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Natural Resources, International Commodity Prices and Economic Performance in Sub-Saharan Africa (1990–2019)

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Abstract

In this paper, we investigate the link between windfall gains and losses of income associated with commodity exports and economic performance in a panel of 45 sub-Saharan African (SSA) countries over the period from 1990 to 2019. Windfall gains and losses of income are measured in terms of fluctuations in a country-specific commodity terms of trade (CTOT) index in which each commodity is weighted by the ratio of exports of that commodity in the country's gross domestic product (GDP). The CTOT index therefore reflects the commodity export specialisation for individual countries. The data on CTOT are taken from the International Monetary Fund. Additionally, we use changes in real GDP per capita as our SSA economic performance measure. We employ a random coefficient model that yields individual estimates for each of the countries included in the analysis. Our approach is based on the assumption that the effect of windfall gains and losses on real GDP per capita growth varies across different SSA countries. Our main conclusion can be elaborated as follows: first, natural resources have undoubtedly contributed to higher economic growth in SSA countries since 1990. Second, when SSA countries are analytically divided into two groups depending on their commodity export specialisation, we find that resource-rich countries—in particular oil rich—are the best economic growth performers during the observation period. Finally, we find that windfall gains from commodity exports are not significantly associated with increased real GDP per capita growth in most agriculture-exporting countries.

Keywords: commodity terms of trade, random coefficient model, resource curse, resource windfalls, sub-Saharan Africa

JEL classification: O13, O55, O57

1. Introduction

Since the early 1990s, sub-Saharan Africa (SSA) has experienced an economic recovery with increased gross domestic product (GDP) alongside improvements in terms of the health and education of children (Young, 2012) and poverty reduction (Pinkovskiy and Sala-i-Martin, 2014). However, a closer look at countries in the region indicates considerable cross-country variations. For example, countries richly endowed with natural resources, in particular oil, have on average experienced higher GDP growth in comparison with their resource-poor counterparts.

This heterogeneity in the growth performance across SSA countries is counter-intuitive given existing robust evidence of a negative association between possession of natural resources such as oil, natural gas or minerals and economic success (Sachs and Warner 2001; Sala-i-Martin and Subramanian, 2012). Windfalls from natural resources have been found to deteriorate the standard of living in SSA (Lee and Gueye, 2015). However, as Mikesell (1997, 192) puts it, 'any explanation for the relatively low performance of resource-abundant countries must be shown to be uniquely characteristic of these countries and have a negative correlation with economic performance (. . .) simply being a resource-abundant country is not a satisfactory answer'.

In fact, theoretical explanations for the potentially harmful effects of natural resource endowments on economic performance cover a range of economic, structural and political factors. For instance, natural resource discoveries and the subsequent rise in national income may weaken efforts to develop effective institutions and economic management. Also, a considerable availability in a territory of certain types of resources that are very valuable, easy to transport and easily sold—such as gold, alluvial diamonds or coltan—can serve as an instigator of armed conflict (Boschini *et al.*, 2013). Moreover, growth in resource-based industries and income might also crowd out other economic sectors, such as agriculture and manufacturing, which have higher linkage effects than primary sectors and are necessary for diversification of the economy and long-term economic growth (Hirschman, 1977). Finally, international commodity markets are unstable and therefore may harm resource exporters due to boom-and-bust cycles.

On the other hand, the same combination of these factors is rarely applicable to all resource-rich countries. This implies that different resource-rich countries can exhibit substantial cross-country heterogeneity. In this vein, it has been established that different types of primary commodities have different effects on the GDP growth rate (Deaton, 1999; Manzano and Rigobon, 2001; Lederman and Maloney, 2007; Brunnschweiler, 2008). Moreover, the economic growth of individual countries can be responsive to common factors such as world-wide shocks or fluctuations in commodity prices. We recognise that SSA countries differ in terms of their commodity exports and, similarly, are affected by unobserved common factors. Therefore, it is essential to investigate whether such factors have influenced the growth experience of SSA countries since 1990. The period after 1990 is believed to have witnessed positive impacts of natural resource abundance on economic growth (Gerelmaa and Kotani, 2016).

The current article investigates the link between the country-specific dimension of global commodity price movements in SSA since 1990 and economic performance. For this purpose, we use the commodity terms of trade (CTOT) index from the International Monetary Fund

(IMF),[1] which measures the composition of a particular country's commodity export basket. The weight of each commodity is given by the share of exports of that commodity in the country's GDP. Hence, variations in CTOT provide an estimate of the windfall gains and losses of income associated with changes in international commodity prices exported by individual countries (Gruss and Kebhaj, 2019). For example, in oil- or mineral-rich countries, variations in CTOT mostly represent the effects of increased (or decreased) earnings from exports of oil or minerals on economic performance. Prior studies have mainly used single-commodity price indices or the share of primary product exports to measure the impact of resource abundance on economic performance.

Moreover, it has been suggested that the effects of commodity price movements on economic performance systematically vary across countries depending on the composition of their exports (Spatafora and Tytell, 2009). For instance, the long-term effects of commodity booms on real GDP growth are more pronounced for oil and minerals exporters in comparison to those of agricultural exporters (Collier and Goderis, 2012). Recently, Ferraro and Peretto (2018) noted that commodity prices and economic growth are correlated in the long run but uncorrelated in the short run. However, no existing studies have examined how SSA countries may differ with respect to the effect of windfall gains or losses on economic performance, especially in the short run.

Our analysis aspires addressing the question of how the contemporaneous relationship between commodity export earnings and economic performance varies across countries, depending on whether they are net oil, minerals or agricultural exporters. For the purposes of our analysis, we define resource-rich countries as those that rely on non-renewable natural resources, namely oil, gas and minerals, for a substantial share of their export earnings. We define resource-poor countries as those that lack such non-renewable resources and instead rely on agricultural products for their export earnings. Our definition therefore divides SSA countries into a resource-rich and a resource-poor group, although we acknowledge that this definition leaves a gray zone of countries that are borderline cases.[2]

We subsequently analyze the relationship between CTOT and economic performance with random coefficient models (RCM) (Swamy, 1970). In fact, RCM allows producing individual regression coefficients for each of the countries included in the analysis. Therefore, it indicates the range of variation in the effects of CTOT on economic performance across countries and when other factors are accounted for. The study relies on an annual panel dataset covering 45 SSA countries and spanning from 1990 through 2019.We find that windfall gains from commodity exports are significantly associated with increased real GDP per capita growth in most resource-rich (in particular oil-rich) countries. However, the size of this relationship is not significant in most countries specialising in agricultural exports.

The remainder of this paper is organised as follows: the second section discusses some theoretical perspectives on the relationship between natural resources and economic performance. This section also sets out to elaborate the hypothesis concerning the difference in

1 The database is available at: https://www.imf.org/en/Research/commodity-prices.

2 There exists no generally accepted definition of when a state should be considered resource rich. For example, the long-standing literature on rentier states provides different estimates about what share of export earnings in national GDP is required to define a country as a rentier state (Elsenhans, 1981; Luciani, 1987).

economic performance between resource-rich (oil and minerals) and resource-poor countries in SSA. Section 3 presents our data and our analytical strategy of singling out a group of 17 resource-rich SSA countries to compare them with 28 other SSA countries considered predominantly agriculture exporting. This strategy helps us highlighting differences in growth rates of the two groups between 1990 and 2019. Sections 4 and 5 further elaborate on our data providing regression analysis and estimations results. Section 6 discusses our empirical findings, namely higher GDP growth rates of the group of resource-rich countries in comparison to the remainder of SSA countries. The conclusion summarises our main ideas and elaborates the implications of our findings.

2. Natural resources and economic performance: conceptual framework and empirical evidence

The resource curse thesis advances the counterintuitive proposition that the presence of natural resources, and in particular of fuels (oil and gas) and minerals, might be harmful for a country's economic development (Auty, 1994; Sachs and Warner, 1995). Specifically, it is claimed that natural resources produce windfall gains for resource-owning states; yet these gains fail to be turned into long-term and growth-generating investments. Instead, states suffer from various unwanted negative results of their resource windfalls and experience in the long run lower rates of economic growth in comparison with states that do not depend on resource endowments for their foreign trade.

Resource-rich and/or resource-dependent countries export natural resources—gifts of nature—to economically advanced industrialised countries and receive payment—royalties, extraction fees, taxes, etc.—that can be classified as a country's rent income once the cost of production has been deduced.[3] Such rent income has historically been more volatile than income from other forms of economic activity in more diversified economies. The absence of diversification means that any downturn in commodity prices must trigger massive cutbacks in the level of government spending with negative impact on the economic performance.

At the same time, one must note that the effects of windfall gains from commodity exports, even temporary ones, on economic growth should not be taken for granted. In fact, there is no universal agreement on the actual properties of the resource curse thesis. For instance, although positive terms-of-trade shocks due to an increase in commodity export prices have a positive effect on the commodity exporters' fiscal balance and revenue ratio (Levy *et al.*, 2020), these gains can be cancelled out through volatility (Joya, 2015; El-Anshasy *et al.*, 2017). Commodity exporters tend to experience negative growth performance during periods of falling commodity prices, compared to commodity importers (Harvey *et al.*, 2017).

More importantly, other studies, such as Yanikkaya and Turan (2018) and Jović *et al.* (2016), have reported the differential effect of different categories of resource rents on economic growth. For instance, countries that specialise in the export of commodities with substantial price volatility have a tendency toward more volatility in their terms of

3 It should be noted that privatization (the selling off of commodity-extracting sectors by state actors) to domestic or international private investors means that state actors might no longer exercise control over rent income. This issue, while relevant, is not discussed further in the present paper.

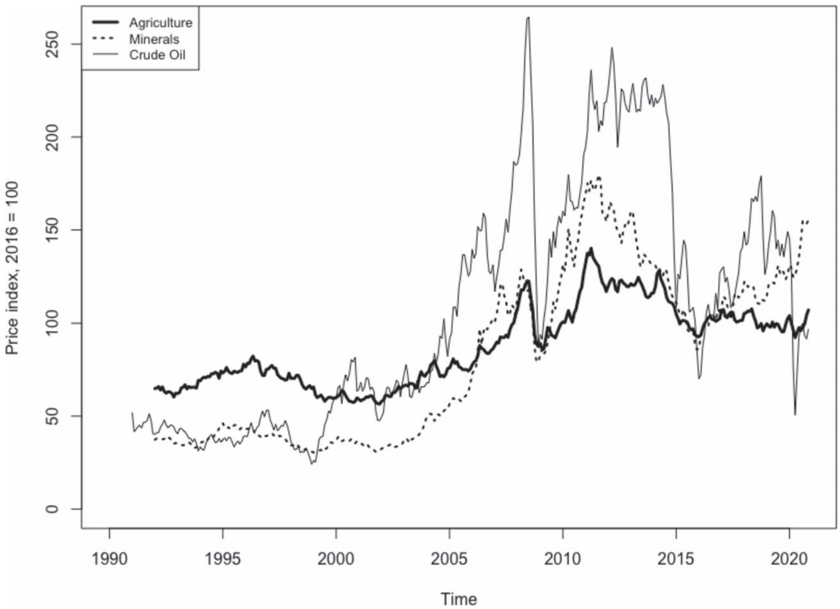

Figure 1: Evolution of the Crude Oil, Minerals, and Agricultural Prices (Index, 2016 = 100) (1990–2020). Source: IMF Primary Commodity Prices, http://www.imf.org/external/np/res/commod/index.aspx. Notes: For agriculture, the price index includes Food and Beverages and Agriculture Raw Materials Price Indices; for minerals, the index is based on Metal Price Index (base metals) and Precious Metals Index; and the price index for crude oil consists of the simple average of three spot prices, namely Dated Brent, West Texas Intermediate and the Dubai Fateh.

trade, which results in economic growth rates of lower magnitude relative to countries that specialise in commodities with more stable prices (van der Ploeg and Poelhekke, 2009).

Thus, movements in international commodity prices may strongly affect the growth performance of SSA countries. Such effects depend on the composition of their primary commodity exports—whether oil, minerals or agricultural. Between 1990 and the early 2000s, prices for oil and minerals were at rather low levels in comparison with agricultural commodities (see Figure 1 for general changes in natural resource prices between 1990 and 2020). Since around 2000, however, oil prices rose substantially before experiencing a dramatic decline in the first quarter of 2008. In comparison, prices for agricultural commodities were fairly stable during the entire period, with the minor exception of a decline following the international financial crisis in 2008 and a subsequent recovery in the first quarter of 2012. In fact, both crude oil and minerals display fairly similar trends over the course of the sample period in comparison with agricultural commodities.

Carmignani and Chowdhury (2007) documented that despite the significantly negative effects of primary commodity exports on the growth performance of SSA countries, not every primary commodity depresses economic growth. They showed that three commodities—cotton, coffee and iron ores—are intrinsically bad for economic growth. On the other hand, oil, cocoa, silver and coal have positive effects on growth, while the effects of other commodities are not significant.

In a similar vein, Aslam *et al.* (2016, 39) concluded that 'despite the upswing in food and raw materials prices in the 2000s, many agricultural commodity exporters did not experience terms-of-trade windfalls given the even stronger surge in their oil import bills'. They also found a particularly strong correlation between output growth and the CTOT trends in exporters of energy and metals.

Previously, Bourguignon (2012) argued that the effects of movements in CTOT on GDP per capita can be more significant for exporters of agricultural commodities than for the mineral [and oil] exporters in two ways. First, the rapid changes in prices of agricultural commodities are more likely to affect the income of the poor. This is because the extraction of most types of minerals and oil involves a very small number of workers and the revenues accrue directly to the state. Agricultural commodities, on the other hand, are more labor intensive and often originate in small farms more vulnerable to poverty. Second, in agriculture-exporting countries, oil is a significant component of import. Therefore, the benefit of an increase in the price of agricultural products can be offset by the increase in oil prices. In such countries, commodity import prices exacerbate budget deficits, thereby hampering economic growth (Levy *et al.*, 2020). High fuel import dependence may depress economic growth through inflationary pressures and deteriorating foreign exchange reserves (International Monetary Fund, 2008; Wodon and Zaman, 2008).

Moreover, rents from different resource types can depress growth through their high potential to serve as an incentive for armed conflict and political instability. A recent meta-analysis based on 46 natural experiments concludes that the effects of commodity prices on conflict vary across commodity types (Blair *et al.*, 2020: 9). Specifically, increases in the price of capital-intensive (i.e., oil) and lootable (i.e., artisanally mined diamonds) commodities increase the likelihood of conflict, while labor-intensive agricultural commodities reduce conflict. In the particular case of SSA countries, the risk of violent conflict has been found to be stronger following downturns in agricultural commodity prices in comparison to oil, gas and minerals (Ciccone, 2018). In the same line, an increase in the price of minerals associated with higher rents (i.e., secondary diamonds, gold and coltan) translates into an increased probability of civil war in SSA countries that possess them (Berman *et al.*, 2017; Rigterink, 2020).

Crucially, it is also instructive to look at the sources of movements in commodity prices and their potential effects on economic fluctuations in resource-exporting countries. Recently, Alquist *et al.* (2020) reported that the primary source of commodity price movements is their endogenous response to global economic factors—i.e., resulting from changes in aggregate economic activity, which affect demands for commodities used to produce final goods. On this particular note, Arezki and Matsumoto (2015) stressed that the demand for natural commodities might be heavily concentrated with particular buyers, such as in the case of minerals with the rapidly expanding demand in Chinese markets. As soon as demand drops in such highly concentrated markets, the fall in prices will be particularly steep. A different case concerns monopolies or near monopolies in certain commodities, such as in the instance of diamonds, which might overdetermine price levels. At least in the case of some minerals, a downturn in global prices might even trigger the closure of local production facilities, which results in the complete disappearance of rent income.

The existing empirical works investigating the impact of commodity prices on economic performance rely on estimators that assume no parameter variations across individual countries based on their commodity export specialisation. Based on the above discussion, we hypothesise a strong positive relationship between windfall gains from natural resource exports and growth among oil (and to a lesser extent minerals) exporters in comparison to countries not specialising in oil and/or minerals.

We make a novel contribution by modelling the cross-country heterogeneity in the association between changes in CTOT and annual variation in GDP per capita in SSA. In particular, we consider that short-term variations in CTOT affect growth in three ways. First, international prices of oil (and to a lesser extent of minerals) are relatively higher in comparison to prices of agricultural products; therefore, in the presence of positive comovements in the price of oil, minerals and agricultural products, exporters of agricultural products—that are also net importers of oil—might experience lower economic growth in comparison to their counterparts exporting oil and minerals.

Second, the magnitude of a country's exports to rapidly growing industrial economies such as China can have implications for the growth performance of SSA commodity exporters. To the extent that SSA's exports to China consist mainly of energy and metals, we hypothesise that the strength of the relationship between movements in commodity prices and growth depends on the country's export size to China, especially for countries specialising in oil and/or agricultural exports. Third, variation in the price of certain commodities, for example, secondary diamonds, gold, coltan, oil or coffee, is more likely to instigate violence, thereby depressing economic growth in countries that possess them (Le Billon, 2013; Gong and Sullivan, 2017).

3. Economic growth of resource-rich and non-resource rich SSA countries since 1990

As pointed out in the previous section, windfall gains from commodity exports, even temporary ones, can trigger economic growth and development depending on the type of commodity a country specialises in. The period since the early 2000s has witnessed large increases in international commodity prices—in particular oil and minerals—implying higher export revenues and rapid economic growth for many SSA countries. It is therefore informative to explore whether the growth experience of resource-rich countries in SSA since 1990, the starting point of our analysis, reflects the changes in international commodity prices.

For our analytical purposes, we start by categorising countries in terms of their export specialisation. As already noted, resource-rich countries are those that specialise in non-renewable natural resource exports (oil, gas and minerals), while resource-poor countries are those that specialise in non-resource exports (in particular, agricultural). This classification is useful for the subsequent analysis, as it will allow for a proper interpretation of our variable of interest, namely CTOT. More specifically, for the resource-rich and resource-poor countries, variations in CTOT will be interpreted as the effect of windfall gains or losses associated with natural resource exports and non-resource exports, respectively.

The sample is split into the two groups based on threshold values of the ratio of the most exported commodity in total merchandise exports. For each country, specialisation is based on the commodity that had the largest share (25% or more) of total merchandise exports to the world during the average of the period 1995–2019 for which data were available.[4] In this analysis, oil and gas exports comprise petroleum oils, oils from bitumen materials, crude and natural gas (whether or not liquefied). Mineral exports include iron, copper, aluminum, uranium, base metals, non-monetary gold and pearls and precious and semi-precious stones. Finally, agricultural exports consist of live animals, fruits and nuts (excluding oil nuts), coffee and coffee substitutes, cocoa, tea and mate, oil seeds and oleaginous fruits, fish, wood, cotton and tobacco (unmanufactured and refuse).

For the 45 SSA countries for which we were able to gather adequate data, 17 are classified as resource rich and the remainder countries are classified as (at least relatively) resource poor (Table 1). Of the 17 resource-rich countries, seven are oil rich (Angola, Cameroon, Chad, Congo, Gabon, Nigeria and Sudan) and 10 are mineral rich (Botswana, Burkina Faso, Central African Republic, DR Congo, Guinea, Mali, Mauritania, Mozambique, Sierra Leone and Zambia). The remainder countries are classified as (at least relatively) non-commodity-dependent (see Table 1).

Based on this classification, we conducted tests of differences in means of real GDP per capita (2010 prices), GDP per capita growth and GDP growth rates between resource-rich and resource-poor groups for the periods 1990–2019. The data presented in Table 2 below indicate a significant difference in the average GDP per capita between the two country categories. In particular, the average GDP per capita for resource-rich countries in our sample is 782.70$ higher than for resource-poor ones. In contrast, average annual GDP per capita growth between 1990 and 2019 was almost 0.5% lower for resource-rich countries relative to resource-poor countries. Finally, the average annual GDP growth for resource-rich countries was not significantly different to that of resource-poor countries.

Once the data of our observation period are disaggregated into six different periods, the two groups display some interesting features (Table 3). In particular, the resource-rich countries tend to show higher volatility in economic growth than the resource-poor countries. During the initial 5-year period (1990–1994), which also corresponds to the low international prices for oil and minerals as illustrated in Figure 1, the resource-rich countries experienced on average a negative annual growth of GDP per capita (−2.35% compared to −0.57% in resource-poor countries). In addition, the overall GDP growth in resource-rich countries was only 0.29% in the first 5-year period. It then rose substantially in the second period (3.86%) and third period (5.13%), reaching a peak of 5.45% in the fourth period, before again declining in the fifth and sixth periods. Thus, the growth trend in resource-rich countries since 1990 to some degree reflects the changes in international commodity prices described earlier (see Figure 1).

Furthermore, the growth trend in resource-poor countries is even more volatile, with alternating ups-and-downs over the observed period. These findings, however, provide no clear indication on the extent of the relationship between movements in CTOT and economic performance in the resource-rich and resource-poor countries, although the former have consistently a higher average level of GDP per capita over the observation period. The next

4 This classification draws from UNCTAD (2019), which considers a country to be commodity dependent if oil, mineral or agricultural exports exceed the commodity group that had the largest share of total merchandise exports to the world during the average of the period 2013–2017. We provide further details on this classification in Appendix 1.

Table 1: Commodities Exports as % of Total Merchandise Exports (1995–2019 Average)

Country	Total commodities (%)	Most exported commodity	% of total merchandise exports
Angola	95.9	Petroleum	92.15
Mauritania	95.9	Iron	39.01
Guinea	92.5	Aluminum	49.63
Nigeria	92.4	Petroleum	84.34
Gabon	89.1	Petroleum	71.98
Mali*	87.4	Gold	47.23
		Cotton	35
Chad*	86.7	Petroleum	54.49
		Cotton	29.17
Congo	83.7	Petroleum	71.61
Burkina Faso*	83.3	Cotton	43.19
		Gold	29.61
Botswana	79.3	Pearls and precious stones	75.06
DR Congo*	74.2	Pearls and precious stones	26.06
		Copper	25.94
Sudan	72.7	Petroleum	35.37
Cameroon	71.9	Petroleum	36.64
Zambia	69.4	Copper	60.39
Sierra Leone	69	Pearls and precious stones	24.9
Central Af. Republic	68.9	Pearls and precious stones	28.59
Mozambique	64.3	Aluminum	29.56
Guinea-Bissau	99.4	Fruits and nuts	72.77
Burundi	85.6	Coffee	48.61
Seychelles	80.5	Fish	79.67
Ghana*	79.2	Cocoa	31.04
		Gold	21.28
Namibia*	76.9	Fish	36.06
		Pearls and precious stones	21.84
Tanzania	76.6	Gold	20.16
Rwanda*	75.5	Coffee	24.94
		Base metals	22.68
Malawi	73.6	Tobacco	57.72
Uganda	72.8	Coffee	30.53
Gambia	67.4	Fish	18.94
Ethiopia	63	Coffee	38.47
Comoros	63	Spices	57.04
Côte d'Ivoire	62.9	Cocoa	37.9
Sao Tome and Principe	61.2	Cocoa	52.27
Benin	60.7	Cotton	37.29
Zimbabwe	47	Tobacco	24.52
Niger	44.9	Uranium	21.54
Madagascar	43.7	Spices	16.41
Senegal	43	Fish	31.82
Cabo Verde	40.9	Fish	39.57
Kenya	35.7	Tea	20.19

(Continued)

Table 1: Continued

Country	Total commodities (%)	Most exported commodity	% of total merchandise exports
Togo	31.9	Cotton	11.12
Liberia	30	Pearls and precious stones	10.02
Djibouti	26.3	Live animals	16.13
South Africa	24	Pearls and precious stones	4.07
Mauritius	17.6	Fish	13.21
Lesotho	14.4	Pearls and precious stones	13.66
Eswatini	4.1	Fruits	1.45

Source: Authors' calculations based on data from UNCTAD (2019). See http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=14. Notes: Countries with (*) indicate cases with more than one commodity type representing at least 20% of total merchandise exports. Sierra Leone is included in the upper half of the table as a borderline case.

Table 2: Selected Economic Indicators, 1990–2019

Group	GDP per capita, constant $ (2010) prices	GDP per capita growth (%)	GDP growth (%)
	1990–2019	1990–2019	1990–2019
Resource-rich	1,940.79	1.03	3.75
Resource-poor	1,158.10	1.49	4.00
Difference	782.70***	−0.46	−0.25
	***p < 0.01, *p < 0.05, *p < 0.1		

Source: Authors' calculations based on data from the World Bank, World Development Indicators (2020). Note: Seychelles, Mauritius and South Africa are not included in these calculations.

section turns to the regression analysis to better understand the link between CTOT and economic performance in SSA during the observed period from 1990 to 2019.

4. Regression analysis

In this section we describe the data and our estimation strategy.

4.1 Data

Our analysis concerns the economic performance of 45 SSA countries between 1990 and 2019. The choice of this particular time period is due to two reasons. First, we are interested in the post-1990 economic performance of SSA countries. As noted earlier, the period from 1990 onwards is believed to have witnessed positive impacts of natural resource abundance on SSA economic growth. The time period starts off with an economic recovery (Arndt *et al.*, 2016), followed by boom-and-bust cycles in commodity prices as well as a steady increase in regional FDI inflows. Second, our choice for a balanced panel dataset does not allow any longer time series: reliable data for most of our variables of interest are not available for many SSA countries. The data for real GDP are taken from the World Bank, World Development Indicators (WDI) database (2019).

Our independent variable of primary interest is the country-specific CTOT, which captures the windfall gains and losses associated with changes in world commodity prices. The CTOT weights the change in the international price of up to 45 individual commodities

Table 3: Performance in Selected Economic Indicators in 1990–1994, 1995–1999, 2000–2004, 2005–2009, 2010–2014 and 2015–2019

Group	Indicator	1990–1994	1995–1999	2000–2004	2005–2009	2010–2014	2015–2019
Resource-rich	GDP per capita, constant $ (2010) prices	1,770.52**	1,787.92**	1,781.35**	1,952.97**	2,156.82**	2,206.99**
	GDP per capita growth (%)	−2.35	1.20	2.23*	2.49	2.75	0.26
	GDP growth (%)	0.29	3.86	5.13**	5.45	5.24	2.93
Resource-poor	GDP per capita, constant $ (2010) prices	956.05	1,008.18	1,044.98	1,164.55	1,310.08	1,423.22
	GDP per capita growth (%)	−0.57*	1.87	0.74	2.16	2.74	1.86**
	GDP growth (%)	1.98*	4.53	3.97	4.66	5.28	4.32**

***$p < 0.01$, *$p < 0.05$, *$p < 0.1$

Source: Authors' calculations based on data from the World Bank, World Development Indicators (2019).

by using trade data at the country level (Gruss and Kebhaj, 2019: 24). Furthermore, the weight of each commodity is given by the share of net exports in aggregate output. Therefore, increases (and decreases) in CTOT are indicative of commodity booms (and busts), thereby capturing gains (and losses) of income. Building on the discussion in the previous sections, we hypothesise CTOT to positively affect real GDP, in particular in resource-rich countries. At the same time, we recognise that the CTOT variable is potentially endogenous given its joint interdependence with the dynamics of economic growth. Following Gruss and Kebhaj (2019) and Ferraro and Peretto (2018), we assume that CTOT is exogenous for the SSA countries included in our sample. This is because none of these countries can (given their fairly low share of global commodity exports) significantly cause fluctuations in world prices.[5] The

5 In fact, SSA's exports of major commodities remain fairly insignificant in terms of global trade flows. In the case of crude oil, for example, SSA OPEC countries, namely Angola, Equatorial Guinea, Gabon and Nigeria, produced just 11.2 percent of OPEC's output in 2017 (Equatorial Guinea and Congo joined OPEC only in 2017 and 2018, respectively) (Organization of the Petroleum Exporting Countries, 2018: 27).

data for CTOT are taken from the IMF World Economic Outlook (WEO) database (2019). We use the 'Individual Commodities Weighted by Ratio of Exports to Total Commodity Exports' index.

As already noted above, the link between CTOT and economic performance may depend on various economic, structural, policy and political factors. In our analysis, we account for some of these variables and their potential long-run effects on economic growth. Official development assistance (ODA) in million USD, obtained from the OECD International Development Statistics database (2020), is included to control for the country dependence on foreign aid. Trade (the ratio of exports and imports to GDP), obtained from the World Bank WDI (2020), is included to capture the degree of a country's trade integration with the rest of the world. The annual percentage change in consumer prices is included to capture macroeconomic stability. The data are obtained from the IMF WEO (2019). For missing observations, we use data from the World Bank WDI. Finally, the fertility rate (total births per woman) is used as a proxy for the effect of population growth on economic growth. This measure is also taken from the World Bank WDI. We deal with missing observations using multiple imputation as proposed by Honaker and King (2010).[6]

It should be noted here that there exists no consensus on which growth determinants should be included in a growth model.[7] The reason we do not include other important variables is twofold: first, we want to use the most parsimonious model; and second, inclusion of additional covariates would severely lower the number of observations in our model.

4.2 Analytical strategy

We use a Swamy (1970) RCM to estimate the effects on real GDP per capita of CTOT. Our preference for RCM dwells precisely in our objective to model cross-country variation in the effects of movements in CTOT and changes in real GDP per capita. In fact, RCM allows for heterogeneity and dependence to be reflected in the parameters in the data and produces coefficients for individual cross-sections (countries). The basic idea behind this approach is that each country has its own experiences in terms of the relationship between movements in CTOT and changes in real GDP per capita. An identifying assumption of RCM is the correlation between the intercept and slope, which respectively measure the height (at time t_0) and the trajectory over time for each group (country). In the current analysis, this correlation indicates the extent to which countries that started off higher in terms of per capita GDP grow more over time relative to countries that started off lower. Also, RCM relaxes assumptions about the form of the relationship between the dependent and independent variables; omitted variables measured by the error term; and measurement errors (Swamy and Tavlas, 2001).

It is also important to stress the advantage of using RCM relative to traditional panel data models in the resource curse literature, such as fixed effects, random effects and generalized method of moments estimators. As pointed out earlier, these three estimators allow the intercepts to differ across countries, but they assume no parameter variations across countries.

6 This is implemented using the Amelia package in R.

7 These variables include human capital (primary, secondary or tertiary education), trade openness, public spending on education, military expenditure, government consumption, equipment investment, civil liberties, black-market premium and exchange-rate distortions, among many others (see, for example, Sala-i-Martin, 2007).

In the case of the current analysis, the assumption of constant slopes across countries would imply that the expected effect of movements in international commodity prices on economic growth is the same for different countries. Such an assumption does not seem to be realistic to the extent that movements in commodity prices affect different countries differently depending on the composition of their exports (Spatafora and Tytell, 2009). Our analysis includes countries with different sizes, institutional quality, political circumstances and economic structures, among other differences. Such cross-country variations make it difficult to assume that all countries in the sample will show the same sensitivity to movements in commodity prices. Therefore, homogeneous panel data models are not suitable for our analysis.

The following model is estimated:

$$Y_{i,t} = \alpha_i + \beta_{1i} X_{i,t-1} + \beta_{2i} Z_{i,t-1} + \mu_{i,t} \tag{1}$$

where i and $t$denote the countries and years, respectively. Y denotes the real GDP per capita. X is the CTOT. Z is a vector of the control variables described above. Accordingly, the model indicates that over time real GDP per capita growth for a country (Y) is determined by a slope estimate (α_i), coefficients associated with CTOT (β_1) and the control variables (β_2) and an error term (μ_i). Following Gruss and Kebhaj (2019), $\beta_1$is interpreted as the effect of windfall gains of income associated with commodity exports (increases in CTOT) on real GDP per capita growth. All the explanatory variables, except for ODA, are lagged for 2 years. Real GDP per capita, CTOT, ODA, trade openness, fertility rate and inflation rates are expressed in natural logarithm. The analysis is based on a balanced dataset.[8]

As said above, parameters in RCM can vary between the countries included in the sample. However, to determine whether the variance between countries is due to CTOT and not simply the other covariates, we re-estimate model (1) but retaining only CTOT as the explanatory variable. We provide results of this estimation in Appendix 2.[9]

5. Estimation results

As noted before, in our analysis, we hypothesise that the effects of movements in CTOT on economic growth differ between SSA countries. Specifically, we have argued that the differential effects of CTOT on economic performance vary between resource-rich and resource-poor countries. Table 4 reports the estimates from the RCM for the two groups. Column 2 shows results for the whole sample of 45 countries, while columns 3 and 4 present results for resource-rich and resource-poor countries, respectively. The last row of Table 4 provides chi-square tests of parameter constancy for each of the three regressions. The test determines whether the difference in the regression coefficients between the countries is significant. The null hypothesis of no parameter heterogeneity across different countries is rejected ($p < 0.05$), thereby supporting our choice to use a RCM. Surprisingly, the test of parameter constancy also indicates that there is heterogeneity within country groups. This within-group heterogeneity deserves further comments and we will return to this point later.

8 Although in RCM, the parameter estimates are based on the available information (that is, missing data pose no particular problems in terms of estimation) (Awn, 2000), our analysis includes countries with complete data.

9 We estimated Swamy's RCM using the Stata's xtrchh2 command (Poi, 2003).

Table 4: Estimates of RCM for the Whole Sample

Variables	Full sample	Resource-rich	Non-resource rich
Log of CTOT	0.87*	1.01**	0.77
	(2.20)	(2.28)	(1.22)
Log of ODA	0.01	0.01	0.01
	(1.38)	(1.34)	(0.95)
Log of trade (% of GDP)	0.03	0.06	0.01
	(1.23)	(1.66)	(0.15)
Log of fertility rate	−1.03***	−1.05**	−1.03***
	(−5.87)	(−2.91)	(−5.34)
Log of inflation	−0.01	−0.01	−0.002
	(−1.36)	(−1.22)	(−0.66)
Constant	4.57**	4.01*	5.02*
	(2.53)	(2.00)	(1.75)
Number of observations	1,260	476	784
Number of countries	45	17	28
Test of parameter constancy across countries (chi-square)	150,000***	45,731.21***	92,107.51***

t values in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

To begin, for the full sample of 45 SSA countries, the coefficient on CTOT is significant at the 5% level. This suggests that windfall gains of income associated with commodity exports are significantly and positively associated with increased real GDP per capita growth in SSA. On the other hand, fertility rate, which is used to capture population growth, has a significant and negative effect on real GDP per capita in SSA. A 1% increase in fertility rate is associated with a reduction of real GDP per capita of about 1.03%. None of the coefficients on the two other control variables, namely ODA, trade and inflation rate, is statistically significant.

However, estimates in columns 3 and 4 indicate some differences between resource-rich and resource-poor countries. For the latter, the overall association between real GDP per capita growth and windfall gains from commodity exports is not significant. Contrarily, in the resource-rich countries case, the coefficient on CTOT is significant and positive at the 5% level. These results give support to our central argument that windfall gains from natural resources are significantly associated with increased economic growth during the period since 1990.

Finally, the coefficients on the control variables indicate that population growth is significantly linked to reduced real GDP per capita in both the resource-rich and resource-poor country groups, while the association between per capita GDP growth and the other control variables (ODA, trade and inflation) each is not significant for both groups.

We now return to the observed within-group heterogeneity. We graphically summarise the variance in the coefficients of CTOT for the sake of simplicity due to the large number of countries (see Figures 2 and 3). The y-axis shows the CTOT coefficients (β_1) and the x-axis displays countries in terms of the magnitude of their coefficients. That is, countries in

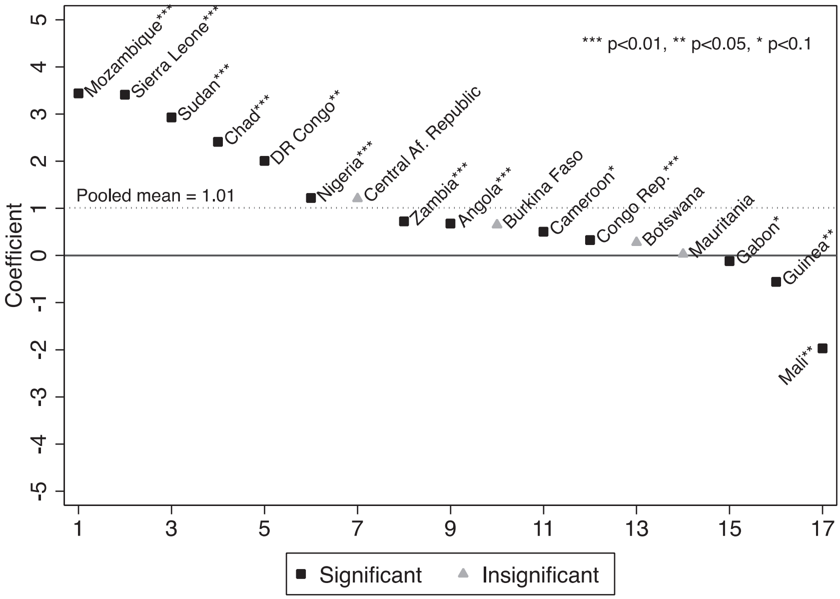

Figure 2: CTOT Effects on Real GDP per Capita Growth in Resource-Rich Countries.

the far left of the figure are those with larger CTOT coefficients, while those with smaller coefficients are located in the far right.[10]

First, with regard to resource-rich countries, the lowest and highest coefficients suggest that the magnitude of the association between CTOT and real GDP per capita growth in resource-rich countries ranges from 3.44 (Mozambique) to −1.97 (Mali). Furthermore, it can be observed that for most of the countries that mainly export petroleum, the coefficient on CTOT is positive and significant. Only Gabon displays a significant and negative coefficient on CTOT.

On the other hand, four mineral-rich countries (Mozambique, Sierra Leone, DR Congo and Zambia) have a significant and positive coefficient on CTOT. The remaining mineral-rich countries (Central African Republic, Burkina Faso, Botswana, Mauritania, Guinea and Mali) display either a negative or insignificant coefficient on CTOT.

Regarding heterogeneity within the resource-poor group (Figure 3), the magnitude of the relationship between CTOT and changes in real GDP per capita growth range from −8.32 (Cabo Verde) to 4.35 (Malawi). Only eight (Malawi, Ghana, Namibia, Ethiopia, South Africa, Togo, Seychelles and Sao Tome and Principe) out of 28 resource-poor countries have positive and significant CTOT coefficients.

By contrast, windfall gains are significantly associated with reduced real GDP per capita growth in four countries (Mauritius, The Gambia, Zimbabwe and Cabo Verde). In the case of the other countries, the association between windfall gains from commodity

10 We also report individual coefficients within the resource-rich and resource-poor group in the online appendix.

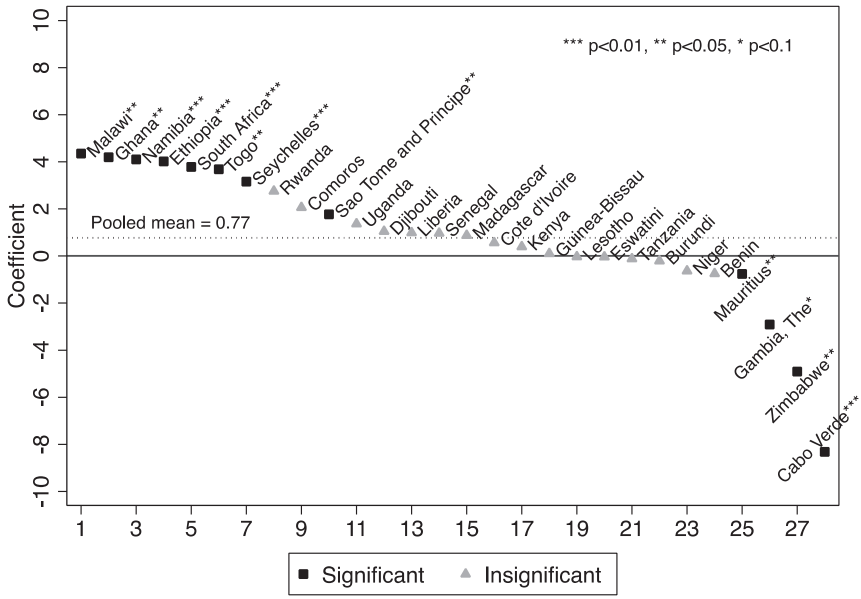

Figure 3: CTOT Effects on Real GDP per Capita Growth in Resource-Poor Countries. Note: Countries are plotted in order of coefficient value.

exports and real GDP per capita growth is insignificant. These countries include Rwanda, Comoros, Uganda, Djibouti, Liberia, Senegal, Madagascar, Côte d'Ivoire, Kenya, Guinea-Bissau, Lesotho, Eswatini, Tanzania, Burundi and Niger.

Overall, the results summarised in Table 4 confirm the positive and statistically significant relationship between windfall gains from commodity exports and GDP per capita growth. However, Figures 2 and 3 show that for resource-rich countries, the relationship between windfall gains and GDP per capita growth is positive and significant especially for oil-rich countries. On the other hand, there are substantial differences in the relationship between windfall gains and GDP per capita growth across countries classified as resource-poor. In the next section, we discuss why the effects of windfall gains on GDP per capita growth vary across countries.

6. Discussion

Results of our panel regression pertain to the effect of CTOT on real GDP per capita growth. More precisely, the results indicate the extent of the relationship between windfall gains from commodity exports (increases in CTOT) and real GDP per capita growth in 45 individual SSA countries. We have shown that, on average, windfall gains (or increases in CTOT) are significantly associated with increased real GDP per capita growth. These associations, however, vary considerably across two country groups, namely resource rich and resource poor. In the latter case, windfall gains tend to have no significant effect on real GDP per capita growth, while the effect is significant and positive for the resource-rich group.

Crucially, we have also observed a considerable heterogeneity in the effects of windfall gains within the resource-rich group. Reported coefficients and significance levels have suggested that the estimated impact on real GDP per capita growth is significant and positive for oil-rich countries, but either negative or insignificant for many mineral-rich countries. Based on our findings, we suggest that contrary to minerals, oil is not detrimental to economic performance in SSA.

The crucial difference between oil and minerals with regard to economic performance can be explained as follows: in the case of oil (and also gas), revenue centralisation by the state is potentially easier compared to minerals, due to the need to install effective extraction mechanisms based on large-scale investment and coordination. This generally requires the agency of the state, although such effort is often backed up by public and/or private domestic and international oil firms.

On the other hand, minerals are frequently more difficult to exploit in a centralised manner. In particular, mineral extraction often does not require large-scale investment and coordination. Instead, extraction can proceed along artisanal lines, i.e., revenue centralisation by the state might be absent and/or monitoring costs might be higher. In each case, the stability of government revenue is negatively affected.

With regard to the country group classified as resource poor, a number of factors might explain the differential effect of windfall gains on GDP per capita growth. First, there is substantial variability across individual commodities exported by these countries. For instance, countries such as Namibia, Ghana, and to a lesser extent, Tanzania are resource rich in the sense that their exports of minerals as percentage of their respective total merchandise exports are fairly high. In Namibia, for example, pearls and precious stones (e.g., diamonds) account for nearly 22% of total exports. Also, in Ghana and Tanzania, gold accounts for significant portions of their export baskets. In this respect, these three countries can be considered as borderline cases (between resource rich and resource poor) and might be expected to experience a different CTOT-growth nexus compared to the remainder of the resource-poor countries. In Tanzania, however, we observed that income generated from commodity exports is not significantly associated with increases in GDP per capita growth.

On the other hand, Malawi, Ethiopia and Seychelles mainly export tobacco, coffee and fish, respectively. Coffee also accounts for a significant proportion of merchandise exports in countries such as Uganda, Rwanda and Burundi. Yet, upsurges in CTOT in these three countries were not significantly associated with increased GDP per capita growth. Moreover, for countries including Mauritius, Gambia, Zimbabwe and Cabo Verde, we found that increases in commodity export earnings are significantly associated with reduced GDP per capita growth. We have noted that these countries' most exported commodities include fish (Mauritius, Gambia and Cabo Verde) and tobacco (Zimbabwe).

Similarly, countries whose association between CTOT and GDP per capita growth is not statistically significant encompass a wide spectrum of commodity export types. These include coffee (Rwanda, Uganda and Burundi), tea (Kenya), spices (Comoros and Madagascar), live animals (Djibouti), pearls and precious stones (Liberia), fish (Senegal), cocoa (Côte d'Ivoire), fruits (Guinea-Bissau and Eswatini), gold (Tanzania), uranium (Niger) and cotton (Benin). With the notable exception of petroleum, it is difficult to argue that countries' commodity specialism has a significant effect on economic growth.

Second, and in line with our theoretical discussion, increases in oil prices place a burden on non-oil exporters, as they are likely to spend more of their income earnings (accruing from their exports of agricultural products) to import oil at higher prices. In other words, even if both oil and agricultural prices comove upwards, non-oil exporters benefit less from their export earnings compared to their oil exporting counterparts. In consequence, net oil exporting countries are likely to experience higher income growth compared to net oil-importing countries. There is evidence of a strong and negative relationship between commodity dependence and the human development index, especially for countries highly dependent on fuel and food imports (UNCTAD, 2017).

Third, the effects of windfall gains from commodity exports on real GDP per capita growth might be influenced by specific structural and policy characteristics of individual countries. Such characteristics might include the existence of domestic price-smoothing mechanisms, well-developed financial systems and safety nets for the poorest populations, among others. It is potentially more instructive for future research to refine the analysis by examining how these factors moderate the relation between upswings in the CTOT and changes in GDP per capita (and/or inequality, food security or poverty) for individual commodity exporters in SSA.

Alternatively, it is worthwhile looking at the impact of other exogenous shocks such as the recent COVID-19 pandemic in SSA countries based on their level of commodity dependence. In this study, we have shown that increased income from commodity exports is associated with a better economic performance, especially in oil-rich countries. However, it has been recently noted that pandemics are strongly associated with the collapse of oil prices and that global agreements concerning climate change will lead to a substantial reduction in the use of fossil fuels (Erten and Ocampo, 2021).

In this regard, failure to diversify, in particular for countries whose commodity exports are driven by the demand from China and other emerging economies (OECD, 2020; Gondwe, 2020) or whose exports consist mainly of fuels are more likely to experience significant economic drawbacks. Thus, it is also instructive to look at how progress in the global targets set in the 2015 Paris Agreement on Climate Change, and shocks associated with the COVID-19 pandemic, are influencing international commodity prices. It needs to be monitored how such events will affect the future performance of SSA commodity exporters.

7. Conclusion

Many countries in SSA specialise in the production and export of primary commodities, be they oil, minerals or agricultural. Therefore, their growth performance can be strongly affected by movements in international commodity prices. The present study has examined the effect of CTOT on economic performance in SSA countries between 1990 and 2019. It used data on country-specific CTOT indices in which the weight of each commodity is given by the share of exports of that commodity in total exports. The goal was to investigate the effects of windfall gains and losses associated with changes in commodity exports on GDP per capita growth.

Our analysis used an RCM that yields individual estimates for each of the countries included in the analysis. The model thus explored the heterogeneity existing in the link between windfall gains associated with different commodity exports and economic growth in SSA. Most of the earlier empirical studies rely on homogeneous models in which the effect of natural resources on the economic performance measure is deemed to be the same for all countries. By contrast, our analytical approach relied on a more realistic assumption, arguing that the effect of windfall gains on economic performance differs from country to country.

Thus, the main conclusion of this paper can be stated as follows: first, natural resources have undoubtedly contributed to higher economic growth in SSA since 1990. Second, when SSA countries are split into two groups depending on their commodity export specialisation, we found that resource-rich countries—in particular oil rich—are clearly the best performers in economic growth during the observation period. Finally, we find that windfall gains from commodity exports are not significantly associated with increased real GDP per capita growth in most agriculture-exporting countries.

We believe that this paper adds informative context to the resource curse literature focusing on SSA. Our results more adequately reflect complexities of the resource curse phenomenon in that the impact of natural resources on economic performance depends on the types of commodities in which a country specialises, and the individual structural and policy features of the country.

Supplementary material

Supplementary material is available at *Journal of African Economies* online.

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Appendix 1: Classification between Resource-rich and Resource-poor

Choosing specific criteria to classify countries into resource-rich and resource-poor categories can be challenging. In fact, there is no universally accepted approach for classifying countries into resource-rich and resource-poor in the literature. Classification is typically measured by the share of commodity export earnings in total exports (IMF), in total merchandise exports (UNCTAD), and in GDP. Alternatively, classification can be based on the percentage of people engaged in the production of commodities or by the share of government revenues due to commodity production and exports.

In the particular case of SSA, one should note that almost all countries in the region are commodity-dependent (see UNCTAD, 2019: 3). Accordingly, our classification follows UNCTAD (2020) practice in grouping commodity exports into three groups, namely (1) oil and gas, (2) minerals, and (3) agricultural. The individual products that comprise each commodity group are as follows:

1. Oil and gas exports comprise petroleum oils, oils from bitumen materials, crude and natural gas, whether or not liquefied);
2. Mineral exports include iron, copper, aluminum, uranium, base metals, non-monetary gold, and pearls and precious and semi-precious stones;
3. Agricultural exports consist of live animals, fish, fruits and nuts (excluding oil nuts), coffee and coffee substitutes, cocoa, tea and mate, oil seeds and oleaginous fruits, wood, and tobacco (unmanufactured and refuse).

A country is considered to be resource-rich if the share of minerals and/or oil and gas constitute the predominant share of its total merchandise exports. More specifically, a country is considered to be resource-rich if at least one product either in the oil and gas or minerals group represents at least 25% of its total merchandise exports for the average of the period 1995–2019 for which relevant data are available. This is obtained using the following formula:

$$Resource\_rich_i = 100 * \frac{Nat\_res\_\exp_i}{Total\ Exports_i}$$

where $Resource\_rich_i$ denotes the ratio of natural resource (oil and gas and/or minerals) exports to total merchandise exports of country i in period 1995–2019; $Nat\_res\_\exp_{it}$ represents the export value in current US$ of individual products (in the oil and gas and/or minerals group) for country i in year t; and $Total\ Exports_{it}$ represents the total merchandise exports in current US$ of country i in the same time period.

Appendix 2: Results Using only CTOT as a Covariate

Variables	Full	Resource-rich	Non-resource rich
Log CTOT	5.89***	2.93**	8.07***
	(4.75)	(3.01)	(3.81)
Constant	−19.98**	−12.27	−30.07**
	(−3.49)	(−12.27)	(−3.45)
Observations	1260	476	784
Number of countries	45	17	28
Test of Parameter Constancy Across Countries (Chis-square)	110000***	39779.8***	66910.30***

t statistics in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$