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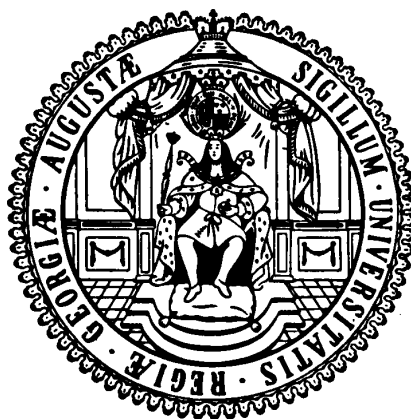
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**Income Distribution Dynamics and Pro-Poor Growth
in the World from 1970 to 2003**

Hajo Holzmann, Sebastian Vollmer, Julian Weisbrod

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Income Distribution Dynamics and Pro-Poor Growth in the World from 1970 to 2003

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Abstract

We estimate and analyze the global income distribution from national log-normal income distributions for the years 1970 to 2003, as well as the income distribution of seven regional subsamples. From these distributions we obtain measures for global and regional inequality and poverty, and find decreasing global poverty and inequality during the time period. By decomposing inequality into within and between country inequality using Theils' measure of inequality, we observe declining inequality between countries whereas overall inequality within countries increased. Furthermore, we calculate growth incidence curves for five year periods between 1970 and 2003, as well as a growth incidence curve for the entire period and corresponding rates of pro-poor growth. In the global income distribution, the 8.5th to 63.5th global income percentiles experienced above average percentile growth rates, while the remaining very lowest quantiles experienced also the lowest percentile growth rates. Using the regional decomposition we find that while in 1970 more than half of the worlds extreme poor and poor people lived in East Asia, it is Sub-Saharan Africa where nowadays two thirds of the extreme poor and half of the worlds poor live.

JEL classification: I32, I31, O47, F01

Keywords: Global income distribution, poverty, inequality, growth incidence curves, pro-poor growth convergence.

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1 Introduction

Over the past decade increased attention has been given to the evolution of global income inequality and the connected questions of global welfare and poverty development. In the light of an ever increasing globalization of the world economy, an increasing concern is to identify global and regional winners and losers of this process. From a welfare point of view the question might not be, if globalization generated economic growth per se, but rather how pro-poor this growth was or in other words which section of the global income distribution benefited most from the relatively successful global growth record of the past decades.

Recent papers model the global income distribution, or a distribution limited to major economic players, by taking into account the underlying national income distributions (Dowrick & Akmal, 2005; Milanovic, 2002; Chen & Ravallion, 2004; Chotikapanich, Valenzuela & Rao, 1997; Bourguignon & Morrisson, 2002; Quah 2002; Bhalla, 2002; Sala-i-Martin, 2002a, 2006). In fact, an objective way to construct the global income distribution from the distinct national income distributions is as a population weighted finite mixture of the national income distributions. Intuitively, if one picks at random an individual with a certain income from this global income distribution, one first randomly draws the country it belongs to (with probability equal to that countries proportion in the world population), and then obtains its income from the corresponding country income distribution. The main task in this approach is to determine the national income distributions.

A debate continues concerning the data sources on which estimates of the income distributions should be obtained. Two main concepts have been used so far. The first approach, labeled concept 2 by Milanovic (2006), combines national accounts income data with household survey inequality data to derive a global income distribution. The second approach (labeled concept 3 by Milanovic 2006) is purely based on income and inequality data from household surveys. Both approaches have their associated merits and serious caveats, which have been discussed extensively in the literature (Milanovic, 2006; Sala-i-Martin, 2006; Ravallion, 2003; Deaton, 2005).

As far as the poverty headcount is concerned, the headcount for the \$2 per day poverty line of studies based on concept 2 (Sala-I-Martin, 2002a, 2006) roughly corresponds to the headcount of the \$1 poverty line estimated under concept 3 (Chen & Ravallion, 2004). A simple reason is that the ratio of household level income to national account is about 1/2 (cf. Deaton, 2005). However, it is beyond the scope of this paper to discuss the advantages or disadvantages of certain poverty lines. We decided to stick to the \$1 and \$2 US (PPP) poverty lines applied to income as it makes our results comparable to those by Chen and Ravallion (2004) and Sala-i-Martin (2006).¹

Sala-i-Martin (2006) argues that from the methodological point of view, one should use nonparametric kernel estimates instead of parametric models for the country income distributions, since these do not assume any specific shape for the income distributions. While we agree with it on the methodological basis, in our opinion nonparametric modeling would require actual income data for all countries under consideration, and on a comparable basis. We therefore prefer to model the national income distributions parametrically as log-normally distributed. The parameters of each country's log-normal income distribution can be determined from its real PPP GDP/per capita and its Gini coefficient (cf. section 2.2). Hence, the data required for this approach is much more readily available than for nonparametric estimation. Our approach also has some methodological merits, which allow us to obtain new insights into the income distribution dynamics. In particular, the resulting global income distribution (a finite mixture of log-normal distributions) is much easier to handle than a non-parametric analogue. A number of measures, such as poverty rates, percentile specific growth rates and rates of pro-poor growth, can be determined directly from the distribution without sampling and without loss in accuracy, and it is moreover a simple matter to sample from the distribution as well. It is this advantage which allows us to construct growth incidence curves of the world income distribution for several semi-decades and for different

¹ Furthermore, we show in figure 3 that any reasonably selected poverty line would show a decline in the poverty headcount ratio as the cumulative distribution function of global income of subsequent time periods are dominant over the cumulative distribution function of the prior time period.

regions as well as a decomposition of inequality into between and within inequality. Thus, we obtain a broad and detailed picture of global and regional inequality, poverty and pro-poor growth, which extends and refines previous studies.

The paper is structured as follows. Section 2 describes the data and our methodology. Section 3 presents our results of the global income distribution. We give estimates of the evolution of global poverty and inequality over time and compare them with previous research (Milanovich 2002; Chen & Ravallion 2001, Sala-i-Martin, 2006). In particular, our findings concerning between and within inequality based on Theils measure appear to be novel. Moreover, we discuss semi-decade specific global growth incidence curves, and therefore can give a precise description of pro-poor growth. In section 4, we decompose the world into seven main regions, and investigate the regional variation in poverty and inequality development. We also analyze the underlying regional growth incidence curves, which yield a regionally comprehensive picture of pro-poor growth and of the intra-distributional dynamics, before we conclude.

2 Methodology and Data

2.1 Data

The subsequent analysis is based on two main data sources. Income data is drawn from the Penn World Tables 6.2 (Heston, Summers and Aten, 2006), which report the real GDP per capita in constant international dollars (chain series, base year 2000), available for most countries. However, for three particularly populous countries, namely Bangladesh, Russia and Ukraine we estimated the initial missing values.² Our second data source is an inequality dataset by Grün and Klasen (2007) based on the WIDER database.³ Their adjusted Gini dataset has substantive advantages in terms of comparability, as, due to different methodologies, the Ginis in the WIDER database are not fully comparable over time and countries.

² For Bangladesh we calculated the values for the two initial years 1970, 1971 using the average income per capita growth rate of the rest of the decade. For Russia and Ukraine we used the derived (Penn World Tables 5.6) USSR growth rates to estimate the average income for the years before 1990.

³ We would like to thank Grün and Klasen for providing their dataset.

Furthermore, as inequality does not change too dramatically over time, we assume the first real observation of the Gini in any given country to be equal to its initial level of inequality. Starting from this initial level we used a moving average to catch changes in trends of inequality. Unfortunately, there is no reliable inequality data for the populous Democratic Republic of Congo, hence we used the neighboring Central African Republics' Gini as a substitute.

2.2 Mixtures of Log-normal Distributions

As stated in section 2, the national income distributions will be modeled by a log-normal distribution. Formally, the log-normal distribution $LN(\mu, \sigma)$ is defined as the distribution of the random variable $Y = \exp(X)$, where $X \sim N(\mu, \sigma)$ has a normal distribution with mean μ and standard deviation σ . It can be shown that the density of $LN(\mu, \sigma)$ is

$$f(x; \mu, \sigma) = \frac{1}{x\sigma\sqrt{2\pi}} \cdot e^{-(\log(x)-\mu)^2/2\sigma^2}, \quad x > 0,$$

and its mean and variance are given respectively by

$$E(Y) = e^{\mu+\sigma^2/2}, \quad Var(Y) = (e^{\sigma^2} - 1)e^{2\mu+\sigma^2}. \quad (1)$$

We should briefly discuss the interpretation of the parameters μ and σ , which is different from that for the normal distribution. In fact, from (1) one sees that $\log \mu$ is proportional to the expectation and $(\log \mu)^2$ is proportional to the variance, and in fact, $\log \mu$ is the scale parameter of the log-normal distribution, whereas σ is a shape parameter. Since the Gini coefficient is invariant under changes of scale (it does not matter whether income is measured in Euro or in Dollar), it should be independent of μ and only depend on σ . This is indeed the case: The Gini coefficient G of $LN(\mu, \sigma)$ is given by

$$G = 2\Phi(\sigma/\sqrt{2}) - 1,$$

where Φ is the distribution function of the standard normal distribution. Therefore, the parameters μ and σ of $LN(\mu, \sigma)$ can be determined from the mean EY and the Gini coefficient G as follows.

$$\sigma = \sqrt{2} \Phi^{-1} \left(\frac{G+1}{2} \right), \quad \mu = \log(E(Y)) - \sigma^2/2.$$

In summary, the parameters μ and σ of each country's log-normal income distribution are easily determined from the real PPP GDP / per capita (EY) and its Gini G .

To conclude this section, we formalize how the density of the world income distribution f_W is obtained as a mixture of national (log-normal) distributions. Assuming that there are n countries under investigation and that the (log-normal) density of the distribution of country i is given by $f(x; \mu_i, \sigma_i)$, then

$$f_W(x; \mu_1, \dots, \mu_n, \sigma_1, \dots, \sigma_n, p_1, \dots, p_n) = \sum_{i=1}^n p_i f(x; \mu_i, \sigma_i),$$

where p_i is equal to the proportion of country i 's population in the whole population of these n countries.

It has to be stressed that although the density f_W is a simple finite mixture of the component country densities $f(x; \mu_i, \sigma_i)$, this does not transfer to relevant quantities such as the Gini or other inequality or poverty measures: the world Gini G_W is not simply the corresponding finite mixture of the country Ginis G_i . Nevertheless, once the parameters of the density f_W are estimated, it is not difficult to compute the poverty rates as well as percentile specific growth rates numerically from the distribution for any given level of accuracy without sampling. Furthermore, we obtained a number of other inequality and poverty measures by Monte Carlo simulation from f_W . To this end we used a random sample of size 10^6 to obtain the desired accuracy. Since there are no substantial differences between the results of different poverty or inequality measures, we will only discuss the poverty measures by Foster, Greer and Thorbecke as well as the Gini and Theil's measure of inequality. Theil's measure

is especially informative since it can be decomposed into separate measures for inequality between and within countries. Our poverty line is set at \$469.9 US (PPP) and \$935.45 US (PPP) a year, which corresponds to the World Bank 1993 poverty line of \$1.08 US and \$2.15 US per day adjusted to our income baseline year 2000 respectively.⁴

Finally, let us remark that, if the world income Y is distributed as f_W , then the log world income $\log Y$ has density

$$lf_W(x; \mu_1, \dots, \mu_n, \sigma_1, \dots, \sigma_n, p_1, \dots, p_n) = \sum_{i=1}^n p_i \phi(x; \mu_i, \sigma_i),$$

where $\phi(x; \mu, \sigma)$ is the density of $N(\mu, \sigma)$. Thus lf_W is simply a finite mixture of normal densities.

3 The Global Income Distribution

3.1 Inequality and Poverty

Figures 1 and 2 show estimates of the global income distribution as well as of the log-income distribution, determined as discussed in section 2.1, for selected years. Two striking features are apparent. First, the average global income increased drastically over the given time period, and second, the global world income distribution has become less dispersed. Interestingly, the 1970s and 1980s still seem to display two distinct modes in the global log-income distribution. However, these "twin peaks" disappear over the years and in particular between 1990 and 2003. Thus, the results clearly show global income expansion and convergence of real global individual income in \$US (PPP). One hypothesis might be that the increased globalization of the time period leads to a further integration of the world citizens' income. The Gini and Theils' inequality measures reported in Table 3 confirm this first impression as both measures decline over the given time period, from 0.68 to 0.64 and from 0.88 to 0.80

⁴ adjusted to our 2000 base year \$1.08 (1993) per day = \$ 1.287 (2000) per day = \$469.9 per year. In the case of the \$2 line \$2.15 (1993) per day = \$2.562 (2000) per day = \$935.45 per year

respectively.⁵ The decomposition of Theils measure shows that this decline in inequality was mainly due to a strong decline in inequality between countries, while inequality within countries even increased. This observation is consistent with a first impression from the biggest countries China and India where inequality increased over time.

Table 1 below shows the results of the Foster-Greer-Thorbecke (FGT) poverty measures for the poverty headcount and the poverty gap ratio. Furthermore, the absolute number of people below the two poverty lines is reported in table 2. It is apparent that from 1970 to 2003 all measures of poverty, absolute and relative, declined strongly. The percentage of the world population living below \$1 a day declined drastically from 21 percent in 1970 to 6 percent in 2003. The reduction of this measure of extreme poverty was particularly rapid in the 1970s and early 1980s as the headcount ratio dropped from 21 percent in 1970 to 8 percent in 1985 which corresponds to a decline of the absolute number of people living with less than \$469.9 (PPP, 2000) per year from slightly over 785 million in 1970 to roughly 400 million in 1985. From 1985 to 2003 the headcount fell further to 6 percent which corresponds to about 365 million people living below \$469.9 (PPP, 2000) per year. Moreover, the poverty gap ratio also displays a constant decline over the given time period, hence, not only did the absolute number of people living in extreme poverty fall, but those which remained poor saw their income improved toward the poverty line. The halving of the number of people living in poverty is especially impressive since the world's population almost doubled in the given time period. The results of the \$2 poverty line follow a very similar pattern. The headcount declined strongly from 43 percent, almost half the world's population, in 1970 to 14 percent in 2003. The most dramatic decline of the \$2 headcount was in the late 1970s and the 1980s from 42 percent in 1975 to 21 percent in 1990. Overall, the absolute number of people who lived below \$935.45 (PPP, 2000) per year declined from 1,571 million in 1970 to 893 million, in 2003. Furthermore, the poverty gap or "distance" of those people below the poverty line to the poverty line also declined considerably. Thus, all conceivable measures

⁵ We calculated a number of other inequality measures. However, they all show more or less the same overall picture, so we only report Gini and Theil.

show a dramatic decline of global poverty in relative and even in absolute terms, although clearly some decades experienced more pro-poor progress than others. In order to get a more refined picture of pro-poor growth we now investigate the global growth incidence curves and corresponding rates of pro-poor growth.

3.2 Growth Incidence Curves and Pro-Poor Growth

In figure 4 global growth incidence curves for different time periods are displayed, which show the percentile specific growth rates over the global income distribution.⁶ The main results are also summarized in table 4 below. If one considers the entire observational period, it is apparent that the middle percentiles of the global income distribution experienced the highest growth rates. In fact, the growth rate from the 8.5th to the 63.5th percentile of the global population experienced income growth rates above the mean of growth rates of all percentiles, which is equal to 2.3 percent per annum. Thus, the bottom-middle of the global income distribution experienced the fastest income growth, which also explains the declining income inequality and global income convergence. This effect is slightly counteracted by the less than average growth performance of the bottom percentiles (up to the 8.5 percentile), with the poorest percentiles experiencing the lowest income growth overall. Furthermore, the global average income grew by 1.8 percent per annum, whereas the median global individual experienced a 3.0 percent per annum income increase. The rate of pro-poor growth⁷ for the \$1 per day poverty line exceeds with 2.2 percent per annum the growth rate of the mean by about 0.4 percentage points per annum. Hence, the 34 years from 1970 to 2003 can be termed pro-poor in the relative sense, as the poor experienced higher income growth rates than the average income. For the \$2 per day poverty line the period was even more pro-poor as the rate of pro-poor growth with 2.7 percent per annum exceeded the growth rate of the mean with almost 0.9 percentage points per annum and is even greater than the mean

⁶ For a methodological discussion of growth incidence curves see Ravallion & Chen (2003)

⁷ The rate of pro-poor growth is defined as the average growth rate of the percentiles below the poverty line.

percentile growth rate. Hence, the global growth incidence curves over the period from 1970 to 2003 confirm and strengthen our inequality and poverty results above, as they show that over the 34 years the income of the poor has grown much faster than the average income. In fact, the bottom-middle income percentiles experienced the highest income growth rates explaining global income convergence, declining inequality and falling poverty headcounts. In order to understand in which era growth was particularly pro-poor, we take a closer look at semi-decade specific growth incidence curves.

For the first half of the 1970s the top and bottom percentiles of the global income distribution experienced the highest growth rate. If one considers the \$1 per day poverty line these years experienced relative pro-poor growth. However, this is not the case, if one applies the \$2 per day line, since the bottom-middle of the income distribution experienced only modest growth rates compared to the mean. The second half of the 1970s is characterized by the strongest global growth performance of 2.2 percent per annum in mean income and can be considered relatively pro-poor under the \$1 and the \$2 per day poverty definition. It is apparent that the bottom half of the distribution had higher growth rates than the average percentile growth rate and thus the bottom-middle of the global income distribution gained the most.

The first half of the 1980s can be considered the most pro-poor over the given time period as the bottom half of the distribution experienced very high growth rates compared to the top percentiles. The mean income grew by only 0.8 percent per annum, but the rate of pro-poor growth was 4.6 and 4.7 per annum for the \$1 and \$2 per day poverty line respectively. The second half of the 1980s experienced an increase in the global mean income growth rate to normal 1.9 percent per annum and is characterized by negative pro-poor growth rates for the extreme poor, at -0.9 percent per annum, and growth rates for the poor, at 1.0 percent per annum. This is mainly due to the fact that the very bottom percentiles experienced an income decline, where as the bottom-middle part of the distribution was doing reasonably well, so the bottom-middle half of the income distribution did catch up further to the upper percentiles. However, it is also important to note that the overall poor percentiles in 1985,

which are considered to be poor under the \$1 and \$2 per day definition, have been extremely reduced from the previous very pro-poor growth spell. In particular, the bottom-middle percentiles grew consistently, closing the income gap between the developing and developed world, which can also be seen if one looks at the log-income distribution where the two modes start to dissolve over the course of the 1980s. One hypothesis might be that the onset of globalization and export-led growth strategy enabled many global poor to participate in the global growth process in particular in China and South East Asia.

The 1990s cannot be considered relatively pro-poor. The highest growth rates over the decade are achieved by the inter-quartile percentiles that experience above mean percentile growth rates. This implies further global income convergence over the 1990s, and at the end of the 1990s no hint of a second peak in the global log-income distribution remains. However, these percentiles are no longer considered poor. The overall growth rate of mean income follows the previous decade pattern with the first half being characterized by relatively slower growth rates, 0.7 percent per annum, followed by stronger growth rates in the second half of 2.0 percent per annum. For the first four years in the new millennium the growth rate of mean income has slowed down again to 1.3 percent per annum. The rate of pro-poor growth is below the average income growth rate with the bottom percentiles growing at only 0.5 percent per annum for the \$1 per day poverty line and 0.6 percent for the \$2 per day poverty line. The highest growth rates are observed in the upper-middle part of the income distribution.

4 Regional Distributions, Inequality, Poverty and Growth Incidence Curves

4.1 Regional Income and Log-Income Distributions

In order to get a more refined picture, we decompose the world into seven regions which are analyzed separately: the West, East Asia and the Pacific, Latin America and the Caribbean,

Middle East and North Africa, Eastern Europe and Central Asia, South Asia and Sub-Saharan Africa (cf. table 5 for the countries belonging to each region).

The income and log-income distributions for these regions, modeled as described in section 2, are shown in figures 1 - 3. One observes a significant increase in the income distributions of East Asia and the Pacific and South Asia, whereas Latin America as well as the Middle East and North Africa, which were initially relatively rich regions in comparison to the West, only saw rather slow progress. Furthermore, Eastern Europe and Central Asia's distribution accounts for the varied experiences of the former Eastern Block countries with initially increasing and then falling income, finally resulting in a stronger dispersed income distribution. Sub-Saharan Africa's distribution hardly shifts at all implying virtually no gains and a relative deterioration compared to the other regions.

4.2 Regional Poverty and Inequality Measures

Poverty and inequality measures for these seven regions, which reflect the overall picture above, are reported in tables 1 - 3. Indeed, the region with the highest poverty headcount in 1970, namely East Asia and the Pacific, experienced the most breathtaking poverty decline from 78 percent in 1970 to 8 percent in 2003 combined with a strong decline in inequality between countries in this region. Moreover, the absolute number of poor decreased, despite strong population growth, from about half a billion or one billion to about 45 and 160 million for the \$1 and \$2 poverty definition respectively. Furthermore, Latin America and the Caribbean, as well as the Middle East and North Africa saw their poverty headcounts decline by almost half. However, their absolute number of poor increased slightly under both definitions due to population growth. Moreover, South Asia also experienced a remarkable poverty decline even though less spectacularly and from a lower initial level than East Asia, causing the absolute number of poor to fall from about 100 or 350 million to about 36 and 200 million for the \$1 and \$2 poverty lines, respectively. This experience was combined with rising inequality from an initially very low level driven by within country inequality.

Furthermore, the often lamented case of Sub-Saharan Africa is confirmed by our numbers, as it is the only region which experiences virtually no improvement in any of the measures. This stagnation of Sub-Saharan Africa and relative decline in comparison to all other regions becomes even more apparent if we take a look at the regional decomposition of the absolute number of poor as part of the global population. While the poverty rates remained more or less constant over the years, the absolute number of people living in poverty more than doubled due to population growth from about 100 and 180 million to about 240 and 420 million for the \$1 and \$2 poverty lines, respectively. Moreover, inequality measures even saw an increase from initially already very high levels, both for within and between country inequality. This implies that Sub-Saharan Africa is nowadays by far the most unequal and poorest region of the world in relative and absolute terms. Furthermore, Eastern Europe and Central Asia contributes little to the global poor if one considers the \$1 and \$2 per day poverty lines and thus is characterized by very low and slightly declining poverty rates and absolute number of poor combined with strongly increasing within country inequality after the breakdown of the Iron Curtain from initially rather low levels. Finally, for completeness' sake, a quick glance at the West shows that it basically contributes nothing to the global poverty dynamics under the applied definitions.⁸ However, the region experienced a marked increase in inequality due to an increase in within country inequality.

4.3 Regional Semi-Decade Specific Growth Rates, Rates of Pro-poor Growth and Growth Incidence Curves

The poverty and inequality dynamics described above becomes even more apparent if one takes a closer look at the regional growth incidence curves and results over the entire period as shown in figure 5. Moreover, a closer look at the semi-decade specific results conveys an

⁸ Clearly neither the \$1 nor the \$2 poverty line is a very suitable poverty measure for rich countries in general.

even more detailed picture of the regions' growth experience during shorter time periods.⁹

The West. The results for the West show that even though the average growth rate varied between better semi-decades, such as the late 1990s or late 1970s, and less strong growth periods, as the early 1990s and the early 1980s, the overall intra-distributional growth pattern is very stable. During all semi-decades, except for the start of the new millennium, the growth incidence curves show higher growth rates for the richest percentiles. Thus, the higher the population percentile the higher the income growth rate, with the logic consequence is increasing inequality over time.

Eastern Europe and Central Asia. Eastern Europe and Central Asia is telling a more interesting story as it is much less homogeneous. It is clear from the growth incidence curves that during the first half of the 1990s the bottom half of the regional income distribution saw their income decline drastically, see figure 6. These high negative growth rates, directly after the Soviet Regime collapse, are causing a slight increase in the poverty rate by 1995. The other semi-decades can be characterized as more pro-poor, except for the very bottom percentiles, accounting for the slightly declining inequality up to 1990 after which inequality increases rather rapidly, before it improves again.

East Asia and the Pacific. The fact that East Asia is by far the most dynamic region and accounts for most of the dramatic global poverty reduction is apparent from a closer look at the regional growth incidence curves. Except for the start of the new millennium, which displays a slow down in the mean of growth rates to about 2.5 percent per annum, and the early 1970s which had around 3 percent, all semi-decades are characterized by a high mean of growth rates of about 4 percent per annum. Furthermore, the early 1980s and 1990s saw most remarkable mean percentile growth rates of more than 6 percent per annum, combined with rates of pro-poor growth of 9.2 and 8.1 percent per annum for the early 1980s respectively (see figure 6); no other region has such a consistently high growth record. From the seventies

⁹ Due to the large amount of semi-decade specific regional incidence curves we only report a few examples for a selected time period here. However, the results in table 4 give a good idea about the semi-decade specific regional growth experience and all graphs are available on request

onwards the poverty headcount index is steadily declining mainly due to good growth records in the bottom middle of the regional income distribution. In the early 1980s it is in particular the bottom percentiles which grew most rapidly. Moreover, the growth spurt of China, as the region's most populous country, accounts mostly for these very high growth rates, and thus accounts for a major share of the dramatic poverty headcount reduction from 61 percent to 39 percent over a 5 year period. For the bottom half of the distribution the 1990s were rather successful, lowering poverty rates even further from 25 to 8 percent. Moreover, the region is displaying a clear lead concerning the overall growth rate in mean, and is therefore the main driving force behind the convergence of the global income distribution.

Latin America and the Caribbean. Latin America saw the second lowest growth rate in mean, which was almost distribution neutral, and is characterized by the third and second lowest rates of pro-poor growth (for the \$1 and \$2 lines, respectively). Consequently, the poverty headcount dropped only slightly from 19 percent in 1970 to 12 percent in 2003 with inequality remaining high. Hence, Latin America was relatively outperformed in terms of growth and poverty reduction by all other regions except for Sub-Saharan Africa. Despite the overall rather stagnant picture there are some marked semi-decade specific variations. Most pro-poor were the late 1970s, however, the promising high growth rates were not maintained. Thus, the relative deterioration with respect to the other regions is mainly due to the 1980s, which are characterized by negative growth rates except for the very rich percentiles and are thus known as the lost decade in Latin America (compare figure 6). The 1990s again display low positive growth rates in mean, however, the rate of pro-poor growth remains negative in the first half of the decade. Overall, Latin America's growth record is disappointing as poverty reduction could have been much more rapid and a further divergence from the richer regions is apparent.

Middle East and North Africa. Overall the Middle East and North Africa display a similarly disappointing growth rate as Latin America with equally bad rates of pro-poor growth. In particular, the very low pro-poor growth rate at \$1 per day is almost as low as

in Sub-Saharan Africa; however, the proportion of the population living below \$1 per day is clearly much lower. Over the 34 year time period the region managed to lower its poverty headcount rate from 23 to 11 percent whilst reducing regional inequality slightly. Taking a closer look at the overall growth incidence curve reveals that the very poor of the region experienced by far the lowest or even negative income growth. However, from about the 10th percentile the growth incidence curves look relatively pro-poor explaining the slight drop in the Gini coefficient and Theils' inequality measure.

Given this overall 34 year development a closer look at the semi-decade specific pro-poor growth rates for the Middle East and North Africa shows a particular strong fluctuation of the pro-poor growth rates ranging from -13.7 to 8.8 percent per annum and -8.3 to 5.5 percent per annum for the \$1 and \$2 poverty lines respectively. Whilst the 1970s saw positive and strong growth rates of the poor, the first half of the 1980s, 1990s, and 2000s are characterized by a growth collapse of the poor. The results are driven mostly by the growth rates of Iraq, in particular during the Gulf Wars.¹⁰ In contrast, the second half of these decades saw compensatory pro-poor growth rates, such that overall the region saw a poverty decline and a lower Gini coefficient at the end of the observational period. However, like Latin America the region has been outperformed in terms of growth and poverty reduction by the South and East Asia.

South Asia. South Asia is the second most dynamic and populous region of the world over the given time period. Even though growth has not been relatively pro-poor, the overall growth record was sufficiently strong to lower the headcount at \$2 per day from half the population to 14 percent, whilst regional inequality saw an increase from initially very low levels due to an increase in within country inequality. In particular, India's growth record accounts for much of the regional dynamics as it is by far the largest country. Even though the early 1970s were characterized by negative growth rates the second half saw very high rates

¹⁰ We would expect that the early 1980s would be characterized by even lower growth records, if we could include data from Iran. However, reliable comparable data is hardly available so that one of the most populous countries of the region can't be included in our analysis.

of relatively pro-poor growth, initiating a constant poverty decline. The entire 1980s display relative pro-poor growth rates. In particular, during the 1980s the very poorest experienced growth rates of about 3 percent per annum. Average growth rates for the percentiles below the \$2 per day poverty line increased from 2.7 to 3.2 percent per annum from the first to the second half of the 1980s respectively. The early 1990s are characterized by a general growth slow down with negative pro-poor growth rates, before growth resurges in the second half of the 1990s and during the first years of the new millennium, however, with only modest gains for the very bottom percentiles (see figure 6). In general, the regions pro-poor and overall growth record is the second major driving force behind global income convergence with India accounting for a large proportion of this income catch-up.

Sub-Saharan Africa. As mentioned above, Sub-Saharan Africa is by far the most troublesome region as it remains virtually stagnant with remaining high rates of poverty and inequality. This is mainly due to the non-existent growth record of the region as a whole and is combined with a worsening of regional inequality at a very high level both within and between countries. This leaves Sub-Saharan Africa in 2003 as the most distinctively poor region in relative and absolute terms, as well as most unequal region in the world. The overall growth rate in mean over the 34 year period is 0.3 percent per annum, with even lower rates of pro-poor growth for both poverty lines with the very bottom of the distribution experiencing even a negative growth record.

Indeed, the semi-decade specific analysis shows relatively successful early 1970s followed by a devastating picture for the late 1970s, 1980s and early 1990s, all of which are characterized by a negative average growth rate and negative or only slightly positive growth rates in mean. Results for pro-poor growth are similar, even though the early 1990s saw the first positive pro-poor growth rates after 15 years. The late 1990s and the start of the new millennium indicate a more encouraging picture. Despite remaining low growth rates at least some slow progress has been made in particular for the poor, which still account for almost 60 percent of the regions population and experienced positive and for the region unparalleled rates of

pro-poor growth. However, over the entire period the region has been virtually stagnant. Whilst it was "only" the second poorest region in the world in 1970, it is by far the poorest region in the world in the new millennium and experienced high relative income deterioration. In fact, about two thirds of the world's extreme poor and about half of the world's poor live in Sub-Saharan Africa nowadays (compare table 2). Hence, it is clear that any serious attempt to further reduce global poverty will fail, if it fails to reach Sub-Saharan Africa.

5 Conclusions

In contrast to studies analyzing the polarization of the cross-national average income per capita distribution, this study of the global income distribution as a whole shows strong global income convergence amongst all the world's citizens. The parametric mixture approach allows a parametric estimation of the global income distribution, under the assumption of log-normality of the national income distributions. Our results show that the past 34 years witnessed a strong global income convergence accompanied by a drastic decline of global inequality and poverty no matter what conceivable poverty line is applied. Noticeably, overall inequality declined because of declining inequality between countries, whilst inequality within countries increased. Furthermore, the analysis of growth incidence curves shows the bottom-middle part of the income distribution experienced above average percentile growth rates, which explains the occurring global income convergence. In particular, the late 1970s and early 1980s are characterized by high global rates of pro-poor growth, initiating the rapid decline of global poverty rates.

A regional decomposition of our data reveals that it is in particular the extraordinary growth record of East Asia and South Asia, which includes the two population heavy weights China and India, which account mostly for the global income convergence and rapidly declining poverty rates. Latin America and the Middle East and North Africa showed slower but steady progress in poverty reduction. However, their more modest growth experience implies

a relative income deterioration vis-a-vis the richer regions and also East and South Asia, and thus, can be seen as a remaining diverging factor in the global income distribution. Lastly, Sub-Saharan Africa has remained virtually stagnant and has become the poorest region in relative and absolute terms, implying a steady divergence and disconnection from the global growth process. Nevertheless, from a global perspective, the observational period is characterized by an unparalleled improvement of income per capita and poverty reduction unprecedented by mankind. This in itself can be considered a great success and is in particular due to the fact that the bottom-middle global income percentiles managed to catch up to higher levels of income, thus reducing the dispersion of income from a global perspective. On the other hand, the remaining very lowest percentiles also experienced the lowest percentile growth rates, such that the remaining extreme poor might be particularly hard to reach. This is likely due to the fact that those remaining poor are mostly citizens of countries with economies stuck in a low income, low growth equilibrium, which fail to connect to the global growth process. However, poverty also remains a pressing issue in many countries which managed to launch their economies on a successful growth trajectory, but which have remaining pockets of poverty, in particular in rural areas, within their national boundaries. Thus, any attempt to reduce global poverty even further must focus on those countries stuck in general national poverty traps and on remaining, in particular rural, national pockets of poverty which suffer from very similar structural weaknesses. The regional decomposition of growth shows that countries and regions which managed to participate the most in globalization, managed to reduce poverty the fastest, despite considerable caveats of such a process. Thus, integration, under fair conditions, of structurally weak economies and pockets of poverty into the global economy should be the best guarantee to strengthen growth and reduce global poverty even further, thus assuring that the global community reaches the targeted MDGs.

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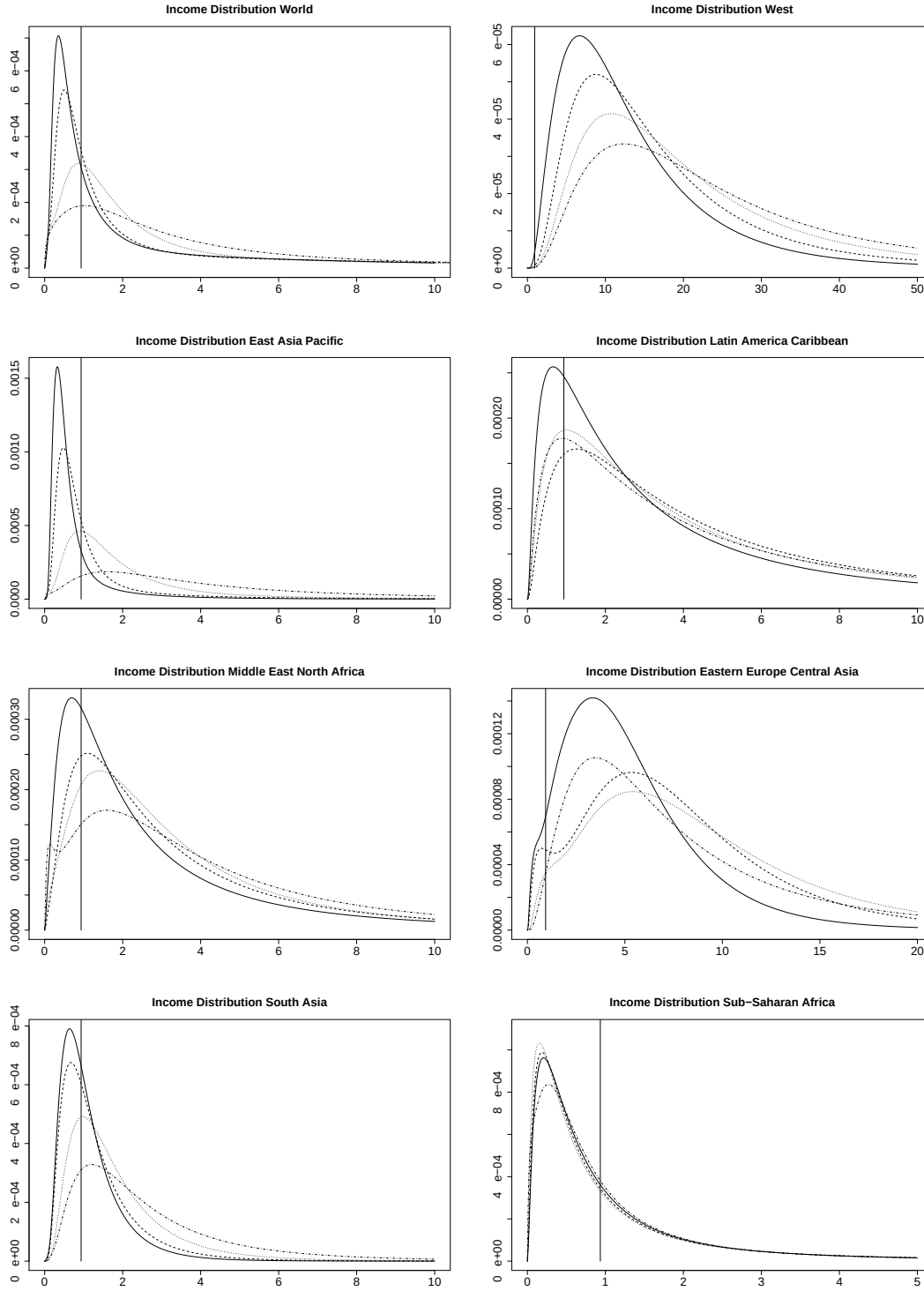
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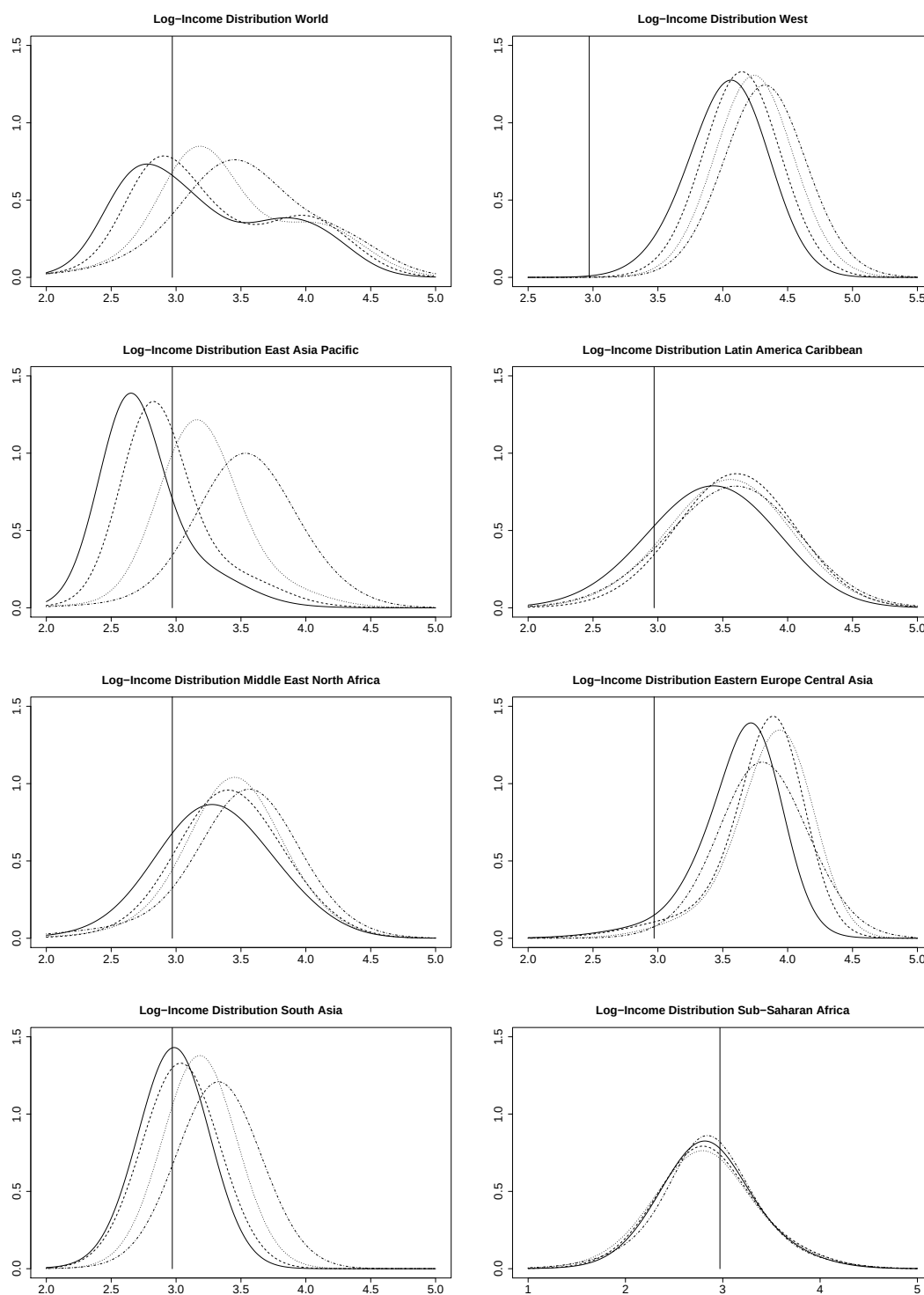
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Figure 1: Global and Regional Distribution of Income



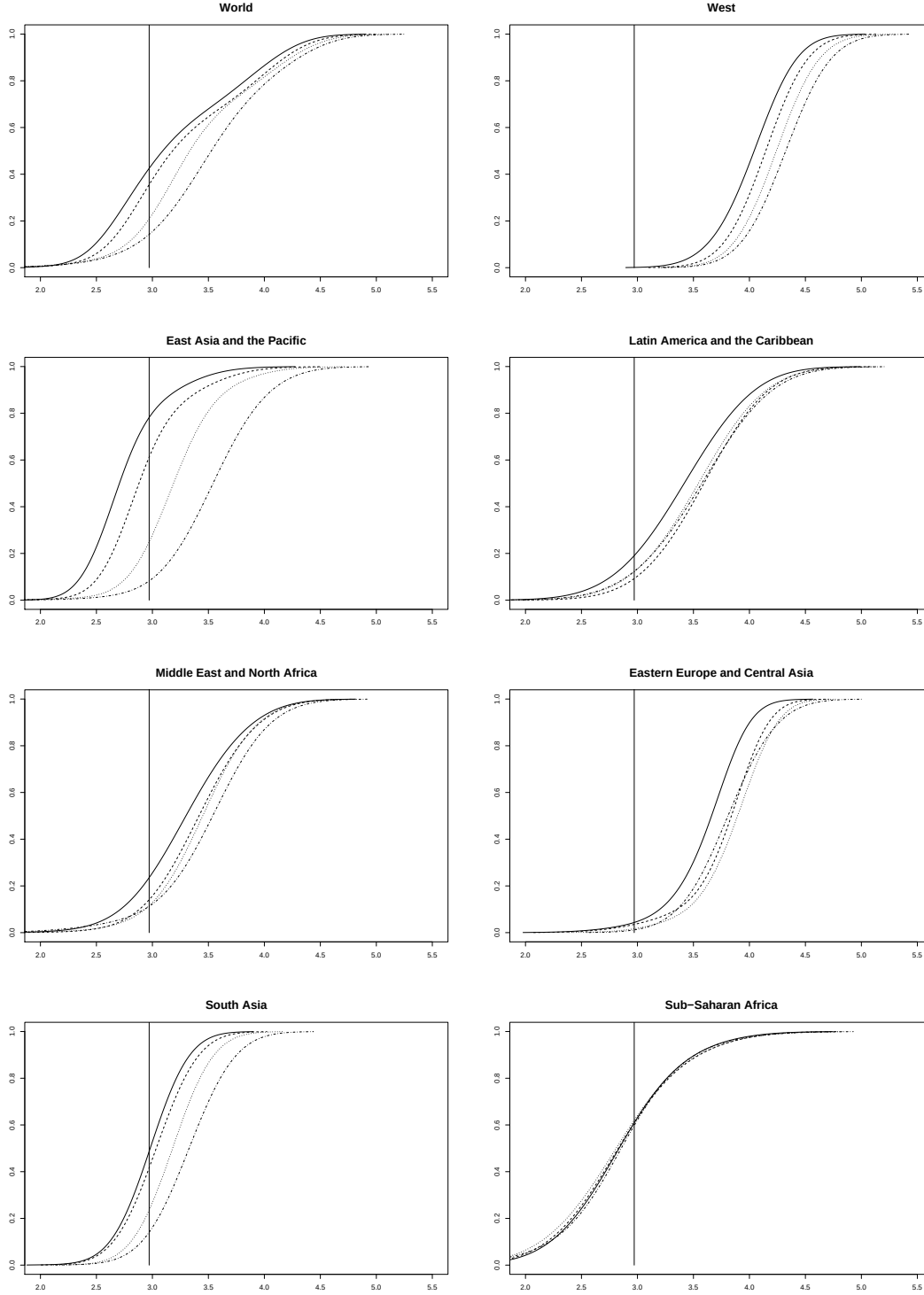
x-axis: income measured in thousands of dollars. Vertical line: \$2 per day Poverty Line. Solid line: 1970, dashed line: 1980, dotted line 1990, dashed-dotted: 2003.

Figure 2: Global and Regional Distribution of Log-Income



x-axis: logarithm of income measured in dollars to the base 10. Vertical line: \$2 per day Poverty Line. Solid line: 1970, dashed line: 1980, dotted line 1990, dashed-dotted: 2003.

Figure 3: Global and Regional Cumulative Distribution of Log-Income



x-axis: logarithm of income measured in dollars to the base 10. Vertical line: \$2 per day Poverty Line. Solid line: 1970, dashed line: 1980, dotted line 1990, dashed-dotted: 2003

Table 1: Global and Regional \$1 and \$2 per day Poverty Headcount and Poverty Gap Measure

Year	Poverty Head- count (\$1)	Poverty Head- count (\$2)	Poverty Gap (\$1)	Poverty Gap (\$2)	Poverty Head- count (\$1)	Poverty Head- count (\$2)	Poverty Gap (\$1)	Poverty Gap (\$2)
	World				West			
1970	0.212	0.425	0.073	0.202	0.000	0.001	0.000	0.000
1975	0.192	0.415	0.062	0.190	0.000	0.000	0.000	0.000
1980	0.137	0.355	0.045	0.149	0.000	0.000	0.000	0.000
1985	0.083	0.272	0.029	0.102	0.000	0.000	0.000	0.000
1990	0.071	0.209	0.028	0.082	0.000	0.000	0.000	0.000
1995	0.068	0.178	0.028	0.074	0.000	0.000	0.000	0.000
2000	0.059	0.148	0.025	0.064	0.000	0.000	0.000	0.000
2003	0.058	0.142	0.025	0.062	0.000	0.000	0.000	0.000
	East Asia Pacific				Latin America Caribbean			
1970	0.454	0.782	0.153	0.403	0.073	0.191	0.026	0.079
1975	0.346	0.724	0.102	0.335	0.067	0.170	0.025	0.071
1980	0.235	0.612	0.067	0.255	0.026	0.092	0.008	0.033
1985	0.082	0.392	0.022	0.126	0.032	0.104	0.010	0.038
1990	0.057	0.250	0.017	0.082	0.040	0.121	0.013	0.046
1995	0.030	0.129	0.011	0.042	0.045	0.132	0.015	0.051
2000	0.020	0.075	0.008	0.026	0.044	0.126	0.015	0.049
2003	0.024	0.082	0.009	0.029	0.043	0.123	0.015	0.049
	Middle East North Africa				Eastern Europe and Central Asia			
1970	0.085	0.235	0.030	0.094	0.016	0.044	0.006	0.017
1975	0.069	0.205	0.024	0.080	0.010	0.032	0.003	0.012
1980	0.039	0.141	0.012	0.049	0.012	0.035	0.004	0.014
1985	0.040	0.132	0.015	0.049	0.008	0.027	0.002	0.009
1990	0.035	0.116	0.013	0.043	0.003	0.017	0.001	0.005
1995	0.047	0.113	0.021	0.050	0.006	0.033	0.001	0.009
2000	0.032	0.097	0.012	0.038	0.002	0.016	0.000	0.004
2003	0.051	0.113	0.024	0.052	0.001	0.012	0.000	0.003
	South Asia				Sub-Saharan Africa			
1970	0.138	0.487	0.036	0.175	0.367	0.609	0.169	0.335
1975	0.199	0.518	0.063	0.214	0.352	0.590	0.161	0.321
1980	0.115	0.417	0.030	0.147	0.377	0.610	0.178	0.342
1985	0.074	0.333	0.018	0.108	0.391	0.626	0.186	0.354
1990	0.042	0.236	0.009	0.070	0.396	0.620	0.196	0.359
1995	0.049	0.231	0.012	0.073	0.401	0.639	0.195	0.364
2000	0.035	0.177	0.009	0.054	0.364	0.616	0.173	0.338
2003	0.026	0.141	0.006	0.041	0.347	0.598	0.162	0.323

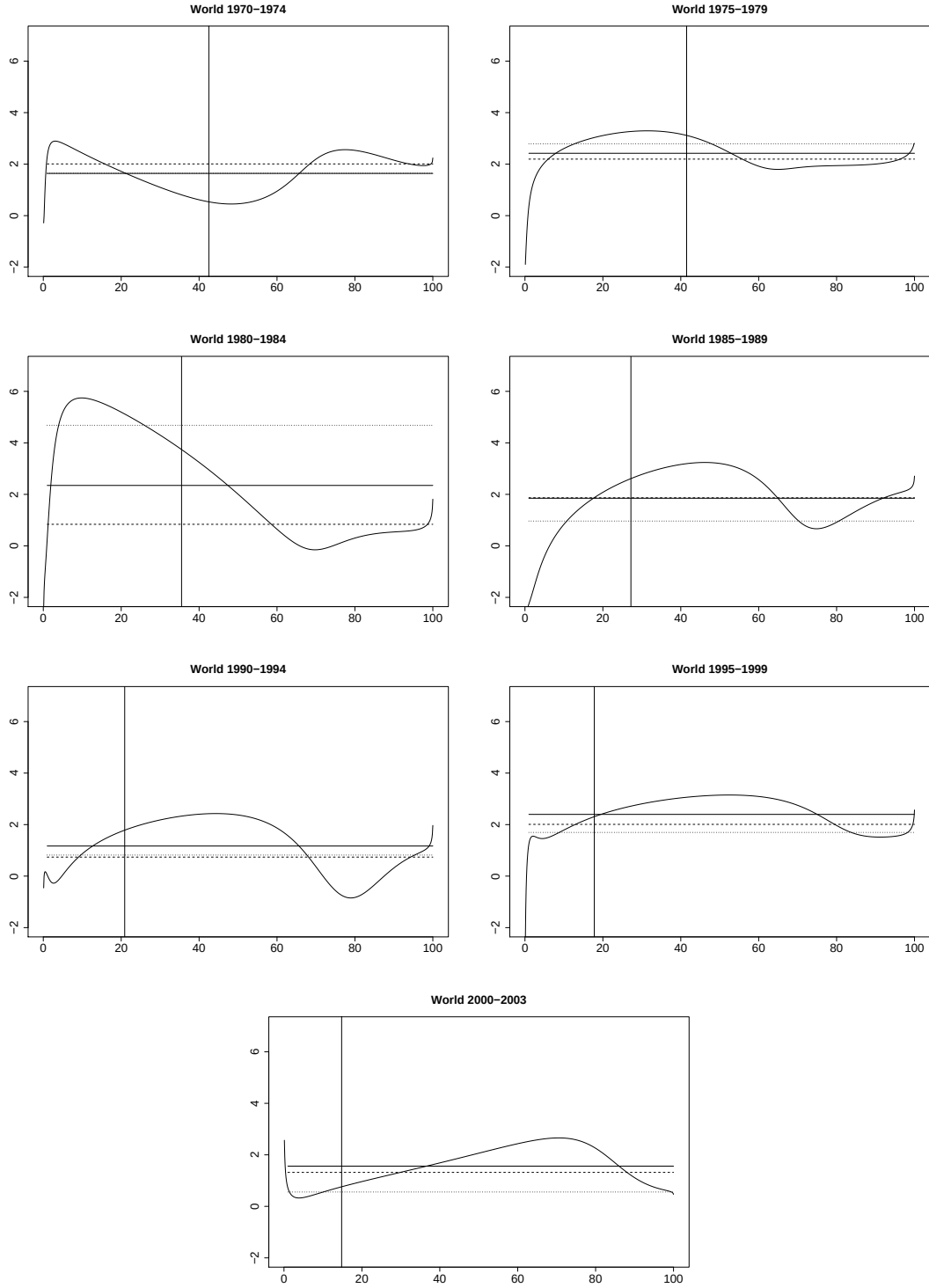
Table 2: Global and Regional Population and Absolute Number of \$1 and \$2 per day Poor

	Population	Poor People (\$1)	Poor People (\$2)	Population	Poor People (\$1)	Poor People (\$2)
	World			West		
1970	3,693,695	784,540	1,570,698	701,854	33	721
1975	4,070,666	779,835	1,691,192	730,625	8	235
1980	4,437,900	609,085	1,577,463	755,245	2	94
1985	4,832,425	399,595	1,313,699	777,772	2	61
1990	5,255,923	370,810	1,097,183	802,713	1	32
1995	5,660,651	385,708	1,006,770	829,867	3	81
2000	6,052,688	359,184	894,835	854,570	1	27
2003	6,275,048	365,006	893,394	869,918	1	31
	East Asia Pacific			Latin America Caribbean		
1970	1,167,975	530,322	913,422	282,977	20,595	53,936
1975	1,307,614	452,382	946,337	321,049	21,521	54,661
1980	1,419,429	332,907	869,163	360,466	9,450	33,328
1985	1,534,017	125,390	601,954	400,724	12,795	41,643
1990	1,662,816	94,202	414,950	442,008	17,500	53,657
1995	1,776,351	53,042	229,147	482,773	21,805	63,503
2000	1,877,921	38,277	140,236	522,037	23,046	65,913
2003	1,929,034	45,379	158,974	544,279	23,602	67,207
	Middle East North Africa			Eastern Europe Central Asia		
1970	137,202	11,594	32,309	387,557	6,034	16,875
1975	157,584	10,927	32,308	408,977	4,255	13,057
1980	184,880	7,180	26,057	429,959	5,276	15,128
1985	219,384	8,846	29,005	451,243	3,396	12,059
1990	253,947	8,942	29,433	469,334	1,625	7,835
1995	282,784	13,259	31,838	477,391	2,744	15,936
2000	314,504	10,140	30,611	480,881	773	7,564
2003	333,963	16,957	37,634	480,573	670	5,649
	South Asia			Sub-Saharan Africa		
1970	726,192	99,960	353,579	289,938	106,307	176,593
1975	813,860	162,234	421,552	330,957	116,482	195,182
1980	906,662	103,946	377,792	381,259	143,776	232,441
1985	1,009,753	75,083	335,824	439,532	171,901	275,029
1990	1,118,609	46,775	263,634	506,494	200,578	314,139
1995	1,231,644	60,695	285,100	579,841	232,567	370,463
2000	1,346,805	47,109	238,323	655,972	238,775	404,047
2003	1,416,242	36,126	199,439	701,039	242,947	419,153

Table 3: Global and Regional Gini, Theils' Inequality Measure and Theils' Decomposition

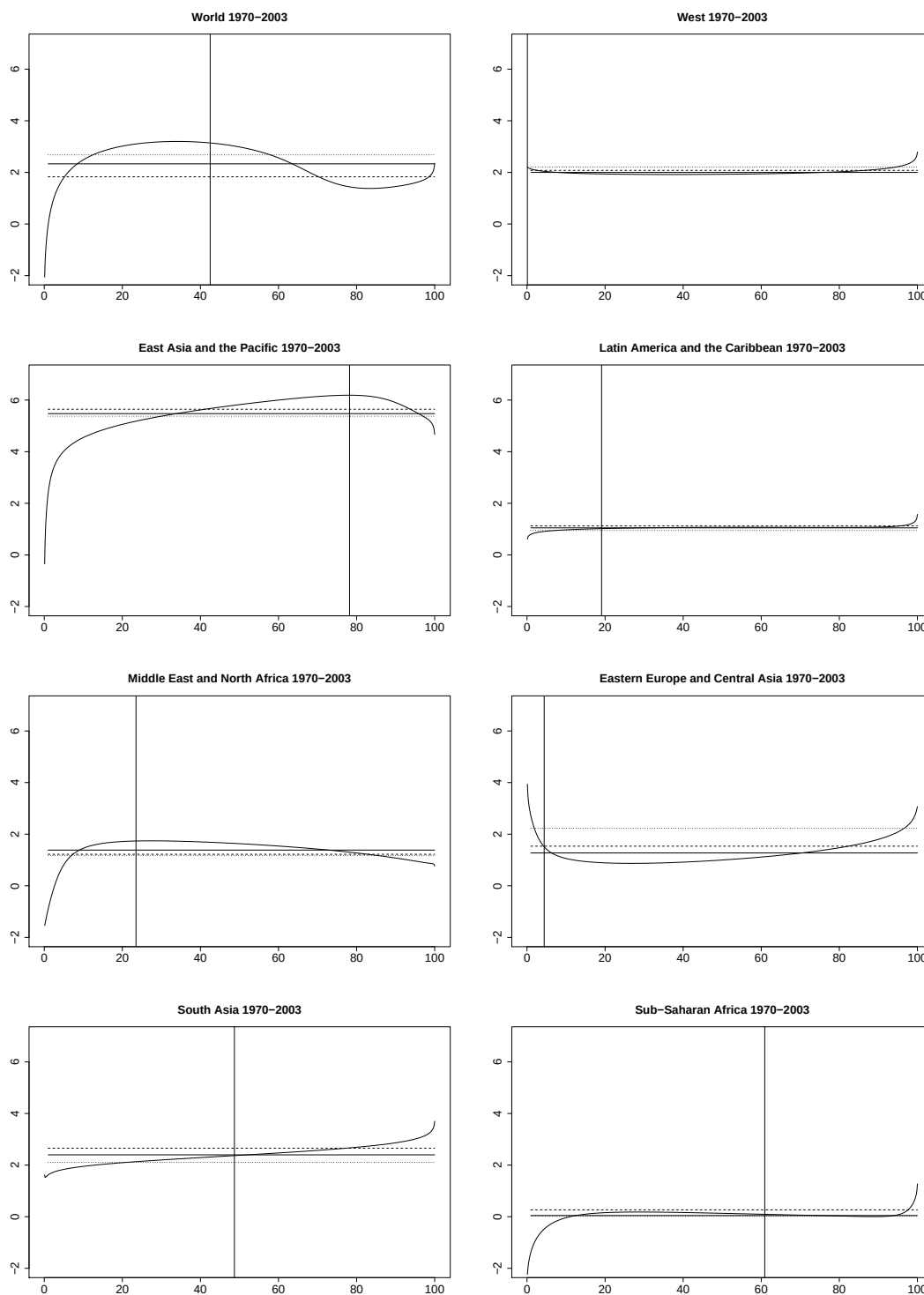
Year	Gini	Theil	Theil Between	Theil Within	Gini	Theil	Theil Between	Theil Within
	World				West			
1970	0.682	0.881	0.615	0.266	0.385	0.251	0.020	0.231
1975	0.684	0.887	0.612	0.275	0.377	0.240	0.015	0.225
1980	0.679	0.875	0.608	0.267	0.378	0.244	0.015	0.229
1985	0.669	0.859	0.592	0.267	0.387	0.259	0.019	0.240
1990	0.662	0.848	0.571	0.277	0.387	0.259	0.014	0.244
1995	0.655	0.845	0.531	0.314	0.404	0.284	0.016	0.269
2000	0.646	0.816	0.502	0.314	0.404	0.285	0.019	0.267
2003	0.640	0.796	0.468	0.328	0.407	0.290	0.018	0.272
	East Asia Pacific				Latin America Caribbean			
1970	0.497	0.522	0.269	0.253	0.573	0.620	0.072	0.547
1975	0.509	0.551	0.307	0.244	0.591	0.686	0.048	0.639
1980	0.524	0.583	0.334	0.249	0.540	0.541	0.040	0.501
1985	0.475	0.484	0.257	0.227	0.544	0.558	0.031	0.527
1990	0.495	0.501	0.248	0.253	0.567	0.619	0.034	0.585
1995	0.491	0.482	0.196	0.285	0.582	0.654	0.042	0.612
2000	0.477	0.436	0.150	0.286	0.590	0.677	0.050	0.627
2003	0.504	0.473	0.124	0.350	0.583	0.657	0.048	0.609
	Middle East North Africa				Eastern Europe and Central Asia			
1970	0.551	0.570	0.144	0.426	0.362	0.221	0.048	0.172
1975	0.555	0.572	0.190	0.382	0.357	0.214	0.045	0.169
1980	0.513	0.484	0.089	0.395	0.360	0.220	0.052	0.168
1985	0.505	0.468	0.087	0.382	0.367	0.226	0.062	0.164
1990	0.489	0.439	0.077	0.363	0.368	0.226	0.063	0.163
1995	0.491	0.450	0.116	0.333	0.448	0.356	0.027	0.328
2000	0.506	0.474	0.100	0.374	0.436	0.334	0.034	0.300
2003	0.512	0.480	0.114	0.366	0.441	0.345	0.049	0.296
	South Asia				Sub-Saharan Africa			
1970	0.351	0.207	0.001	0.206	0.637	0.879	0.347	0.532
1975	0.413	0.295	0.002	0.292	0.638	0.859	0.349	0.509
1980	0.375	0.239	0.004	0.235	0.660	0.948	0.411	0.537
1985	0.373	0.238	0.005	0.232	0.666	0.968	0.452	0.516
1990	0.366	0.229	0.006	0.223	0.677	1.027	0.432	0.595
1995	0.396	0.269	0.008	0.261	0.666	1.040	0.442	0.599
2000	0.412	0.295	0.009	0.286	0.663	1.049	0.448	0.601
2003	0.412	0.295	0.009	0.286	0.659	1.033	0.442	0.590

Figure 4: Global Semi-decade specific Growth Incidence Curves



Solid line: Growth Incident Curve, solid vertical line: \$2 per day Poverty Line, solid horizontal line: Mean of Growth Rates, dashed line: Growth Rate in Mean, dotted line: Pro-poor Growth Rate

Figure 5: Global and Regional Growth Incidence Curves 1970-2003

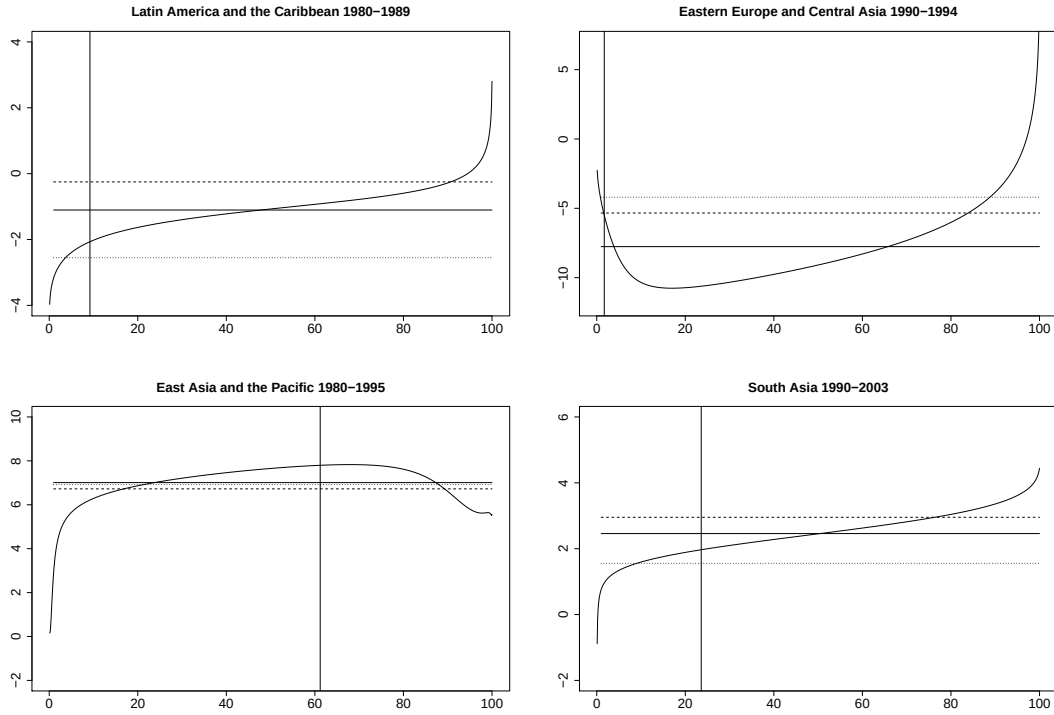


Solid line: Growth Incident Curve, solid vertical line: \$2 per day Poverty Line, solid horizontal line: Mean of Growth Rates, dashed line: Growth Rate in Mean, dotted line: Pro-poor Growth Rate

Table 4: Global and Regional Semi-decade Specific various Growth Rates 1970-2003.

Year	Mean of Growth Rates	Growth Rate of Mean	Rate of PPG (\$1)	Rate of PPG (\$2)	Mean of Growth Rates	Growth Rate of Mean	Rate of PPG (\$1)	Rate of PPG (\$2)
	World				West			
1970-2003	2.332	1.830	2.192	2.679	2.000	2.079	2.210	2.210
1970-1974	1.640	2.008	2.272	1.646	2.836	2.434	4.994	4.994
1975-1979	2.421	2.195	2.280	2.789	2.636	2.729	3.493	3.493
1980-1984	2.347	0.838	4.560	4.684	1.230	1.273	2.061	2.061
1985-1989	1.850	1.867	-0.881	0.965	2.356	2.439	1.719	1.719
1990-1994	1.169	0.739	-0.005	0.817	0.750	0.936	-0.894	-0.894
1995-1999	2.397	2.009	1.285	1.697	2.061	2.106	2.580	2.580
2000-2003	1.561	1.318	0.536	0.556	0.461	0.553	-0.096	-0.096
	East Asia Pacific				Latina America Caribbean			
1970-2003	5.475	5.646	4.919	5.376	1.048	1.123	0.876	0.946
1970-1974	3.135	3.549	3.421	3.001	2.170	3.152	-0.382	0.576
1975-1979	3.607	4.630	2.165	3.084	4.198	2.217	8.298	7.212
1980-1984	6.562	4.578	9.257	8.151	-1.538	-1.557	-2.026	-1.764
1985-1989	4.024	5.299	-0.693	1.606	-0.892	0.630	-3.741	-3.131
1990-1994	6.122	6.193	4.083	5.157	0.251	1.359	-1.700	-1.501
1995-1999	4.342	4.048	2.059	3.247	0.840	1.132	0.099	0.262
2000-2003	2.520	4.068	-0.049	-1.363	0.015	-0.414	0.071	0.261
	Middle East North Africa				Eastern Europe and Central Asia			
1970-2003	1.384	1.222	0.375	1.175	1.274	1.536	2.905	2.230
1970-1974	2.771	3.127	2.196	2.230	4.240	4.144	4.563	3.946
1975-1979	3.177	1.591	6.417	5.490	2.618	2.737	-0.440	-0.321
1980-1984	0.299	0.136	-1.538	-0.121	1.793	2.003	3.065	2.635
1985-1989	-0.053	-0.676	1.592	1.094	1.431	1.586	5.790	4.881
1990-1994	1.397	1.669	-4.718	-1.196	-7.764	-5.340	-2.685	-4.197
1995-1999	2.177	2.475	8.851	5.049	1.399	0.584	7.102	5.930
2000-2003	-0.591	0.379	-13.745	-8.323	4.150	4.401	0.762	1.976
	South Asia				Sub-Saharan Africa			
1970-2003	2.397	2.654	1.856	2.106	0.045	0.264	-0.051	0.023
1970-1974	-0.316	-0.277	-0.221	-0.329	1.374	1.292	1.127	1.202
1975-1979	2.873	1.706	5.304	4.137	-0.820	0.020	-1.307	-1.160
1980-1984	2.429	2.300	3.054	2.675	-0.588	-0.385	-0.263	-0.445
1985-1989	3.048	2.914	3.065	3.207	-0.567	0.248	-1.566	-1.039
1990-1994	0.281	0.958	-1.808	-1.031	-0.610	-1.463	0.409	0.164
1995-1999	3.058	3.594	1.721	2.198	1.295	1.136	1.552	1.488
2000-2003	2.884	2.887	2.654	2.854	1.367	0.964	1.665	1.502

Figure 6: Growth Incidence Curves Various Years



Solid line: Growth Incident Curve, solid vertical line: \$2 per day Poverty Line, solid horizontal line: Mean of Growth Rates, dashed line: Growth Rate in Mean, dotted line: Pro-poor Growth Rate

Table 5: Regions and Associated Countries

West Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States
East Asia and the Pacific Cambodia, China, Fiji, Hong Kong, Indonesia, Republic of Korea, Laos, Malaysia, Mongolia, Papua New Guinea, Philippines, Singapore, Taiwan, Thailand
Latin America and the Caribbean Argentina, Bahamas, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Suriname, Trinidad and Tobago, Uruguay, Venezuela
Middle East and North Africa Algeria, Egypt, Iran, Iraq, Israel, Jordan, Morocco, Tunisia
Eastern Europe and Central Asia Hungary, Poland, Romania, Russia, Turkey, Ukraine
South Asia Bangladesh, India, Nepal, Pakistan, Sri Lanka
Sub-Saharan Africa Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Democratic Republic of Congo, Republic of Congo, Cote d'Ivoire, Ethiopia, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe