Africa is on time

Maxim Pinkovskiy · Xavier Sala-i-Martin

Abstract We present evidence that the recent African growth renaissance has reached
Africa's poor. Using survey data on African income distributions and national accounts
GDP, we estimate income distributions, poverty rates, and inequality indices for African
countries for the period 1990–2011. We show that: (1) African poverty is falling rapidly;
(2) the African countries for which good inequality data exists are set to reach the Millen-
nium Development Goal (MDG) poverty target on time. The entire continent except for the
Democratic Republic of Congo (DRC) will reach the MDG in 2014, one year in advance,
and adding the DRC will delay the MDG until 2018; (3) the growth spurt that began in 1995,
if anything, decreased African income inequality instead of increasing it; (4) African poverty
reduction is remarkably general: it cannot be explained by a large country, or even by a
single set of countries possessing some beneficial geographical or historical characteristic.
All classes of countries, including those with disadvantageous geography and history, expe-
rience reductions in poverty. In particular, poverty fell for both landlocked as well as coastal
countries; for mineral-rich as well as mineral-poor countries; for countries with favorable or
with unfavorable agriculture; for countries regardless of colonial origin; and for countries
with below- or above-median slave exports per capita during the African slave trade.

Keywords Economic growth · Poverty · Africa

1 Introduction

In 2012, the World Bank confirmed that the world as a whole reached the Millennium Devel-
opment Goal poverty target 5 years ahead of the deadline in 2015. However, this impressive

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achievement was mainly attributed to the growth performance of East and South Asia, and of China in particular. In particular, the 2013 United Nations Development Program notes that "Extreme poverty rates have fallen in every developing region, with one country, China, leading the way…Poverty remains widespread in sub-Saharan Africa and Southern Asia, although progress in the latter region has been substantial (United Nations 2013)." It is also believed that most of the recent African growth is due to rising oil and natural resource prices, which entails a redistribution of income from mineral-poor countries to mineral-rich countries (Collier 2006). Moreover, gains from natural resource wealth are believed to accrue to very narrow elites and to be irrelevant for poverty reduction.

In this paper, we combine national accounts estimates of African GDP with survey estimates of African inequality under parametric assumptions to estimate income distributions for African countries, and compute their poverty rates for the period 1990–2011. Our results show that the conventional wisdom that Africa is not reducing poverty quickly enough to achieve the MDGs on time is wrong. In fact, since 1995, African poverty has been falling steadily. Moreover, contrary to the commonly held idea that African growth is largely based on natural resources and helps only the rich and well-connected, we show that Africa's income distribution has become, if anything, *less* rather than more unequal than it was in 1995, and therefore, that a great deal of this growth has accrued to the poor.

We find that the African countries for which we have a reasonable amount of inequality data[1]—which contain 78 % of Africa's population and 32 out of its 47 countries—will achieve the Millennium Development Goal of halving poverty in the target year of 2015. Our sensitivity analysis suggests that, changing our procedure in various ways, including changing the GDP series used, changing the surveys used, and employing different assumptions for the behavior of inequality at the end of the sample period for which data is poor, delays this date by at most 5 years.[2] Moreover, not only has poverty fallen in Africa as a whole, but this decline has been remarkably general across types of countries that the literature suggests should have different growth performances. In particular, poverty fell for both landlocked as well as coastal countries; for mineral-rich as well as mineral-poor countries; for countries with favorable or with unfavorable agriculture; for countries regardless of colonial origin; for both democratic and nondemocratic countries, and for countries with below- or above-median slave exports per capita during the African slave trade.[3]

For countries with fewer than two income or consumption surveys, we cannot capture the trend of inequality and therefore must be cautious. However, if the behavior of their within-country inequality is similar to that of the remaining African countries for which we do have data, we can analyze poverty reduction in all of Africa. Based on this analysis, we conjecture that the MDG will be achieved in Africa as a whole by 2018, three years after the target. We show that this conjecture is robust to a variety of assumptions on the evolution of within-country inequality in countries with poor survey data, although all of these conjectures are

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[1] By "reasonable amount of data" we mean at least two consumption or income surveys conducted between 1990 and 2011.

[2] Young (2012) has recently argued that traditional sources of national accounts data understate African growth by several percentage points of GDP per year. However, Alwyn Young does not use this finding to compute poverty or inequality estimates for Africa. The novelty of our contribution is to show that not only is Africa growing rapidly, but this growth is translating into poverty reduction fast enough to achieve the MDGs at or close to the target date of 2015. In particular, we show that if Alwyn Young's growth estimates for Africa are extrapolated after 1990, poverty reduction is even more striking and the MDG has already been achieved.

[3] Bloom and Sachs (1998) suggest that landlocked countries, or countries with unfavorable agriculture have poorer performance than geographically advantaged countries. Porta et al. (1999) argue that the identity of the colonizer may matter for subsequent economic development. Nunn (2008) presents evidence that the impact of the African slave trade was highly persistent, and affected recent African performance.

somewhat ad hoc, unlike our analysis of the African countries with reasonable survey data.
The primary reason for the MDG being achieved a few years late is the aftermath of the war in
the Democratic Republic of Congo (hereafter, DRC; formerly, Zaire), which devastated the
country and from which it is still in the process of recovery. According to our calculations,
Africa without Congo will achieve the millennium development goal of halving the 1990
poverty rate by 2014.

Two papers closest in spirit to ours are Sala-i-Martin (2006) and Pinkovskiy and
Sala-i-Martin (2009), which use nonparametric and parametric methods of recovering
within-country income distributions from grouped survey data and aggregate country dis-
tributions to obtain the world distribution of income. However, while they forecast that the
world as a whole will achieve the MDGs before 2015, they did not make such a prediction
for Africa because Africa's growth spurt was still in its early stages at the time of writing.
Bourguignon and Morrisson (2002) analyzed the world distribution of income by combining
national accounts and survey-based inequality measures, but their paper considered a period
before the African growth began. Other researchers, e.g. Chen and Ravallion (2004, 2010),
have noted that world poverty (and, in 2010, African poverty) is falling, but concluded that
the speed of the African poverty decline is small because they used survey means rather than
national accounts data as anchors for the within-country inequality distributions. We will
discuss the role of using national accounts rather than survey means in Sect. 2. Recently,
Young (2012) estimated Africa's growth rate using changes in demand for goods consumed
by the poor as expressed in the Demographic and Health Surveys, and argued that the national
accounts substantially underestimate African growth rates.

The rest of the paper is organized as follows. Section 2 provides a brief description of the
data and the statistical procedure to estimate the income distributions of African countries
and of groups of African countries in every year in the sample period. Section 3 describes
the evolution of the income distributions for African countries with reasonable survey data.
Section 4 analyzes the evolution of poverty rates for African countries with reasonable survey
data and provides robustness checks. Section 5 discusses the evolution of poverty for various
African regions. Section 6 discusses African inequality. Section 7 discusses poverty reduction
in countries without good survey data and makes conjectures on poverty in Africa as a whole.
Section 8 concludes.

2 Data and statistical procedure

For our baseline estimates, we use national accounts purchasing-power-parity (PPP)-adjusted
GDP data from the World Bank (2012). We follow the suggestion of Johnson et al. (2013),
who note that successive updates of the Penn World Table do not successfully estimate GDP
at purchasing power parity for years far away from the date of their construction, and do not
use PWT data to estimate our baseline scenario. However, we will check the robustness of
our results by considering the most recent vintage of the Penn World Tables constructed at the
Center for International Comparisons (PWT 7.1, Heston et al. 2012), the most recent vintage
of the PWT (PWT 8, Feenstra et al. 2013), a synthetic vintage of the PWT that makes progress
against the problems highlighted in Johnson et al. (2013) (whose construction is described in
Appendix 10), and GDP data based on the calculations of Angus Maddison (Bolt and Zanden
2013). We anchor the mean of national income distributions to the national accounts because
for a meaningful analysis of the impact of growth on poverty, the income distribution used to
calculate poverty must be consistent with the observed growth rates. Using the survey mean

time series, which is known to underestimate economic growth, would imply growth rates inconsistent with the growth experience Africa has been understood to have.[4]

We obtain inequality data from Chen and Ravallion (2010), and supplement it with similar data from the WIDER-DS dataset, pioneered by Deininger and Squire (1996) and maintained by the United Nations University (UNU-WIDER 2008). Both datasets provide Gini coefficients and quintile shares for countries and years in which income or consumption surveys were conducted. In order to maintain comparability of the survey data, we select surveys from WIDER-DS that match the income concept and covered population of the surveys in the Chen and Ravallion dataset as closely as possible. Overall, we have 173 surveys for 47 African countries for the period 1970–2010 (the surveys before 1990 helping us avoid extrapolation at the beginning of the sample period).

While the Millennium Development Goal is postulated in terms of income, most surveys construct a distribution of consumption. Since consumption is more equally distributed than income, using the uncorrected survey data will lead to lower inequality and lower poverty rates throughout. Hence, we adjust surveys with consumption data so that they are comparable to surveys with income data by a regression procedure that exploits surveys with data on both consumption and income in WIDER-DS. We provide more detail on this procedure in Appendix 9.

The crux of our methodology is to assume that the distribution of income in each country and each year has the same functional form, with changes in GDP and inequality manifesting themselves through changes in the parameters of this form only. We experiment with three 2-parameter functional forms for the income distribution: the lognormal (which will be our baseline distribution), the gamma and the weibull distributions. We choose these three functional forms because of their longstanding use in the inequality literature and their tractability: each has a single scale parameter (determined by GDP) and a single distribution parameter (determined by inequality from the surveys). We use the national accounts and survey data to recover the functional form parameters, and from these parameters we compute a number of poverty and inequality statistics and indexes for particular countries and for Africa as a whole.

Our baseline method is to select the scale parameter to minimize the sum of squared deviations between the quintile shares in the survey and their theoretical values based on the functional form assumption. We also experiment with two other ways: first, inverting the empirically computed Gini coefficient to obtain the scale parameter, and second, minimizing the sum of squared deviations between the three middle quintiles normalized by the share of the middle 60 % and their theoretical counterparts. The second method is useful because it is robust to mismeasurement of income in the top and the bottom quintiles, where such mismeasurement is likely to be prevalent. Rich people tend to underreport their incomes and poor people's incomes may involve substantial in-kind components that are difficult to value.

For country-years with missing inequality data, we must make educated guesses as to what value inequality took at that time and place. For countries with 2 or more surveys (hereafter, the group A countries), we can do so via interpolation of the survey series in the Gini coefficient and via assuming the Gini is constant after the last survey and before the first survey. We then invert the resulting Gini series to obtain distribution parameters for the years with missing data. In our robustness checks, we show that alternative extrapolation methods—linear extrapolation of the trend in the Gini defined by the last two surveys of

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[4] For example, the Nigerian survey mean in the Chen–Ravallion dataset declines by −0.04 % per year between 1992 and 2010, while Nigerian GDP grows by 2.2 % per year during the same time period in the World Bank's GDP series. For Ethiopia, Tanzania and Mozambique, survey mean growth rates are one-third to two-thirds of the national account growth rates.
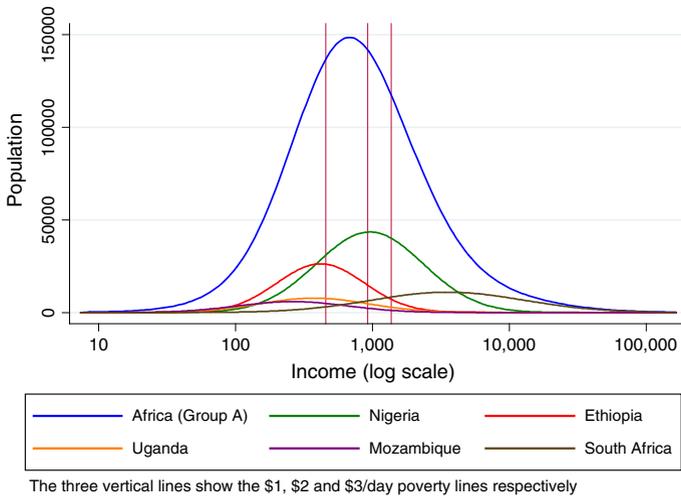
The three vertical lines show the $1, $2 and $3/day poverty lines respectively

Fig. 1 African income distribution in tear 1990

each country, and a conservative procedure that extrapolates the trend when inequality is rising but assumes the Gini coefficient is constant after the last survey when the trend implies falling inequality—perform very similarly. For countries with exactly one survey (group B countries) or with no surveys (group C countries), we must impute inequality based on surveys in other countries. We will describe these imputation methods in greater detail in Sect. 7 of the paper.

3 Dynamics of the African distribution of income

Figures 1, 2, and 3 present graphs of distributions of income for Africa (Group A countries only). To have a visual anchor, each of the graphs contains three vertical lines corresponding to daily incomes of $1, $2 and $3. The one-dollar-a-day poverty line corresponds to 457 dollars per year.[5] The $2/day and $3/day thresholds are exactly twice and three times the $1/day line. The Group A countries comprise 32 out of the 47 African countries, including most of its large countries such as Nigeria, Ethiopia, South Africa, and Tanzania (but not the DRC) and contain 81 % of Africa's population and 79 % of its $1-a-day poor in 1990.

Figure 1 plots the 1990 distributions for the Group A countries as a whole as well as for individual countries with the greatest number of $1-a-day poor people in 1990 (Ethiopia, Nigeria, Uganda and Mozambique, which collectively account for 49 % of the Group A African poor and for 39 % of all-African poor in 1990, as well as South Africa). The mode of African distribution is located between the $1/day line and the $2/day line. Nigeria's mode is at the $2/day line, while the modes for Ethiopia, Uganda and Mozambique are below $1 a day. South Africa, though one of the largest African countries (the fourth-largest after Nigeria, Ethiopia and the DRC), does not appreciably contribute to African poverty as it is a very rich country by African standards, and most of its distribution is above the$1-a-day poverty line.

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[5] Various definitions of the $1-a-day poverty line have been used in the literature; we use the $1.25-a-day line in 2005 PPP, which is currently used by the World Bank.
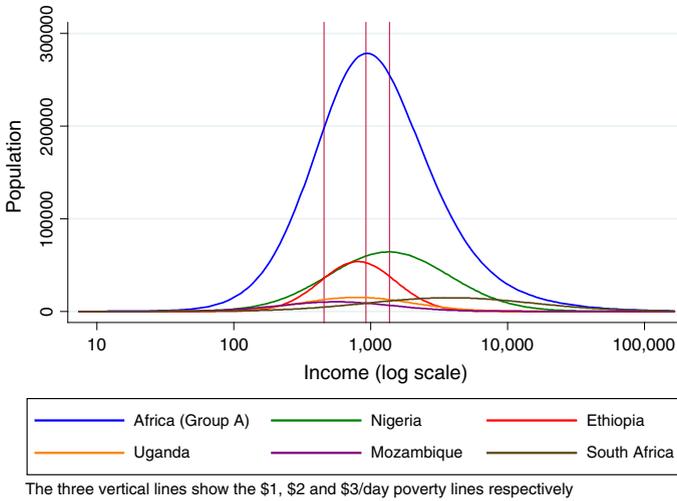
The three vertical lines show the $1, $2 and $3/day poverty lines respectively

Fig. 2 African income distribution in year 2011

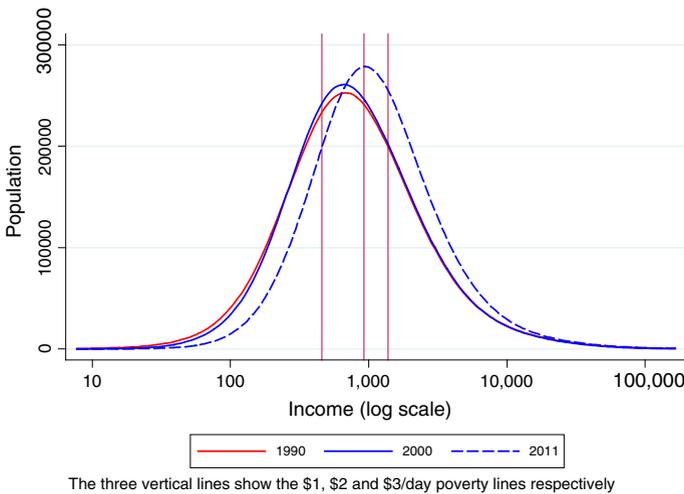The three vertical lines show the $1, $2 and $3/day poverty lines respectively

Fig. 3 African (Group A) income distribution: 1990–2011

By 2011 (Fig. 2), all the distributions shift to the right. This, of course, is the result of Africa undergoing substantial economic growth between 1990 and 2011. The modes of the Ethiopian and Ugandan and Mozambican distributions move above the $1/day line, with the Ethiopian mode approaching the $2/day line. The mode of the Nigerian distribution shifts to the $3/day line. For the Group A countries as a whole, the mode shifts to $2/day line. We also do not observe any appreciable widening of the income distribution in the Group A countries.

To observe the dynamics, Fig. 3 plots the African (Group A) distributions for 1990, 2000 and 2011. We note that the lower tail of the income distribution started modestly shifting to the right before 2000, but nearly all the improvement in the income distribution as a whole took place between 2000 and 2011.
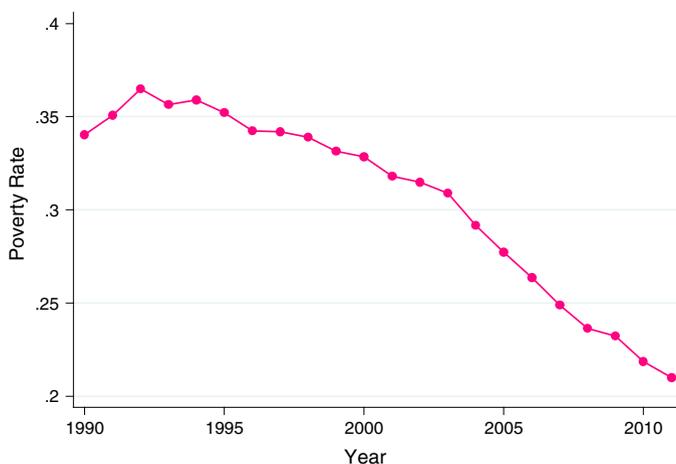
Fig. 4 Baseline $1/day poverty rate, Africa Group A countries 1990–2011

4 Poverty

To better assess the evolution of poverty, Fig. 4 and Table 1 display the yearly African $1/day poverty rate between 1990 and 2011 (again, for Group A countries). The poverty rate for these countries in 1990 was 34 %. That is, over a third of the entire population lived on less than one dollar a day in Africa in 1990. Poverty rose to a maximum of 36.5 % in 1992, and then began a sustained decline that continues to the present. By 2011, $1/day poverty had fallen to under 21 %.

What caused this dramatic change? A hint lies in Fig. 5, where the $1/day poverty rate is plotted along with (Group A) African GDP per capita. The evolution of poverty is an almost exact mirror image of the evolution of GDP per capita. That is, the driving force that appears to explain the substantial reduction in poverty between 1992 and 2011 is economic growth. A similar conclusion is reached if we analyze the evolution of poverty and GDP per capita for the largest countries in the region. Figures 6, 7, 8, and 9 show that, for Ethiopia, Nigeria, Uganda and Mozambique, poverty and GDP per capita are mirror images of each other.

These results contradict the 2013 Millennium Development Goals Report (http://www.un.org/millenniumgoals/pdf/report-2013/mdg-report-2013-english.pdf), which asserts that "in contrast [to East and South Asia] the poverty rate in sub-Saharan Africa fell only 8 percentage points over the same period [1990–2010]" (brackets ours). Our estimates disagree: the African poverty rate fell by 13 percentage points between 1990 and 2011, and was 38 % lower than in 1990 (34 %). That is, while progress in Africa has by no means been as extraordinary as that of East Asia, there has been a significant reduction in poverty and a substantial movement towards achieving the MDGs. The poverty rate in 1990 was 34 %. Hence, the MDG is for the poverty rate to be 17 % by 2015. The rate in 2011 was 21 %, so even though substantial progress has been made, we still have four percentage points to go. But we also have 4 years left. We do not know what the future will look like, but if poverty continues to fall at the rates it fell between 2000 and 2011, we project that the $1/day poverty rate will be 16.7 % in 2015. In fact, we project that the MDG will be achieved in 2015: right on target.

Of course we don't know whether poverty will continue to decline at the rates it fell between 2000 and 2011. But then again, we do not think that there is anything magic about

Table 1 African poverty sensitivity analysis (Group A countries)

Variation	Poverty rate in 1990 (%)	Poverty rate in 2011 (%)	Percentage poverty reduction 1990–2011 (%)	Projected poverty in 2015 (%)	Projected poverty reduction, 1990–2015 (%)	Year in which MDG attained (%)
Baseline	34.0	21.0	−38.3	16.7	−51.0	2015
PWT 7.1 GDP	40.1	27.1	−32.4	22.4	−44.2	2017
PWT 8 GDP	43.3	23.5	−45.8	15.1	−65.1	2012
Synthetic PWT GDP	38.1	27.1	−28.8	23.1	−39.3	2019
Maddison GDP	26.7	15.7	−41.1	11.7	−56.2	2013
Alwyn young (3.4%) growth	34.0	12.6	−62.9	9.2	−73.1	2006
CR (2010) surveys only	34.0	20.8	−38.8	16.9	−50.4	2015
No consumption adjust	30.5	16.5	−45.8	11.7	−61.6	2012
Conservative extrapolation	34.6	21.0	−39.3	16.8	−51.3	2015
Linear extrapolation	34.1	20.2	−40.7	15.6	−54.1	2014
Gamma distribution	35.5	25.2	−29.1	21.8	−38.6	2020
Weibull distribution	35.3	25.2	−28.7	21.9	−38.0	2020
Scale parameter from Gini	34.6	21.6	−37.7	17.3	−49.9	2015
Misreporting adjustment	31.2	16.0	−48.6	11.4	−63.5	2011

We assume linear trend since 2000

2015 either. And we do not think there is anything special about "halving the 1990 poverty rate." In other words, the MDGs are interesting goals but if the 1990 poverty rate is cut by one half in 2016 or 2020 rather than 2015, so what? The main point is that Africa has been moving in the right direction and, while progress has not been as spectacular as in Asia, poverty has been falling and it has been falling substantially.

The finding that African poverty falls does not apply exclusively to poverty as measured by the $1-a-day standard, but rather to a wide range of poverty lines relevant for Africa. Figure 10 shows the CDFs of the African income distribution between 1990 and 2011. The image of the CDF corresponds to the poverty rate if the poverty threshold happened to be the level of income in the horizontal axis. We see that for most conceivable poverty lines, the poverty rate between 1990 and 2011 has fallen. In particular, this is true for the $1/day, $2/day and $3/day lines, which are also displayed in Fig. 10 as vertical lines.

In order to be confident in the robustness of our results, we analyze changing the baseline specification in several directions. Given that poverty appears to be a mirror image of economic growth, the most important check is for robustness with respect to GDP. Figure 11 presents our baseline plot of poverty in the Group A countries, together with alternative plots using GDP from Penn World Tables 8 (the most recent vintage), Penn World Tables 7.1 (the most recent vintage created at the University of Pennsylvania), and the GDP estimates of Angus Maddison. Additionally, we include a synthetic GDP series that we created by taking GDP numbers for 2011 from PWT 7.1 and obtaining GDP for previous years by using annual
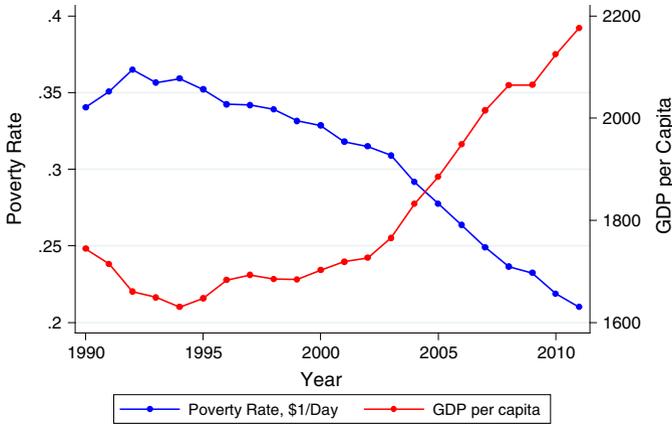
Fig. 5 $1/day poverty and growth in Sub-Saharan Africa (Group A), 1990–2011
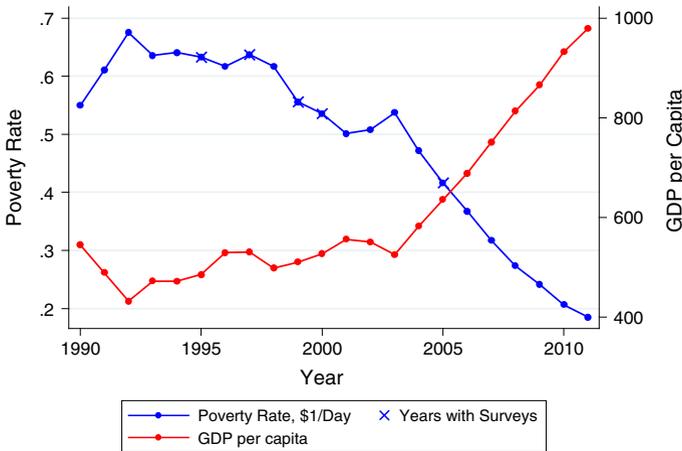

Fig. 6 $1/day poverty and growth in Ethiopia, 1990–2011

growth rates from the PWTs developed closest to the year of interest. This series was inspired by Johnson et al. (2013)'s criticism of the PWT for failing to provide estimates at purchasing power parity at years other than the price survey years from which different vintages of the PWT are based. Finally, we include a GDP series inspired by Alwyn Young's argument that national accounts-based GDP growth rates substantially underreport African growth and that calculations based on changes in demand for products used by the poor suggest that Africa has been growing at a rate of 3.4 % a year. To act on this suggestion, we take GDP data for African countries in 1990 (from the World Bank) and increase them by 3.4 % every year for each country.

We see from the figure that all the series slope downward: poverty falls regardless of the GDP series. The rates of poverty decrease appear to be similar to, or even larger than those for our baseline GDP series (World Bank GDP). Table 1 presents estimates of years in which the MDG of halving poverty would be achieved for the Group A countries given each of the GDP series: the most optimistic estimate is that it was already achieved in 2006 (based on
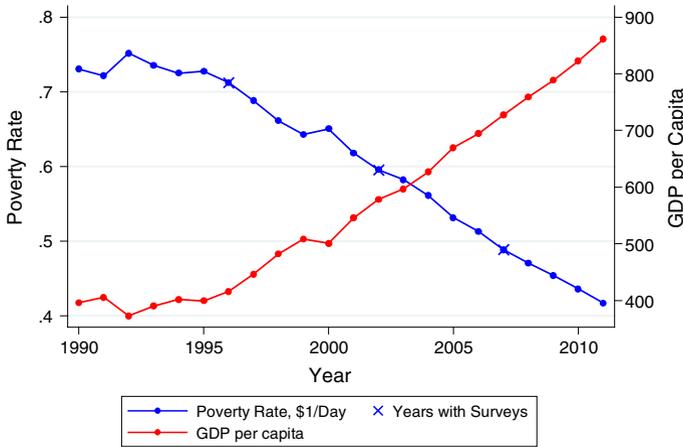
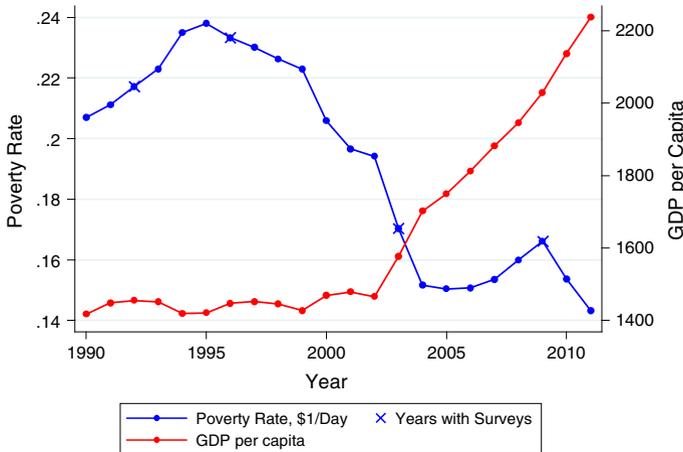**Fig. 7** $1/day poverty and growth in Mozambique, 1990–2011

Fig. 8 $1/day poverty and growth in Nigeria, 1990–2011

Alwyn Young's conjecture) and the most pessimistic estimate is that it will be achieved in 2019 (based on the synthetic PWT GDP series). If we use the PWT7.1, we predict that the MDGs will be attained in 2017 and if we use PWT8.1, the goals were already achieved in 2012. All of these are excellent news for Africa even in the most pessimistic scenario: even if the MDG is achieved 4 years late in 2019, this is still great news given that Africa has begun growing only recently and that we have not been confident in whether this growth is reaching the poor. We should not let the literal interpretation of the MDGs turn good news (Africa is rapidly moving in the right direction) into bad news (Africa will not achieve the MDGs on time).[6]

Figure 12 presents the $1/day poverty rate for Africa under various methodological assumptions for recovering the income distributions of African countries and for extrapolating African inequality. Here we present poverty series that would obtain under the linear

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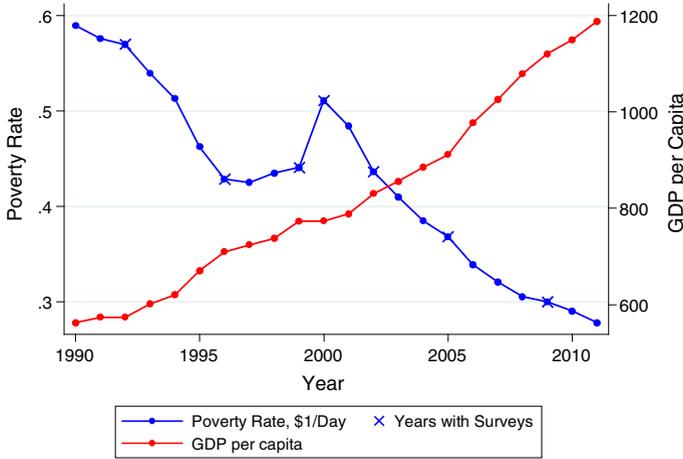
[6] This argument is made in Easterly (2009).

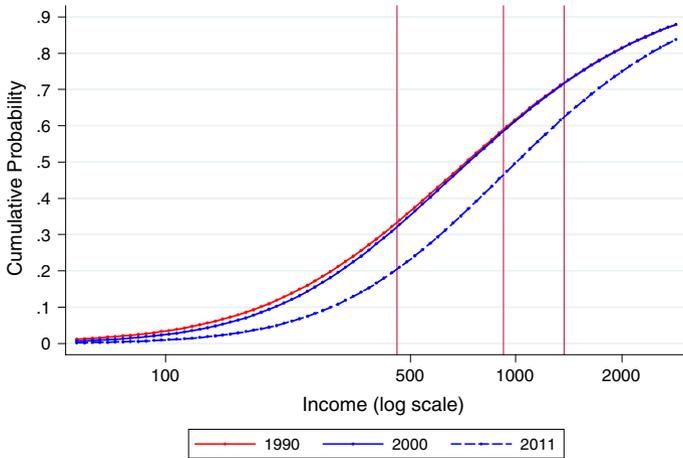**Fig. 9** $1/day poverty and growth in Uganda, 1990–2011

Fig. 10 Africa (Group A) CDFs: 1990–2011

trend and the conservative extrapolation methods described in Sect. 2, under the gamma and Weibull functional form assumptions for country distributions, for an alternative survey selection procedure (just using the surveys employed by Chen and Ravallion (2010) without adding any others from UNU-WIDER to achieve greater homogeneity of surveys), for not adjusting the consumption surveys' inequality to make them comparable to income surveys, and for the two alternative procedures of obtaining Gini coefficients from survey data. Table 1 presents estimates of the year in which the MDG is attained under each variation. Once again, for every variation in treatment, African poverty falls, with the MDG being attained within 5 years of the 2015 target date. For all the variations except the use of the gamma and Weibull distributions, which may have unrealistically thick lower tails for income distributions, the MDG is attained on target in 2015, or, for some robustness checks, even earlier. It is also clear that the variability in the poverty forecasts from changing model assumptions is much less than that from changing GDP, which is consistent with the idea that the rate of economic
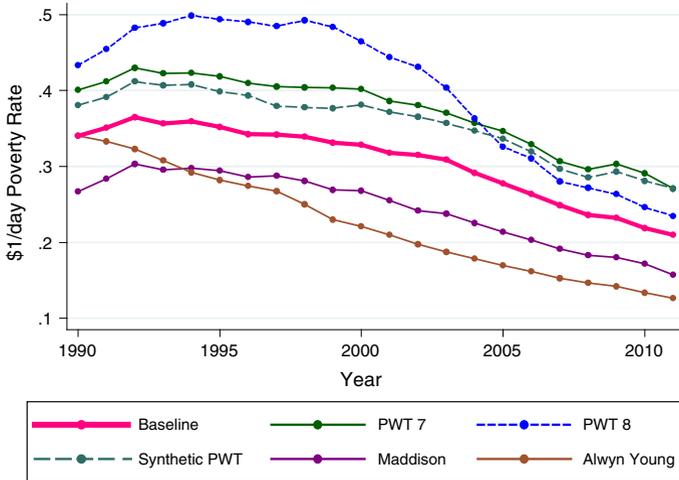
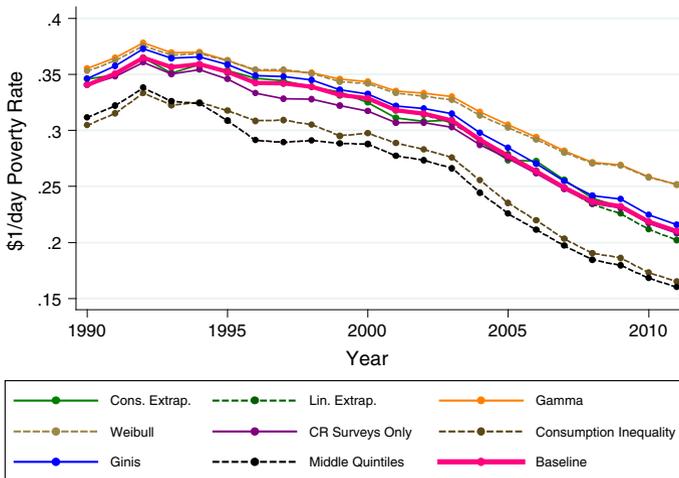**Fig. 11** Falling poverty in Africa (Group A): robustness to GDP

Fig. 12 Falling poverty in Africa (Group A): extrapolation and methodology

growth rather than changes in African inequality is what explains poverty reduction. Interestingly, the "adjusted" series based on the middle three quintiles, which should not depend on mismeasurements of income at the top or at the bottom of the distribution, shows a lower level of poverty for the entire sample period, which suggests that if the lognormal functional form assumption is correct, then mismeasurement of income may take place primarily for the poor, probably through undervaluing in-kind income. Such a finding is also consistent with Alwyn Young's result, based on looking at the demand patterns of the poor, that African growth may be substantially mismeasured by the national accounts.[7]

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[7] Another partial explanation for the discrepancy between national accounts-based poverty estimates and those made on the basis of Alwyn Young's growth findings is that the sample of countries considered by Alwyn Young tended to have faster poverty reduction. Figure 13 shows that once we consider poverty reduction in the
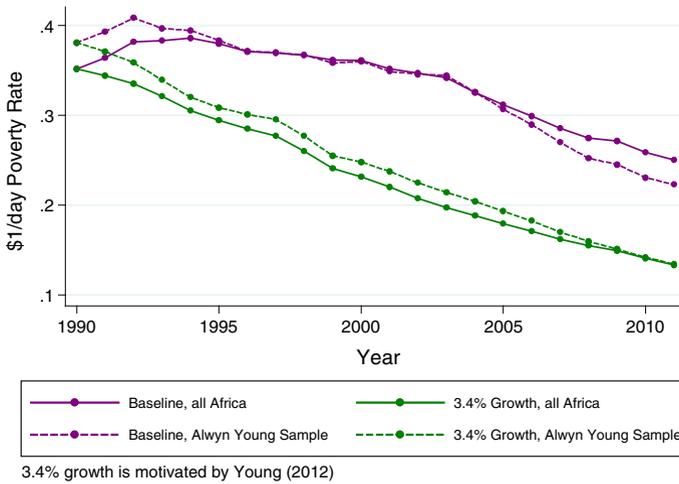
3.4% growth is motivated by Young (2012)

Fig. 13 African poverty: Alwyn young versus Nat. Acct.-based estimation

5 Regional analysis

It is interesting to see whether African poverty reduction has been not only fast, but also general across characteristics of countries that the literature has identified as important for development. Bloom and Sachs (1998) point to adverse geography as a cause of slow development: in particular, countries that have unfavorable agriculture should be poorer than countries with more favorable conditions. Collier (2006) argues that coastal countries will perform better than landlocked countries in general. Also, mineral-rich countries should have been better-positioned than mineral-poor countries to take advantage of the increase in natural resource prices in the 2000s. For example, the 2008 UN Millennium Development Goals Report states that "*since 2002, one of the factors contributing to growth in many developing countries... has been the increased prices of commodities, including oil. For exporters, this has been a boon. But higher commodity prices, particularly oil prices, have dampened growth in countries importing these products. Many are among the poorest countries in the world*." Collier (2006), suggests that being mineral-rich or mineral-poor will matter differently for coastal and landlocked countries.

Others have suggested that troubled history may have a persistent effect on growth performance. Nunn (2008), for example, argues that the African slave trade had "*particularly detrimental consequences, including social and ethnic fragmentation, political instability and a weakening of states, and the corruption of judicial institutions,*" which led the parts of Africa most affected by the slave trade to grow much slower than the parts that were not. Porta et al. (1999) suggest that the identity of the colonizer mattered substantially for development. Since these factors are permanent (and cannot be changed with good policy), they imply that some parts of Africa may be at a persistent growth disadvantage relative to others.

Footnote 7 continued

Alwyn Young sample only (this time, without restricting ourselves only to the Group A countries in that sample to maintain comparability to Alwyn Young's results) the discrepancy between our national accounts-based series and the series based on Alwyn Young's findings shrinks by 25 %.

Panel A

Landlocked vs. Coastal Countries (Group A): GDP

Panel B

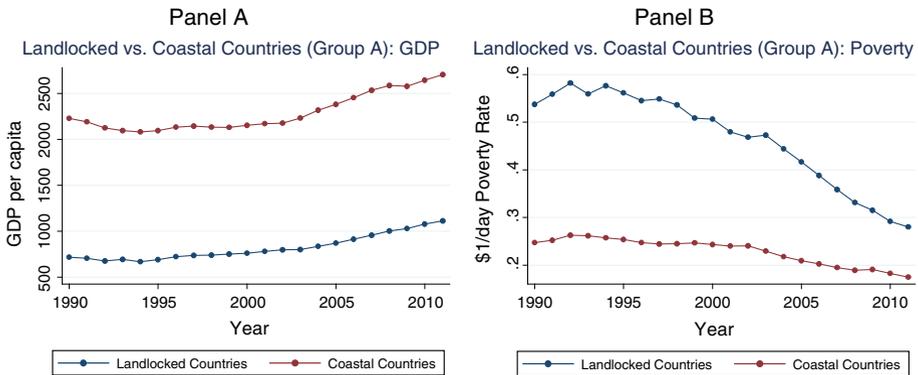Landlocked vs. Coastal Countries (Group A): Poverty

Fig. 14 African growth and poverty breakdown: landlocked versus coastal countries (Group A countries)

In this section, we show the differential growth and poverty reduction performance of these types of African countries.[8] Figure 14 breaks down Africa into landlocked and coastal countries. The list of countries in each category is provided in Table 2. Panel A shows that between 1990 and 2011, GDP per capita was larger for coastal than for landlocked countries, which is not surprising given the importance of access to the sea for trade. Panel B displays the evolution of the poverty rate for the two regions. As expected, the poverty rate for coastal countries is smaller than that for landlocked countries, and it fell after 2000. The interesting phenomenon, however, is that poverty in landlocked countries has also fallen, and, in fact it has fallen faster than in coastal regions. Poverty in 1990 was over 50 % for the landlocked and about 25 % the coastal countries. By 2011 the poverty rates in the two regions was 28 and 18 % respectively. Hence, it does not appear that being landlocked is an insurmountable impediment to reducing poverty in Africa.

Figure 15 breaks down the sample of African countries into mineral-rich and mineral-poor. The definition of mineral-rich is taken from Nijkam (2008) and supplemented with data from the CIA World Factbook (2009).[9] The list of countries in each classification is provided in Table 2. Panel A shows that mineral-rich countries have higher levels of GDP per capita than the mineral-poor countries. Since mineral riches are easily expropriated, it would be alarming if we find that most poverty reduction takes place in mineral-rich countries (as we might be attributing some of the increases from mineral wealth to the poor who don't actually receive it). However, this is not the case. Panel B shows that, while poverty rates in mineral-rich countries started out being much lower than in mineral-poor countries in 1990, by 2011, mineral-poor countries have reduced poverty by more (in percentage point terms) than mineral-rich countries did. Hence, the notion that African progress in poverty reduction is a statistical artifact due entirely or even mainly the favorable terms of trade shocks of the mineral-rich countries does not appear to be consistent with the data.

Following Collier (2006) we also look at the differential performance of mineral-poor countries depending on whether they are landlocked or coastal. The definitions are derived

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[8] For consistency with our baseline results, we will present regional results for Group A countries only. However, the regional analysis of all African countries, if anything, strengthens the patterns we find.

[9] For the mineral-rich/mineral-poor breakdown, as well as for the favorable/unfavorable agriculture breakdown, omitting the countries not classified by Nijkam (2008) from the analysis does not qualitatively change the results

Table 2 Classification of countries

Country	Landlocked	Mineral rich	Favorable agriculture	British colony	French colony	Portuguese colony	Belgian colony	High slave exports	War in 1997	Group A	Alwyn young sample
Angola	0	1	0	0	0	1	0	1	1	0	0
Benin	0	0	1	0	1	0	0	1	0	0	1
Botswana	1	1	0	1	0	0	0	0	0	1	0
Burkina Faso	1	0	0	0	1	0	0	1	0	1	1
Burundi	1	0	0	0	0	0	1	0	1	1	0
Cameroon	0	1	1	0	1	0	0	0	0	1	1
Cape Verde	0	0	0	0	0	1	0	0	0	0	0
Central African Republic	1	1	1	0	1	0	0	0	0	1	1
Chad	1	1	0	0	1	0	0	1	0	0	1
Comoros	0	0	0	0	1	0	0	0	0	0	1
Congo, Dem. Rep.	0	1	1	0	0	0	1	1	1	0	0
Congo, Rep.	0	1	1	0	1	0	0	1	1	0	1
Cote d'Ivoire	0	0	1	0	1	0	0	1	0	1	1
Equatorial Guinea	0	1	0	0	0	0	0	0	0	0	0
Eritrea	0	0	0	0	0	0	0	1	0	0	0
Ethiopia	1	0	0	0	0	0	0	1	0	1	1
Gabon	0	1	0	0	1	0	0	0	0	1	1
Gambia, The	0	0	1	1	0	0	0	1	0	1	0
Ghana	0	0	1	1	0	0	0	1	0	1	1
Guinea	0	1	1	0	1	0	0	1	0	1	1
Guinea-Bissau	0	0	1	0	0	1	0	1	0	1	0
Kenya	0	0	1	1	0	0	0	0	0	1	1
Lesotho	1	1	1	1	0	0	0	0	0	1	1
Liberia	0	1	0	0	0	0	0	0	0	0	0

Table 2 continued

Country	Landlocked	Mineral Rich	Favorable Agriculture	British Colony	French Colony	Portuguese Colony	Belgian Colony	High Slave Exports	War in 1997	Group A	Alwyn Sample	Young Sample
Madagascar	0	0	0	0	1	0	0	1	0	1	1	
Malawi	1	0	1	1	0	0	0	1	0	1	1	
Mali	1	0	0	0	1	0	0	1	0	1	1	
Mauritania	0	1	0	0	1	0	0	1	0	1	0	
Mauritius	0	0	0	1	0	0	0	0	0	0	0	
Mozambique	0	0	0	0	0	1	0	1	0	1	1	
Namibia	0	1	0	1	0	0	0	0	0	1	1	
Niger	1	1	0	0	1	0	0	1	0	1	1	
Nigeria	0	1	1	1	0	0	0	1	0	1	0	
Rwanda	1	0	0	0	0	0	1	0	1	1	1	
Sao Tome and Principe	0	0	1	0	0	1	0	0	0	0	0	
Senegal	0	0	1	0	1	0	0	1	0	1	1	
Seychelles	0	0	0	0	1	0	0	0	0	1	0	
Sierra Leone	0	1	1	1	0	0	0	1	0	1	0	
Somalia	0	0	0	0	0	0	0	0	1	0	0	
South Africa	0	1	1	1	0	0	0	0	0	1	1	
Sudan	0	1	1	1	0	0	0	1	1	0	0	
Swaziland	0	0	1	1	0	0	0	0	0	1	0	
Tanzania	0	1	0	1	0	0	0	1	0	1	1	
Togo	0	0	1	0	1	0	0	1	0	0	1	
Uganda	1	1	1	1	0	0	0	0	1	1	1	
Zambia	1	1	1	1	0	0	0	0	0	1	1	
Zimbabwe	1	0	1	1	0	0	0	0	0	1	1	
Total	14	22	24	17	17	5	3	24	8	32	28	

"1" indicates country belongs to category, "0" that it does not belong, red numbers indicate imputation on basis of CIA World Factbook. Sources: for geographical variables, Nijkam (2008) and the CIA World Factbook, for the war variable, Correlates of War (2008)
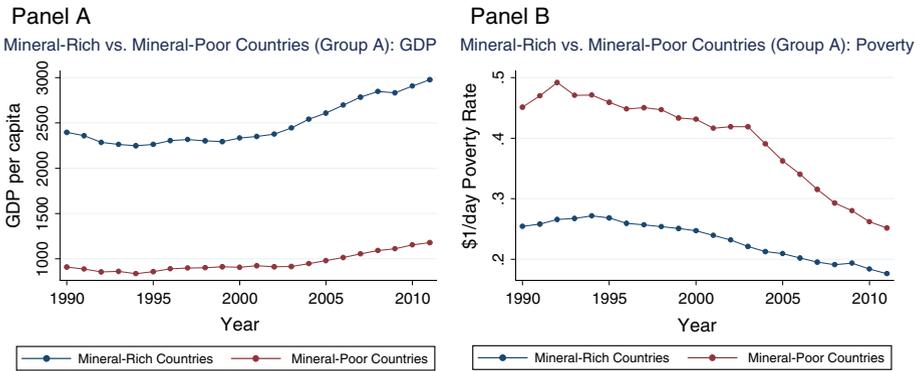
Fig. 15 African growth and poverty breakdown: mineral-rich versus mineral-poor countries (Group A countries)
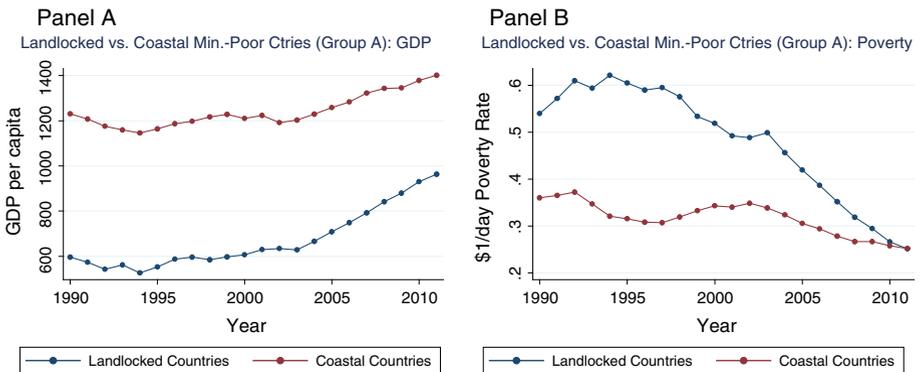

Fig. 16 African growth and poverty breakdown: landlocked versus coastal mineral-poor countries (Group A countries)

from Nijkam (2008) and the CIA World Factbook by combining the definitions for landlocked and mineral-poor countries that are presented in Table 2. Figure 16 shows the GDP per capita and the poverty rates over time for these two sets of countries. Panel A confirms Collier (2006) by showing that the GDP per capita of landlocked mineral-poor countries is much lower than that of coastal mineral-poor countries, but the gap has been shrinking in the 2000s. Panel B shows while landlocked mineral-poor countries were much poorer in 1990 than coastal mineral-poor countries were, since 1995, landlocked mineral-poor countries have cut their poverty rate by more than 20 percentage points, and by 2011, their poverty rate has converged to that of coastal mineral-poor countries.

We now compare the performance of countries with favorable and unfavorable agricultural environments. The definition of favorable and unfavorable agriculture is taken from Nijkam (2008) and supplemented with data from the CIA World Factbook (2009). The list of countries in each category is provided in Table 2. Panel A of Fig. 17 shows that African countries with favorable agricultural environments are richer than countries with unfavorable agriculture. Panel B shows that the speed at which poverty has fallen in the unfavorable agriculture countries has been substantial: from 47 % in 1990 to 27 % in 2006. The poverty rate of countries with favorable agricultural environments has gradually declined from about 27 % to under 20 % during the sample period.
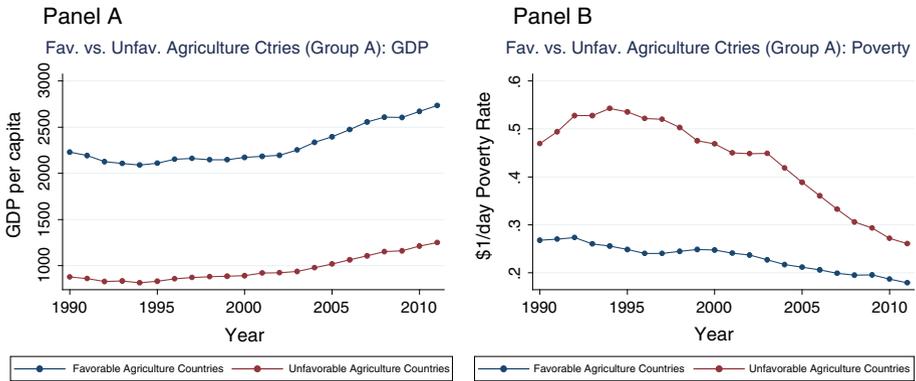
Panel A

Fav. vs. Unfav. Agriculture Ctries (Group A): GDP

Panel B

Fav. vs. Unfav. Agriculture Ctries (Group A): Poverty

Fig. 17 African growth and poverty breakdown: favorable versus unfavorable agriculture countries (Group A countries)

Panel A

Countries at War vs. Peace in 1997 (Group A): GDP

Panel B

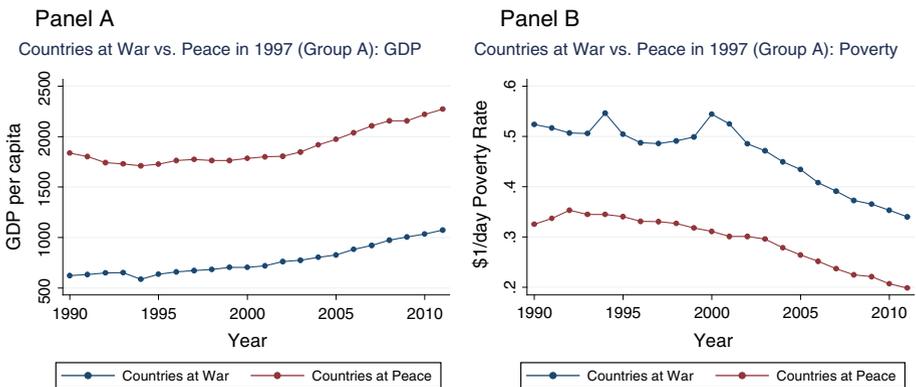Countries at War vs. Peace in 1997 (Group A): Poverty

Fig. 18 African growth and poverty breakdown: countries at war in 1997 versus countries at peace in 1997 (Group A countries)

We now compare the performance of countries at war with countries at peace. Since many African countries have been at war at some point during the sample period, we use 1997 (the last year of the availability of Correlates of War data) as a breaking point. A country is labeled to be at war if it was at war in 1997 and it is labeled to be at peace if it is at peace in 1997 according to the Correlates of War dataset (Sarkees 2000). Table 2 provides a list of countries at war in 1997. Figure 18 shows the differential performance of both sets of countries. Once again, countries at peace in 1997 are richer than countries at war in 1997. Panel B shows that the poverty rate of countries at war has been consistently higher than that of countries at peace (with upward blips in the 1990s during the wars) but since 2000, both countries at war and countries at peace in 1997 have been reducing poverty at a similar linear rate.

Nunn (2008) argues that a substantial part of Africa's underdevelopment can be explained by the African slave trades. In essence, countries that did not suffer from the slave trades should tend to perform better than countries that did because the slave trades had damaging and permanent effects such as social and ethnic fragmentation, political instability and a weakening of states, and the corruption of judicial institutions. To assess this point Fig. 19
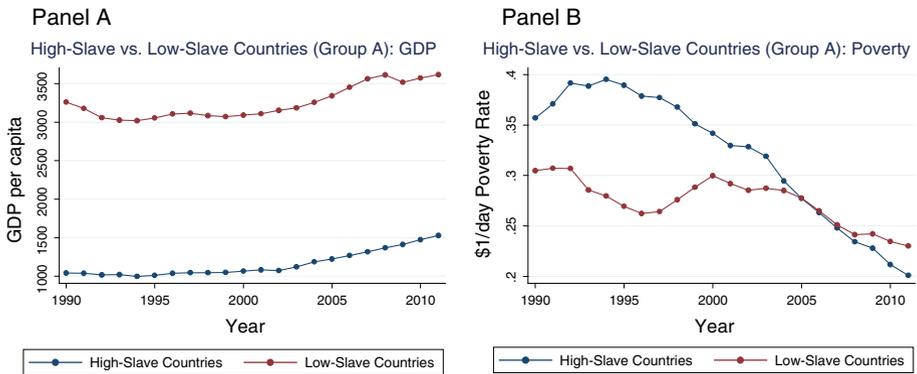
Fig. 19 African growth and poverty breakdown: countries with above median versus below median slave exports per capita during the African slave trade (Group A countries)

decomposes Africa into countries that had slave exports per capita above (high-slave countries) and below (low-slave countries) the African median respectively. The definitions are taken from Nunn (2008) and the list of countries in each category is reported in Table 2. Panel A shows that low-slave countries have higher GDP per capita than high-slave countries. Panel B shows that while the high-slave countries had higher poverty in 1990 than did the low-slave countries, this difference was completely erased by 2005, and since then, poverty has evolved similarly in the two sets of countries.

Our conclusion is that African poverty reduction has not only been large, but it also has been general, affecting many different types of countries. It is important to understand what our regional results do and do not imply. There is nothing in these results that should be interpreted as causal: the variation we are using is not exogenous. In particular, we cannot conclude that there is an "advantage to backwardness" because countries with disadvantaged history or geography reduce poverty faster (for instance, we may observe this because these countries are poorer in the first place, and have more poverty to reduce). However, we can conclude that neither geography nor history is destiny: it is possible for countries with poor geography and troubled history not only to reduce poverty rapidly, but to converge to the more advantaged countries, at least for the range of the data that we observe.

6 Inequality

Many analysts claim that, because Africa's economy is largely based on natural resources, the growth rate of the last decade has benefited mainly the political and economic elites that own those resources, without reaching the poor. A criticism of our analysis could be that our methodology overestimates the growth reaching the poor if it does not have inequality data for African countries during the period of poverty reduction. This is an important challenge to the conclusion that Africa is reducing poverty fast enough to reach the MDGs close to the target 2015 date. In this section, we argue that this is not the case: we have ample data on African within-country inequality during the crucial period in which we assert that poverty begins declining, and the data suggest that inequality, if anything, fell between 1990 and 2011.

Figure 20 shows the percentage of the (Group A) African population in each year living in countries for which we have surveys in years before and after the given year. That is, within-
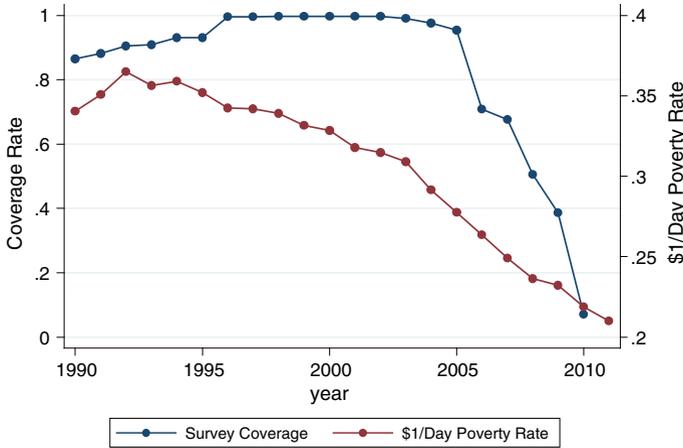
Fig. 20 Consumption and income interpolation: poverty (Group A countries)
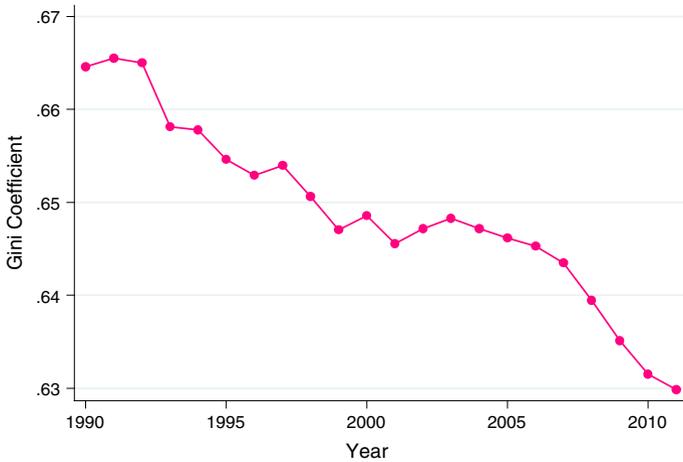

Fig. 21 Baseline Gini, Africa Group A countries

country inequality for that country in that year is either obtained directly from a survey or is
obtained by interpolation rather than extrapolation. We see that between 1996 and 2005, when
Africa transitions into poverty decline, this measure is nearly constant and close to 100 %
of the African population. Hence, our conclusion that poverty is falling is not driven by the
mere assumption that growth in African countries did not become unevenly tilted towards
the rich, but rather incorporates data on how growth was distributed for the overwhelming
majority of Africans.

What do we find out about African inequality? Figure 21 shows the (Group A) African
Gini coefficient series obtained from our baseline specification. We see that it is declining,
and in particular, that most of the decline takes place during the period of high survey data
availability. Figure 22 shows sensitivity plots of (Group A) African inequality that parallel
Figs. 11 and 12 for poverty.[10] We see that regardless of the assumptions made, (Group A)

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[10] All of these plots show inequality between African citizens within and across countries. It may be
argued that while growth accrued to the poorest African countries, within-country inequality in Africa may
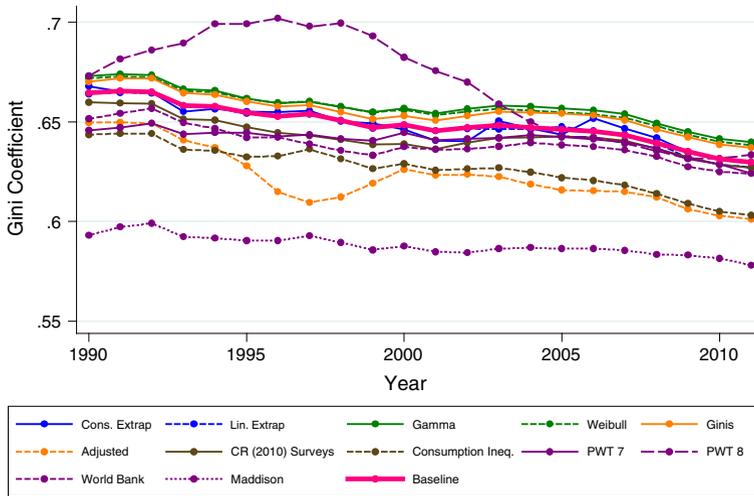
Fig. 22 Inequality in Africa, Group A countries

African inequality is declining (though its level varies, most notably, with assumptions about GDP), Hence, during the African poverty decline, our ample survey data on African inequality shows that it was not rising and not counteracting the role of growth in reducing poverty. [11]

The importance of GDP relative to inequality in explaining poverty can be readily seen from the "mirror graph" Figs. 6, 7, 8, and 9. We label all years for which we have survey data with X's, and it is apparent that we have multiple years of survey data scattered throughout the sample period for Ethiopia, Nigeria, Uganda and Mozambique. However, for these countries, poverty is a mirror image of GDP, and rarely deviates from the mirror image path in years with surveys. The variation in African inequality documented by the surveys is simply too small to meaningfully dampen the poverty-reducing impact of growth.

7 Countries with fewer than two surveys

While we have shown that the Group A countries—the ones for which we have survey data to avoid imputation—are on track to achieve the MDGs on target, it is interesting and important to ask what has happened to poverty in Africa as a whole. To do so, we need to impute inequality data and trends to countries with fewer than two surveys. We do this in two basic types of ways. The first way is to compute the raw or population-weighted average of Gini coefficients for the Group A countries for each year, impute the deviations from this series to a country with exactly one survey (so that we set the level of inequality to match the single available survey but use the trend information for Africa as a whole), and impute the entire series for countries without any inequality data. The second way is to compute bounds on the

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Footnote 10 continued

have risen. While the Gini cannot be decomposed into between and within components, we have looked at (Group A) African within-country inequality as measured by the Atkinson inequality index and the Generalized Entropy index. Within-country Group A African inequality declines between 1990 and 2011 for parameters of the Atkinson index between 0.5 and 2, and for parameters of the GE index between −1 and 1.5.

[11] For Africa as a whole, inequality declines but trivially (by a few tenths of a percentage point), and rises (also trivially) between 1990 and 2006 if PWT 7.1 GDP is used.
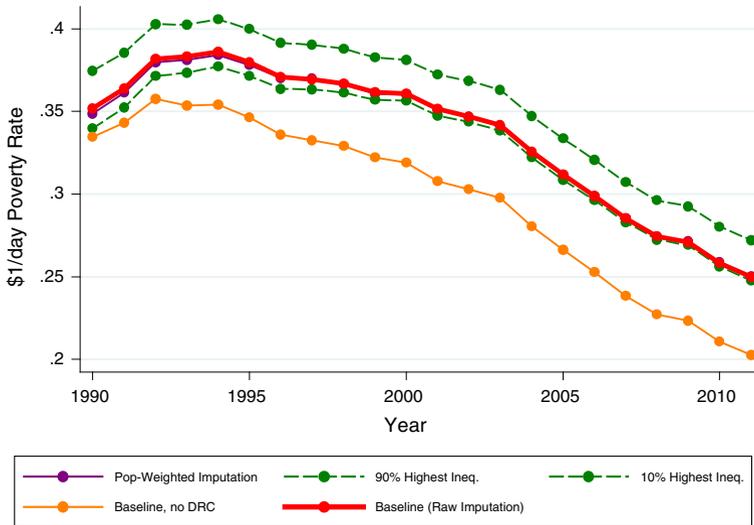
Fig. 23 Falling poverty (all Africa): imputation

poverty series under the assumption that inequality in countries with fewer than two surveys is bounded by certain percentiles of the distribution of Gini coefficients among the Group A countries. Since we make the lognormal assumption, an increase in the Gini holding the mean income constant increases poverty, so poverty will be monotonically increasing in inequality for any given country (though not necessarily for an aggregate of countries).

Figure 23 and Table 3 present poverty series and MDG attainment estimates for Africa as a whole (not just the Group A countries) for a variety of imputation assumptions. The baseline imputation assumption is to impute the raw average of Gini coefficients among the Group A countries as the inequality series (or as the series of deviations to be anchored at a single survey) for the Group B and C countries. We see that under this imputation, African poverty continues to decline rapidly as it did for just the Group A countries. However, from Table 3 we see that the MDG is achieved 3 years after the 2015 target date for Africa as a whole: in 2018. Using population-weighted averaging rather than raw averaging makes little difference in the poverty series, although it delays the MDG by an additional year.

Why will the MDGs be achieved late, though still close to the target date? A major reason is that the DRC, which is a Group B country, descended into anarchy after the fall of the autocratic Mobutu regime in 1996, and has only slowly been emerging from the conflict. If we exclude the DRC from our sample, the African poverty rate in 1990 was 33.4 %. Hence, the MDG is to cut that number to 16.7 % by 2015. The poverty rate in 2011 was 20.3 %. Projecting the rate of progress between 2000 and 2011 into the future, we expect the African poverty rate to be 16 % in 2015, and the MDG to be achieved on time (in fact, in 2014). Figure 23 presents a plot of African poverty without the DRC; we see that it starts lower and declines much more rapidly than does the series for Africa as a whole.

We also present bounds on the estimates of all-Africa poverty rates and MDG attainment dates based on bounds on within-country inequality in African countries. The bounds assume that inequality in any of the Group B and C countries could not have been lower than the 10th percentile or higher than the 90th percentile of the distribution of Gini coefficients in the

Table 3 African poverty sensitivity to imputation (all Africa)

Variation	Poverty rate in 1990 (%)	Poverty rate in 2011 (%)	Percentage poverty reduction 1990–2011 (%)	Projected poverty in 2015 (%)	Projected poverty reduction, 1990–2015 (%)	Year in which MDG attained (%)
Baseline (raw avg. Gini imputation)	35.2	25.0	−28.9	21.0	−40.4	2018
Pop.-weighted avg. Gini imputation	34.9	25.0	−28.2	21.0	−39.7	2019
Upper 10–90 % Bound[a]	34.0	27.2	−19.9	24.1	−28.9	2024
Lower 10–90 % Bound[a]	37.5	24.8	−33.9	19.9	−46.8	2016
Excludes Fmr. Port. colonies	34.4	24.9	−27.5	21.1	−38.7	2019
Alwyn young sample	38.1	22.3	−41.5	17.3	−54.6	2014
Outside AY sample	30.4	29.4	−3.3	27.0	−11.4	2034
Excludes DRC	33.4	20.3	−39.4	16.0	−52.1	2014
Excludes Nigeria	38.8	27.5	−29.0	23.1	−40.5	2018
Excludes Ethiopia	33.0	25.7	−22.0	22.7	−31.2	2023
Excludes Uganda	34.3	24.9	−27.4	21.0	−38.7	2019
Excludes Kenya	35.1	25.1	−28.6	21.0	−40.1	2018
Excludes Tanzania	35.5	25.5	−28.1	21.5	−39.3	2019
Excludes Sudan	35.4	25.9	−27.0	21.8	−38.5	2019

We assume linear trend since 2000

[a] Upper bound computed by assuming that countries with fewer than 2 surveys had the 10th percentile Gini in 1990 and 2000, and the 90th percentile Gini in 2011. Lower bound computed by assuming they had the 90th percentile Gini in 1990 and 2000, and the 10th percentile Gini in 2011

Group A countries (pooled across countries and years). The resulting bounds are shown by the green dashed lines in Fig. 23. We see that any poverty path inside these bounds must be declining: the upper bound in 2011 is lower than the lower bound in 1990. The lower bound on the MDG achievement date is 2016 and the upper bound is 2024, nine years late. However, we see that even rather extreme assumptions about how much inequality could have increased for the Group B and C African countries—from the 10th to the 90th percentile of the Group A Gini coefficient distribution—do not reverse the contention that Africa is reducing poverty, but only delay somewhat the date at which it is halved.

We also check for the robustness of our estimates to dropping individual African countries. Table 1 presents estimated years in which the MDG is achieved if any of the African countries with large numbers of poor people are dropped. They range from 2014 (on time) if the DRC
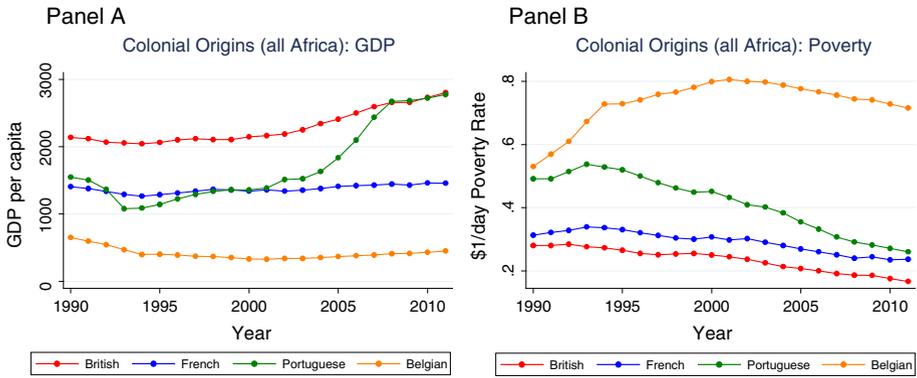
Panel A
Colonial Origins (all Africa): GDP

Panel B
Colonial Origins (all Africa): Poverty

Fig. 24 African growth and poverty breakdown: countries by identity of the colonizer (all Africa)

Panel A
Alwyn Young Sample: GDP
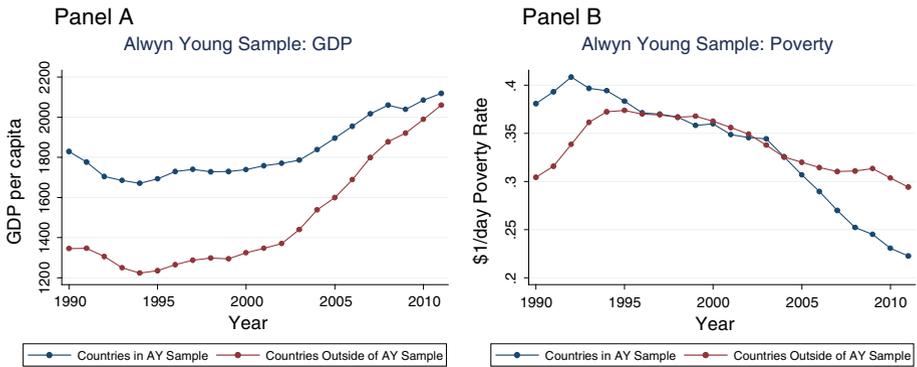
Panel B
Alwyn Young Sample: Poverty

Fig. 25 African growth and poverty breakdown: Alwyn Young sample versus rest of Africa

is dropped to 2023 (8 years late) if Ethiopia is dropped. The sensitivity of our results to these countries is intuitive: they had, respectively, the second-largest and largest number of poor people in 1990, and during the 1990s Ethiopia ended a period of political instability and famine, while the DRC collapsed into civil war.

We use our all-Africa estimates for two more regional analyses. First, we compare the experience of African countries by colonial origin. This comparison could also be made for Group A countries only, but some large former Portuguese colonies (e.g. Angola) have only one survey. Porta et al. (1999) argue that colonized countries inherited the legal framework of their colonizers and that some legal frameworks are more favorable to development than others. Panel A of Fig. 24 displays the evolution of GDP. Former British colonies are the richest, followed by the Portuguese and French colonies. However, the Portuguese colonies grew rapidly in the 2000s to become richer than the British colonies by 2011. (Omitting them from the sample delays MDG attainment by only one year). All three sets of countries reduced poverty relatively similarly. Belgian former colonies (essentially the DRC and the two small countries of Rwanda and Burundi), starting out as the poorest, witnessed a continued decline in GDP because of the poor performance of the DRC during the conflict surrounding the end of the Mobutu regime in 1997. The civil war in the DRC meant that poverty in the former Belgian colonies increased dramatically between 1990 and 2006 (Panel B).

Finally, we compare countries inside and outside the sample considered by Alwyn Young (2012). We see that the countries in the Alwyn Young sample are richer, though they have had less growth as measured by the World Bank than the countries outside that sample. However, the Alwyn Young countries have also been much more successful in reducing poverty than the non-Alwyn Young countries. From Fig. 25, we see that while the Alwyn Young countries reduced poverty continuously since the early 1990s and are predicted to reach the MDG by 2014, the non-Alwyn Young countries saw poverty rise in the 1990s and only now have decreased poverty back to the 1990s level. Much of this rise is driven by the DRC's descent into civil war over the course of the 1990s.

8 Conclusion

Our main conclusion is that Africa is reducing poverty, and doing it much faster than we thought. The growth from the period 1992–2011, far from benefiting only the elites, has been sufficiently widely spread that African inequality, if anything, declined during this period. In particular, the African countries for which good inequality data exists are set to reach the Millennium Development Goal of halving poverty relative to 1990 by 2015, the target date. The entire continent except for the DRC will reach the MDG in 2014, one year in advance, and adding the DRC will delay the MDG until 2018. These results are qualitatively robust to changes in our methodology, including using different data sources and assumptions for what happens to inequality when inequality data is not available. In particular, there is no evidence for, and substantial evidence against the hypothesis that African growth has been monopolized by a small elite and did not reach the poor.

We also find that the African poverty reduction is remarkably general: it cannot be explained by a large country, or even by a single set of countries possessing some beneficial geographical or historical characteristic. All classes of countries, including those with disadvantageous geography and history, experience reductions in poverty. In particular, poverty fell for both landlocked as well as coastal countries; for mineral-rich as well as mineral-poor countries; for countries with favorable or with unfavorable agriculture; for countries regardless of colonial origin; and for countries with below- or above-median slave exports per capita during the African slave trade. This observation is particularly important because it shows that poor geography and history have not posed insurmountable obstacles to poverty reduction. The lesson we draw is largely optimistic: even the most troubled parts of the poorest continent can set themselves firmly on the trend of limiting and even eradicating poverty within the space of a decade.

9 Appendix I: Construction of combined PWT GDP

Johnson et al. (2013) caution against using recent versions of the Penn World Tables to obtain purchasing-power-parity adjusted estimates of GDP for prior years. In particular, they suggest

assessing relative GDPs of countries in a given year by using the PWT created closest to that year. In light of this suggestion, we construct our GDP measure as follows:

1. We start with the 2011 estimate of GDP from PWT 7.1 (base year 2005). These are computed by taking the 2010 estimates and updating them with the growth rates for 2010-2011 from the World Development Indicators, since there is no data for 2011 in PWT 7.1
2. We generate estimates for prior years with growth rates computed as follows:

   a. PWT 7.1 growth rate for years 2005 and later.
   b. Average of PWT 6.2 and PWT 7.1 growth rates for years between 2000 and 2004.
   c. Average of PWT 6.1 and PWT 6.2 growth rates for years between 1996 and 1999.
   d. Average of PWT 5.6 and PWT 6.1 growth rates for years between 1991 and 1995.

Recently, PWT 8 has been released at the University of Groningen. However, its methodology is considerably distinct from that of the first 7 iterations of the PWT, so we do not use any growth rates from it for our computations.

10 Appendix II: Consumption adjustment

To adjust consumption surveys in order to use them in our analysis, we adapt the procedure of Bhalla (2002). We select all country-years from the UNU-WIDER World Income Inequality Database for which both income and consumption surveys are available, and manually select which income and consumption surveys of those available for a given country-year to use. We base our selection on 1) similarity of source, and 2) similarity of income sharing units, units of analysis and equivalence scales. Altogether, we have 100 pairs of income and consumption surveys.

We then estimate the system of seemingly unrelated equations:

$$q_{ijI} = \beta_j q_{ijC} + u_{ij}, J = 1, \ldots 5$$

where q is the quintile share, I and C index income and consumption, i indexes observations (country-years), and we allow the $u_{ij}'^s$ to be correlated across j (since quintile shares must sum to unity, the errors in the above regression are probably correlated across quintile shares). We exclude a constant from estimation. Our estimates are as follows:

Seemingly unrelated regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P	
q1_I	100	1	1.785765	0.8624	1498.20	0.0000	
q2_I	100	1	2.237161	0.9321	3755.21	0.0000	
q3_I	100	1	2.337126	0.9662	7431.34	0.0000	
q4_I	100	1	2.709944	0.9812	9206.86	0.0000	
q5_I	100	1	8.073047	0.9801	10443.53	0.0000	
		Coef.	Std. Err.	z	P > |z|	[95% Conf. Interval]	
q1_I	q1_C	.8273436	.0213748	38.71	0.000	.7854498	.8692374
q2_I	q2_C	.8973646	.0146437	61.28	0.000	.8686634	.9260658
q3_I	q3_C	.9321035	.0108126	86.21	0.000	.9109111	.9532958
q4_I	q4_C	.9756106	.0101677	95.95	0.000	.9556824	.9955388
q5_I	q5_C	1.072232	.0104922	102.19	0.000	1.051668	1.092797

Correlation matrix of residuals

	q1_I	q2_I	q3_I	q4_I	q5_I
q1_I	1.0000				
q2_I	0.9217	1.0000			
q3_I	0.7526	0.9033	1.0000		
q4_I	0.3906	0.5839	0.7973	1.0000	
q5_I	−0.7649	−0.8790	−0.9198	−0.7769	1.0000

Breusch-Pagan test of independence: chi2(10) = 616.843, Pr = 0.0000

Hence we see that the residuals are highly correlated across j, so the SUR procedure made sense. We then multiply all consumption quintile shares for the surveys we use by these estimates, and renormalize the resulting shares to sum to unity. (In practice, the shares sum very close to unity even without renormalization).

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