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The fate of the poor in growing mineral and energy economies ☆

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ABSTRACT

There are frequent suggestions that countries specializing in mineral and energy extraction have a type of growth that is bad for the poor. Others claim that extraction-led growth is particularly good for the poor. Both claims are made without the support of substantial empirical evidence. This paper uses longitudinal data on income growth by quintile in 57 developed and developing countries to statistically assess how mineral and energy extraction has affected the relationship between growth and the poor. We can find no evidence that the data support either the claim that extraction-led growth is good for the poor or that extraction-led growth is bad for the poor. This finding does not rule out that extractive activity can have special positive or negative impacts on the poor in some countries or regions. Rather, it simply brings to light that such effects are not evident as a persistent statistical phenomenon in the national level data that are available, which may be why the debate tends to move along without resolution.

> The economic plight of Botswana's poor has worsened as a direct consequence of the mining sector's success. Curry (1987, p. 1).

> Mining can contribute to poverty reduction in a variety of ways. … In countries such as … Botswana…, substantial positive fiscal impact from mining has contributed to economic and social development. Weber-Fahr et al. (2002, p. 442).

Introduction

This paper empirically investigates whether economic growth in countries that have substantial mineral or energy extraction has a greater or lesser tendency to be pro-poor than in countries that have less extractive activity. Several political scientists and non-governmental organizations claim that extraction activity and extraction-led growth are particularly bad for the poor. The World Bank and the mining industry, and to a more muted extent the oil and gas industry, counter-claim that extraction-led growth has for the most part been good for the poor. The claims on both sides are largely being made without the benefit of substantial empirical investigation. To paraphrase Sherlock Holmes, one should never theorize before one has the facts. Given the absence of clarity on the impacts of extraction on the poor, there have been calls from both sides for more research on the issue (e.g., Weber-Fahr, 2002; Karl, 2007; Ross, 2007).

Our empirical examination of the available data finds no statistically significant positive or negative impact of the level of resource extraction on the pro-poor nature of economic growth. That is, the relationship between positive or negative growth and changes in the welfare of the poor are not conditional on the level of extractive activity in a country. There is, however, evidence that countries with *growing* extractive activity have a higher probability of a pro-poor outcome during a given positive or negative growth spell.[1] The statistical significance of this result is weak enough that we do not see it as confirming the industry position. While normally an empirical analysis that fails to find any statistically significant pattern in the data would be considered uninformative, in this case, the results recommend caution

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[1] A growth spell is defined as positive or negative economic growth between two periods in time, and represents one data point.

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when designing national development policies around claims that mining and energy extraction has special positive or negative impacts on the poor.

A review of the claim and counter-claim

Mineral and energy extraction can have both concurrent and lagged impacts on a nation's economic and social outcomes. Most research to date has focused on the lagged relationship between an initial and possibly ephemeral extractive boom and the rate of economic growth or development over subsequent decades. That research is largely supportive of a "resource curse," whereby future economic growth and human development is impeded by earlier extractive activity.[2]

With regard to concurrent impacts, which are of interest here, there is a strongly held belief that mineral and energy dependence "produce a type of economic growth that offers few direct benefits to the poor," and "make pro-poor forms of growth more difficult" (Ross, 2001, p. 16).[3] Mineral and energy economies have experienced positive long-run economic growth as their extractive sectors develop and expand (Alexeev and Conrad, 2009), and growth tends to be good for the poor (Dollar and Kraay, 2002; Kraay, 2006; World Bank, 2001). The anti-extractive literature simply counters that economic growth in extractive economies is not as good for the poor as it is in non-extractive economies, and may even be anti-poor. This is then proposed to be the cause for the high rates of poverty and inequality found in the developing nations that are intensive producers of minerals and energy. The alleged negative impacts variously include a higher probability of increasing income inequality, decreasing employment and real income for the poor, and decreasing public sector expenditures on health care and public education. On the other side of the debate, the International Council on Mining and Metals, a mining-industry-sponsored organization, is bullish on the prospects for mining-led reductions in poverty and illustrates its point through an investigation of selected case studies (McPhail, 2008, 2009). The oil and gas industry's support for extraction and poverty reduction takes the form of full-page advertising in the popular press and statements on their corporate web pages.

In this tug of war the negative views have predominated. At the beginning of the century recommended policy varied, but in some cases was as drastic as calls for a complete overhaul of the state apparatus regulating mining and energy production and the diversification away from non-renewable extractive activity. Exemplifying the bite of these calls for reform, the World Bank, a traditional supporter of mining and energy projects in developing countries, initiated internal and external reviews of the wisdom of such support (World Bank, 2003). The external review suggested that the Bank's support for coal mining and petroleum extraction be phased out due to their negative effect on poverty. Even so, the World Bank has continued to promote mining and energy extraction as having positive concurrent impacts on the poor.[4] Current thinking on the general matter of extraction and the poor is strongly centered on the role of transparency, institutions and capacity building, with additional suggestions to develop agriculture and rural non-resource sectors to improve employment opportunities for the poor (Africa Development Bank, Organization for Economic Cooperation and Development, United Nations Development Programme, and United Nations Economic Commission for Africa, 2011; Hilson and Maconachie, 2009; McFerson, 2009; Pegg, 2009; World Bank, 2012).

The literature on resource extraction and the poor

Cross-country econometric analyses have found that *on average* the incomes of the poor rise with rising average incomes (e.g., Dollar and Kraay, 2002; Kraay, 2006). As Ravallion (1997, p. 1812) notes, "An average is just that," and there are certainly countries in which the income of the poor has fallen despite long periods of positive economic growth (Lal and Myint, 1996; Page, 2006).[5] The early analyses of disparities in the impacts of growth on poverty did not find any statistical regularity that explains the relatively high variation in cross-country poverty outcomes for a given growth rate (Chen and Ravallion, 2001; Dollar and Kraay, 2002). Notably, they did not single out mineral and energy extraction as being a significant determinant of the disparate outcomes. This leads Kraay (2006, p. 220) to state that "the search for pro-poor growth should begin by focusing on determinants of growth in average incomes," rather than focusing on idiosyncratic sectoral effects. [6] White and Anderson (2001) suggest that any sectoral influences are likely to be country-specific and thus not broadly evident.

An anti-poor bias in extractive-country growth may nevertheless arise due to a series of concurrent dynamic sectoral mechanisms as the extractive resource sector grows and Dutch Disease pressures ensue. These mechanisms have been loosely suggested to be: A crowding out of environmental resources, like fresh water, that the poor rely upon (Amuzegar, 1999; Curry, 1987; Power, 2008; Slack, 2009); downward pressure on wages due to a capital-intensive export base (Lal and Myint, 1996, pp. 187–188); displacement-induced poverty as landowners are resettled (Downing, 2002); and a reduction in agricultural sector jobs through Dutch disease effects, agriculture being a sector that is suggested to have special importance in reducing poverty (Ross, 2007; World Bank, 2008). Extraction-led or accompanied growth is also suggested to result in a reduction in manufacturing jobs that favor women, older workers and the poor (Collier, 2007; Ross, 2004a, 2007). Some empirical studies have found manufacturing-led growth to be especially favorable to the poor (Birdsall and Londoño, 1997a, 1997b), though others have not (Ravallion and Datt, 1996; White and Anderson, 2001). On a positive note, extraction takes place mainly in rural areas. Improvements in poverty have been shown to be realized when

[2] See Davis and Tilton (2005), Frankel (2010), and van der Ploeg (2011) for a review of the literature and theories relating to the resource curse. Recent empirical investigations suggest that the resource curse may be a statistical artifact (Brunnschweiler and Bulte, 2008; Lederman and Maloney, 2007; van der Ploeg and Poelhekke, 2010) or at least only a short-run problem during periods of declining extractive output after the initial resource boom (Alexeev and Conrad, 2009; Davis, 2011; James and James, 2011).

[3] See also Christian Aid (2003), Curry (1987), Karl (2007), Africa Development Bank, Organization for Economic Cooperation and Development, United Nations Development Programme, and United Nations Economic Commission for Africa (2011), Page (2006), Pegg (2006), Power (2002, 2008), Ross (2003), UNCTAD (2002).

[4] See Weber-Fahr (2002), Weber-Fahr et al. (2002) and Pegg (2003) for a review of the Bank's traditional position regarding mining and energy extraction and the poor. The World Bank's response to the Extractive Industries Review can be found at http://siteresources.worldbank.org/INTOGMC/Resources/finaleirmanagementresponse.pdf.

[5] Page (2006) measures progress for the poor as increasing income of the bottom quintile, while Ravallion (1997) defines the poverty rate as the headcount index of those living on less than $1/day at 1993 Purchase Power Parity.

[6] Kraay's sample contains many mining and energy economies, including Nigeria, Chile, Indonesia, Niger, Venezuela, and Peru. Visual inspection of the residuals in the middle panel of his Figure 4 does not reveal any particular clustering of the these economies as outliers. Nor does Lal and Myint's (1996) case study analysis identify extractive economies as being subject to any systematic deviation from the normal growth and poverty reduction relationship.

rural primary sector activity in aggregate ramps up (Ravallion and Datt, 1996).

Challenges and opportunities can also be created by the mere presence of a large domestic extractive sector within a country, an initial condition effect. According to some, the political and socio-economic conditions for pro-poor growth are less likely to exist in extractive economies. For example, extractive economies may have high income inequality (Figueroa, 2009; Gylfason and Zoega, 2003; Leamer et al., 1999; Ross, 2001; Sokoloff and Engerman, 2000), perhaps due to their higher economic volatility (van der Ploeg, 2011). Not only can this lead to unrest in mining-dependent provinces when certain inequality thresholds are exceeded (Booth, 2003; Figueroa, 2009), but there is also evidence that initial income inequality reduces growth and reduces the pro-poor nature of growth (Bourguignon, 2003; Ravallion, 1997, 2012; White and Anderson, 2001). Extractive economies may also have weaker institutions that have no political will or ability to deal with poverty and inequality (Karl, 2007).[7] Rent-seeking, corruption and the possibility of civil wars are associated with high levels of extractive activity (Karl, 2007; Ross, 2004a), and one would therefore not expect growth spells in extractive economies to have the same benefits for the poor as in other countries. On the other hand, the presence of a high rent "cash cow" sector provides opportunities for poverty relief in tough times, reducing the chance that slow or negative economic growth will be anti-poor. In Botswana, mining revenues funded the government's drought relief program that prevented rural poverty from increasing during the 1979 to 1988 drought (Valentine, 1993). State-owned oil companies sometimes fund massive social programs directly (Ellsworth, 2004). Extractive jobs can also provide an opportunity for income diversification. Interviews of more than 1500 households in 35 villages in northern India found diversification away from agricultural income sources to be the single most important factor in households moving out of poverty (Krishna, 2004). Working for wages in the mining sector is specifically mentioned by Krishna as an income-diversifying household activity.

There have been very few studies that actually measure the fate of the poor in growing extractive economies. Davis (1995) and Sachs (2007) claim that mineral- and oil-producing nations are generally better off than the mineral- and oil-poor nations in many categories of well-being, though do not specifically mention the plight of the poor. Booth (2003) reports relatively low rates of poverty in the mining provinces in Indonesia compared with the non-mining provinces. Davis (2004) measures \$1/day and \$2/day poverty rates in a cross-section of 153 countries and finds that mining and energy economies have high levels of poverty due to their relatively low levels of GDP per capita. Even so, compared with non-extractive economies that are also poor, mining and energy economies actually have lower levels of poverty than expected due to reduced income inequality. Goderis and Malone (2011) support this finding in a model where wages of unskilled workers in developing mining- and oil-intensive countries will increase relative to the wages of skilled workers during a resource boom, causing a temporary reduction in income inequality. Their empirical testing across a panel of 90 countries confirms the proposition. Davis (2009) examines the fate of the poor during 240 positive and negative growth spells in 88 countries and finds that there is a higher chance of decreased poverty and inequality in extractive economies than in non-extractive economies during positive growth spells. All of these studies indicate that the poor in mining and energy economies have been helped by the extractive activities. A more equivocal study is that of Loayza and Raddatz (2010), who perform a sectoral analysis on a cross-section of growth spells in 51 countries and find that mining sector growth has no statistically reliable positive or negative impact on poverty after controlling for the impacts of growth in the general economy on poverty.[8] On the negative side, Amuzegar (1999, 219), after reviewing the performance of the 13 OPEC countries from 1974 to 1994, asserts that incomes per capita rose as a result of rising oil revenues, but that income inequality grew as well. Ross (2001) measures several dimensions of poorness and finds that the indicators are worse in mining and energy economies than in other economies with the same level of per capita GDP.

Our paper adds to this literature by directly examining the pro-poor quality of growth in extractive economies. It has three methodological innovations. First, we expand the analysis of the plight of the poor during growth spells to include changes in income inequality as a proxy for conditions like voicelessness and powerlessness. Second, we simultaneously control for mining and energy sector growth and level (an initial condition) so that these two effects can be disentangled. Finally, with the exception of Goderis and Malone (2011), the related studies that are empirically based (e.g., Davis, 2004, 2009; Loayza and Raddatz, 2010; Ross, 2001) have used cross-sectional data. As Haber and Menaldo (2011) point out, it does not make much sense to draw inferences about processes that are purported to happen within countries over time from techniques that are primarily driven by the variation between countries. We therefore use panel data to examine the longitudinal effects of extraction-led growth. The need for longitudinal studies of resource extraction and poverty outcomes is identified in Freudenburg (1992) and Ross (2007). Easterly (1999) also makes a general case for longitudinal studies of development outcomes during growth episodes. The use of panel data allows for the impacts of changes in extractive intensity on the poor to be identified and separated out from general changes in the economic environment.

Defining pro-poor and anti-poor growth

Our first task is to determine what the extractive industry's proponents and critics mean by "pro-poor" and "anti-poor" growth. White and Anderson (2001) suggest that pro-poor growth implies that positive economic growth increases the absolute income of the poor *and* decreases relative income inequality. They give the example where the poor, arbitrarily defined as those in the first income quintile in a country, initially have an income share of 6%. The rich, defined as those in last income quintile, initially have an income share of 35%. If 7 cents of a dollar's worth of growth goes to the poor and 34 cents goes to the rich, this is pro-poor growth because it increases the income of the poor *and* decreases the relative income gap. Income-related measures of poorness are plentiful, and of use to our study, but there are many other dimensions by which the poor could be said to be made better off or worse off. The World Bank's (2001) landmark study in this regard mentions deprivations in health and education, vulnerability, and voicelessness and powerless. Sen (1997, p. 212), one of the main proponents for moving beyond simple income measures of poverty, notes that "relative deprivation in terms of incomes can yield absolute deprivation in terms of capabilities," and argues for distribution-adjusted poverty measures, even if it removes some of the precision of the standard income-based poverty measures. Duclos (2009) provides additional support

[7] Brunnschweiler and Bulte (2008) argue that weak institutions create a comparative advantage in extractive activity, rather than extractive activity creating weak institutions. If this is the case, one would still expect extractive economies to have a higher frequency of anti-poor growth outcomes, although one would not blame resource extraction activities in this case.

[8] It is not clear whether the mining sector includes energy extraction in their work.

for this argument. International development organizations also equate development progress with the twin outcomes of reduced income poverty and reduced income inequality (Asian Development Bank, 2004; United Nations Development Programme (UNDP), 2003). These proposals would seem to be aligned with the commentary on the pro-poor nature of extractive activity. The critics of mining and oil make a particular point of noting rising inequality as extraction proceeds (e.g., Slack, 2009). We, therefore, start by qualitatively defining pro-poor growth as growth that simultaneously decreases absolute income poverty *and* decreases relative income inequality.[9] The inclusion of the pro-inequality outcome, though not traditional, is a nod to requiring that non-monetary measures of poorness be included. Our assumption is that Sen is right, and that we can pick up absolute deprivations such as voicelessness and powerlessness by measuring relative income inequality. We define anti-poor growth as simultaneously increasing income poverty *and* increasing relative income inequality. We also perform a more traditional analysis and separately examine poverty and inequality changes associated with extractive activity during a growth spell.

Measuring pro-poor and anti-poor growth

The inclusion of inequality within a measure of the pro-poor nature of growth creates a challenge in adopting an algorithm that measures pro-poor growth (Sen, 1997). Given that the language of the debate over pro-poor outcomes uses the dichotomous "good, bad," our first guiding criterion is that the measure of growth quality creates a binary indicator. A second desirable criterion is that categorization as a pro-poor growth spell be unequivocal.

Research that has focused on pro-poor growth often looks at whether the income share of the lowest one or two quintiles increases during a growth spell (White and Anderson, 2001). This satisfies the criterion that the measurement be binary, but not the criterion that the relative income gap decrease. Case A of Table 1 shows White and Anderson's example of pro-poor growth, noted above. Initial income across the country is 100, and the initial income share of the poorest quintile is 6%. After one dollar of growth, the lowest quintile's income share is higher and the relative income ratio between the highest and lowest income quintiles is lower. In fact, the income share of the poor has increased no matter where one draws the poverty line. The Lorenz curve has also shifted up, indicating less country-wide inequality. But Case B, which distributes the income growth differently at the upper income levels, shows that it is not enough just to track the income share of the lowest quintile; the large income flow to the rich in Case B has meant that whilst the lowest quintile is as rich in case B as it is in case A (growth has been pro-poverty), the income gap between the poorest quintile and the richest quintile has widened (growth has not been pro-equality). Moreover, if one defines the poor as being the lowest three income quintiles, their cumulative income share has fallen ($35.23/101 < 35/100$) and the income gap has widened ($35/35 < 35.426/35.220$). To be sure that growth has both beneficial income *and* equality effects one must track not only incremental income to the poor but incremental income for all income groups.

Son (2004) has developed an algorithm for evaluating pro-poor growth that is both binary and includes these full inequality effects by tracking income changes across all income groups. It also creates unambiguous measures of poverty reduction, holding for all poverty measures and poverty lines. Son's method relies on the generation of a "poverty growth curve," $g(p)$,

$$g(p)_{i,t} = \frac{1}{\tau}\ln\left(\frac{RGDPCH_{i,t+\tau} I(p)_{i,t+\tau}}{RGDPCH_{i,t} I(p)_{i,t}}\right) = \frac{1}{\tau}\ln\left(\frac{RGDPCH_{i,t+\tau}}{RGDPCH_{i,t}}\right) + \frac{1}{\tau}\ln\left(\frac{I(p)_{i,t+\tau}}{I(p)_{i,t}}\right), \quad (1)$$

where $g(p)$ is the real per capita growth in cumulative income up to the pth percent income level during a growth spell, $I(p)$ is the cumulative income share up to the pth percent income level in the ith country at time t, $RGDPCH$ is the real GDP per capita in that country, and τ is the length of the growth spell. Since $I(100)=1.00$, $g(100)$ is the growth of real GDP per capita during the spell. Using this poverty growth curve and its relation to computations for the Lorenz curve, growth spells may be characterized as pro- or anti-poor using the algorithms described in Table 2. The algorithm for pro-poor growth is consistent with rising income shares,[10] only with the change in income share tracked across *all* cumulative income quintiles to make sure that there are no undesirable income inequality effects. Case A in Table 1 is unambiguously pro-poor according to the calculations of $g(p)$ for that case, since $g(p) > g(100)\ \forall p < 100$. The categorization is logical, as under this scenario relative income gaps are falling and incomes are rising. The check on income inequality is picked up by the upward shift in the entire Lorenz curve. Case B in Table 1 is an "ambiguous" growth spell, since $g(p) < g(100)$ for $p=60\%$ and $p=80\%$. It is ambiguous because the growth spell increases incomes of the poor but widens the income gap between the poor and the rich. The widening income inequality is picked up by the upper end of the Lorenz curve shifting downwards.

The algorithms in Table 2 will thus guide our initial classifications of growth spells as being pro- or anti-poor. When we look separately at poverty and inequality impacts we will characterize growth spells as unambiguously pro-poverty, anti-poverty, pro-equality, or anti-equality using Son's poverty growth curve and the algorithms described in Tables 3 and 4 (Son, 2004; Davis, 2007). The growth spell in Case A in Table 1 is unambiguously pro-poverty, since income for all quintiles has risen ($g(p) > 0 \forall p < 100$), and it is also unambiguously pro-equality, since income gaps have fallen ($g(p) > g(100) \forall p < 100$) as reflected by the upward shift in the entire Lorenz curve. The growth spell in Case B is also unambiguously pro-poverty ($g(p) > 0 \forall p < 100$), but its impact on equality is ambiguous since the income gap between the poor and the rich increases while the gap between the poor and the middle class decreases ($g(p) < g(100)$ for $p=60\%$ and $p=80\%$).

The data

Measuring pro-poor growth brings with it challenges not only in deriving a quantitative measure of pro-poor growth, but also with respect to the quality of the longitudinal data on income shares. We have elected to use the World Income Inequality Database v1 (WIID1) and v2 (WIID2) compiled by the World Institute for Development Economics and Research at the United Nations University (UNU—WIDER).[11] WIID is a secondary database which consists of a checked, corrected, and updated version of Deininger and Squire's (1996) database from the World Bank, and it includes new estimates from the Luxembourg Income

[9] Another definition would require that absolute income inequality be reduced. There are virtually no measured growth spells in history that have had a pro-poor outcome under this definition (White and Anderson, 2001).

[10] From (1), $g(p) > g(100) \Leftrightarrow I(p)_{t+\tau} > I(p)_t$, or that income shares are rising in the pth quintile.

[11] UNU-WIDER *World Income Inequality Database*, Version 1.0, September 2000 and Version 2.0c, May 2008, http://www.wider.unu.edu/research/Database/en_GB/wiid/. Version 1.0 is no longer publicly available, but is useful because it contained data for the mineral and energy rich countries that are not available in the newer data set. The data are available from the authors upon request.

Table 1
Measuring the pro-poor nature of a growth spell for a stylized country with an initial income of 100 and 1.00% income growth that is not evenly distributed.

Income quintile	1	2	3	4	5
Initial income ($)	6.000	14.000	15.000	30.000	35.000
Initial income share (%)	6.000	14.000	15.000	30.000	35.000
Initial cumulative income ($)	6.000	20.000	35.000	65.000	100.000
Initial income ratio (rich/poor)	5.833				
Initial income ratio (middle/poor)	2.500				
Initial Lorenz curve	0.06000	0.20000	0.23333	0.65000	1.00000
Growth case A					
Incremental income ($)	0.070	0.150	0.150	0.290	0.340
Incremental income share (%)	7.000	15.000	15.000	29.000	34.000
Final income ($)	6.070	14.150	15.150	30.290	35.340
Final income share (%)	6.010	14.010	15.000	29.990	34.990
Final cumulative income ($)	6.070	20.220	35.370	65.660	101.000
Final income ratio (rich/poor)	5.822				
Final income ratio (middle/poor)	2.496				
Final Lorenz curve	0.06010	0.20020	0.23347	0.65010	1.00000
Growth in cumulative income, *g(p)*	1.17%	1.10%	1.06%	1.02%	1.00%
Growth case B					
Incremental income ($)	0.070	0.150	0.000	0.000	0.780
Incremental income share (%)	7.000	15.000	0.000	0.000	78.000
Final income ($)	6.070	14.150	15.000	30.000	35.780
Final income share (%)	6.010	14.010	14.851	29.703	35.426
Final cumulative income ($)	6.070	20.220	35.220	65.220	101.000
Final income ratio (rich/poor)	5.895				
Final income ratio (middle/poor)	2.471				
Final Lorenz curve	0.06010	0.20020	0.23248	0.64574	1.00000
Growth in cumulative income, *g(p)*	1.17%	1.10%	0.63%	0.34%	1.00%

Table 2
Unambiguous characterizations of the pro- and anti-poor growth spells.

Positive growth spells ($g(100)>0$)	Characterization	Description
$g(p)>g(100)>0 \forall p<100$	Unambiguously pro-poor	Income of poor increases, inequality decreases
$g(p)<0<g(100) \forall p<100$	Unambiguously anti-poor	Income of poor decreases, inequality increases
Negative growth spells ($g(100)<0$)		
$g(p)>0>g(100) \forall p<100$	Unambiguously pro-poor	Income of poor increases, inequality decreases
$g(p)<g(100)<0 \forall p<100$	Unambiguously anti-poor	Income of poor decreases, inequality increases

Table 3
Unambiguous characterizations of pro- and anti-poverty growth spells.

	Characterization	Description
$g(p)>0 \forall p<100$	Unambiguously pro-poverty	Income of poor increases
$g(p)<0 \forall p<100$	Unambiguously anti-poverty	Income of poor decreases (immiserizing growth when growth is positive)

Table 4
Unambiguous characterizations of pro- and anti-equality growth spells.

	Characterization	Description
$g(p)>g(100) \forall p<100$	Unambiguously pro-equality	Inequality decreases (upward shift in the Lorenz curve)
$g(p)<g(100) \forall p<100$	Unambiguously anti-equality	Inequality increases (downward shift in the Lorenz curve)

Study and TransMONEE database, as well as other new sources as they have became available.[12] Atkinson and Brandolini (2001) have noted not only the problems with secondary income inequality data, but also the problems associated with attempts to examine changes in inequality over time using these data given the lack of uniform income survey practices. Our own experience building this data set confirms that the comparability of the data across various surveys, even within a single country, leaves much to be desired. The compilation of WIID has taken into account most of the recommendations made by Atkinson and Brandolini (2001) regarding the proper building of secondary data sources for income distribution studies. It is recognized in the literature that the WIID is the best available source to carry out income distribution and growth studies at a country level.[13] Nevertheless,

[12] See UNU-WIDER (nd) and Mukhopadhaya (2004) for further details about this dataset.

[13] According to Mukhopadhaya: "The quality of the inequality database [WIID1] for OECD and other developed countries is quite high. For the developing countries, the researchers made considerable efforts to cleanse the data and calculate quite reliable inequality figures. *Despite its minor limitations, the WIID is perhaps the best data set available now for time series inequality examination*. For

we want to stress that there are many researchers who distrust these data, and we use them here only because they are all that is available over the historical time series that is of interest (the period when many of the mineral and energy economies had booming resource sectors).

Our sample contains 169 positive and negative growth spells, by income quintile, across 57 developed and developing economies from 1962 to 1997, the time period that has led to the claims noted at the beginning of the paper.[14] Appendix A contains the list of the economies and the periods of the growth spells. The sample is a pseudo-random sampling from the population of all growth spells in all countries given the requirement that each growth spell had to be at least five years in length and that the full suite of data had to be available at the beginning and end of the spell. The limiting factor in including more countries and growth spells in the sample was the availability of quality extractive activity data in some of the poorer countries (cf. Amuzegar, 1999) and the availability of income inequality data in some of the extractive economies. Ross (2007), in particular, has noted this latter limitation in moving the debate forward empirically. The 169 growth spells range from 5 to 28 years, and average 6.9 years. They are computed in real dollars, using chain-indexed 1985 PPP exchange rates.[15] Much of the country coverage spans thirty year or more periods over which countries dramatically increased their extractive activity, providing a very relevant set of data for the analysis at hand. Data for mineral and energy extraction are from the World Bank (2007). Our dataset does not have enough observations of oil economies to carry out statistically meaningful econometric analyses that separate oil and mineral states into two different samples, and so we combine mining and energy into an aggregate extractive sector. In addition, the primary data source does not contain measures for individual mineral and energy commodities. In this regard, our results are limited due to aggregation.[16]

As we noted above, the income distribution data, $I(p)$, used to calculate $g(p)$ in Eq. (1) are secondary survey data reported by WIID1 and WIID2. Income inequality data are infrequent for many extractive economies, and so in some of the early growth spells for these economies we have had to use inequality surveys that are ranked as "unreliable" by WIID given that there was not much to choose from. Even so, most of the survey data that we use are identified as "quality" data, and only 2% of the growth spell data are considered unreliable. We elect to keep these early growth spells in the data set to bolster the sample size.[17]

Table 5
Association between type of economy and the number of pro-poor growth spells.

Extractive economy?	Type of growth: Other	Pro-poor	Total
No	86	49	135
Yes	22	12	34
Total	108	61	169
LR $\chi^2(1)$	0.012		
p-value	0.913		

Of the 169 growth spells, we characterize 61 as unambiguously pro-poor using Son's algorithm (Table 2). These are listed in bold in Appendix A. Nigeria, for example, had an unambiguously pro-poor growth spell from 1992 to 1997. The pro-poor growth spells coincided with positive economic growth in all but three cases, one of which is the Nigerian case just mentioned, where growth averaged -0.2%/yr over the five year growth spell. There are 15 unambiguously anti-poor growth spells, listed in italics in Appendix A. Nine of these coincided with negative economic growth. The other six occurred during positive but lackluster growth, mainly below 2%/yr. This correlation of pro-poor outcomes with the level of overall growth is consistent with previous findings that growth tends to be good for poverty when it exceeds 2%/yr (Deininger and Squire, 1996). The remaining 93 growth spells (55%) are characterized as having ambiguous effects on the poor due to conflicting income and inequality effects, as with illustrative Case B in Table 1.

That over half of the recorded growth spells in our sample have ambiguous effects on the poor causes us to immediately question statements on general tendencies about the quality of growth in extractive economies. For these ambiguous data points, the impact of growth on the poor is at the discretion of the analyst. Some spells have increasing poverty but decreasing inequality, for instance, and one analyst may focus on positive inequality effects while another may focus on negative income effects. Our task is to examine whether there are any statistical regularities between extractive activity and the remaining 45% of growth spells that we identify as being unambiguously pro- or anti-poor, since it is only here that there are uniquivocal statements about how the poor fared over time.

As a first pass at this, Table 5 parses the pro-poor outcomes against whether or not a country in our sample is defined as extractive by Davis (1995, Table 1).[18] In a Likelihood Ratio Chi-Square test for a two-way table, the null hypothesis is that the rows and columns in the table are independent. The Chi-Square p-value of 0.913 indicates a failure to reject the null. When we perform the same test for anti-poor growth spells (Table 6), we also fail to reject that the rows and columns are independent. These results indicate that the 14

(*footnote continued*)
cross-country investigation as well this data set, within its limitation, is immensely helpful" (2004, p. 233), italics added.

[14] Though small, the number of countries considered in our analysis is around the sample size of other studies on the subject, such as that by Sachs and Warner (1997), who considered as few as 52 countries in their cross-section growth analysis. Ross (2001) uses 51 countries, as do Loayza and Raddatz (2010).

[15] In some cases, the growth spells extend beyond the 1985 PPP series, in which case we used 1996 PPP data to index real growth in the later years in a continuous series. We use PPP figures from the Penn World Tables v.6.1 (1996 base year) and v.5.6 (1985 base year). This information is available at http://pwt.econ.upenn.edu/php_site/pwt_index.php.

[16] There are suggestions in the literature that oil states might be different from mining states. Karl (2007) makes the argument that oil states are resource-dependent states and are different from other non-oil resource-rich states. Ross (2004b) finds that some of the civil war findings hold for oil but not for other minerals. Petermann et al. (2007) find that resources promote corruption more strongly for oil than for minerals. Presumably, oil price volatility might be higher or more extreme than the price volatility of some other minerals. Oil also often generates larger revenue streams for states than minerals do. Another differentiation that we are aware of is between point source production of high-rent commodities (fuels and minerals) versus diffuse production of low-rent commodities (food and agriculture) (e.g., Bulte et al., 2005; Leite and Weidmann, 1999). There has been no work assessing whether the impacts of growth on the poor in mining economies are different from the oil economies. Nor has there been work comparing low-rent with high-rent resources.

[17] The unreliable data points are the income surveys for Colombia 1964, Costa Rica 1961, 1969, Germany 1969, Nigeria 1959, and South Korea 1971. A sample that excludes the unreliable observations produces virtually identical results to those impacts reported in Tables 8 and 9 below, and as such we are confident that the unreliable observations are not influential data points. The tables from this exercise are available upon request.

[18] The extractive economies are Algeria, Bolivia, Chile, Ecuador, Indonesia, Jamaica, Mexico, Nigeria, Norway, Peru, Trinidad and Tobago, Tunisia, Venezuela, and Zambia.

Table 6
Association between type of economy and the number of anti-poor growth spells.

	Type of growth		
Extractive economy?	Other	Anti-poor	Total
No	124	11	135
Yes	30	4	34
Total	154	15	169
LR $\chi^2(1)$	0.412		
p-value	0.521		

heavily extractive economies in the sample did not have a reliably higher frequency of unambiguously pro- or anti-poor growth spells, providing an early indication that there is nothing in the data to support claims that the level of extractive activity affects the pro-poor nature of economic growth.

Empirically assessing the quality of growth in mineral and energy economies

In this section, we propose a reduced-form econometric framework to further examine the influence of level of extractive activity and change in level of extractive activity on the pro-poor nature of economic growth. The framework is constrained in part by the quality of the income inequality data; we need a method that is robust to inequality measurement error and which can handle binary growth-quality categorizations. A random-effects Logit panel regression suffices.

Assume that the impact of a growth spell on the poor can be measured by an unobserved (latent) continuous variable $d^*_{i,t}$ affected by a vector of explanatory (conditioning) variables $\boldsymbol{X}_{i,t}$ (country "i" in period "t"):

$$d^*_{i,t} = \alpha + \boldsymbol{X}'_{i,t}\beta + u_i + \varepsilon_{i,t}, \tag{2}$$

where u_i represents the specific non-observed attributes that characterize each growth spell for country i, β is a vector of coefficients, and $\varepsilon_{i,t}$ is a stochastic error term. While it is not possible to observe the latent variable, we define a dichotomous variable that assigns a value of one if the latent variable surpasses the threshold φ and zero otherwise:

$$d_{i,t} = \begin{cases} 1 & \text{if} \quad d^*_{i,t} > \varphi \\ 0 & \text{if} \quad d^*_{i,t} < \varphi. \end{cases}$$

It is now possible to build a probabilistic model in order to analyze the probability of a given growth spell having specific characteristics. Let the probability that $d_{i,t}$ equals 1 be:

$$\begin{aligned} \Pr(d^*_{i,t} > \varphi | \boldsymbol{X}_{i,t}) &= \Pr(\alpha + \boldsymbol{X}'_{i,t}\beta + u_i + \varepsilon_{i,t} > \varphi | \boldsymbol{X}_{i,t}) \\ &= \Pr(\varepsilon_{i,t} < a + \boldsymbol{X}'_{i,t}\beta | \boldsymbol{X}_{i,t}, u_i) = F[a + \boldsymbol{X}'_{i,t}\beta], \end{aligned}$$

where F is a cumulative distribution function and $a = (\alpha - \varphi)$. The binary model that results from this derivation is:

$$P_{i,t} = \Pr(d_{i,t} = 1 | \boldsymbol{X}_{i,t}, u_i) = \Pr(\varepsilon_{i,t} < a + \boldsymbol{X}'_{i,t}\beta | \boldsymbol{X}_{i,t}, u_i), \tag{3}$$

where $P_{i,t}$ is the probability that a country i experiences a given outcome in period t.

The probability $P_{i,t}$ is conditioned on the explanatory variables and the non-observed specific attributes of the country. As we noted above, White and Anderson (2001) suggest that sectoral impacts on growth quality are likely to be country-specific. In that regard, to further control for omitted variable bias and to emphasize the longitudinal aspect of pro-poor growth, we use a random effects Logit panel regression.[19] If $u_i | \boldsymbol{X}_{i,t} \sim N(0, \sigma_u^2)$ and $\varepsilon_{i,t}$ follows a logistic distribution, Eq. (2) represents a random effect Logit model (Wooldridge, 2001):

$$F(d_{i,t}, z) = \begin{cases} \frac{1}{1+\exp(-z)} & \text{if} \quad d_{i,t} = 1 \\ \frac{1}{1+\exp(z)} & \text{otherwise}, \end{cases} \tag{4}$$

where

$$z = \alpha + \boldsymbol{X}'_{i,t}\beta + u_i.$$

The estimation procedure of this model requires integration over the values of the random intercept effects, u_i, which cannot be analytically solved because the integral does not have a closed form. However, it is possible to use numerical methods to estimate this integral (Greene, 2002; Wooldridge, 2001).[20] In this paper, we use STATA v11.2 to generate the Logit results.

We now discuss our selection of the vector of conditioning variables, $\boldsymbol{X}$. White and Anderson (2001) test how various conditioning factors affect the change in the income shares of the poorest 20% and 40% income quintiles during 68 positive growth spells. Though they do not measure pro-poor growth spells the same way we do, the higher the change in the income share of the lowest two income quintiles (their measure DQ40), the higher the probability that a growth spell will be pro-poor (our measure), and so their results have some meaning for our analysis.[21] White and Anderson (2001) find that very few conditioning variables are statistically significant determinants of change in income share. This result motivates them to recommend the use of a parsimonious model. By our definition of unambiguously pro-poor growth, and given that our data measure income by quintiles, pro-poor growth requires increasing income and decreasing inequality across the bottom four income quintiles. Increasing income is more likely the higher the level of economic growth. Deininger and Squire (1996) find a strong positive correlation between aggregate growth and changes in income at each income quintile, and Davis (2009) finds a positive correlation between the pro-poor quality of growth and aggregate growth level. Our first conditioning variable is therefore *the rate of average per capita growth* during the growth spell, $g(100)$. This variable also helps control for institutional capability given the widespread belief that better institutions promote better growth,[22] and for the effect that other omitted variables could have on the probability of a pro-poor outcome (Sachs and Warner, 1997). For instance, foreign direct investment (FDI) appears to impact quintile income growth (White and Anderson, 2001), and overall growth is likely related to FDI. To maintain consistency between our growth spell quality measures and overall changes in consumption, our per capita income growth measure is the $g(100)$ variable from the income share survey data. Although our sample includes both positive and negative growth, we pool these spells given past findings that the poverty elasticity of growth appears to be consistent across positive and negative growth spells (Dollar and Kraay, 2002; Ravallion, 1997).

[19] We also tested a fixed effects model. Using Hausman's test, we fail to reject any difference in the regression coefficients. Hausman's $\chi^2(4)$ statistics for the pro-poor and not pro-poor regressions are 3.81 (p-value=0.43) and 1.86 (p-value=0.76). Since the random effects model provides asymptotically more efficient estimators, we prefer it to the fixed effects model.

[20] The literature suggests using the Gauss–Hermite's quadrature method, which consists of a polynomial approximation of the integral. See Geweke (1996).

[21] Growth meets our definition of pro-poor if the incremental income share exceeds the current income share for the lowest four quintiles. The higher the incremental income share of those in the two lowest income quintiles, the greater the probability that it will exceed the initial income share.

[22] See Alexeev and Conrad (2009) and the references therein.

Our aim is not to build a structural model that explains the pro-poor nature of growth, but rather to simply test whether the pro-poor nature of growth is affected by extractive activity. Thus, our other conditioning variables are related to extractive activity. As noted above, extractive economies can suffer a type of growth that is unfavorable to the poor either because of (i) dynamic sectoral effects, where an extraction-led growth spell is not of the same quality as a growth spell driven by, say, increased manufacturing activity, and (ii) initial condition effects, where the impact of extraction on political economy creates unequal sharing of prosperity or unfavorable socio-economic conditions that cause growth spells to be bad for the poor. The second conditioning variable is then the *average change in real extractive exports per capita* during the growth spell. This variable is intended to capture the dynamics of growth spells that are extraction-led. For example, the variable controls for the likelihood that increasing extraction leads to increasing income inequality, which we noted above reduces the chance that a growth spell will be pro-poor.[23] To construct this variable, we first compute the level of real non-renewable exports per capita at the start of the growth spell:

$$RNREp_{i,t} = \frac{(\%O_{i,t} + \%F_{i,t})ME_{i,t}}{PRICE_{i,t}POP_{i,t}},$$

where *ME* represents the free on board (F.O.B.) value of manufactures exported to the rest of the world in current $US (World Bank, 2007), *PRICE*[24] is the price level of GDP in 1996 US$ as measured by the Penn World Table PPP deflator (ver. 6.1) (Heston et al., 2002), and *POP* is population, taken from the World Development Indicators (WDI-2007) (World Bank, 2007). $\%O_{i,t}$ represents the percentage of merchandise exports that are made up of ores and metals. This variable comprises the commodities in the Standard International Trade Classification (SITC) [25] sections 27 (crude fertilizer, stones, sand, gravel, sulphur and unroasted iron pyrites, natural abrasives including industrial diamonds, and other crude minerals), 28 (metalliferous ores and scrap), and 68 (non-ferrous metals). It excludes gold and precious stones.[26] $\%F_{i,t}$ represents the percentage of merchandise exports that are made up non-renewable fuels. The variable comprises the commodities in SITC Section 3 (oil, coal, and natural gas). This has been taken from WDI-2007 as well. The average change in real non-renewable exports per capita in a particular country over a growth spell that starts in period t and is $\tau > 0$ years in length is then:

$$\Delta RNREp_{i,t} = \frac{RNREp_{i,t+\tau} - RNREp_{i,t}}{\tau}.$$

With no reason to believe that there are asymmetric impacts of positive and negative changes in extractive output on the poor – shrinking extractive activity should be pro-poor if expanding extractive activity is anti-poor – we pool positive and negative values of $\Delta RNREp_{i,t}$.

The third conditioning variable is an *extraction level variable* ($\%O_{i,t}+\%F_{i,t}$) that controls for the possibility that extractive economies have static, unfavorable socio-economic (high inequality) or political economy (poor institutions) conditions for pro-poor growth. The variable measures the percentage of merchandise exports that are made up of ores, metals, and non-renewable energy. Because of the volatility in this measure, we follow Brunnschweiler and Bulte (2008) and average it over the time span of each growth spell.[27] Because the developing extractive economies in the sample will have higher extraction measures than the developed extractive economies, the variable also controls for differences in experience across developed and developing countries.

The final conditioning variable is a cross-product term that multiplies the growth in per capita extractive exports by the growth in real GDP per capita. Those who suggest that booming extractive sectors are bad for the poor are likely thinking of adverse inequality effects during positive growth episodes. It would be difficult to imagine that a booming extractive sector, even with its meager employment stimulus, would be seen to be bad for the poor in a recessionary period. In this situation it cannot, for example, be crowing out employment in other sectors. Based on this argument, the cross-product term is included to allow for asymmetric extractive sector growth effects across positive and negative growth spells.

These conditioning variables produce the following regression specification for a growth spell for country i beginning in year t:

$$\ln\left(\frac{P_{i,t}}{1-P_{i,t}}\right) = \beta_0 + \beta_1 g(100)_{i,t} + \beta_2 \Delta RNREp_{i,t} + \beta_3(\%O_{i,t}+\%F_{i,t}) + \beta_4(g(100)_{i,t}\Delta RNREp_{i,t}) + u_i + \varepsilon_{i,t}. \quad (5)$$

We do not condition on initial level of income per capita, as others have, for two reasons. First, when longitudinal data is examined, there is no evidence of a Kuznets curve that may create a relationship between level of income and inequality (and hence the poverty elasticity of growth) (Deininger and Squire, 1996). Second, because extractive economies tend to be high-income developing economies, conditioning on income per capita is problematic, as it sets up an extractive country peer group that consists of developed economies (Alexeev and Conrad, 2009; Davis, 2009). Nor do we condition on initial income inequality, as this is taken into account via the random effects term. Finally, the binary nature of the growth spell classification obviates the need to control for the differences in consumption and income-based household surveys since we are not making comparisons of levels of poverty or inequality across countries or time (growth spells are binary).

We initially perform two analyses, the first using a binary (1,0) "pro-poor, other" characterization of the growth spells, where "other" includes ambiguous and anti-poor growth outcomes. The second uses a binary (1,0) "anti-poor, other" characterization of the growth spells, where "other" includes pro-poor and ambiguous growth outcomes. Since growth is good for poverty but bad for inequality (White and Anderson, 2001), the coefficient β_1 in Eq. (5) may be positive or negative given our definition of pro-poor growth. Dynamic resource sector impacts on growth quality will be picked up by β_2 and β_4, and static socio-economic forces associated with resource extraction will be picked up by β_3. In the first analysis, the hypothesis of less frequent pro-poor growth

[23] It reduces it on two fronts: By decreasing the income growth of the poor, and by increasing the chance that the growth spell will fail the test of reduction in inequality.

[24] In the case of the U.S.A., the PPP deflator is 1.00, so we used the U.S. CPI to control for inflation in that country.

[25] The last version of the SITC tables is available at http://unstats.un.org/unsd/cr/registry/regcst.asp?cl=14.

[26] Not capturing rents that arise from gold and gem production is clearly undesirable, but not readily remedied. Categories like fertilizer, stone, sand, and gravel are not typically what most researchers have in mind when they are either arguing for or against a "resource curse" in terms of mining. The data are aggregated in such a way that it is not possible to separate their components. However, we propose that the inclusion of commodities such as stone and gravel will not have a significant impact on our results since they are not predominant in the trade of ores and minerals and certainly even less predominant in our aggregate mining and energy index (Davis and Vásquez Cordano, 2011).

[27] Extractive intensity and institutional capacity are likely co-determined, and so an average value of this variable is also more likely to capture the general institutional capability of an economy than would a single observation at the start of the growth period. Since there is no suggestion that anti-poor growth creates poor institutions, endogeneity is not a concern.

Table 7
Correlation between average percentage increase in real (PPP) per-capita non-renewable exports, $\Delta RNREp_{i,t}$, and real (PPP) per capita percentage income growth by cumulative income quintile, $g(p)_{i,t}$, across 169 pooled growth spells.

Income quintiles (%)	Correlations	Bootstrap Std. error*	z-Statistics	p-Value
20	0.2633	0.082	3.19	0.00
40	0.3544	0.119	2.98	0.00
60	0.2189	0.078	2.81	0.01
80	0.1968	0.085	2.31	0.02
100	0.1320	0.091	1.46	0.15

* Standard errors based on 500 bootstrap replications.

associated with resource extraction would be affirmed by negative values of β_2 and β_3. In the second analysis, the hypothesis of more frequent anti-poor growth associated with resource extraction would be met by positive values of β_2 and β_3. The coefficient β_4 is a priori negative in the first analysis and positive in the second under the hypothesis that extractive sector growth is bad for the poor during positive growth spells and good for the poor during negative growth spells. The alternative hypothesis is that there is no unambiguous impact of extractive activity level or change in level on the quality of a growth spell: $\beta_2=\beta_3=\beta_4=0$.

Empirical results

A simple correlation analysis shows that growing per capita domestic extractive activity, as proxied by increasing mining and energy exports per capita, is positively correlated with increasing income at each cumulative income quintile (Table 7). Conversely, decreasing per capita domestic extraction activity is positively correlated with decreasing real income for the poor. The strongest and most statistically reliable correlations are at the bottom income quintiles. From this analysis, there is some evidence that increasing extractive activity reduces poverty by increasing the incomes of the poor.

Table 8 presents the results of the random-effect Logit regression (Eq. (5)) that tests the pro-poor nature of growth conditional on the level of growth in a country.[28] We cannot reject that the regression coefficients are jointly insignificant. The pro-poor nature of growth is positively related to the level of growth, but is statistically insignificant. There is evidence of a positive relationship between the change in extractive activity and the pro-poor nature of growth spells, but only at a 10% level of significance. The difference between the results in Tables 7 and 8 is consistent with those of Loayza and Raddatz (2010), who find that mining sector growth is negatively correlated with $1/day poverty headcount, but that the effect becomes statistically insignificant once one controls for overall growth. Table 8 also uses a measure of pro-poor growth that includes inequality changes, whereas Table 7 uses only a measure of income.

Table 9 presents the results of the same analysis for anti-poor growth. [29] The results are much stronger here, as we can reject that the coefficients are jointly insignificant. While higher economic growth may not create pro-poor outcomes (Table 8), it does help to prevent anti-poor outcomes (Table 9). Here again neither the level of extractive activity nor change in extractive activity during a growth spell significantly influences the probability of a growth spell being anti-poor. The interaction term is also insignificant. Given this, the increasing poverty in several mining-exporting least developed countries in the 1980s and 1990s highlighted by UNCTAD (2002) likely needs little more explanation than the low growth rates that these countries endured over that period (see UNCTAD, 2002, Table 29, p. 120 and Chart 37, p. 126).[30]

Due to the non-linear nature of the random-effect Logit model, the coefficient values in Tables 8 and 9 do not have a direct interpretation with respect to economic importance. However, it is possible to calculate total elasticities in the neighborhood of the means of the explanatory variables.[31] Because we use the means of the explanatory variables we call this the total average elasticity. The total average elasticities of changes in extractive activity on the pro-poor nature of growth are given in the first row of Table 10. The total average elasticity of the probability of pro-poor growth with respect to a change in extractive intensity is 0.10, but is statistically insignificant at the 5% level. To understand how to interpret this elasticity point estimate, at the average sample growth rate (2.28%) and extraction export level (19.84%), an increase of 1% in average annual extractive intensity ($11/capita/year) over a growth spell increases the probability of having a pro-poor outcome by 0.1%. The total average elasticity of a change in extractive intensity on the probability of anti-poor growth is also statistically insignificant (Table 11). From the second row in these tables there is also no evidence that the level of extractive activity in a country – the so-called political economy effect – has any impact on whether or not a growth spell will be good or bad for the poor. [32]

We also compute the average elasticities of pro-poor growth with respect to a change in extractive intensity separately for the extractive and non-extractive countries in our sample, as defined by Davis (1995), in order to evaluate whether the resource-intensity elasticity calculated in the first row of Table 10 differs across countries according to the base level of extractive activity. As shown in Table 12, the average elasticity of an increase in resource extraction on the probability of having pro-poor growth spells is actually *higher* in extractive than in non-extractive economies, and reaches a 5% level of significance in those countries.[33] These regression results – that there is a weakly statistically significant positive relationship between a resource boom and the chance of a pro-poor growth episode, and that this effect is stronger in extractive economies – are robust to the choice of price deflator for extractive output growth (we also tested CPI and PPI deflators), and to the choice of extractive intensity index (we replaced the percentage of merchandise exports that were minerals and energy with the average level extractive exports per capita, *RNREp*, over the growth spell).

We also ran a cross-sectional version of the regression that pools the time dimension of the panel dataset,

$$\ln\left(\frac{P_i}{1-P_i}\right)=\beta_0+\beta_1 g(100)_i+\beta_2\Delta RNREp_i +\beta_3(\%O_i+\%F_i)+\beta_4\left(g(100)_i\Delta RNREp_i\right)+\varepsilon_i, \quad (6)$$

since there is some concern that a panel data approach to measuring the quality of growth has a low signal-to-noise ratio

[28] We also ran a model including regional dummy variables (Africa, South America, Central America, North America, Europe, Asia and Oceania), but were jointly insignificant ($\chi^2_{(7)}=11.83$, p-value$=0.11$). Due to this result, we exclude the dummy variables from the analysis.

[29] As in the previous case (see footnote 28), we ran a model with regional dummy variables, but these were again jointly insignificant ($\chi^2_{(7)}=11.20$, p-value$=0.13$). Thus, we excluded the dummy variables from the regression.

[30] UNCTAD mentions the plight of Central African Republic, Democratic Republic of the Congo, Guinea, Liberia, Niger, Sierra Leone, and Zambia. They link the problem to slow growth, which in turn appears to have been from slowly growing or even declining mineral and energy exports over the observation period.

[31] See Wooldridge (2001) for further details.

[32] The statistical significance is different here from in Tables 8 and 9 because we are taking into account both the direct effect and the interaction effect.

[33] We carried out a t-test to evaluate the statistical significance of the difference between the elasticities corresponding to non-extractive and extractive economies. The t-statistic was equal to 8.88 with p-value equal to 0.00, which means that the difference is statistically significant.

Table 8
Mineral and energy resource intensity and its relation with pro-poor growth, panel analysis, regression Eq. (5).

Variable	Coefficient	Std. error	*t*-Statistic	*p*-Value	95% Confidence interval	
Growth	0.0882	0.0787	1.12	0.26	−0.0660	0.2424
Extraction level	−0.0015	0.0088	−0.17	0.87	−0.0187	0.0158
Change in mineral and energy extraction	0.0123	0.0074	1.65	0.10	−0.0023	0.0269
Interaction effect	0.0007	0.0022	0.32	0.75	−0.0036	0.0051
Constant	−0.9324	0.3427	−2.72	0.01	−1.6041	−0.2607
Wald $\chi^2(4)$	5.29					
p-value	0.26					
Log-likelihood	−105.35					

Binary dependent variable: pro-poor growth spell = 1, otherwise = 0.

Table 9
Mineral and energy resource intensity and its relation with anti-poor growth, panel analysis, regression Eq. (5).

Variable	Coefficient	Std. Err.	*t*-statistic	*p*-value	95% Confidence Interval	
Growth	−0.7362	0.1802	−4.09	0.00	−1.0893	−0.3831
Extraction level	−0.0056	0.0117	−0.48	0.63	−0.0285	0.0173
Change in mineral and energy extraction	−0.0122	0.0125	−0.98	0.33	−0.0368	0.0123
Interaction effect	−0.0049	0.0031	−1.58	0.11	−0.0109	0.0012
Constant	−1.4043	0.4455	−3.15	0.00	−2.2775	−0.5312
Wald $\chi^2(4)$	18.39					
p-value	0.00					
Log-likelihood	−35.00					

Binary dependent variable: anti-poor growth spell = 1, otherwise = 0.

Table 10
Total average elasticities of change in real extractive exports per capita, level of extractive activity, and in the level of real growth on the probability of pro-poor growth.

Explanatory variable	Average elasticity	Std. error	*z*-Statistic	*p*-Value
Change in mineral and energy extraction	0.1019	0.0537	1.90	0.06
Extraction level	−0.0187	0.1128	−0.17	0.87
Growth	0.1419	0.1147	1.24	0.22

Binary dependent variable: pro-poor growth spell = 1, otherwise = 0.

Table 11
Total average elasticities of change in real extractive exports per capita, level of extractive activity, and in the level of real growth on the probability of anti-poor growth.

Explanatory variable	Average elasticity	Std. error	*z*-Statistic	*p*-Value
Change in mineral and energy extraction	−0.2546	0.2028	−1.26	0.21
Extraction level	−0.1064	0.2227	−0.48	0.63
Growth	−1.7363	0.4363	−3.98	0.00

Binary dependent variable: anti-poor growth spell = 1, otherwise = 0.

that may be hiding statistically significant relationships in the data (Easterly, 1999). These regressions did not reveal any additional relationships between extraction and growth quality.

To allow comparisons with more traditional analyses of extractive activity and the welfare of the poor, we also test separately for the influence of extractive level and changes in extractive level on the unambiguous pro-poverty and unambiguous pro-inequality of growth spells (see Tables 3 and 4 for the definitions of these spells).[34] Looking at poverty, the degree of income growth is the only

Table 12
Total average elasticity of change in real extractive exports per capita on the probability of pro-poor growth for extractive and non-extractive economies.

Countries	Average elasticity	Std. error	*z*-Statistic	*p*-Value
Extractive economies	0.2672	0.1387	1.93	0.05
Non-extractive economies	0.0547	0.0294	1.86	0.06

Binary dependent variable: pro-poor growth spell = 1, otherwise = 0.

statistically significant and important variable here, and as expected comes in with a positive sign since there are no confounding negative effects of growth on inequality in this measure of outcomes. We find no statistically significant impact of the level of extractive activity or the change in level of extractive activity on the probability that a growth spell will be unambiguously pro- or anti-poverty. This ties in to the observed disappointment that the recent vast increases in mineral and energy production in Ghana, Chad, and Guinea have not markedly improved the quality of life for the poor (Hilson and Maconachie, 2009).

When we test for the effect of extraction on income inequality, neither growth in extractive activity nor level of extractive activity have any impact on whether or not a growth spell will be unambiguously pro-equality. The difference between our results and the positive findings of Goderis and Malone (2011) may be because they measure reductions in inequality using the Gini coefficient, while we define a decrease in inequality as an upward shift in the entire Lorenz curve. An increase in the Gini coefficient is an ambiguous indicator of decreasing inequality.[35] We do find that an increase in extractive activity during a growth spell reduces that spell's probability of worsening income

[34] Given that they do not overturn our previous results, we do not present the results. They are available from the authors upon request.

[35] For example, the Gini coefficient for the income distributions shown in Table 1 above rises from a Base Case value of 0.2960 to a value of 0.2981 for Case B, indicating increased inequality. Yet in Case B the poorest 20% have gained ground on the middle income group, even if they lost ground to the rich. We view this as an ambiguous outcome. The Gini coefficient for Case A drops to 0.2958, correctly indicating the unambiguous drop in inequality.

inequality at a 5% level of significance, with a reasonable level of impact on the probability. This is consistent with the correlations in Table 7 showing that resource booms have a stronger correlation with income growth of the poor than with income growth of the rich.

Conclusions

Our analysis of 169 positive and negative growth spells across 57 developed and developing countries from 1967 to 1997 finds no statistically reliable predictor of a country experiencing an unambiguously pro-poor outcome (increasing incomes for the poor and decreasing income inequality) during a growth spell. Countries with higher growth did have a predictably smaller chance of having an anti-poor outcome; for the average country a 1% increase in the rate of growth resulted in a 1.7% decrease in the chance of an anti-poor outcome. We cannot say that higher economic growth was unambiguously good for the poor, but we can say that it was not unambiguously bad for the poor. At a weak level of statistical significance there is evidence that growth in mining and energy activity improved the chance that a given positive or negative growth spell would be pro-poor, especially in economies that had heavy mining and energy activity to start with. We do not find the degree of statistical significance of these results compelling enough to assert that this is a reliable statistical pattern.

When we look only at changes in poverty, a more common measure of growth quality that excludes income inequality considerations, we find no reliable link between the level of or change in mineral and energy production and unambiguous changes in poverty during a given growth spell. Only positive overall economic growth led to a higher probability of a reduction in poverty. Our results are consistent with Loayza and Raddatz's (2010) finding that mining sector growth has no impact on $1/day headcount poverty after controlling for the impact of overall growth on the change in poverty. We also find that growing extractive activity was not unambiguously bad for income inequality, even though we cannot say with confidence that it was unambiguously good for income inequality.

In sum, our analysis provides no evidence that the level of mineral and energy extraction activity or changes in the level of that activity affect the probability of a country experiencing a pro-poor growth outcome with any statistical reliability. The implication for policy requires that broad pronouncements about positive or negative impacts of resource extraction on the pro-poor nature of growth be viewed with caution given the absence of support for these claims in the admittedly poor data that is available to test them.[36]

We end with several caveats. Robustness is always an issue in empirical work. Our study only includes 57 countries, and the results may not be applicable to the many extractive economies not included in the database due to missing inequality data. It is possible that there is an omitted variable in our regressions that is creating the lack of statistical significance. That omitted variable, however, would have to be correlated with growth in extractive activity and also be correlated with changes in poverty and inequality, and would have to maintain these correlations in each country through time. We are hard pressed to identify what such a variable might be. We have also limited our attention to unambiguous monetary poverty and inequality outcomes associated with a growth spell. It may well be that ambiguous measures of the pro-poor nature of growth, such as those that select an arbitrary poverty line and poverty measure, do worsen when that growth is accompanied by extractive activity or an extractive boom. We have tried to create a multidimensional pro-poor measure by including reduced income inequality as a proxy for reduced vulnerability and voicelessness (World Bank, 2001), but here too, direct measures of vulnerability and voicelessness may reveal a correlation with resource extraction that our income inequality measure misses. There may also be local and regional impacts that are not picked up in the national-level data used here. Moreover, data limitations have required that we abstract from a gradation of types of resource extraction. It may be that certain types of extractive activity or certain mineral and energy commodities, such as oil and diamonds, are damaging for the poor, whereas others are beneficial.

Finally, the data on income inequality at the national level are problematic given that there is no standard for its construction; some data are income based, others are consumption based. While we have endeavored to construct an empirical methodology that minimizes the impacts of imprecise data and data inconsistencies by only looking at binary outcomes, future analysis could further investigate these issues using higher-quality micro-level data, with more detail over types of mineral, over a larger set of countries or regions.

[36] Soares de Oliveira (2007) puts forward the concept of "successful failed states" to address Gulf of Guinea oil producers in this regard. Those states are "successful" for the extremely small number of political elites who reap incredible rewards from oil extraction and for the oil companies who generally have stable political environments to work in and for western consumers who benefit from the oil that is produced. They are "failed" for the other 99% of the country's population that suffers the costs of a highly corrupt, brutally repressive and largely dysfunctional states that does next to improve social welfare. Soares de Oliveira argues that such systems would be liable to collapse or likely candidates for major reforms except that the oil wealth enables them to stay the course and continue being both successful for the few and failed for the many, a possibility that our study may miss since most of these countries were not in our sample.

Appendix A

Table A1
Countries and Growth Spells in the Sample (bold = ending year of unambiguously pro-poor growth spell, italic = ending year of unambiguously anti-poor growth spell).

Country	Year	Country	Year	Country	Year
1. Algeria	1988	23. Hungary	1967	41. Panama	1969
	1995		1972		1979
2. Australia	1967		**1977**		*1989*
	1976		**1982**		1995
	1981		1987	42. Peru	1986
	1986	24. India	1964		*1994*
3. Bangladesh	1978		*1969*	43. Philippines	1965
	1983		1977		1971
	1988		**1983**		**1985**
4. Belgium	1979		1988		1991
	1985		**1994**		**1997**
	1992	25. Indonesia	1976	44. Portugal	1973
5. Bolivia	1968		1981		1980
	1990		**1987**		1990
6. Brazil	1970		**1993**		1995
	1976	26. Ireland	1973	45. Romania	1989
	1981		1980		*1994*
	1986		1987	46. Singapore	1978
	1993	27. Italy	1979		1988
8. Canada	1965		**1984**	47. Spain	1965
	1971		**1989**		**1973**
	1977	28. Jamaica	1988		**1980**
	1982		1993		**1985**
	1987	29. Japan	1962		1990
	1994		**1967**		1996
9. Chile	1968		1972	48. Sri Lanka	1963
	1987		1977		**1970**
	1992		1982		1979
10. China	1985	30. Jordan	1980		**1986**
	1990		**1986**		**1991**
	1995		*1991*	49. Sweden	1963
11. Colombia	1964		**1997**		**1975**
	1970	31. South Korea	1966		*1980*
	1978		1971		**1985**
	1988		1976		1990
	1995		**1982**	50. Thailand	1962
12. Costa Rica	1969		**1988**		1969
	1977		**1993**		1975
	1989	32. Madagascar	1980		1981
	1996		1993		*1986*
13. Denmark	1963	33. Malaysia	1970		1992
	1976		1976	51. Trinidad and Tobago	1971
	1981		**1984**		**1976**
14. Ecuador	1968		1989		**1981**
	1988		1995		1988
	1994	34. Morocco	1984	52. Tunisia	1965
15. El Salvador	1965		1991		1971
	1977	35. México	1963		**1990**
	1990		1968	53. Turkey	1968
	1995		1975		**1973**
16. Finland	1977		**1984**		**1987**
	1982		*1989*		**1994**
	1987		1994	54. United Kingdom	1966
17. France	1962	36. Netherlands	1962		1971
	1970		**1975**		**1976**
	1981		**1981**		1981
	1989		1986		1986
18. Germany	1964		1991		1991
	1969	37. New Zealand	1973	55. United States	1964
	1978		*1978*		**1969**
	1983		1983		1974
	1989		1989		1979
19. Ghana	1992	38. Nigeria	1985		*1984*
	1997		1992		1989
20. Greece	1974		**1997**		1994
	1981	39. Norway	1962	56. Venezuela	1962
	1988		1967		1971
21. Guatemala	1979		1973		**1976**
	1987		1979		1981
22. Honduras	1968		**1984**		*1987*
	1996		1989		**1992**
22. Hong Kong	1971	40. Pakistan	1964	57. Zambia	1976
	1976		**1969**		1996
	1981		1979		
	1986		1985		
	1991		1990		
			1996		

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