of Empirical Growth Models'. *Economics Letters*, 76(3): 411–17. https://doi.org/10.1016/S0165-1765(02)00083-6

Bornhorst, F., S. Gupta, and J. Thornton (2009). 'Natural Resource Endowments and the Domestic Revenue Effort. *European Journal of Political Economy*, 25(4): 439–46. https://doi.org/10.1016/j.ejpoleco.2009.01.003

Chaudhry, K.A. (1997). *The Price of Wealth: Economies and Institutions in the Middle East*. Ithaca, NY, and London: Cornell University Press.

Clist, P. (2016). 'Foreign Aid and Domestic Taxation: Multiple Sources, One Conclusion'. *Development Policy Review*, 34(3:, 365–83. https://doi.org/10.1111/dpr.12154

Corden, W.M. (1984). 'Booming Sector and Dutch Disease Economics: Survey and Consolidation'. *Oxford Economic Papers*, New Series, 36(3): 359–80. https://doi.org/10.1093/oxfordjournals.oep.a041643

Corden, W.M., and J.P. Neary (1982). 'Booming Sector and De-industrialization in a Small Open Economy'. *The Economic Journal*, 92(368): 825–48. https://doi.org/10.1109/TDEI.2009.5211872

Crivelli, E., and S. Gupta (2014). 'Resource Blessing, Revenue Curse? Domestic Revenue Effort in Resource-Rich Countries'. *European Journal of Political Economy*, 35: 88–101. https://doi.org/10.1016/j.ejpoleco.2014.04.001

Deacon, R.T. (2011). 'The Political Economy of the Natural Resource Curse: a Survey of Theory and Evidence'. *Foundation and Trends in Microeconomics*, 7(2): 111–208. https://doi.org/10.1561/0700000042

Deaton, A., and R. Miller (1995). 'International Commodity Prices, Macroeconomic Performance and Politics in Sub-Saharan Africa'. Princeton Studies in International Finance 79. Princeton, NJ: International Finance Section, Department of Economics, Princeton University.

Fjeldstad, O.-H., and M. Moore (2008). 'Tax Reform and State Building in a Globalized World'. In Brautigam, D., O.-H. Fjeldstad, and M. Moore (eds). *Taxation and State Building in Developing Countries: Capacity and Consent.* In Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511490897.010

Foster, V., W. Butterfield, C. Chen, and N. Pushak (2009). 'Building Bridges: China's Growing Role as Infrastructure Financier for Sub-Saharan Africa'. Trends and Policy Options 5. Washington, DC: World Bank. https://doi.org/10.1596/978-0-8213-7554-9

Gupta, A.S. (2007). 'Determinants of Tax Revenue Efforts in Developing Countries'. IMF Working Paper 07/184. Washington, DC: International Monetary Fund (IMF). https://doi.org/10.5089/9781451867480.001

Gupta, S., and S. Tareq (2008). 'Mobilizing Revenue'. *Finance and Development*, 45(3): 44–47.

Halland, H., J. Beardsworth, B. Land, and J. Schmidt (2014). *Resource Financed Infrastructure: A discussion on a new form of infrastructure financing*. Washington, DC: International Bank for Reconstruction and Development/World Bank. https://doi.org/10.1596/978-1-4648-0239-3

Hausman, J.A. (1978). 'Specification Tests in Econometrics'. *Econometrica*, 46(6): 1251–71. https://doi.org/10.2307/1913827

Holtz-Eakin, D., W. Newey, and H.S Rosen (1988). 'Estimating Vector Autoregressions with Panel Data'. *Econometrica*, 56: 1371–95. https://doi.org/10.2307/1913103

Hu, A.G., and G.H. Jefferson (2009). 'A Great Wall of Patents: What Is Behind China's Recent Patent Explosion?' *Journal of Development Economics*, 90(1): 57–68. https://doi.org/10.1016/J.JDEVECO.2008.11.004

IMF (2016). *World Economic Outlook: Subdued Demand:Symptoms and Remedies*. Washington, DC: International Monetary Fund. Available at: https://www.imf.org/en/Publications/WEO/Issues/2016/12/31/Subdued-Demand-Symptoms-and-Remedies (accessed 21 August 2019).

Jensen, A.D. (2011). 'State-Building in Resource-Rich Economies'. *Atlantic Economic Journal* , 39: 171–93. https://doi.org/10.1007/s11293-011-9269-z

Keen, M., and M. Mansour (2009). 'Revenue Mobilization in Sub-Saharan Africa: Challenges from Globalization' Working Paper 09/157. Washington, DC: IMF. https://doi.org/10.5089/9781451873047.001

Kilian, L., and B. Hicks (2013). 'Did Unexpectedly Strong Economic Growth Cause the Oil Price Shock of 2003–2008?' *Journal of Forecasting*, 32(5): 385–94. https://doi.org/10.1002/for.2243.

Knack, S. (2009). 'Sovereign Rents and Quality of Tax Policy and Administration'. *Journal of Comparative Economics*, 37(3): 359–71. https://doi.org/10.1016/j.jce.2009.04.001

Knebelmann, J. (2017). 'Natural Resources' Impact on Government Revenues'. WIDER Working Paper 10/2017. Helsinki: UNU-WIDER. https://doi.org/10.35188/UNU-WIDER/2017/234-2

Lim, D. (1988). 'Tax Effort and Expenditure Policy in Resource-Rich Countries'. In M. Urrutia and S. Yukawa (eds), *Economic Development Policies in Resource-Rich Countries*. Tokyo: The United Nations University.

Lin, J.Y., and Y. Wang (2016). 'New Structural Economics and Resource Financed Infrastructure'. *Pacific Economic Review*, 21(1): 102–17. https://doi.org/10.1111/1468-0106.12154

Marshall, M.G., T.R. Gurr, and K. Jaggers (2016). *Polity IV Project: Dataset Users' Manual, v. 2015*. Vienna, VA; Centre for Systemic Peace.

Masi, T., A. Savoia, and K. Sen (2018). 'Is There a Fiscal Resource Curse? Resource Rents, Fiscal Capacity and Political Institutions'. ESID Working Paper 96. Manchester: Effective States and Inclusive Development Research Centre, The University of Manchester. https://doi.org/10.2139/ssrn.3123027

McNabb, K. (2017). 'Towards Closer Cohesion of International Tax Statistics'. WIDER Working Paper 184/2017. Helsinki: UNU-WIDER. https://doi.org/10.35188/UNU-WIDER/2017/410-0

Mohtadi, H., M.L. Ross, and S. Ruediger (2016). 'Oil, Taxation and Transparency!' Working paper.

Moore, M. (2007). 'How Does Taxation Affect the Quality of Governance?' IDS Working Paper 280. Brighton: Institute of Development Studies.

Nakyea, A.A., and J.K. Amoh (2018). 'Have the Generous Tax Incentives in the Natural Resource Sector Been Commensurate with FDI Flows? A Critical Analysis from an Emerging Economy'. *International Journal of Critical Accounting*, 10(3/4): 257–73. https://doi.org/10.1504/IJCA.2018.093064

Neary, J.P., and S. van Wijnbergen (1985). 'Natural Resources and the Macroeconomy: A Theoretical Framework'. Centre for Economic Research Working Paper Series 36. Dublin: School of Economics, University College Dublin.

Ossowski, R., and A. Gonzales (2012). 'Manna from Heaven'. IDB Working Paper 337. Washington, DC: Inter-American Development Bank.

Parente, P.M.D.C., and J.M.C. Santos Silva (2012). 'A Cautionary Note on Tests of Overidentifying Restrictions. *Economics Letters*, 115(2): 314–17. https://doi.org/10.1016/J.ECONLET.2011.12.047

Poelhekke, S., and F. van der Ploeg (2013). 'Do Natural Resources Attract Nonresource FDI?' *Review of Economics and Statistics*, 95(3): 1047–65. https://doi.org/10.1162/REST_a_00292

PRS Group (2015). 'Political Risk Services Country Reports: International Country Risk Guide Methodology'. Available at: http://epub.prsgroup.com/products/political-risk-services/country-reports (accessed 20 August 2019).

Pomeranz, D., and J. Vila-Belda (2019). 'Taking State-Capacity Research to the Field: Insights from Collaborations with Tax Authorities'. *Annual Review of Economics*, 11(1): 755–81. https://doi.org/10.1146/annurev-economics-080218-030312

Prichard, W. (2016). 'Reassessing Tax and Development Research: A New Dataset, New Findings, and Lessons for Research'. *World Development*, 80: 48–60. https://doi.org/10.1016/j.worlddev.2015.11.017

Prichard, W., A. Cobham, and A. Goodall (2014). 'The ICTD Government Revenue Dataset'. ICTD Working Paper 19. Brighton: International Centre for Tax and Development. https://doi.org/10.2139/ssrn.2496442

Ramsey, F.P. (1927). 'A Contribution to the Theory of Taxation'. *The Economic Journal*, 37(145): 47–61. https://doi.org/10.2307/2222721

Ricciuti, R., A. Savoia, and K. Sen (2018). 'How Do Political Institutions Affect Fiscal Capacity? Explaining Taxation in Developing Economies'. *Journal of Institutional Economics*, 15(2): 351–80. https://doi.org/10.1017/S1744137418000097

Roodman, D. (2008). 'A Note on the Theme of Too Many Instruments'. Working Paper 125. Washington, DC: Centre for Global Development. https://doi.org/10.2139/ssrn.1101731

Stock, J.H., J.H. Wright, and M. Yogo (2002). 'A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments'. *Journal of Business and Economic Statistics*, 20(4): 518–29. https://doi.org/10.1198/073500102288618658

Thomas, A.H., and J.P. Treviño (2013). 'Resource Dependence and Fiscal Effort in Sub-Saharan Africa'. IMF Working Papers 2013/188. Washington, DC: IMF. https://doi.org/10.5089/9781484391501.001

UNU-WIDER (2017). 'ICTD/UNU-WIDER Government Revenue Dataset (GRD): User Guide, Comparisons & FAQs'. Helsinki: UNU-WIDER.

UNU-WIDER (2019). 'GRD—Government Revenue Dataset'. Helsinki: UNU-WIDER. Available at: https://www.wider.unu.edu/project/government-revenue-dataset (accessed 18 June 2020).

Van der Ploeg, F., and S. Poelhekke (2017). 'The Impact of Natural Resources: Survey of Recent Quantitative Evidence'. *Journal of Development Studies*, 53(2): 205–16. https://doi.org/10.1080/00220388.2016.1160069

Vasquez, P. (2018). 'China, Oil and Latin America: Myth vs. Reality'. Washington, DC: Atlantic Council.

Venables, A.J. (2016). 'Using Natural Resources for Development: Why Has It Proven So Difficult?' *Journal of Economic Perspectives*, 30(1): 161–84. https://doi.org/10.1257/jep.30.1.161

Verbeek, M. (2004). *A Guide to Modern Econometrics* (second edition). Chichester, West Sussex: John Wiley & Sons.

Villafuerte, M., and P. Lopez-Murphy (2010). 'Fiscal Policy in Oil Producing Countries during the Recent Oil Price Cycle'. Working Paper 10/28. Washington, DC: IMF. https://doi.org/10.5089/9781451962536.001

World Bank (2017). *World Development Indicators 2017*. Washington, DC: World Bank. https://doi.org/10.1596/26447

Zongwe, D. (2010). 'On the Road to Post Conflict Reconstruction by Contract: The Angola Model'. *Development Economics eJournal*. https://doi.org/10.2139/ssrn.1730442