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Do Resource Windfalls Improve the Standard of Living in Sub-Saharan African Countries?

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Cheikh Anta Gueye

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African Department

Do Resource Windfalls Improve the Standard of Living in Sub-Saharan African Countries? Evidence from a Panel of Countries

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Abstract

We examine the impact of resource windfall on the standard of living both in the short-run and long-run, using a sample of 130 countries, 1963-2007. Then, we systematically investigate the effect of resource windfall on welfare in three different groups of countries: We find that in the short-run resource windfall is welfare enhancing in the whole sample, especially via increases in income and decreases in inequality. However, in SSA countries, the size of welfare improvement is small and it is smaller and almost zero after one year in fragile Sub-Saharan Arican (SSA) countries. In the whole sample, a resource windfall shock leads to significant welfare growth even in the long-run, but we couldn't find any significant long-run effect of resource windfall in SSA countries.

JEL Classification Numbers: C33, I30, O11, O13, O55, Q32, Q33, Q38.

Keywords: commodity prices; natural resources; inclusive growth; welfare; governance

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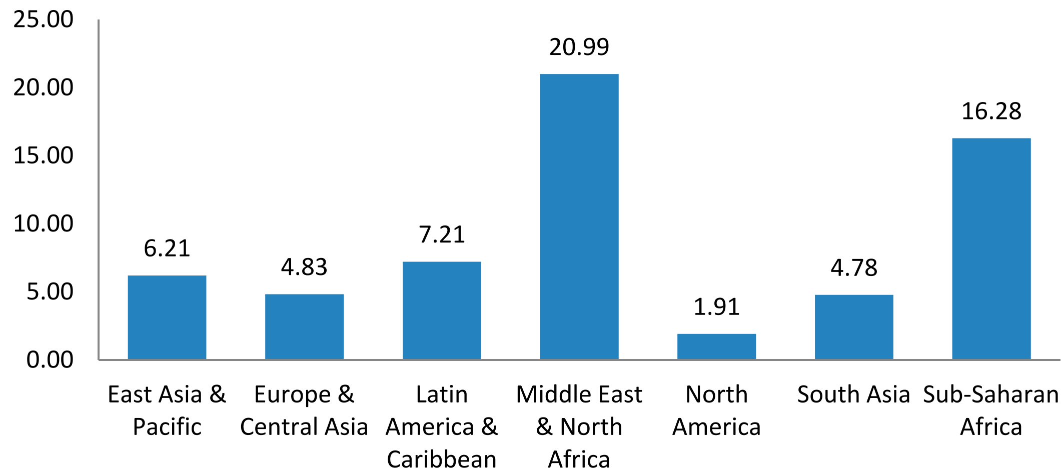
CONTENTS

TABLES

I. Background and Motivation

In Sub-Saharan African (SSA) countries, natural resource endowments provide an opportunity to improve economic growth and alleviate poverty. In 2012, total natural resource rents[2] accounted for 16.2 percent of gross domestic product in SSA countries (Figure 1), much higher than world average, 9.8 percent, and only behind Middle East and North Africa, 20.9 percent. Rents from natural resources have grown over time in Sub-Saharan Africa. Since 1990, rents increased from 13.0 percent of GDP to 17.7 percent in 2010 (Figure 2). After the 2000s energy crisis and recent oil discoveries, natural resource boom have contributed significantly to increases in government revenue, which could have been used to accelerate economic growth. Nevertheless, due to low absorptive capacity and the absence of strong institutions for natural resource wealth management in these countries, the use of resource revenues has been disappointing.

Figure 1. Natural Resource Rents (percent of GDP) in 2012



[2] Resource rent is defined as the contribution of natural resource revenues to gross domestic product. Total natural resource rents are the sum of oil, natural gas, coal (hard and soft), mineral, and forest rents. The estimates are based on sources and methods described in World Bank (2011). Due to lack of data, the rents omit some mineral resources such as diamonds, uranium, and lithium, even though they are extremely important for some countries. This is because information about reserves and the costs of production is not generally available for these minerals. As a result, rents are underestimated, and for certain countries, this omission can be significant. We will touch on this issue later in the paper since some SSA countries like Botswana is a major exporter of omitted resource like diamond.

Figure 2. Natural Resource Rents (percent of GDP) in SSA Countries, 1990-2010

Source: World Bank World Development Indicators

Therefore, despite the increase in natural resource revenue, economic growth and development in resource-rich SSA countries haven't been better than other resource-poor countries. Even though GDP per capita and Human Development Index (HDI)[3] have increased overtime, the gap between SSA countries and other countries haven't narrowed (Figure 3). In 2010, average GDP per capita for 44 SSA countries was $2,316, which is about eighth of the average for other countries[4]. Average HDI in SSA countries (0.46) was much lower than that in other countries (0.74). Therefore, it seems that SSA resource-rich countries may have not exploited well the opportunity from natural resource boom.

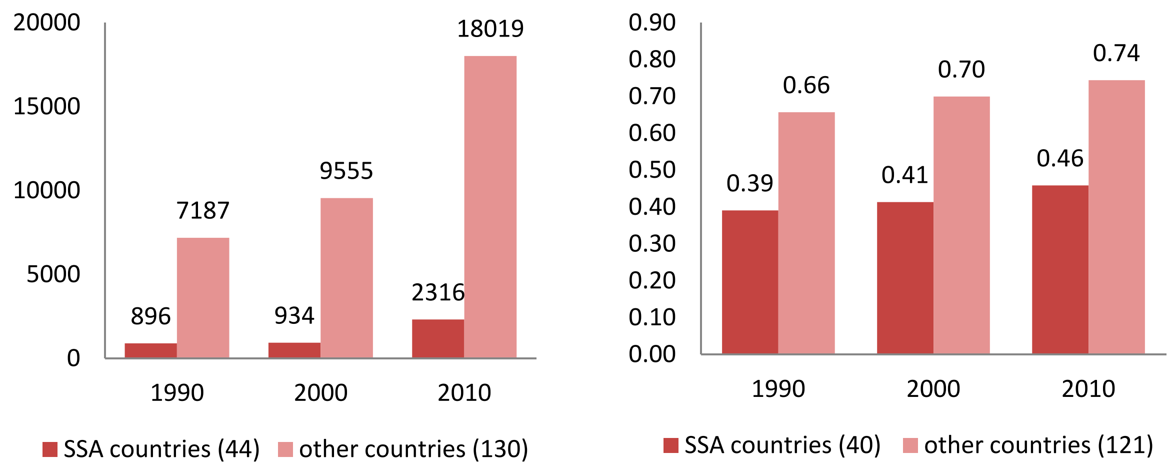
We also compare SSA countries to regions with similar income levels. We construct a hypothetical comparison group of 44 countries from other continents with the same GDP per capita in 1990, so that we can clearly compare the rate of economic convergence for both sets of countries during 1990-2010. GDP for comparison group has increased faster than SSA countries (Left panel of Figure 20 in the Appendix). In the same vein, we construct a hypothetical comparison group for HDI and find slower convergence rate for SSA countries (Right panel of Figure 20 in the Appendix).

[3] The Human Development Index (HDI) is a composite statistic of life expectancy, education, and income indices used to rank countries into four tiers of human development.

[4] 86 countries in other continents of East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, Middle East & North Africa, North America and South Asia.

Figure 1. GDP Per Capita and HDI in SSA Countries

GDP per capita (current US $) Human Development Index



Sources: World Bank World Development Indicators and UNDP

This relative stagnation of GDP per capita and HDI could be mainly due to:

- **Resource curse phenomenon**. Indeed, many empirical works have shown that an abundance of natural resources may lead to less economic growth and development outcomes. For example, Sachs and Warner (1995) showed that a higher dependence on natural resources reduces economic growth in a large number of countries. Natural resource boom may create disincentives for non-resource production; mining industries extract economic rents and competitiveness of other economic sectors. Furthermore, real exchange rate appreciation from natural resource boom could depress non-resource traded goods sectors further.[5]

- **Poor governance**. Resource-rich countries tend to have weaker institutions. There seems to be a strong correlation between corruption[6] and natural resource rents in SSA countries (Figure 4). Linear fitted line establishes correlation[7] between resource rents and corruption level. For example, Mauritania and Equatorial Guinea with the highest natural resource rents as a share of GDP (49 percent and 48 percent, respectively) have very low control of corruption scores (31 and 20, respectively).

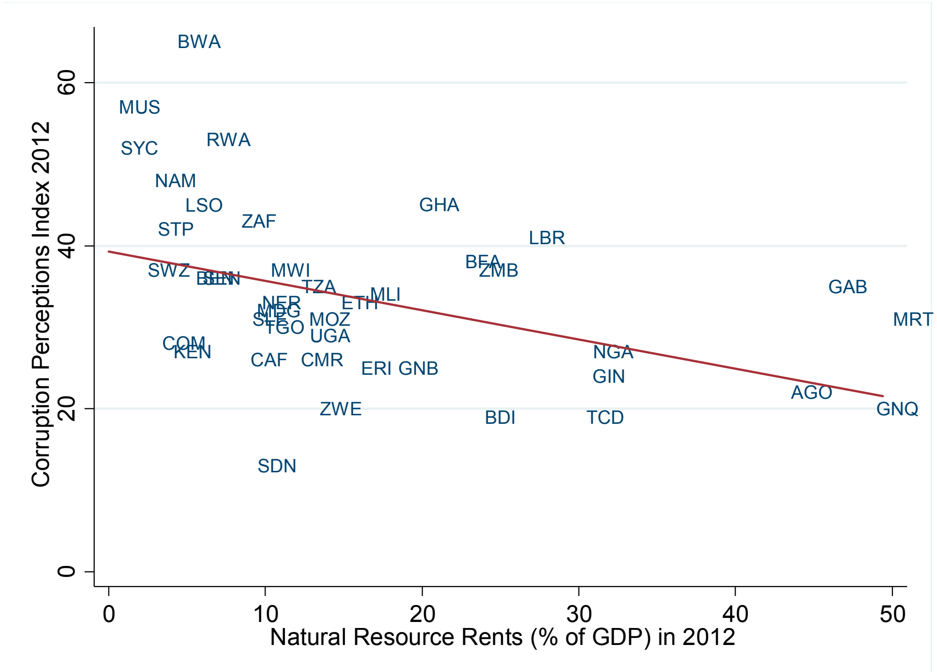
[5] Trevino (2011) found evidences of Dutch Disease phenomenon from net oil exporters in the Central African Economic and Monetary Community (CEMAC): large appreciation of the real exchange rate and a rapid shift of labor away from the agricultural sector.

[6] Corruption perceptions index indicates the perceived level of public sector corruption on a scale of 0-100, where 0 means that a country is perceived as highly corrupt and 100 means it is perceived as very clean.

[7] Slope is -0.35 and standard error is 0.11. The coefficient is significant at the 1 percent level.

Global competitiveness index[8] is also negatively correlated[9] with the availability of natural resources (Figure 5).[10]

Figure 4. Corruption and Natural Resource Rents in Sub-Saharan Africa



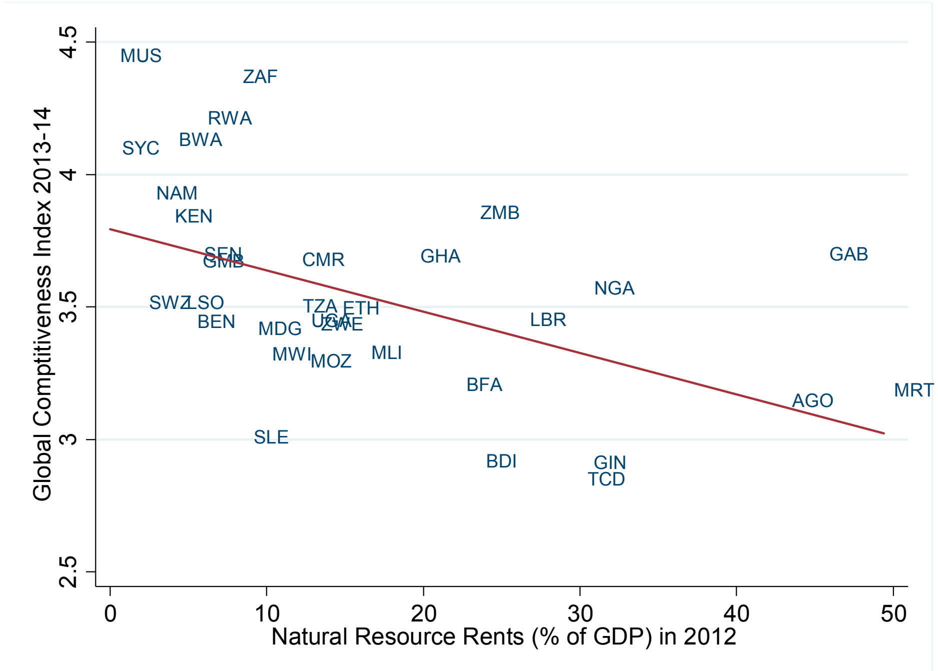
* Straight line is a linear fitted line.
Source: World Bank and Transparency International.

[8] The Global Competitive Index developed by Xavier Sala-i-Martin and Elsa V. Artadi assesses macroeconomic and micro/business aspects of competitiveness of countries. It "measures the set of institutions, policies, and factors that set the sustainable current and medium-term levels of economic prosperity" (Schwab 2013).

[9] Slope is -0.016 and standard error is 0.005. The coefficient is significant at the 1 percent level.

[10] As discussed before, the data on natural resource rents provided by the World Bank omit some minerals like diamonds. Among Sub-Saharan African countries, Botswana is a major diamond exporter but its rent is just 3.7 percent. Mining in Botswana consistently has accounted for about 40 percent of GDP (World Bank, 2010). So, the natural resource rent in Botswana is extremely underestimated. Nonetheless, in Figure 4 and 5, we can still see a strong correlation, even after excluding Botswana from the sample.

Figure 5. Competitiveness and Natural Resource Rents in Sub-Saharan Africa



* Straight line is a linear fitted line.
Sources: World Bank and World Economic Forum.

In contrast to SSA resource-rich countries, developing resource-poor countries like Mauritius and Seychelles tend to have stronger institutions. Both countries have strong control of corruption and high global competitiveness.[11] With strong institutions, both rich countries like Canada and emerging markets like Chile have translated natural resource revenue into economic growth and development. Resource governance index[12] from 17 resource-rich SSA countries is 43.8, lower than world average 50.6 and OECD average 87.7 (Figure 6). The index for successful countries such as Canada and Chile are 76 and 75, respectively. Therefore, according to this index, most countries in Sub-Saharan Africa haven't succeeded in achieving good governance in their extractive sectors.[13] These examples show that

[11] As shown in Figure 4, corruption perception index in 2012 is 57 for Mauritius and 52 for Seychelles. As shown in Figure 5, the global competitiveness index is 4.45 for Mauritius and 4.10 for Seychelles.

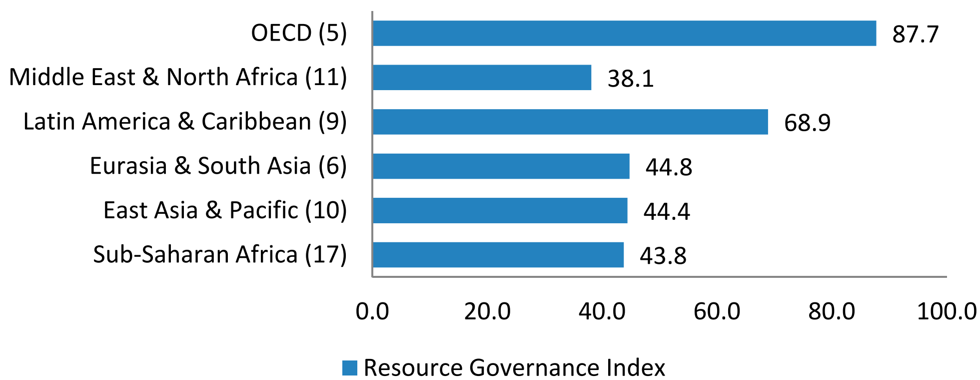
[12] The Resource Governance Index (RGI) measures the level of transparency and accountability in the oil, gas and mining sectors of 58 countries. The index is a hybrid, with three components based on the questionnaire that specifically assesses the extractive sectors, and the fourth rates the country's overall governance. It is a weighted average of "Institutional and Legal Setting (20 percent)," "Reporting Practices (40 percent)," "Safeguards and Quality Controls (20 percent)," and "Enabling Environment (20 percent)".

[13] Among 58 resource-rich countries in the world, the index shows that only 11 of the countries—less than 20 percent—have satisfactory standards of transparency and accountability. The 11 countries are Norway (98.0), United States, United Kingdom, Australia, Brazil, Mexico, Canada, Chile, Colombia, Trinidad and Tobago, and Peru (72.8). In addition, it may be puzzling that the index for Eurasia, South Asia, East Asia and Pacific has very low index. A few failing countries in those continents have contributed to the significant drop

(continued…)

resource curse is avoidable when resource boom is accompanied by strong institutions and good governance practices. Thus, SSA resource-rich countries could be prosperous if natural resource revenue was well managed.

Figure 2. Resource Governance Index in 2013 by Continents



Source: Natural Resource Governance Institute

Against this background, the objective of this paper is to analyze the impact of natural resource windfalls on standard of living and to provide policy implications especially to SSA countries. The analysis follows the recent method suggested by Jones and Klenow (2010) to measure welfare across countries and time, using welfare measures such as income (GDP), inequality (Gini coefficient), and health (life expectancy).[14] The rest of paper is organized as follow: Section II presents stylized facts, Section III discusses the methodology and data. Section IV presents the econometric analysis, while Section V provides policy implications.

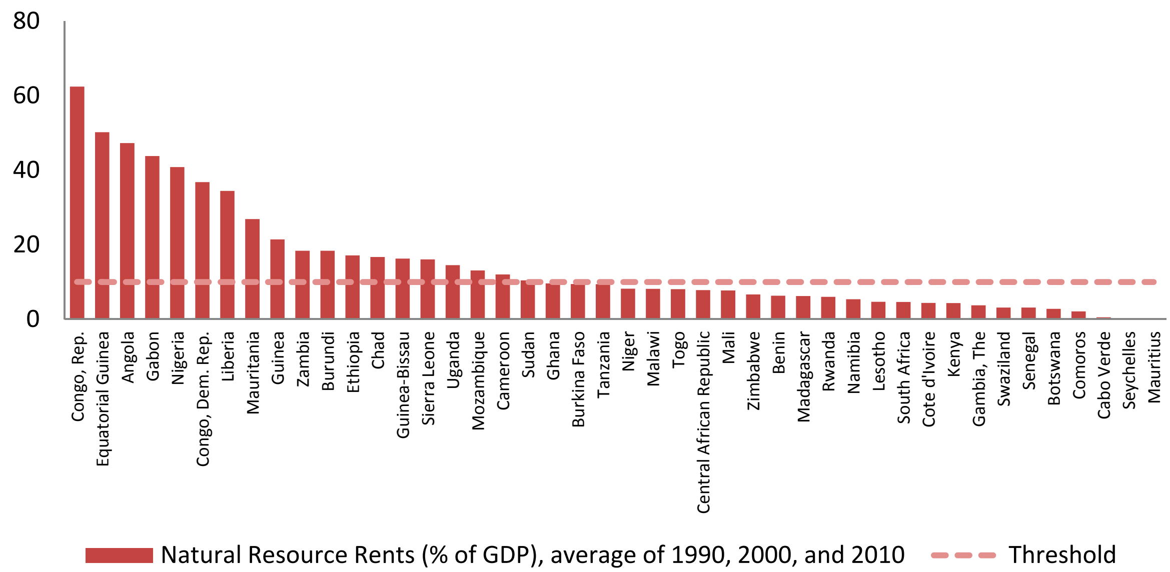
in the average index. One of the ten East Asia & Pacific countries is Myanmar with the index of 3 and one of the six Eurasia & South Asia countries is Turkmenistan with the index of 5.

[14] GDP alone may be a flawed measure of economic welfare (see Stiglitz, Sen, and Fitoussi (2009) for further discussions).

II. STYLIZED FACTS

Resource rich countries in Sub-Saharan Africa present not only lower economic performance but mediocre income distribution and health conditions (Figure 8).[15] GDP per capita in SSA resource-rich countries has been stagnant while resource-poor countries have grown rapidly. Gini coefficient has increased over time in both types of countries but the growth rate has been higher in resource-rich countries. Life expectancy has grown in resource-rich countries but it is still lower than resource-poor countries.

Figure 3. Resource-Rich Countries in SSA: Natural Resource Rents

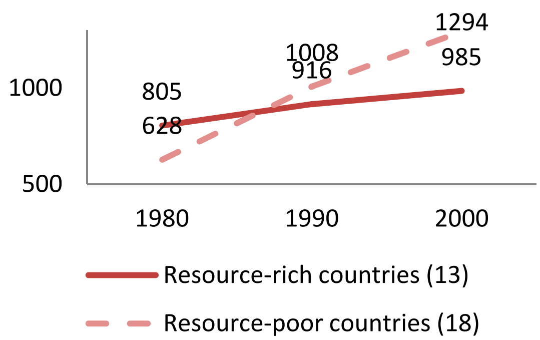


Source: World Bank

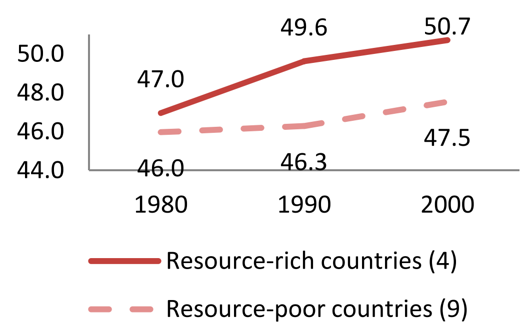
[15] Resource rich countries are defined as those whose average natural resource rents as a percentage of GDP for 1990-2010 is higher than 10 percent (Figure 7). As discussed before, Botswana is a resource-rich country but its rent from Diamond is not captured by the data provided by the World Bank due to lack of data. Based on this criterion, among the 44 countries, 20 Congo, Rep. (62.4 percent) to Sudan (10.4 percent) and Botswana are categorized as resource-rich and other 24 countries from Ghana (9.6 percent) to Mauritius (0.02 percent) are as resource-poor countries.

Figure 4. Selected Development Indicators in SSA: Resource-Rich[16] and Poor[17] Countries

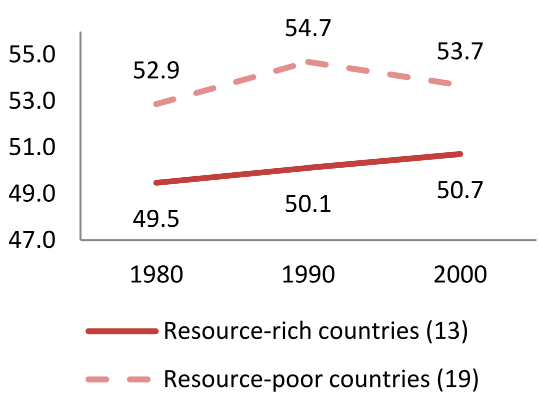
GDP per capita



Gini coefficient[18]



Life Expectancy[19]



Sources: World Bank and University of Texas Inequality Project

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[16] Thirteen resource-rich countries in this comparison are Angola, Botswana, Burundi, Cameroon, Congo, Rep., Ethiopia, Gabon, Liberia, Mozambique, Nigeria, Sudan, Uganda, and Zambia.

[17] Eighteen resource-poor countries are Benin, Burkina Faso, Central African Republic, Cote d'Ivoire, Gambia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Rwanda, Senegal, Seychelles, South Africa, Swaziland, Togo, and Zimbabwe.

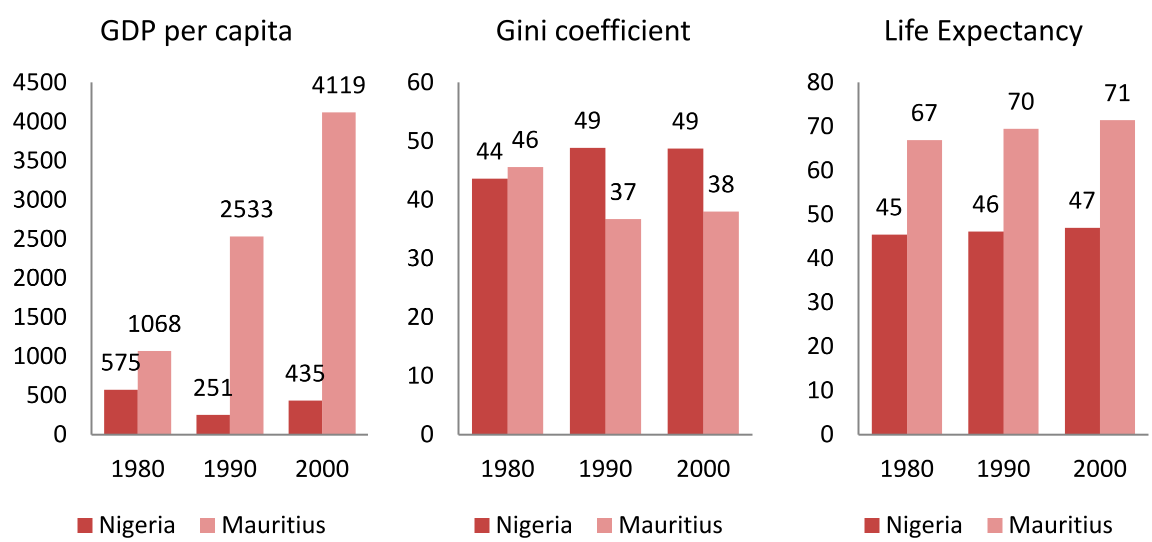
[18] For 1980-2000, we have only four resource-rich countries (Botswana, Cameroon, Nigeria, and Uganda) and nine resource-poor countries (Cote d'Ivoire, Kenya, Madagascar, Malawi, Mauritius, Senegal, South Africa, Tanzania, and Zimbabwe). To deal with this data limitation, we also report average Gini coefficients for the recent period 1991-2007, where more countries are available (Figure 20 in Appendix). Average for eleven resource-rich countries is 50.8 which is lower than average for thirteen resource-poor countries, 48.2. So, the fact that resource-rich SSA countries have higher inequality is robust.

[19] Countries in the sample are the same as in Figure 1-6, except that we have one more resource-poor country, which is Tanzania.

Growth in SSA resource-rich countries has been less inclusive (Lundgren et al., 2013). For example, Nigeria and Angola have a large income advantage as Africa's biggest oil producers but the two countries have shown poor performance on other welfare measures, compared with other resource-poor SSA countries. In 2000, the Gini coefficients in those countries were much higher than other SSA countries.[20] Life expectancies were much lower, 46.6 (Nigeria) and 45.2 (Angola). Poor natural resource management could have contributed to weak social indicators. Especially, long lasting civil war after independence affected Angola's weak performance in equality and health.[21]

Resource-poor countries like Mauritius and Seychelles, however, have had faster economic growth and strong development outcomes. Surprisingly, these tiny islands have outperformed most economies on the continent, benefiting from stable political systems and transparent business environment. Their corruption perception indices in 2013 are 57 (Mauritius) and 52 (Seychelles), comparable to Republic of Korea (56). Figure 9 shows stagnant growth and development in Nigeria relative to the growth miracle in Mauritius for 1980-2000.

Figure 5. Growth and Development of Nigeria and Mauritius for 1980-2000



Data: World Bank and University of Texas Inequality Project

[20] 48.8 for Nigeria (from EHII, 10-year moving average) and 58.6 (from World Bank, 2000 Data).

[21] For further reference, see Ross (2004), which finds high correlation between natural resources and civil war and discusses possible hypotheses behind this correlation.

III. METHODOLOGY AND DATA

We construct a panel dataset to examine the impact of resource windfalls on standard of living in both the short run and the long run. The data on welfare and resource windfalls is for 130 countries during the period 1963-2007. We investigate the effect of resource windfalls on welfare in three different groups of countries: (i) a whole sample with 130 countries, (ii) 28 SSA countries and (iii) nine fragile SSA countries.

We use two measures: (i) welfare index and (ii) resource windfall index.

i. The welfare metrics combines data on income (GDP), inequality (Gini coefficient), and health (life expectancy). To convert mean income to individual utility, expected income is discounted by the probability of dying and the variance of income. Welfare is increasing in income and life expectancy and decreasing in inequality.

ii. Resource windfall index captures a change in commodity price in global market. Commodity exporting countries are more sensitive to the change in price. The index consists of average of various commodity prices weighted by exports of each commodity for a given country.

A. Methodology

Borrowing from Jones and Klenow (2010), we construct a welfare measure, assuming a person who lives for a year in a particular country, but doesn't know whether she/he would be rich or poor, and even whether or not a deadly disease could kill her/him before she/he gets a chance to enjoy her/his year. With probability of living p and guaranteed income I, expected utility is

$$p \cdot Eu(I) + (1-p) \cdot 0$$

where $u(\cdot)$ is a utility function.

We then assume the standard log utility function, $u(I) = \log I$, and that the person could be assigned any age with equal probability and maximum age 100. Therefore, the overall probability that she/he is alive and gets to consume is

$$p = \frac{e}{100}$$

where e is the life expectancy at birth.

Suppose income in the country where this person lives is log-normally distributed with arithmetic mean m and standard deviation of income given by σ. Then, the expected utility is

$$Eu(I) = E[\log I] = \log m - \frac{\sigma^2}{2}$$

where inequality is penalized by a concave utility function.[22]

[22] Our framework is static. Unlike standard DSGE models, we do care about cross-sectional variation instead of time-series volatility. Panelizing by income inequality is analogous to discounting by consumption volatility in dynamic model.

In sum up, utility of this fictitious person is

$$V(e,m,\sigma) = p \cdot Eu(I) = \frac{e}{100}(\log m - \frac{\sigma^2}{2})$$

As the person could live randomly in the current United States or in another country at any past period, the factor, $\lambda_{i,t}$, by which we must adjust his income in the current United States to make him indifferent between living in the current US and country i at time t should satisfy the following condition:

$$V(e_{US,T}, \lambda_{i,t} m_{US,T}, \sigma_{US,T}) = V(e_{i,t}, m_{i,t}, \sigma_{i,t})$$

In this equation, $\lambda_{i,t}$ represents welfare of country i in year t; this consumption-equivalent welfare follows in the tradition of Lucas (1987) where welfare is measured by consumption unit. Here, $\lambda_{i,t}$ is the ratio in consumption we should compensate to make the fictitious person indifferent. By construction, the current welfare in the United States is normalized to 1. Many countries will have a welfare level lower than 1, which means that their consumption equivalents are lower than the current United States level. In other words, their standard of living is lower than that of the United States. Some economies like Scandinavian countries can have a welfare level higher than 1, due to their higher GDP per capita, lower Gini coefficients and longer life expectancy.

Consumption-equivalent welfare metrics share the same motivation with human development index (HDI): income alone is a flawed measure for standard of living. One of the main advantages of consumption-equivalent metrics is its high frequency data availability as data spans annually from 1963 to 2007.[23] By extending the dataset from Jones and Klenow (2010) to construct annual welfare measure[24] for longer time periods, we are able to analyze the short- and long-term impact of resource windfall on the standard of living. Table 1 summarizes consumption-equivalent metrics and human development index in terms of construction, variables, and frequency. While the HDI is the most widely used welfare measure, it is only available from 1980.[25] As shown in Figure 10, consumption equivalent welfare and HDI, are strongly correlated.

[23] This is the maximum data period, given data on income, inequality, and health. We use Gini coefficient as measured by the University of Texas Inequality Project since it is the most comprehensive data. Even though Gini coefficients for recent periods are available from the World Bank, we could not mix this data with the ones from the University of Texas Inequality Project because these datasets are constructed using slightly different methods.

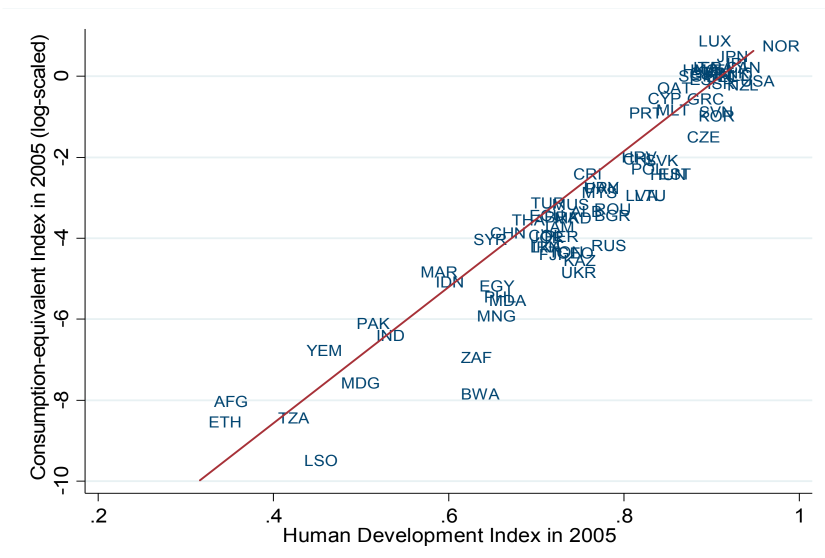
[24] Jones and Klenow (2010) constructed welfare measure only for two years, 1980 and 2000, since their interest was cross-country comparison in current welfare and long-run welfare growth rate.

[25] The consumption-equivalent metrics could also be useful for research on inclusive growth, which particularly require annual welfare measure for many countries. The codes and data are available upon request.

Table 1. Consumption-Equivalent Metrics and HDI

		Consumption-equivalent metrics	Human Development Index
Construction		Consumption-equivalent based on expected utility theory	Single number index from three dimension
Variables	Income	GDP per capita	GNI per capita
	Inequality	Gini coefficient	N/A[26]
	health	Life expectancy	Life expectancy
	education	N/A	Years of schooling (2010 onwards) Adult Literacy Index and Gross Enrollment Index (before 2010)
Frequency		annual, 1963-2007	1980, 1990, 2000, 2005, 2007, 2010, 2011, 2012, 2013

Figure 6. Consumption-Equivalent Metrics and HDI in 2005



* Straight line is a linear fitted line.
Sources: Authors’ calculation with World Bank and EHII data.

[26] Inequality-adjusted HDI is available from 2010.

We also compute a measure of resource windfalls. Although there are many possible sources of resource boom such as increases in commodity prices, new discoveries and improvements in mining technology, we investigate one specific source: a change in international commodity prices. The index consists of a geometric average of international prices of various commodities using (time-invariant) weights based on the average value of exports of each commodity in GDP for a given country (Arezki et al., 2011).[27] The index is country-specific and responsive to exogenous shocks arising from the change in international prices. Resource windfall index is identified by the (log) change in the international commodity prices by the following formula for countries i in year t.

$$Windfall_{i,t} = \sum_{c \in C} \theta_{i,c} \Delta \log(\mathrm{ComPrice}_{\mathrm{c,t}})$$

where $\theta_{i,c}$ is an average value of exports of each commodity c in GDP and $\mathrm{ComPrice}_{\mathrm{c,t}}$ is the global price of commodity c in year t.[28]

We use price proxy rather than quantity proxy because of the following two reasons. First, price based index gives us much more variation and power in the regression. International commodity prices change every second. However, the quantity shock is relatively rare and is not easy to measure correctly. Second, proxy for quantity could be endogenous. One possible proxy for quantity shock is the size of commodity exports. Unlike international commodity price changes, the size of exports could be associated with unobservable domestic factors affecting both welfare and export, such as the change in political regime. This endogeneity can cause potential bias in the regression. We are relatively free from this issue by using seemingly exogenous shock, which is the change in international commodity prices.

By using a price shock rather than quantity shock, we don't capture resource windfalls from the discovery of new resources. So, one should be careful to interpret our results. Some of the largest resource windfalls in SSA countries have occurred with the discovery of new resources (e.g. natural gas in Mozambique). Quantity shock is not the same with price shock. The quantity shock is more persistent and it does not immediately translate into revenue. We believe the quantity shock will bring us to another interesting avenue but it is beyond our current study.[29]

[27] One possible concern is that the weight is time-invariant. Despite this concern, fixed weight is a crucial assumption to make the index exogenous. Export share of commodity depends on domestic conditions affecting welfare while the international price is plausibly exogenous to those conditions. To avoid omitted variable bias, we follow the same definition in Arezki et al. (2011).

[28] We use average of 1980, 90, 2000 as time-invariant weights.

[29] Recently, Arezki et al. (2015) explores the effect of news shocks on the current account and other macroeconomic variables using worldwide giant oil discoveries.

B. Data Analysis

To construct consumption-equivalent welfare metrics, we collect data on income, inequality and life expectancy:

- **Income**: GDP per capita for each country is from the World Bank (2014).[30] The dataset covers 53 years, 1960-2012, across 236 countries. We have 9,944 observations, which is about 42 years of observations per a country.

- **Inequality**: Data on inequality is from the Estimated Household Income Inequality Data Set (EHII) of the University of Texas Inequality Project (Galbraith and Kum, 2005 and Galbraith et al., 2014). This measure of inequality is much more comprehensive than any other available sources. The dataset covers 45 years, 1963-2007, and 149 countries. It provides 3,872 observations so about 26 years of observations per a country.

  To compute standard deviation given the Gini coefficients from the EHII data, we use the following formula[31]:

  $$G = 2\Phi\left(\frac{\sigma}{\sqrt{2}}\right) - 1$$

  where G is a Gini coefficient and σ^2 is the standard deviation of log income. $\Phi(\cdot)$ is the cumulative probability function of the standard normal distribution.

- **Life expectancy**: The data on life expectancy is from the World Bank (2014). The dataset covers 53 years, 1960-2012, and 238 countries. We have 11,969 observations, which is about 50 years of observations per country.

Empirical work shows a strong relationship between welfare growth rate and GDP growth.[32] Analysis of the data show that almost all countries lie above 45 degree line, suggesting that GDP growth rate underestimates the improvement in standard of living (Figure 11). Equality and life expectancy have improved for those periods, especially in developing countries. All 69 countries in this calculation have positive welfare growth during 1970-2000, except Zimbabwe where life expectancy has dropped from 55.1 to 44.8 due to war and disease. Welfare growth for Uganda has been stagnant: the Gini coefficient and life expectancy in 2000 are almost the same as before. The average annual welfare growth rate in Sub-Saharan

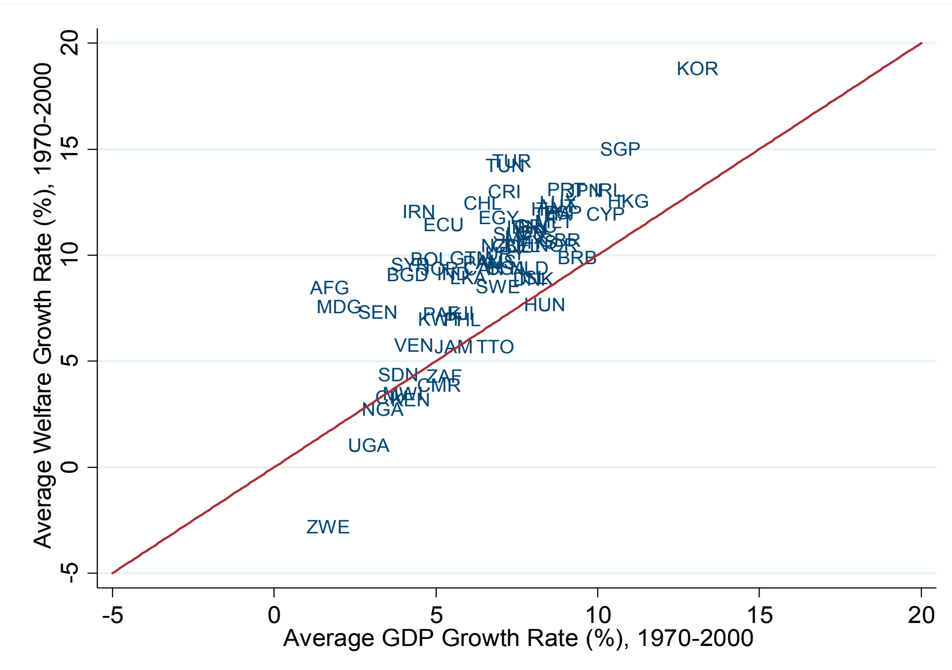
[30] We pick GDP rather than GNP. GDP captures living standards of a country better than GNI since income from abroad may not be transmitted to people living in the country.

[31] Refer to Aitchison and Brown (1957) for mathematical derivation.

[32] Using an unbalanced panel (1963-2007), we calculated ten year averages (1970 to 2000) and long-run annual growth rates from 1970-2000. The ten-year average panel comprises 69 countries, including 11 SSA countries. However, without averaging, we have 19 countries including just one SSA country, South Africa (Figure 21 in Appendix).

Africa is 3.5 percent, which is much lower than other continents (Figure 12). Even Middle East and North Africa have shown high welfare growth rates, 10.8 percent, mainly due to improvements in life expectancy. Figure 13 shows Sub-Saharan African countries. On average, resource-rich countries have grown at 3.0 percent while resource-poor countries have grown at 3.8 percent annually.[33]

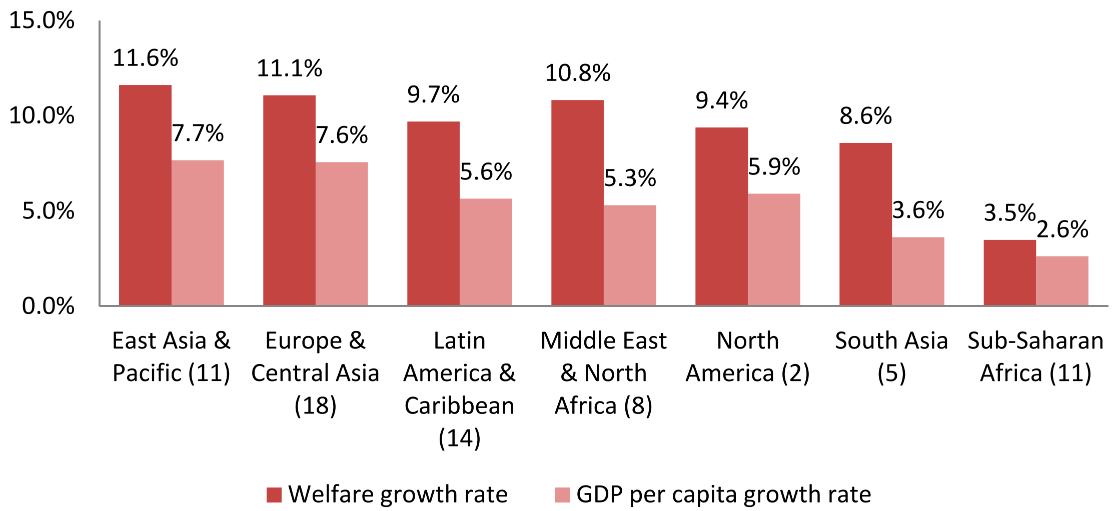
Figure 7. Welfare Growth Rate and GDP Growth Rate, 1970-2000



* The straight line is a 45-degree line. We average ten years around 1970 and 2000 respectively.
Sources: Authors' calculation with World Bank and EHII data

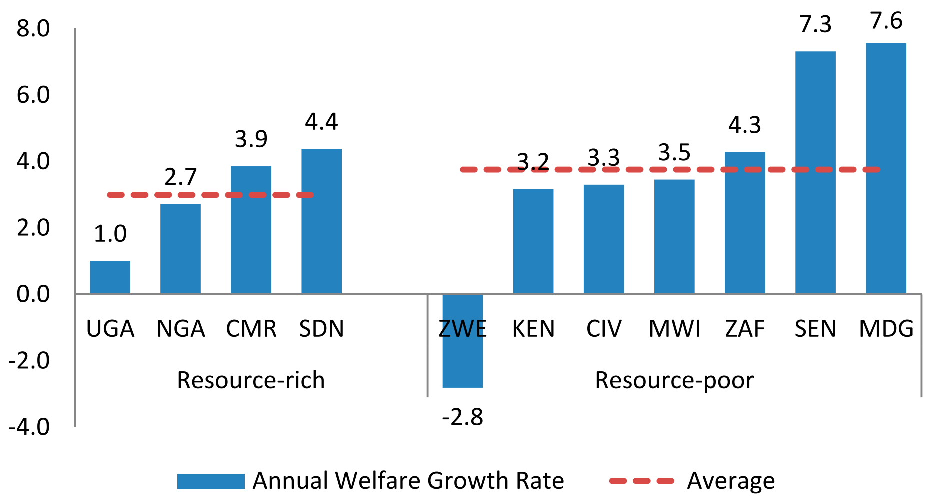
[33] Excluding Zimbabwe, mean growth rate for resource-poor countries increases to 4.9 percent.

Figure 8. Welfare and GDP Growth Rates by Continents, 1970-2000



Sources: Authors' calculation with World Bank and ELII data.

Figure 9. Annual Welfare Growth Rate for 1970-2000, SSA Countries



Source: Authors' calculation with World Bank and ELII data.

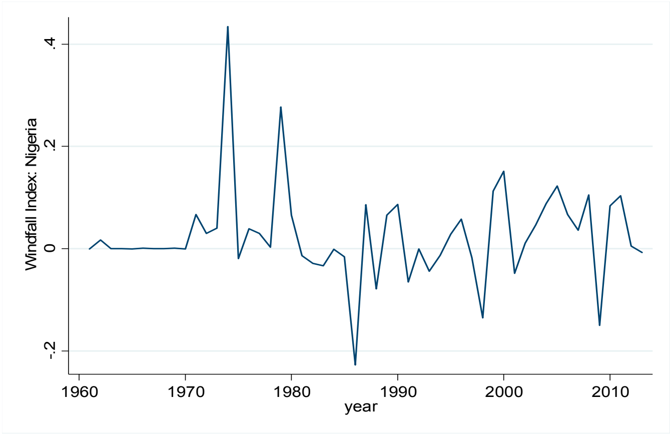
We also collect data on global commodity price and commodity export by country in order to construct resource windfall measure:

- **Global commodity price:** Annual international commodity price data are from United Nations Conference on Trade and Development (UNCTAD) Commodity Statistics. Following Arezki et al. (2011), the commodities included in the resource windfall are aluminum, beef, coffee, cocoa, copper, cotton, gold, iron, maize, oil, rice, rubber, sugar, tea, tobacco, wheat, and wood. In case there were multiple prices listed for the same commodity, a simple arithmetic price average was used. Table 6 in Appendix shows a list of commodity prices. All prices are in constant US dollar.[34]

- **Commodity export by country:** Data on the value of commodity exports is from the NBER-United Nations Trade Database.[35] Weights are based on the average value of exports of each commodity in GDP for a given country.

For example, in Nigeria, oil export share in GDP is 34 percent, while the shares for other commodities such as, cocoa, wood, and cotton, are negligibly less than 0.5 percent. So, Nigeria's windfall depends on the change in oil price. As shown in Figure 14, windfall index in Nigeria shows two peaks at 1973 oil crisis and 1979 energy crisis. We can also observe a fall during the recent great recession.

Figure 10. Windfall Index for Nigeria, 1961-2013



Sources: Authors' calculation with UNCTAD and NBER-UN data

[34] We use resource prices in real terms. Given large changes in inflation rates in the 70s and 80s, nominal commodity prices are problematic in the analysis.

[35] Data is available on http://cid.econ.ucdavis.edu/data/undata/undata.html. Refer to Feenstra et al. (2005) for construction.

IV. ECONOMETRIC ANALYSIS

A. Sample Statistics

As earlier mentioned, the dataset covers 130 countries, spread over all the continents for 45 years, 1963-2007 (Table 2). In particular, 28 SSA countries are represented.[36] Sample statistics shows that welfare has increased over time: average growth rate is 9.6 percent but SSA countries have grown less than other continents (Table 3). Its welfare growth rate is just 5.7 percent, much lower than other continents' growth rate, 11.2 percent. Average windfall index in the whole sample is 0.0045. It is positive because commodity prices have increased over time. Average windfall for SSA countries is higher, at 0.0055, which implies that SSA countries have been more exposed to natural resource shocks than other countries.

Table 2. Number of Countries by Continents

	Number of countries
Total	130
East Asia & Pacific	14
Europe & Central Asia	40
Latin America & Caribbean	25
Middle East & North Africa	16
North America	2
South Asia	5
Sub-Saharan Africa	28

Table 3. Sample Statistics

	Annual Welfare Growth Rate		Windfall Index	
	Obs.	Mean (Percent)	Obs.	Mean
Total (130 countries)	2,911	10.34	5,850	0.0045
Sub-Saharan Africa (28 countries)	458	5.72	1,260	0.0055
Other continents (102 countries)	2,453	11.21	4,590	0.0043

Sources: Authors' calculation with World Bank, EIHH, UNCTAD and NBER-UN data

[36] 28 countries in SSA are as follows: Angola, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Congo, Rep., Cote d'Ivoire, Ethiopia, Gabon, Ghana, Kenya, Liberia, Madagascar, Malawi, Mauritius, Mozambique, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

To identify the most and least resource dependent countries, we compute average size of windfall index (Table 4). Oman, Angola, and Libya experienced the highest average windfall, while Iceland, Jordan, and Nepal fall at the bottom. Conceptually, top countries (resource-rich countries) are used as a treatment group with time-varying shocks, while bottom countries (resource-poor countries) are used as a control group with fewer shocks. Our main interest, the impact of windfall shock on welfare, will be mainly governed by resource-rich countries. However, we keep the whole sample, even with net resource importers, to control for global welfare trend over time by the time fixed effect.

Table 4. List of Most and Least Resource-Dependent Countries

Most dependent countries[37]		Least dependent countries	
	Avg. size of windfall		Avg. size of windfall
Oman	0.11918	Iceland	<0.00001
Angola	0.07518	Jordan	<0.00001
Libya	0.06236	Nepal	<0.00001
Iraq	0.06130	Bangladesh	<0.00001
Nigeria	0.05978	Japan	<0.00001
Gabon	0.05787	Albania	0.00012
Kuwait	0.05687	Seychelles	0.00019
Iran, Islamic Rep.	0.05470	United States	0.00019
Congo, Rep.	0.05448	Slovenia	0.00022
Qatar	0.04465	Senegal	0.00023

Sources: Authors' calculation with UNCTAD and NBER-UN data

B. Short-Term-and-Medium-Term Effects

To estimate the short-term and medium-term effects of resource windfall on welfare, we use a panel VAR analysis with the following specification:

$$Y_{i,t} = A(L)Y_{i,t} + \gamma_i + \delta_t + \epsilon_{i,t}$$

where $Y_{i,t}$ is a vector of covariates and $A(L)$ is a matrix of lagged coefficients with lag L. γ_i and δ_t represent country and time fixed effects. We introduce country and time fixed effects to control for country-specific time-invariant factors and global time-varying factors.[38]

[37] Top 11-30 countries are as follows: Kazakhstan (0.03885), Venezuela, Yemen, Rep., Papua New Guinea, Suriname, Liberia, United Arab Emirates, Algeria, Syrian Arab Republic, Azerbaijan, Trinidad and Tobago, Singapore, Estonia, Norway, Cote d'Ivoire, Latvia, Cameroon, Fiji, Mongolia, and Ecuador (0.01462).

For this analysis, we specify $Y_{i,t}$ as follows:

$$Y_{i,t} = \begin{pmatrix} \text{Windfall Index} \\ \text{Welfare Index} \end{pmatrix}$$

Note that windfall index is balanced but welfare index is unbalanced at the annual frequency.[39]

For identification purpose, we use a standard Cholesky decomposition with the order given above to construct impulse response functions. The windfall index responds only to its own shock and the second variable (welfare index), responds to shocks to the first variable and to shocks to the second variable. In other words, the welfare index reacts without delay to all shocks in the system.

The relationship between the reduced-form errors and the structural disturbance is given by:

$$\begin{bmatrix} u_{i,t}^{\text{windfall}} \\ u_{i,t}^{\text{welfare}} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ g & 1 \end{bmatrix} \begin{bmatrix} e_{i,t}^{\text{windfall}} \\ e_{i,t}^{\text{welfare}} \end{bmatrix}$$

where lower-triangular matrix is identified by the Cholesky decomposition.[40]

To select appropriate lag length, we checked significance of coefficients up to 5 lags. In every specification, only the first lag coefficients were significant, therefore we use one year lag in the analysis, which has the advantage of preserving the information given the short data span and preserves the degrees of freedom.

We estimate and simulate the system for three different groups of countries: (i) a whole sample (130 countries), (ii) Sub-Saharan African countries (28 countries) and (iii) fragile SSA countries (9 countries). We classify countries as fragile if state fragility index is higher than or equal to 17, as shown in Figure 15.

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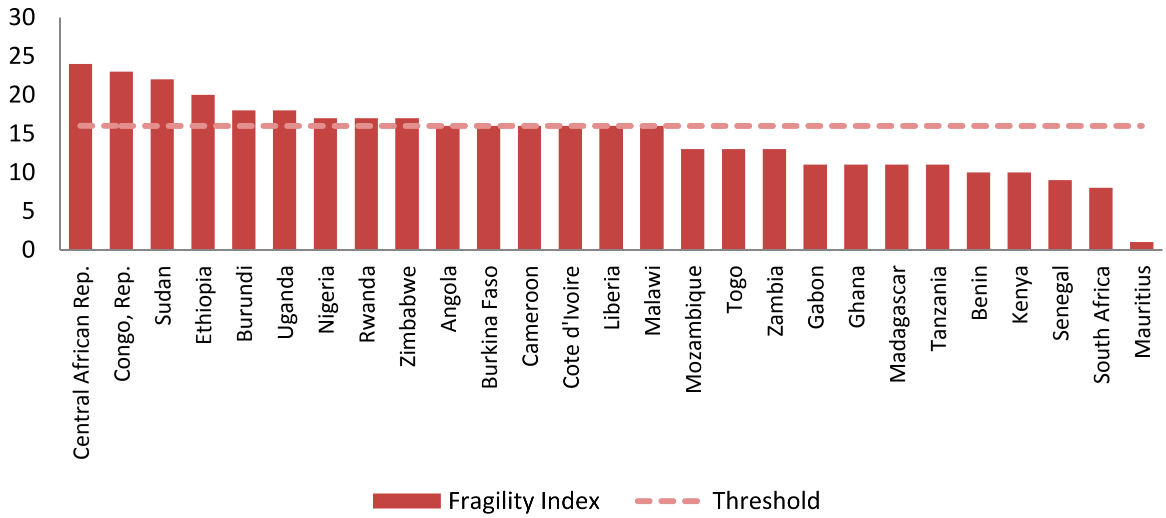
[38] One concern could be omitted-variable bias because there are only two variables in the system. However, omitted-variable bias doesn't hold in this case because the independent variable, windfall index, is exogenous to domestic conditions that affect welfare.

[39] Missing years in the welfare index may cause potential bias. One way to solve this problem is by running the regression over multiple-year averages. However, we work with annual frequency in order to have more power and to find policy implications in the short-term and medium term.

[40] We used the STATA code from Fort, Haltiwanger, Jarmin and Miranda (2013), developed by Ryan Decker based on the original version of PVAR in Love and Zicchino (2006).

Figure 11. Fragile Countries in SSA: State Fragility Index



Source: Center for Systemic Peace.

In the whole sample with 130 countries, short-term and medium-run estimates show improvements in welfare. Figure 16, left-bottom shows the response of welfare to windfall shocks. A one standard deviation shock to resource windfall leads to about 3.4 standard deviation increase in welfare at the peak.[41] One possible concern is whether this result holds for the whole sample period. Especially, given that some countries recently became natural resource exporters due to new discoveries, improvements in technology, or termination of internal conflicts. Therefore, we check for robustness of the results in two sub-periods: pre-1980 and post-1980. For 1963-1980, welfare increases by 3.6 standard deviation at the peak after a shock and, for 1981-2007, it increases by 2.5 standard deviation at the peak (Figure 21 and 22 in Appendix). The result is robust but the response has been higher during pre-1980 period.

Figure 17 shows the impulse responses of each component, GDP (top-left), Gini coefficient (top-right) and life expectancy (bottom). GDP increases by 3.8 standard deviation at the peak, and Gini coefficient decreases by 0.2 standard deviation after one standard deviation windfall shock. There is almost no change in life expectancy. However, these results should be interpreted cautiously given the wide confidence interval.

A decrease in inequality in the short-run is consistent with Goderis and Malone (2011), who found theoretically and empirically that income inequality falls in the short run immediately after a resource boom. Their theory is based on the Dutch disease: the resource revenue harms competitiveness of the non-resource export sector, which is relatively intensive in the

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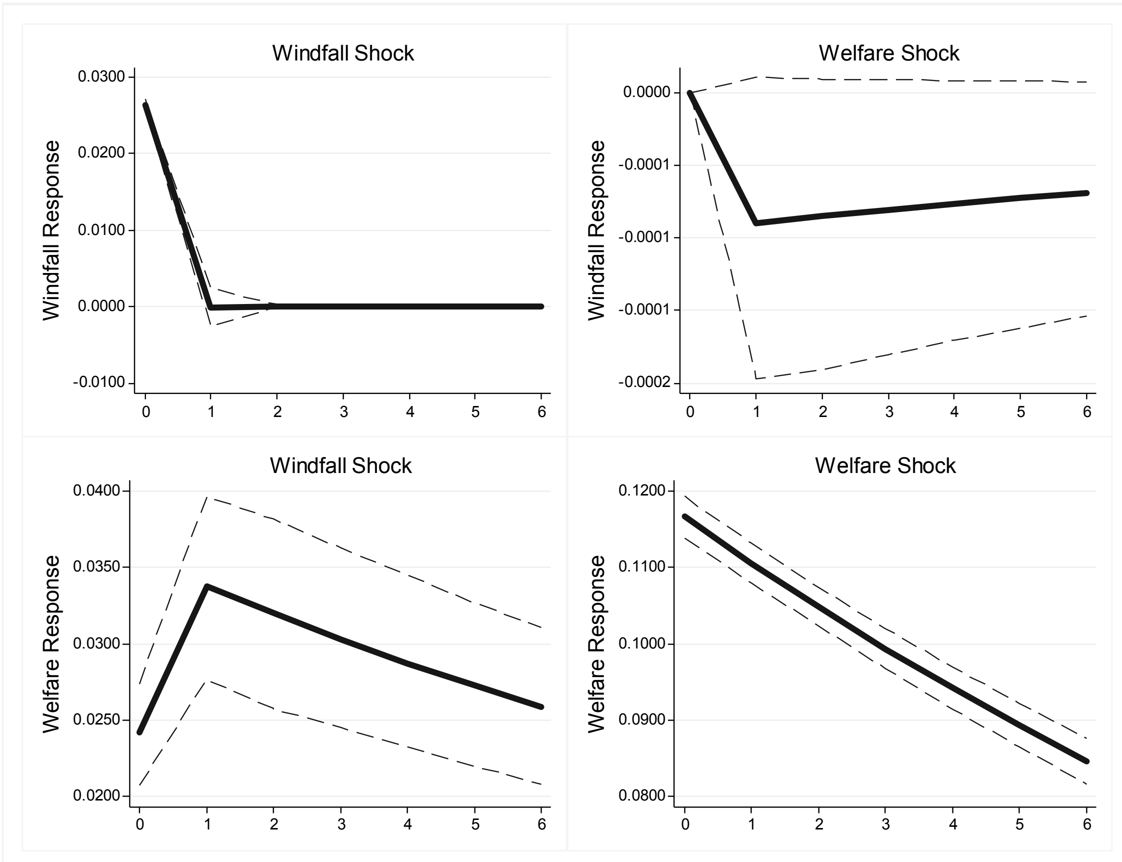
[41] Other information we can read from the figure is as follow: left-top figure (response ofwelfare response to its own shocks) shows that welfare is persistent, while right-bottom figure (response of windfall to its own shocks) shows that windfall is temporary.

use of skilled labor. Thus, income inequality falls after a boom arising from either a discovery or an exogenous world price increases.[42]

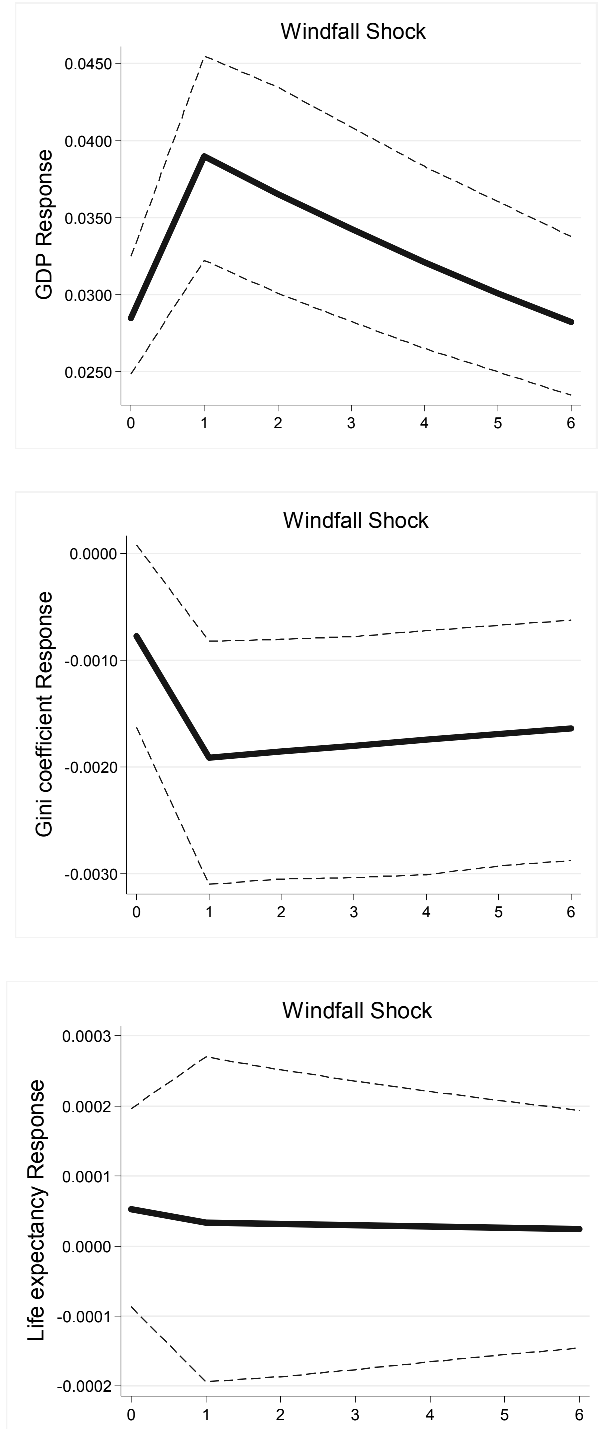
Figure 12. Impulse Responses for All Countries



*The solid lines are point estimates and dotted lines are 95 percent confidence interval.

[42] For further references on natural resource endowments and inequality, refer to Leamer et al. (1999), Sokoloff and Engerman (2000), Gylfason and Zoega (2003), and Ross (2007), among others.

Figure 13. Impulse Response of Each Component for All Countries

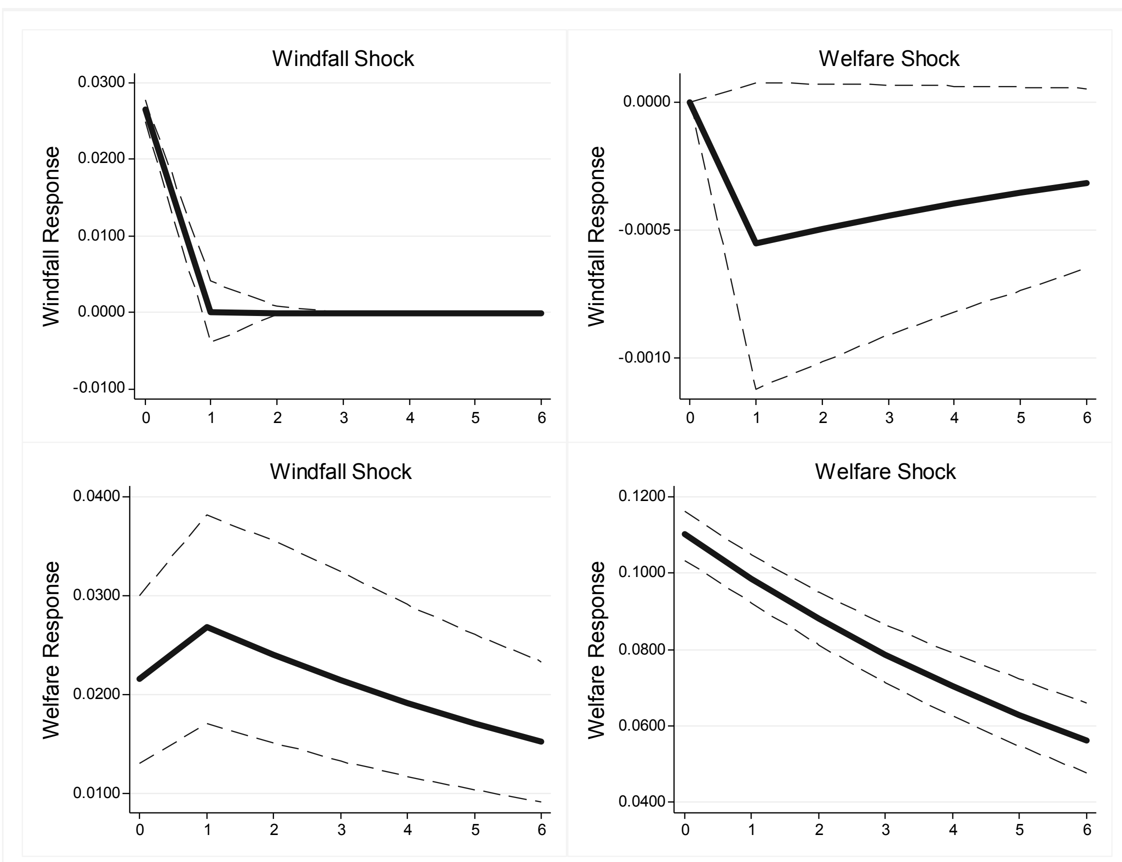


* The solid lines are point estimates and dotted lines are 95 percent confidence interval.

For Sub-Saharan African countries, the effect of resource windfall is welfare enhancing but smaller in size. Figure 18 (left-bottom graph) shows the response of welfare to a windfall shock. In SSA countries, welfare increases by 2.7 standard deviation at the peak after a shock, which is lower than 3.4 in the whole sample. This weaker "resource blessing" might be due to relatively poor resource management, which is predominant in SSA countries. As already mentioned, the resource governance index in Sub-Saharan Africa (43.8) is lower than world average (50.59) and OECD average (87.7) (Figure 6). Some countries negotiate poor terms with extractive companies, forsaking potential long-term benefits (Revenue Watch Institute, 2013). And even when resource revenues end up in the government, they are not always spent in ways that benefit the public. Rent seeking in SSA countries has benefited only a small group of elites or vested interests, leaving the masses excluded from the benefits of growth (IMF, 2013).

Furthermore, a confidence interval is wider, suggesting that we cannot statistically take a positive point estimates and there might be heterogeneity across countries within Sub-Saharan Africa. One possible source of heterogeneity across countries is the quality of institutions. So, we investigate the result in fragile SSA countries.

Figure 14. Impulse Responses for SSA Countries



*The solid lines are point estimates and dotted lines are 95 percent confidence interval.

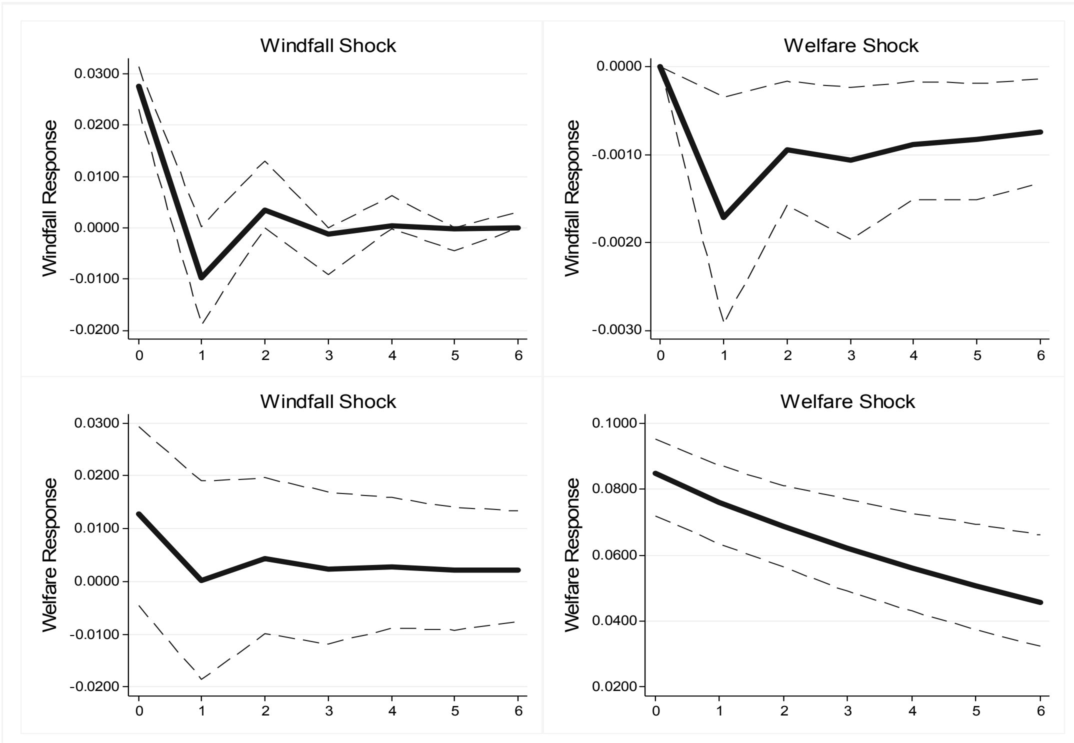
In the case of fragile SSA countries, an increase in welfare after a windfall shock is only temporary and small (Figure 19). In the left-bottom graph, welfare increases in the same year with the shock and, after one year, the response becomes almost zero. A one standard deviation shock in windfall leads to about 1.2 standard deviation increase in welfare in the same period. This response is much smaller than the peak in the whole sample, 3.4, and in the SSA countries, 2.7. This flat response of welfare could also come from good governance, which is not true in our case. If government piled up resource revenue for future generations, then it might have not affected current welfare, especially GDP. However, since the flat response is observed in the fragile SSA countries rather than countries with proper fiscal policy, we can rule out this possibility.

Therefore, fragile SSA countries may have failed to translate the revenue from resource windfall into their standard of living. This finding is consistent with the literature which emphasizes the importance of political institutions in achieving better growth outcomes (see Persson, 2002). Fragile SSA countries keep citizens in the dark regarding government contracts and resource revenues. These less accountable governments may exercise more discretion in the conduct of fiscal policy in turn leading to more macroeconomic instability (Arezki et al., 2011).

The October 2014 Regional economic outlook: Sub-Saharan Africa found that the fragile states commonly have bad quality of budget institutions and low fiscal spaces. These weak fiscal institutions could be the reason behind our finding that fragile states have failed to translate natural resource revenue to welfare growth. Unfortunately, we don’t have a way of decomposing or identifying each policy or institutional dimensions in our current setup. We think this is a very important but also very challenging research question.[43]

[43] Interaction Panel VAR suggested by Towbin and Weber (2013) will be potential analytic tool to answer these questions.

Figure 15. Impulse Responses for fragile SSA Countries



* The solid lines are point estimates and dotted lines are 95 percent confidence interval.

C. Long-Term Effects

In this sub-section, we test for the presence of long-run relationships between resource windfalls and standard of living. We use the ARDL (p,q) model[44] as follows:

$$\Delta Y_{i,t} = \beta_0 + \sum_{j=1}^{p} \beta_j \Delta Y_{i,t-j} + \sum_{j=1}^{q} \gamma_j \Delta X_{i,t-j} + \theta_0 Y_{i,t-1} + \theta_1 X_{i,t-1} + \gamma_i + \delta_t + \epsilon_{i,t}$$

where $Y_{i,t}$ is welfare and $X_{i,t}$ is windfall index. γ_i and δ_t represent country and time fixed effects. The estimations provide a set of short-run coefficients (β_j and γ_j's) and long-run coefficients (θ_0 and θ_1).

The long-run effect of windfall shock is only significant in the whole sample (Table 5). The windfall shock significantly increases welfare in the long-run. In SSA countries however, the coefficient is still positive but not statistically significant. In Fragile SSA countries, the long-run effect is negative with a large standard error.

[44] Autoregressive-Distributed Lag model with two lags p and q. For further reference on the technique, refer to Pesaran and Smith (1995), Pesaran (1997) and Pesaran, Shin and Smith (1999, 2001).

Resource boom is a blessing even in the long run, if it is well-managed. As discussed before, weaknesses in natural resource and macroeconomic management in addition to poor governance in some Sub-Saharan African countries seem to have played an important role. There might have been a long-run "resource curse" in fragile SSA countries for last 45 years. This finding supports the cross-sectional evidence shown in Section II: resource rich countries in Sub-Saharan Africa present not only lower economic performance but mediocre income distribution and health conditions. A lack of inclusive growth policies in resource-rich economies in Sub-Saharan Africa could be due to poor governance.

Table 5. ARDL Estimation Results

	Whole Sample	SSA countries	Fragile SSA countries
Long-run coefficient			
Welfare_{t-1}	-.0299**	-.0078	-.2877
	(.0054)	(.0127)	(.3903)
Windfall_{t-1}	**.7299****	**.4686**	**-1.7954**
	(.1282)	(.2861)	(1.5605)
Short-run coefficient			
$\Delta\text{Welfare}_{t-1}$	.1962**	.1955**	-.1460
	(.0203)	(.0560)	(.2698)
$\Delta\text{Windfall}_{t-1}$	.7183**	.5684**	-1.0149
	(.0886)	(.1932)	(1.0348)
Intercept	-.1067	.0103	-2.8143
	(.0576)	(.1534)	(4.1546)
Country FE	Y	Y	Y
Time FE	Y	Y	Y
No. of countries	130	28	9

Note: The dependent variable is welfare. ** and * represent statistical significance at 1percent and 5 percent levels, respectively.

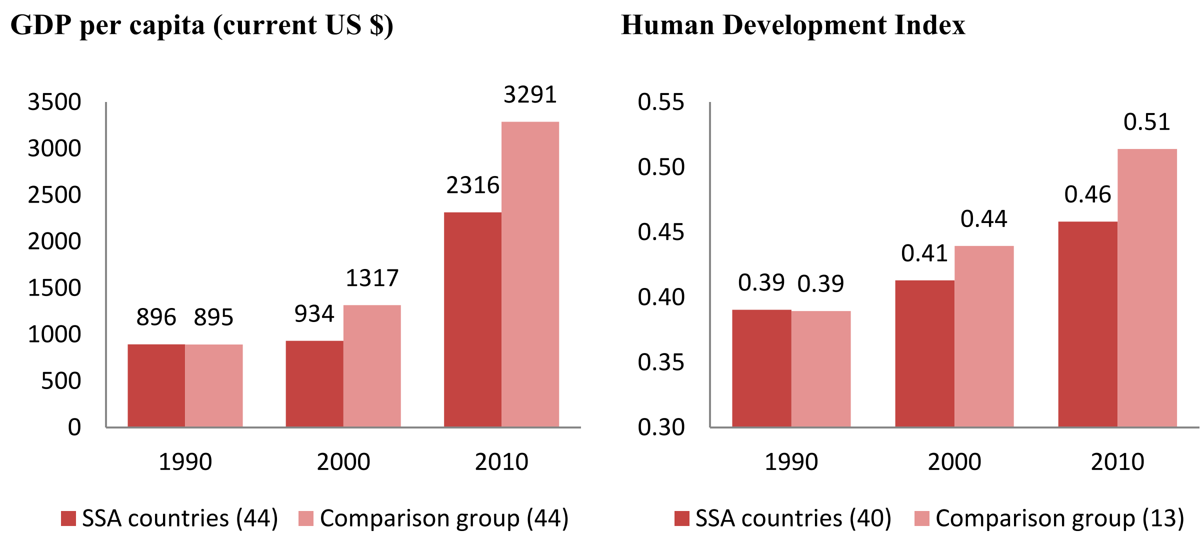
V. POLICY IMPLICATIONS

A key challenge for resource-rich SSA countries is to translate revenue from resource windfall into sustainable growth. Resource rich countries need to understand and exploit the short-run and long-run effects of resource windfall. Resource windfall could improve welfare both in the short-run and the long-run, if it is well-managed. Especially, resource booms could contribute to lowering inequality in the short-run, potentially due to increases in demand for unskilled workers in the non-tradable sector, which provides an opportunity for inclusive growth. Above all, strong institutions and good governance are important in achieving better growth outcomes following resource booms.

We find evidence that resource boom in SSA countries has been less of a blessing both in the short run and long run, and this finding plausible given poor natural resource management and weak institutions in these countries. We suggest that the decrease in inequality after a resource boom could be due to the Dutch disease effects, but it may also be due to improved government transfers following increased resource revenue. This is one possible area for future research. Another area for future research would be to investigate further public expenditure in SSA countries, assessing the role of fiscal policy in SSA countries following resource booms.

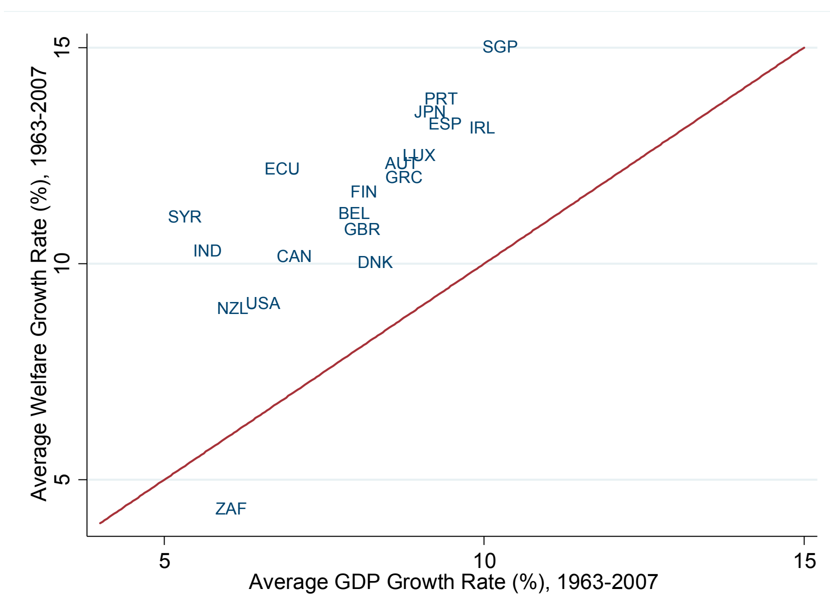
APPENDIX

Figure 16. GDP Per Capita and HDI in SSA Countries, Compared to Comparison Group



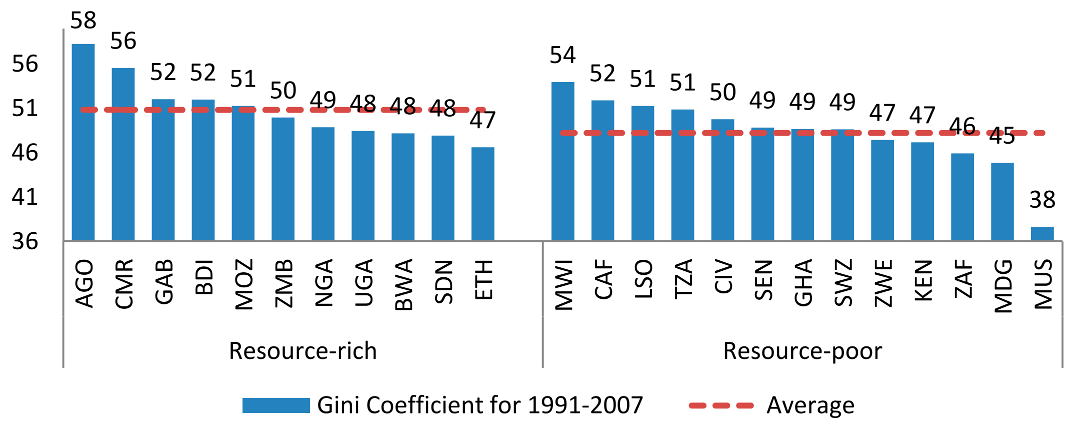
* Comparison groups from other continents are constructed to match 1990 level.
Sources: World Bank World Development Indicators and UNDP.

Figure 17. Welfare Growth Rate and GDP Growth Rate, 1963-2007



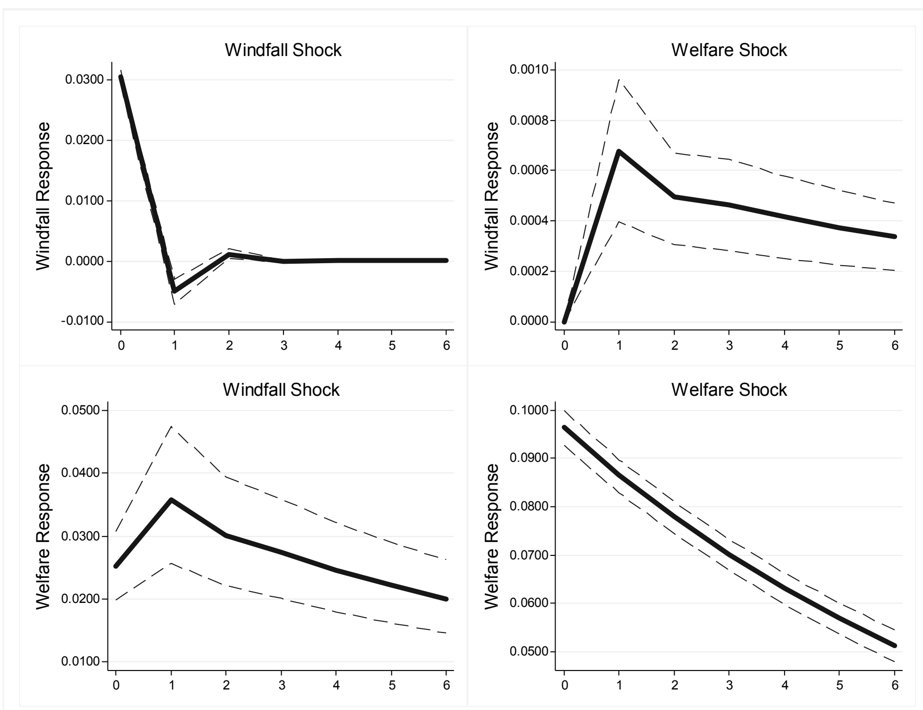
* The straight line is a 45-degree line.
Sources: Authors' calculation with World Bank and EHII data.

Figure 18. Average Gini Coefficients for 1991-2007: Resource-Rich and Poor Countries



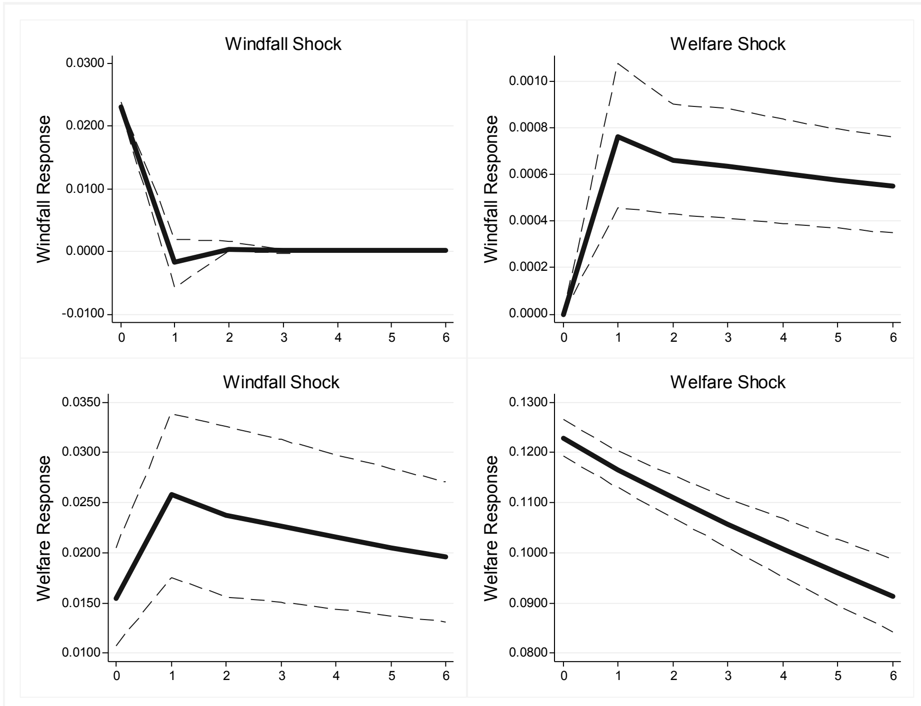
Sources: Authors' calculation with World Bank and EHII data.

Figure 19. Impulse Response for All Countries (1963-1980)



* The solid lines are point estimates and dotted lines are 95 percent confidence interval.

Figure 20. Impulse Response for All Countries (1980-2007)



* The solid lines are point estimates and dotted lines are 95 percent confidence interval.

Table 6. List of Commodity Prices

No.	Commodity	Detail	Period
1	Aluminum	high grade, London Metal Exchange, cash	60-13
2	Beef	Australia & New Zealand, frozen boneless, U.S. import price FOB port of entry (¢/lb.)	60-13
3	Coffee	composite indicator price 1976 (¢/lb.)	60-13
4	Cocoa	average daily prices New York/London (¢/lb.)	60-13
5	Copper	grade A, electrolytic wire bars/cathodes, London Metal Exchange, cash (£/t) wire bars, U.S. producer, FOB refinery (¢/lb.)	60-13
6	Cotton	Sudan Barakat, X4B, CFR Far Eastern quotations (¢/lb.) U.S. Memphis/Eastern, Midd.1-3/32", CFR Far Eastern quotations (¢/lb.) U.S. Memphis/Orleans/Texas, Midd.1-3/32", CFR Far Eastern quotations (¢/lb.) Pakistan Sind/Punjab, SG Afzal, 1-1/32", CIF North Europe quotations (¢/lb.) Egypt, Giza 88, good +3/8, CFR Far Eastern quotations (¢/lb.)	60-13
7	Gold	99.5 percent fine, afternoon fixing London ($/troy ounce)	70-13
8	Iron	Brazilian to Europe, Vale Itabira SSF, 64.5 percent Fe content, FOB (¢/Fe unit)	60-09
9	Maize	Argentina, Rosario, FOB United States, yellow n° 3, FOB Gulf	86-13
10	Oil	average of UK Brent (light)/Dubai (medium)/Texas (heavy) equally weighted ($/barrel) UK Brent, light blend API 38°, FOB UK ($/barrel) Dubai, medium, Fateh API 32°, FOB Dubai ($/barrel)	60-13
11	Rice	Thailand, white milled, 5 percent broken, nominal price quotes, FOB Bangkok	60-13
12	Rubber	n°1 RSS, in bales, FOB Singapore TSR 20, New York	60-13
13	Sugar	average of I.S.A. daily prices, FOB Caribbean ports (¢/lb.)	60-13
14	Tea	Kenya, BPF 1, Mombasa auction prices (¢/kg)	93-13
15	Tobacco	unmanufactured, U.S. import unit value	60-13
16	Wheat	Argentina, Trigo Pan Upriver, FOB United States, n° 2 Hard Red Winter (ordinary), FOB Gulf	60-13
17	Wood	Non-coniferous woods, U.K. import price index 2005=100, dollar equivalent	91-13

* All commodity prices are in constant US dollars.

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