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THE WORLD DISTRIBUTION OF INCOME AND ITS INEQUALITY, 1970–2009

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This paper provides a full decomposition of world inequality, as measured by the Gini coefficient, in the period 1970–2009. In particular, using the Analysis of Gini (ANOGI), the paper describes the evolution of *between* inequality, *within* inequality, and the impact of *overlapping* on both factors. While there is evidence that *between inequality* in the last decade significantly declined due to the rapid Chinese growth, *within inequality* and *overlapping* went in the opposite direction. Furthermore, with the exception of some Asian countries, the rest of the world has not moved significantly. As a result, world inequality remains high by any standard.

JEL Codes: H000, I310

Keywords: ANOGI, Gini coefficient, lognormal, world inequality

1. Introduction

The issue of world inequality has been at the forefront of the economic research for many years. After the pioneering work of Theil (1979), the main stimulus to the investigation of world inequality has originated from the publication of the Penn World Tables (Summers and Heston, 1988, 1991), which provide comparable information on per capita GDP for a large number of countries. At the same time, the scarcity of data on national income distributions has for some time confined the analysis to the *between* component of world inequality (Theil, 1979; Podder, 1993; Theil and Seale, 1994; Theil, 1996; Melchior *et al.*, 2000; Melchior, 2001; Sala-i-Martin, 2006; Decancq *et al.*, 2009 in a multidimensional perspective), with few attempts to estimate a world income distribution or to investigate inequality *within* countries (see, in this latter case, Galbraith *et al.*, 1999; Cornia and Kiiski, 2001).

This shortcoming has been more recently addressed in a number of ways (Milanovic, 2006, 2011; Anand and Segal, 2008). One approach has been to mix information from national accounts and survey data. For example, Berry *et al.* (1983, 1989) computed a world income distribution by apportioning the per capita GDP to income shares as reported in countries' national surveys or as estimated by a regression analysis. Similar techniques have been subsequently used by Grosh and Nafziger (1986), Korzeniewicz and Moran (1997), Schultz (1998), Firebaugh

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(1999), and Bourguignon and Morrisson (2002), where national surveys are always used to get the cumulative share of income at specific quantiles of the income distribution. Bhalla (2002) also uses quintile shares to estimate within-country distributions, and a regression to fit a three-parameter Lorenz curve. More recently, Sala-i-Martin (2006) has also integrated national accounts with micro-data to measure the dispersion of the distribution around the mean and then used a non-parametric technique to estimate the world income distribution.

A second approach consists in recovering the world income distribution by some known parameters of a specific functional form. In this vein, Chotikapanich *et al*. (1997) calculated the world distribution of income using mean incomes and Gini coefficients under the assumption that income is log-normally distributed, paving the way to a series of contributions using similar techniques (Dikhanov and Ward, 2002; Quah, 2002; Wade, 2004; Pinkovskiy and Sala-i-Martin, 2009; van Zanden *et al*., 2011).

A third approach exclusively relies on the use of survey data, as in Milanovic (2002) and Milanovic and Yitzhaki (2002).[1] In the first case, data refer to 1988 and 1993; in the second case, results are replicated for 1993 using the Analysis of Gini (ANOGI) to decompose world inequality. The scant availability of survey data, however, has often confined these studies to specific years, preventing a comprehensive investigation of the dynamics of world inequality.

All methods have shortcomings. In the first approach, survey data are often used to apportion per capita GDP and not to build a "true" world income distribution. In the best case, either missing quantiles are estimated by a regression analysis (Berry *et al*., 1983; Korzeniewicz and Moran, 1997; Sala-i-Martin, 2006) or missing income distributions are approximated by income distributions of one or more countries in the same group (Bourguignon and Morrisson, 2002). In the worst case, countries with missing data are not treated. In both cases, the distribution of income *within each quantile* remains unknown and assumed to be stable.

The second approach usually entails that all distributions follow the same parametric pattern, which may be a debatable assumption. A robustness analysis is thus usually required to check the impact of other assumptions about the form of the income distribution (e.g., Pinkovskiy and Sala-i-Martin, 2009; Chotikapanich *et al*., 2012).

The third approach assumes that countries' surveys are a better representation of the true income. Yet, the quality of survey data widely differs across countries: some income sources are very imperfectly captured (self-employment income, financial incomes, rents, etc.); the incomes of the very rich and those of the very poor are usually significantly underreported (Anand and Segal, 2008; Pinkovskiy and Sala-i-Martin, 2009); individuals do not always reveal their true income when interviewed; and household surveys are often harmonized and presented as secondary data (Atkinson and Brandolini, 2001). Thus, even if all national surveys were available, a great number of adjustments would in principle be required to achieve something close to the *true* world income distribution, including whether to scale survey means to national accounts (Milanovic, 2005;

[1]Earlier works using this method, in a poverty context, are by Ravallion *et al*. (1991), Chen *et al*. (1994), and Ravallion and Chen (1997).

Anand and Segal, 2008). The superiority of one of these approaches is therefore hardly sustainable on a mere list of advantages and disadvantages. Rather, it would be more profitable to consider them as complementary methods, for example to set inequality bounds or benchmarks, and to choose between them according to a criterion of appropriateness to the investigation undertaken.[2]

This paper expands over existing studies by merging two approaches. First, it follows Chotikapanich *et al.* (1997) and Pinkovskiy and Sala-i-Martin (2009) when assuming that income is log-normally distributed. Second, the paper proposes a 40-year decomposition of inequality using the ANOGI to investigate the path of *between* inequality (BI), of *within* inequality (WI), and of the *overlapping* term (*O*). This method avoids dealing with survey- country-, and year-specific biases that originate from independent (and sometimes unclear) country practices, and provides a full decomposition of the Gini coefficient by the world's geographical areas for a long time interval, providing—through overlapping—additional information about the degree of stratification of countries' income distributions. This additional information is not given a normative content in this paper; yet, it aims at highlighting a further economic and descriptive aspect of the global income distribution that is not captured by the traditional decomposition in BI and WI.

The paper is organized as follows. Section 2 briefly deals with the more consolidated issues of between and within inequality. Section 3 will implement a more comprehensive approach to derive a world income distribution and to describe its inequality using ANOGI. Section 4 will provide some sensitivity analyses and comparison with other studies. Section 5 concludes.

2. An Updated Focus on *Between* and *Within* Inequality

2.1. *Between Inequality*

The availability of per capita GDP for a large number of countries and years has stimulated a series of empirical works on BI that have made recourse to the Gini coefficient calculated on values either at current prices or at purchasing power parity. Figure 1, which updates the data until 2009, shows that the period from 1970 to 1990 can be considered as an *age of high and flat inequality*, while after 1990, two *ages of declining inequality* can be identified.[3] The first, from 1990 to 1995, is an age of *moderate decline*, which stopped in the second half of the 1990s. In this period, the persistent economic misery in sub-Saharan Africa, the modest economic growth in Latin American countries, and some unfavorable economic performances in South Asian countries all contributed to counterbalance the Chinese convergence force (Melchior, 2001). The second is instead an age of

[2]For example, there may be good reasons to use per capita GDP, as it includes education and health services as well as non-disbursed corporate profits that may be invested, items that are hardly reflected in survey data. Poor countries that have grown faster may have expanded their education and health system; income measures that disregard these items may also underestimate forces toward convergence (Melchior, 2001, p. 104).

[3]In defining this period as an age of *high* inequality we take 1970 as the starting point, disregarding the empirical evidence that suggests that inequality increased in the 1950s and in the 1960s and followed an opposite trend afterwards. The only exception, in the period 1970–90, has been that the peak of between inequality occurred in 1989 (0.624), where the large 1988 recession in China gave rise to a short-term increase of income inequality (Sala-i-Martin, 2006).

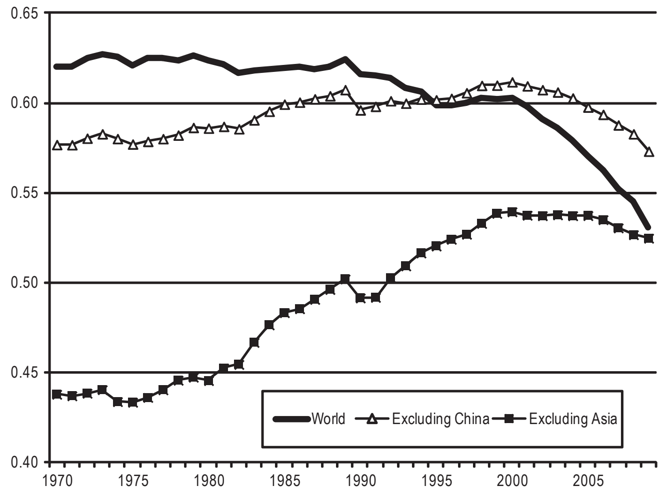

Figure 1. Gini Coefficient of PPP Converted Per Capita GDP (1970–2009, population weighted)
Source: Author's calculation on PWT 7.0 data (see Appendix A).

rapid decline, extending from 2000 onwards, with a more marked trend than that identified by previous studies reporting data until around 2000 (Sprout and Weaver, 1992; Melchior, 2001; Sala-i-Martin, 2006). China has played a prominent role in shaping these trends over time. In particular, it has acted as a force of convergence and divergence at the same time. On the one hand, the convergence is due to the fact that, in recent years, China is moving faster than the bulk of richer countries, which entails a large inequality reduction in the last years. On the other hand, the Chinese growth acts as a force of divergence, as it widens the gap with poorer and large countries, leading to an increase of inequality (see Appendix A for more detail). Given the presence of poor and populous countries in the Asian continent (India, Vietnam, Indonesia, Pakistan, and Philippines), Figure 1 also reports the path of inequality when China and all Asian countries are excluded.[4] In this case, BI increased faster from 1970 to 2000, which means that per capita GDP diverged among the rest of the world. After 2000, instead, the downward trend of inequality becomes less pronounced, which means that there are countries elsewhere in the world that display a weaker or even an opposite stimulus to the convergence that originates from the Asian countries.[5]

2.2. *Within Inequality*

The analysis of BI is not informative about what happens to WI and about its possible counterbalancing effect. Unfortunately, the empirical evidence on WI is

[4]The use of the Gini coefficient entails that the exclusion of a country from the analysis involves the standard between effect and the overlapping effect. This marks a difference with other perfectly decomposable inequality indices.

[5]On average, from 2000 to 2004, East Asian countries and South Central Asian ones have grown by 3.3 and 3.8 percent, respectively. The corresponding growth in North America and North Europe was 1.6 and 2.0 percent. From 2005 to 2009, again on average, the differential was even higher, with about 3.7 percent for all Asian countries and less than 1 percent for both North America and North Europe.

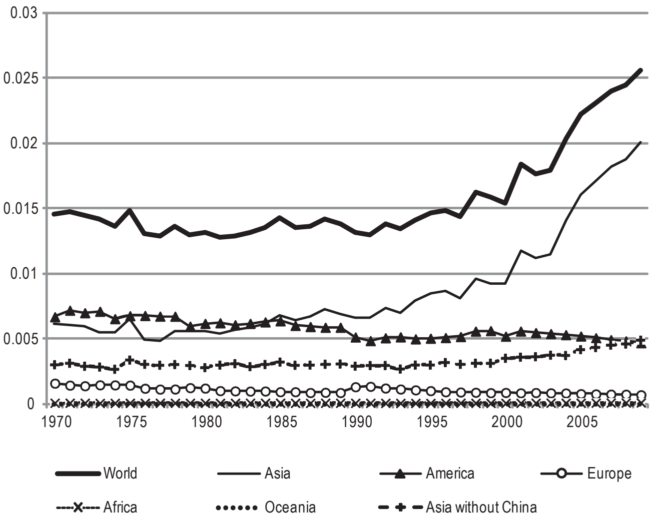

Figure 2. Within Inequality, World and by Continents

Source: Author's calculation on WIID2 dataset (see Appendix B).

more scattered than that on BI and this renders comparisons with other studies more difficult. The reason lies in the availability of data. To be consistent with the previous measurement of BI, WI should be measured using the Gini coefficients of income distributions in each country. Since the available data do not cover all countries and the whole period, our attempt to measure WI is based on a procedure that merges the available Gini coefficients with an estimation of the missing points. The method is detailed in Appendix B. The outcome is instead reported in Figure 2, where the bold line shows that total WI has been almost stable until the mid-1990s and has steadily increased since then.[6] This marks a similarity with BI for what concerns the long age of stability from 1970 to 1995; but it also marks a difference with respect to BI, as WI has followed an increasing trend from 1995 onwards. Since the calculation of WI weights any Gini coefficient by the product of population and income shares, larger weights would emerge in countries that are richer and populous at the same time, while smaller weights would be attached to poorer and smaller countries. But usually, larger countries are poorer and smaller countries are richer. The composite weight is thus on average small, which makes the magnitude of WI dwarfed by the level of BI (e.g., Quah, 2000).[7]

[6]The stability of within inequality for a smaller number of countries (49) has been observed also by Li *et al.* (1998).

[7]In our dataset, for example, the highest weight is observed in China 2009 (0.029) as the product of a population share of 19.8 percent and an income share of 14.7 percent. The same weight in 1970 was 0.01, which means that, in the calculation of WI, a given Gini coefficient in China counts three times as much today than 40 years ago, with the plausible forecast that this weight will further grow in the next years. On the other hand, the highest U.S. weight was in 1970 (0.015), as a product of a population share of 6.1 percent and an income share of 25.3 percent. This weight, in 2009, has declined to just around 0.01, which is the same weight achieved by India in the same year, with a much larger population and a much lower income share.

Again, the role of China in WI is fundamental, as by excluding China the marked upward trend disappears, while in other areas of the world WI remains relatively low and flat. Yet, the counterbalancing effect of overall WI is evident, which means that the negative trend of BI overestimates the decline of total inequality.

However, by separately exploring BI and WI as measured by the Gini coefficient, a fraction of total Gini inequality is left out. The Gini coefficient is not perfectly decomposable in BI and WI; thus, by summing these two components, total inequality falls short of *O*. As we will see in the next paragraph, *O* measures the degree in which countries' income distributions are intertwined. To this respect, the Gini decomposition gives additional information compared with other traditional decomposable measures of inequality.

3. The World Distribution of Income and the Analysis of Gini

3.1. *Recovering the World Income Distribution*

The method used to estimate WI (Appendix B) leaves us with a full country–year set of observations on per capita GDP at PPP and on Gini coefficients. This rich dataset can be used to recover the world income distribution and to provide a full decomposition of Gini inequality (now including *O*) in a long-run perspective, given that the use of individual countries' survey data is inhibited by the absence of long time series for all countries.

The starting point of the approach is to assume that income X is log-normally distributed (as, for example, in Pinkovskiy and Sala-i-Martin, 2009), which implies that $Y = \ln(X)$ is normally distributed. By the properties of the lognormal distribution, we know that any income X of the original income distribution can be calculated by using:

$$X = \exp(\mu_Y + \sigma_Y Z), \tag{1}$$

where the mean and the standard deviation in the round brackets refer to the distribution of log incomes Y, and Z assumes the values of a standard normal distribution. This means that if μ_Y and σ_Y were known, the income distribution X could in principle be recovered. Aitchison and Brown (1957) showed that if income is log-normally distributed, the Gini coefficient could be obtained by $G = 2\Phi\left[\frac{\sigma_Y}{\sqrt{2}}\right] - 1$, where $\Phi[]$ is the value of the cumulative standard normal distribution. Inverting the previous formula yields:

$$\sigma_Y = \sqrt{2}\Phi^{-1}\left[\frac{1+G}{2}\right], \tag{2}$$

where now $\Phi^{-1}[]$ is the value of the inverse of the cumulative standard normal distribution. Furthermore, since in a log-normal distribution, $\mu_Y = \ln\mu_X - 0.5\sigma_Y^2$, once the standard deviation is estimated by (2), the mean of Y can also be estimated, if μ_X (as in our case) is a known parameter. Note that even though the real line is the support of all distributions, the continuous estimation assumption of log-normality based on mean incomes and on Gini coefficients may produce simulated discrete distributions with different minimal and maximal values. This means that countries' income distributions will be more or less stratified depending on the specific parameter values.

Following this method and in order to assign the appropriate weight to each country in the world income distribution, the Chinese income distribution is built by imposing 500,000 observations, while other countries are assigned a number of observations that is proportional to the ratio of their population to the Chinese one. The advantages of this method should not conceal its possible shortcomings, as raised in Milanovic (2002, pp. 53–54). On the other hand, the shortcomings of this approach should not be magnified compared with alternative methods of analysis of world inequality (Pinkovskiy and Sala-i-Martin, 2009, pp. 4–6). Comparisons with other results and the sensitivity analysis of Section 4 will help understand the complementarity of this method with alternative options.

3.2. *The ANOGI Decomposition: Conceptual Issues*

The problematic issue of the analysis of the world income distribution with the Gini coefficient is related to its imperfect decomposition (Pyatt, 1976). A residual term (O) must be added to BI and WI that is not recoverable unless the full income distribution is available. Unfortunately, the results of the previous section are not informative about the intensity of O and about its impact on total inequality. This is the reason why all empirical studies, at the best, provide an overall value of the Gini coefficient, while inequality decomposition in BI and WI is usually performed with a Theil index or similar decomposable inequality measures.[8] In what follows, we try to fill this gap by applying ANOGI (Yitzhaki, 1994).

In particular, let $Y = Y_1 \cup Y_2 \cup \ldots \cup Y_n$ define the world income distribution given by the union of the income distributions of different n countries, and denote G as the Gini coefficient of the world income distribution. According to ANOGI, the Gini coefficient can be decomposed as follows:

$$G = \sum_i s_i G_i O_i + G_b = \sum_i s_i G_i + \sum_i s_i G_i (O_i - 1) + G_{bp} + \left(G_b - G_{bp}\right), \tag{3}$$

where G_b is the Gini coefficient of between-inequality, G_{bp} is the between-Gini index of the Pyatt's (1976) decomposition, and $O_i = \frac{\operatorname{cov}(Y_i, F_w(Y))}{\operatorname{cov}(Y_i, F_i(Y))}$ is the measure of how the income distribution of country i overlaps with the world income distribution. The numerator of this index is the covariance between incomes of country i and their ranking in the world income distribution $F_w(Y)$, while the denominator is the covariance between the same incomes and their rankings within each country. This means that $O_i = 1$ if the incomes of a country i have the same ranking as in the world income distribution—that is, if the two distributions

[8]The Theil T-index uses income shares as weights. This implies that changing between country inequality will also change within country inequality, with similar problems of interpretation as in the Gini coefficient. Thus, in this respect, the only safe index would be the Theil L-index, with population-share weights (Anand and Segal, 2008, p. 85), which is not however of universal use among studies on the world income distribution.

perfectly overlap. More generally, $O_i < 1$ when the scatter of the ranks of a given country is narrower than that of the total population; analogously, $O_i > 1$ when the scatter of the ranks of a country is larger than that of the total population.

The overlapping index can give an additional and useful information that is based on the following formula:

$$O_i = \sum_j p_j O_{ji} = p_i + \sum_{j \neq i} p_j O_{ji}, \quad (4)$$

where p_j is the share of population of country j and $O_{ji} = \frac{\operatorname{cov}(Y_i, F_j(Y))}{\operatorname{cov}(Y_i, F_i(Y))}$, where the numerator is now the covariance between the income of country i and their ranking in distribution j. If no member of the j distribution lies in the range of distribution i, country j is a perfect stratum and $O_{ji} = 0$. In this case, $O_i = p_i$, i.e. overlapping with the world distribution is equal to the share of population i. When the distributions are identical, instead, $O_{ji} = 1$ and $O_i = p_i + \sum_{j \neq i} p_j = 1$. The maximum value of O_{ji} is instead reached when all observations of the distribution j that are located in the range of i are concentrated at the mean of the distribution i. In this case, $O_{ji} \leq 2$, depending on the assumption on the distribution (see Schechtman, 2005; Frick *et al.*, 2006). In the general case, $O_i > p_i$.

In what follows, we give an alternative representation of the standard ANOGI decomposition, by combining equations (3) and (4) to get $\sum_i s_i G_i O_i = \sum_i s_i G_i p_i + \sum_i s_i G_i \sum_{j \neq i} p_j O_{ji}$. In this case, the overall WI is split in a term representing the standard WI *without overlapping* (the first term on the right hand side) plus the impact of O on WI (the far right term).[9] This latter term is the sum of the contribution of each country i to intra-group inequality times the sum of its overlapping index with all other j countries weighted by their population. If all countries were perfect strata (i.e., $O_{ji} = 0 \; \forall_{j \neq i}$), then the previous expression would become $\sum_i s_i G_i O_i = \sum_i s_i G_i p_i$, which is the exact measure of within inequality provided by the standard Gini decomposition when distributions do not overlap. On the other hand, if income distributions in all countries would perfectly overlap (i.e. $O_{ji} = 1 \; \forall_{j \neq i}$), then $\sum_i s_i G_i O_i = \sum_i s_i G_i p_i + \sum_i s_i G_i \sum_{j \neq i} p_j = \sum_i s_i G_i p_i + \sum_i s_i G_i (1 - p_i) = \sum_i s_i G_i$.

Consider now the definition of the between Gini coefficient. In equation (3), a distinction is made between G_b and G_{bp}. The original Pyatt's (1976) decomposition defines $G_{bp} = \frac{2 \operatorname{cov}(\bar{Y}_i, \bar{F}_i(Y))}{\bar{Y}}$, where $\bar{F}_i(Y)$ is the rank of the mean income of country i among the distribution of mean incomes of all countries. Alternatively, Yitzhaki and Lerman (1991), provide a version of between inequality based on the covariance between mean incomes and the mean rank of individuals according to

[9]What we call here WI *without overlapping* is the standard within inequality term in the classical Gini decomposition where overlapping is entirely contained in the residual term of that decomposition. It amounts to WI calculated in Appendix B.

their incomes in the country. In this case, $G_b = \frac{2\operatorname{cov}(\bar{Y}_i, \bar{F}_w(Y))}{\bar{Y}}$, where $\bar{F}_w(Y)$ is the mean rank of individual incomes of country i in the world income distribution.

When countries are perfectly stratified, the mean rank of individual incomes is equal to the rank of mean incomes in the overall income distribution for each country, which implies $\bar{F}_w(Y) = \bar{F}_i(Y)$ and $G_b = G_{bp}$. In this special case, the last term of equation (3) would disappear and between inequality is uniquely identified by G_{bp}.

With overlapping the two ranks may differ.[10] In this case, the overlapping coefficient measures the quality of ranking countries according to average income (Yitzhaki and Schechtman, 2009). If overlapping is zero, stratification is perfect and the quality of classification is high. On the other hand, if overlapping is at its maximum value, the quality of classification is poor.[11] Thus, to some extent the additional information provided by *O* when applied to global income inequality is about the quality of grouping. A lower *O* will signal that a given average income is more representative of the place the individual belongs to. When distributions strongly overlap, *O* is higher and the between component is lower, which means that average income alone does not clearly identifies the group.

3.3. *The Inequality of the World Income Distribution*

Equipped with these techniques, we now proceed to discuss the ANOGI decomposition for each year with individual countries as benchmark units (Table 1). The first thing to note is that *total* inequality declines, with few exceptions, even though the downward trend is particularly accentuated in the last decade (column (1)). Yet, a Gini coefficient of 0.650 in 2009 is still high by any standard, as it would almost correspond to an income distribution where two thirds of the population had zero incomes and all incomes were equally divided among the rest of the population (Milanovic and Yitzhaki, 2002). As can be seen from column (4), this downward trend is mainly driven by between inequality as measured by G_{bp}.

On the contrary, the standard WI has increased faster in the last decade, after a period of long stability (column (2)). The different paths of these elements are captured in Figure 3 where the series of total inequality, BI, and WI are normalized to the corresponding means. On the one hand, BI pushes total inequality down, especially since 2000 onwards; on the other hand, WI partially compensates

[10]This implies that the correlation between the rank of mean incomes and the average rank of incomes is less than one. In this case, $G_b - G_{bp} < 0$, or, alternatively, $\frac{G_b}{G_{bp}} < 1$. In this latter form, the ratio can be used as an indicator of the reduction of between inequality caused by overlapping of incomes across countries compared with the case where the two income distributions were perfectly stratified (Milanovic and Yitzhaki, 2002). In addition, $G_b < 0$ in the case where one distribution has a low mean rank of individual incomes (e.g., there are many poor individuals), but at the same time, it has a higher mean income because of the presence of few very rich individuals. In this case, the covariance between mean incomes and the mean rank can be negative. See Frick *et al*. (2006).

[11]More in general, given several classifications into subgroups of the same population, the grouping with the lowest overlapping (or highest stratification) will be defined as the best grouping. In this respect, ANOGI provides an additional decomposition of the overlap term described in Lambert and Decoster (2005), as this latter overlapping term is further decomposed into the contribution of each group, revealing who overlaps with whom.

TABLE 1
Summary of the ANOGI Decomposition, by Country

	Total Inequality (1)	Standard within Inequality (2)	Impact of Overlapping on within Inequality (3)	Between Inequality (G_{bp}) (4)	Impact of Overlapping on between Inequality (5)	Average Income (PGDP) (6)	Number of Countries (7)
1970	0.704	0.015	0.120	0.620	–0.051	4,929	157
1971	0.706	0.015	0.125	0.620	–0.054	5,044	157
1972	0.708	0.014	0.120	0.625	–0.052	5,217	157
1973	0.711	0.014	0.122	0.627	–0.053	5,445	157
1974	0.707	0.014	0.118	0.626	–0.051	5,454	157
1975	0.709	0.015	0.128	0.621	–0.055	5,428	157
1976	0.705	0.013	0.120	0.625	–0.053	5,603	157
1977	0.702	0.013	0.115	0.625	–0.051	5,725	157
1978	0.701	0.014	0.115	0.623	–0.052	5,892	157
1979	0.701	0.013	0.111	0.626	–0.049	6,014	157
1980	0.698	0.013	0.111	0.623	–0.049	6,010	158
1981	0.694	0.013	0.110	0.622	–0.050	6,006	158
1982	0.689	0.013	0.107	0.617	–0.043	5,955	158
1983	0.690	0.013	0.109	0.618	–0.050	6,013	158
1984	0.690	0.014	0.109	0.619	–0.051	6,192	158
1985	0.693	0.014	0.112	0.620	–0.053	6,303	158
1986	0.693	0.014	0.111	0.620	–0.052	6,484	163
1987	0.691	0.014	0.111	0.619	–0.052	6,624	164
1988	0.695	0.014	0.115	0.620	–0.054	6,783	164
1989	0.699	0.014	0.116	0.624	–0.055	6,858	165
1990	0.691	0.013	0.119	0.616	–0.057	7,122	174
1991	0.690	0.013	0.116	0.615	–0.055	7,118	174
1992	0.690	0.014	0.119	0.614	–0.057	7,113	176
1993	0.684	0.013	0.122	0.608	–0.060	7,100	186
1994	0.684	0.014	0.126	0.606	–0.062	7,232	137
1995	0.678	0.015	0.127	0.599	–0.062	7,383	187
1996	0.678	0.015	0.127	0.599	–0.063	7,515	187
1997	0.678	0.014	0.127	0.600	–0.063	7,700	187
1998	0.686	0.016	0.134	0.603	–0.066	7,737	187
1999	0.683	0.016	0.131	0.602	–0.065	7,897	187
2000	0.683	0.015	0.127	0.603	–0.062	8,146	188
2001	0.689	0.018	0.141	0.598	–0.069	8,209	188
2002	0.679	0.018	0.139	0.591	–0.068	8,353	188
2003	0.675	0.018	0.140	0.586	–0.069	8,544	188
2004	0.676	0.020	0.151	0.579	–0.075	8,882	188
2005	0.673	0.022	0.159	0.571	–0.079	9,234	189
2006	0.669	0.023	0.164	0.562	–0.031	9,669	189
2007	0.663	0.024	0.170	0.552	–0.084	10,071	189
2008	0.659	0.025	0.174	0.545	–0.036	10,214	189
2009	0.650	0.026	0.182	0.531	–0.088	9,932	189

Source: Author's calculations on the basis of Gini coefficients and PPP converted per capita GDP.

this decline, pushing inequality upward. In absolute values, it is confirmed that the decline of BI is larger than the increase of WI even after the inclusion of the overlapping term. This is the reason why total inequality declines; yet, it is clear from Figure 3 that the mounting distance of WI from its mean is larger than the negative distance of BI from its mean, which implies that WI grows at a faster pace than BI declines.

Third, column (3) of Table 1 adds to the previous results, measuring the degree of stratification of countries' income distributions and thus how much of total WI

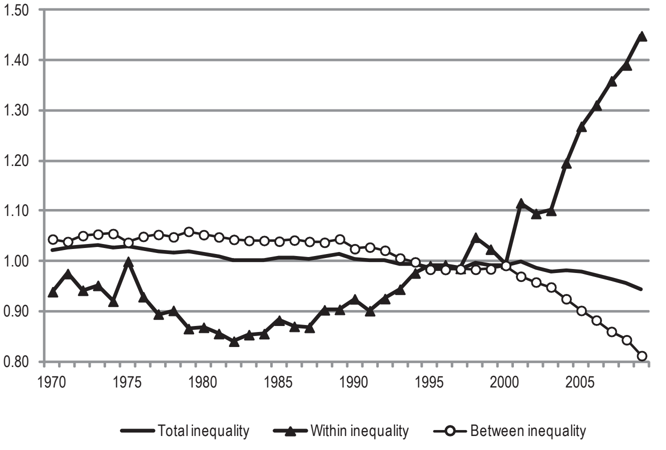

Figure 3. Total, Between and Within Inequality, Normalized on Their Means
Source: Author's calculations.

is given by overlapping of individual incomes. The upward trend of *O* reveals that the income distributions of different countries are actually becoming more intertwined, especially from the mid-1990s. In other terms, a greater number of individuals in given countries, compared to the past, have incomes that fall in the range of the income distributions in other countries, i.e. income distributions are less stratified. China is again responsible for an important fraction of overlapping. For example, by repeating the calculations for 2009 by excluding China, *O* would be lower, signaling more stratification. It means that the Chinese growth has now the effect of positioning more Chinese individual incomes within the range of income distributions of other (possibly richer) countries. On the other hand, by repeating the calculations for 1970, the exclusion of China would have increased overlapping, which means that in that period the Chinese income distribution was more stratified.

The consequence of this lower stratification in recent years is that between inequality declines, with the effect that average incomes more imperfectly identify the place the individuals belong to; with more overlapping, the quality of grouping by average incomes deteriorates. Column (5) gives account of this fact, as the difference $G_b - G_{bp} < 0$ is increasing in absolute terms. If income distributions were perfectly stratified, this difference would be zero.

3.4. *The ANOGI Decomposition by World Regions*

The previous observations suggest that additional information could be obtained by looking at more compact world regions as reference units in selected years. Results are reported in Table 2 for the first and the final year of the period observed (1970 and 2009). To get a picture of the distance between world regions, column (4) reports the expected rank in the world income distribution of an individual living in a given area. Several worlds emerge. First, considering East Asia, in 1970 the mean rank of individuals living in that region was the 39.3rd percentile, i.e. well below the median in the world income distribution. In 2009, the

TABLE 2

ANOGI Decomposition, by Region

1970	Total Gini (1)	Standard within Inequality (2)	Impact of Overlapping on within Inequality (3)	Mean Rank (4)	Income Share (5)	Overlapping (6)
East Asia	0.660	0.040	0.073	0.393	0.164	1.040
South Central Asia	0.319	0.003	0.006	0.340	0.039	0.663
Middle East	0.534	0.001	0.011	0.667	0.035	0.617
North Africa	0.496	0.000	0.003	0.474	0.008	0.764
South Africa	0.665	0.000	0.007	0.394	0.010	1.053
Central West Africa	0.540	0.000	0.005	0.331	0.010	0.932
East Africa	0.500	0.000	0.002	0.241	0.004	0.899
North America	0.437	0.011	0.033	0.861	0.296	0.339
Central America	0.487	0.000	0.001	0.626	0.004	0.601
South America	0.554	0.002	0.020	0.626	0.056	0.677
Caribbean	0.499	0.000	0.002	0.661	0.008	0.612
North Europe	0.346	0.006	0.015	0.880	0.245	0.249
South Europe	0.386	0.001	0.009	0.841	0.081	0.304
East Europe	0.298	0.000	0.002	0.735	0.022	0.252
Oceania	0.412	0.000	0.004	0.813	0.017	0.537
Total	0.704	0.064	0.191			
2009	**Total Gini (1)**	**Standard within Inequality (2)**	**Impact of Overlapping on within Inequality (3)**	**Mean Rank (4)**	**Income Share (5)**	**Overlapping (6)**
East Asia	0.577	0.050	0.091	0.535	0.280	0.872
South Central Asia	0.418	0.050	0.014	0.349	0.068	0.722
Middle East	0.578	0.050	0.025	0.552	0.054	0.860
North Africa	0.441	0.050	0.004	0.498	0.013	0.727
South Africa	0.709	0.050	0.007	0.255	0.009	1.168
Central West Africa	0.557	0.050	0.003	0.173	0.008	0.801
East Africa	0.493	0.050	0.001	0.147	0.005	0.659
North America	0.504	0.050	0.045	0.820	0.226	0.465
Central America	0.554	0.050	0.002	0.464	0.004	0.904
South America	0.546	0.050	0.022	0.554	0.053	0.822
Caribbean	0.564	0.050	0.003	0.563	0.006	0.896
North Europe	0.286	0.050	0.007	0.903	0.142	0.209
South Europe	0.324	0.050	0.004	0.863	0.052	0.284
East Europe	0.408	0.050	0.013	0.701	0.066	0.553
Oceania	0.448	0.050	0.005	0.775	0.015	0.723
Total	0.650	0.072	0.247			

Source: Author's calculations on the basis of Gini coefficients and PPP converted per capita GDP.

mean rank of East Asian people has climbed, rising to the 53.5th percentile, which is mainly due to the rapid Chinese growth. The same effect, for example, does not apply in South Central Asia, where there are a number of populous and still poor countries (Bangladesh, India, Pakistan and then Bhutan, Nepal, Sri Lanka, and Maldives). In this case, the average rank of people in the area was the 34th percentile in 1970 and still the 34.9th percentile in 2009. Thus, even within the fast-growing Asia, there are countries that do not move significantly in 40 years relative to other continents and parts of the world.

Second, looking at the various partitions of African countries (Central West Africa, East Africa, North Africa, and South Africa), there is the clear impression that the continent is losing positions and has not benefited from the rapid growth which occurred elsewhere. In all cases, the average rank of individuals living in Africa (with the exception of North Africa) is lower in 2009 than in 1970. According to our estimates, the rank of Central West African countries would fall from the 33.2nd percentile in 1970 to the 17.3rd percentile in 2009, which means that on average all Central West Africans are relatively poorer now than 40 years ago. South African and East African countries are not performing better, while North African countries are still below the median. Instead, South American and Central American countries, that were, on average, well above the median in 1970, have either converged to the median rank (South America) or even fallen below it (Central America), deteriorating their position in the world income distribution.

Third, as a world apart, the mean rank of Europe, North America, and Oceania, is always above the 70th percentile of the total ranking, with North Europe, South Europe, and North America always above the 80th percentile.

Thus, with very few exceptions, the dynamics of the world income distribution is slower than it seems, if one makes exception for China. The same impression is obtained by looking at the income shares of different areas over time (column (5)). East Asian countries had 16.4 percent of total world income in 1970 and 28 percent in 2009. Correspondingly, even the shares of the richest countries (North Americans and North Europeans) have significantly fallen over the period. Given the importance of China in the world income distribution, it is not a case that the Gini coefficient of the East Asian area is always very close to the total Gini (column (1)), and that the bulk of within inequality actually arises from the East Asian regions.

As before, a further way of looking at the nature of the regions and at the quality of grouping is to analyze the overlapping index in column (6), which gives information on the degree of stratification of the income distribution of each region compared to the world income distribution. Some of the richest regions of the world (North America and North Europe) are significantly stratified ($O < 0.5$). Especially in North Europe, overlapping is extremely low (0.209) which means that, even though it is not a perfect stratum (as $O_i > p_i$), North Europe is a distinct group and its income distribution is very far from representing the typical world income distribution. On the other hand, the overlapping index of the South African region, which is always and increasingly greater than one, indicates that the income distribution of this region is rather heterogeneous with respect to the world income distribution, being more characterized by two separate strata, one richer and the other poorer than the rest of the world, an information that the traditional decomposition in BI and WI of other inequality measures cannot capture. Of particular importance is also the persistence of this characteristic over the years, as revealed by the corresponding values in 1970 for most of the world regions.

Four worlds seem therefore to emerge from the analysis: some Asian regions, involved in a rapid growth; almost all African regions, worsening their conditions; Central and South American regions as well as South Central Asia to some extent preserving their living standards or slightly deteriorating it; and North America, North Europe, and Oceania in their “splendid isolation,” as highlighted by the overlapping index. In any case, it is rather impressive that in 40 years, almost all regions are stuck where they were in terms of relative positions, with very few exceptions.

3.5. *The Overlapping Matrix*

The general overlapping index of Table 2 can be further decomposed to obtain the matrix O_{ji}. Table 3 reports this information again for 1970 and 2009. Just recall that $O_{ji} = 0$ when income distributions are perfectly stratified. In Table 3, rows represent the region whose distribution is used as the base distribution (region *i*). Several factors can be noted that further characterize the existence of different worlds. Consider the matrix for 2009. First, when the richest part of the world is used as a baseline (North America, North Europe, and Oceania), many regions in the world form an almost perfect stratum. This is particularly true for all African regions, especially when the baseline is either North America or North Europe (the corresponding overlapping coefficients are close to zero). When African regions are instead used as the baseline, the richest countries also form a stratum in many cases, with the caveat that the overlapping indices are usually higher. For example, $O_{6,8} < O_{8,6}$, where region 6 is Central West Africa and region 8 is North America. The interpretation of these differences is that usually there are relatively more (poor) citizens of the "richest world" in the range of the African income distribution, than there are Africans in the range of the income distribution of the richest regions.

This is also more clearly seen by comparing North Europe (region 12) and East Asia (region 1). In this case, $O_{1,12} = 0.187$, which means that there are only a few percent of East Asian people that fall into the income range of European countries. On the other hand, $O_{12,1} = 0.898$, which means that more Europeans are within the income range of the East Asian distribution. Particularly interesting is when $O_{ji} > 1$. In this case, the base country forms two strata, one poorer and one richer than the country whose distribution is compared to. This occurs significantly for South Africa compared with most of the income distribution of other regions, which is another way to capture the large inequality of the income distribution of this region.

Has something changed compared to 1970? When the richest part of the world is used as a base, African regions were already a world apart, and South Africa had the same characteristic of having two strata with respect to many regions in the world. Overall, the values of the overlapping coefficients in the matrix reveal that the quality of classification according to geographical areas is only partially satisfactory, as in many cases O_{ji} is high and consequently between-group inequality in the specific pair of countries is low, which means that drawing the average income of an individual one cannot say which country she belongs to. Compared with those inequality indices that are perfectly decomposable in WI and BI, the use of ANOGI—and of the overlapping coefficient—allows us to quantify the level of stratification of different geographical areas, to release a judgment on the quality of the classification by subgroups, to give information on the ability of the between component to distinguish among groups, and to follow the stratification of different world regions over time.

3.6. *The Ranking Matrix*

Table 4 finally shows the average ranking of members of one region in terms of the other, which means that the main diagonal is 0.5 for all regions. A value

TABLE 3

The Overlapping Matrix, by Region

1970	East Asia	South Central Asia	Middle East	North Africa	South Africa	Central West Africa	East Africa	North America	Central America	South America	Caribbean	North Europe	South Europe	East Europe	Oceania
East Asia	1.000	0.978	1.327	1.198	0.919	0.883	0.670	1.031	1.377	1.309	1.339	1.045	1.195	1.511	1.008
South Central Asia	0.884	1.000	0.386	0.756	0.537	0.737	0.667	0.063	0.460	0.446	0.336	0.011	0.036	0.158	0.139
Middle East	0.472	0.392	1.000	0.672	0.559	0.427	0.285	0.918	0.982	0.942	1.044	0.976	1.107	1.284	0.857
North Africa	0.829	0.863	0.910	1.000	0.736	0.767	0.606	0.421	1.032	0.945	0.919	0.350	0.524	1.034	0.406
South Africa	1.110	1.133	1.191	1.230	1.000	1.026	0.889	0.748	1.278	1.209	1.208	0.717	0.892	1.324	0.743
Central West Africa	1.096	1.178	0.867	1.124	0.878	1.000	0.895	0.369	0.985	0.923	0.853	0.298	0.431	0.838	0.405
East Africa	1.136	1.253	0.636	1.022	0.837	1.029	1.000	0.196	0.737	0.707	0.604	0.129	0.204	0.468	0.273
North America	0.148	0.052	0.521	0.179	0.204	0.094	0.048	1.000	0.393	0.440	0.507	1.129	0.995	0.560	0.999
Central America	0.518	0.468	0.955	0.743	0.592	0.492	0.346	0.670	1.000	0.930	1.006	0.664	0.852	1.258	0.599
South America	0.558	0.491	1.045	0.766	0.627	0.512	0.364	0.886	1.051	1.000	1.088	0.922	1.071	1.328	0.826
Caribbean	0.497	0.431	0.955	0.679	0.566	0.455	0.325	0.824	0.952	0.908	1.000	0.859	1.000	1.227	0.759
North Europe	0.084	0.004	0.355	0.070	0.114	0.031	0.010	0.853	0.223	0.282	0.328	1.000	0.836	0.322	0.888
South Europe	0.112	0.014	0.507	0.136	0.180	0.061	0.023	0.926	0.369	0.419	0.507	1.087	1.000	0.575	0.930
East Europe	0.136	0.060	0.621	0.311	0.292	0.148	0.072	0.427	0.619	0.571	0.707	0.426	0.630	1.000	0.312
Oceania	0.387	0.310	0.762	0.472	0.417	0.322	0.232	0.992	0.686	0.699	0.759	1.105	1.062	0.855	1.000
2009	**East Asia**	**South Central Asia**	**Middle East**	**North Africa**	**South Africa**	**Central West Africa**	**East Africa**	**North Amerfca**	**Central America**	**South America**	**Caribbean**	**North Europe**	**South Europe**	**East Europe**	**Oceania**
East Asia	1.000	0.751	1.021	1.058	0.488	0.337	0.272	0.950	0.928	1.056	1.007	0.898	1.059	1.253	0.778
South Central Asia	0.808	1.000	0.750	0.993	0.550	0.551	0.499	0.281	0.837	0.788	0.579	0.062	0.140	0.564	0.250
Middle East	0.978	0.733	1.000	1.022	0.482	0.338	0.277	0.972	0.904	1.031	0.990	0.935	1.075	1.228	0.813
North Africa	0.857	0.746	0.852	1.000	0.439	0.322	0.254	0.574	0.834	0.900	0.786	0.376	0.534	0.937	0.412
South Africa	1.248	1.371	1.223	1.380	1.000	1.004	0.999	0.771	1.277	1.249	1.113	0.585	0.728	1.130	0.710
Central West Africa	0.798	1.147	0.751	0.903	0.873	1.000	1.054	0.256	0.885	0.753	0.624	0.094	0.148	0.462	0.322
East Africa	0.631	0.999	0.587	0.700	0.780	0.925	1.000	0.152	0.721	0.578	0.475	0.031	0.057	0.287	0.247
North America	0.485	0.180	0.517	0.365	0.173	0.068	0.046	1.000	0.371	0.508	0.578	1.287	1.198	0.784	1.005
Central America	1.029	0.927	1.028	1.148	0.588	0.481	0.425	0.757	1.000	1.069	0.963	0.591	0.762	1.123	0.603
South America	0.944	0.704	0.966	1.000	0.463	0.318	0.258	0.896	0.878	1.000	0.958	0.831	0.989	1.189	0.726
Caribbean	0.994	0.818	1.013	1.029	0.579	0.473	0.437	0.936	0.940	1.036	1.000	0.900	1.038	1.190	0.807
North Europe	0.187	0.011	0.195	0.064	0.046	0.005	0.001	0.630	0.102	0.178	0.229	1.000	0.834	0.343	0.740
South Europe	0.279	0.037	0.305	0.141	0.079	0.012	0.005	0.729	0.181	0.288	0.366	1.078	1.000	0.539	0.770
East Europe	0.644	0.338	0.694	0.625	0.264	0.123	0.083	0.760	0.570	0.710	0.756	0.759	0.933	1.000	0.578
Oceania	0.782	0.550	0.796	0.740	0.390	0.284	0.248	1.017	0.689	0.804	0.798	1.216	1.196	1.002	1.000

Source: Author's calculations.

TABLE 4

The Ranking Matrix, by Region

1970	East Asia	South Central Asia	Middle East	North Africa	South Africa	Central West Africa	East Africa	North America	Central America	South America	Caribbean	North Europe	South Europe	East Europe	Oceania
East Asia	0.500	0.553	0.192	0.390	0.508	0.573	0.690	0.053	0.221	0.232	0.197	0.039	0.054	0.100	0.106
South Central Asia	0.447	0.500	0.121	0.321	0.457	0.523	0.654	0.012	0.142	0.159	0.124	0.001	0.003	0.014	0.067
Middle East	0.808	0.879	0.500	0.753	0.765	0.852	0.907	0.180	0.576	0.556	0.502	0.135	0.207	0.432	0.231
North Africa	0.610	0.679	0.247	0.500	0.575	0.666	0.764	0.048	0.294	0.297	0.243	0.020	0.042	0.126	0.109
South Africa	0.492	0.543	0.235	0.425	0.500	0.558	0.640	0.064	0.277	0.275	0.237	0.041	0.067	0.160	0.109
Central West Africa	0.427	0.477	0.148	0.334	0.442	0.500	0.605	0.025	0.177	0.186	0.150	0.009	0.019	0.057	0.073
East Africa	0.310	0.346	0.093	0.236	0.360	0.395	0.500	0.012	0.112	0.123	0.098	0.003	0.007	0.023	0.051
North America	0.947	0.988	0.820	0.952	0.936	0.975	0.988	0.500	0.882	0.853	0.837	0.484	0.592	0.842	0.533
Central America	0.779	0.858	0.424	0.706	0.723	0.823	0.888	0.118	0.500	0.484	0.420	0.071	0.127	0.323	0.177
South America	0.768	0.841	0.444	0.703	0.725	0.814	0.877	0.147	0.516	0.500	0.444	0.105	0.165	0.361	0.201
Caribbean	0.803	0.876	0.498	0.757	0.763	0.850	0.902	0.163	0.550	0.556	0.500	0.113	0.188	0.433	0.213
North Europe	0.961	0.999	0.865	0.980	0.959	0.991	0.997	0.516	0.929	0.895	0.887	0.500	0.628	0.913	0.541
South Europe	0.946	0.997	0.793	0.958	0.933	0.981	0.993	0.408	0.873	0.835	0.812	0.372	0.500	0.822	0.436
East Europe	0.900	0.986	0.568	0.874	0.840	0.943	0.977	0.158	0.677	0.639	0.567	0.087	0.178	0.500	0.211
Oceania	0.894	0.933	0.769	0.891	0.891	0.927	0.949	0.467	0.823	0.799	0.787	0.459	0.564	0.789	0.500

2009	East Asia	South Central Asia	Middle East	North Africa	South Africa	Central West Africa	East Africa	North America	Central America	South America	Caribbean	North Europe	South Europe	East Europe	Oceania
East Asia	0.500	0.715	0.479	0.548	0.787	0.878	0.905	0.174	0.579	0.477	0.456	0.077	0.117	0.304	0.225
South Central Asia	0.285	0.500	0.270	0.296	0.663	0.772	0.815	0.051	0.365	0.257	0.273	0.003	0.009	0.097	0.130
Middle East	0.521	0.730	0.500	0.575	0.795	0.881	0.906	0.186	0.599	0.500	0.476	0.080	0.125	0.329	0.230
North Africa	0.452	0.704	0.425	0.500	0.775	0.883	0.915	0.112	0.538	0.420	0.393	0.020	0.042	0.216	0.184
South Africa	0.213	0.337	0.205	0.225	0.500	0.561	0.578	0.057	0.268	0.200	0.219	0.018	0.030	0.104	0.101
Central West Africa	0.122	0.228	0.119	0.117	0.439	0.500	0.519	0.019	0.175	0.110	0.150	0.001	0.003	0.035	0.067
East Africa	0.095	0.185	0.094	0.085	0.422	0.481	0.500	0.013	0.146	0.085	0.134	0.000	0.001	0.022	0.058
North America	0.826	0.949	0.814	0.888	0.943	0.981	0.987	0.500	0.878	0.823	0.791	0.392	0.484	0.724	0.493
Central America	0.421	0.635	0.401	0.462	0.732	0.825	0.854	0.122	0.500	0.397	0.384	0.036	0.064	0.226	0.180
South America	0.523	0.743	0.500	0.580	0.800	0.890	0.915	0.177	0.603	0.500	0.471	0.069	0.112	0.319	0.225
Caribbean	0.544	0.727	0.524	0.607	0.781	0.850	0.866	0.209	0.616	0.529	0.500	0.090	0.145	0.372	0.236
North Europe	0.923	0.997	0.920	0.980	0.982	0.999	1.000	0.608	0.964	0.931	0.910	0.500	0.631	0.855	0.567
South Europe	0.883	0.991	0.875	0.958	0.970	0.997	0.999	0.516	0.936	0.588	0.855	0.369	0.500	0.804	0.477
East Europe	0.696	0.903	0.671	0.784	0.896	0.965	0.978	0.276	0.774	0.681	0.628	0.115	0.196	0.500	0.289
Oceania	0.775	0.870	0.770	0.816	0.899	0.933	0.942	0.507	0.820	0.775	0.764	0.433	0.523	0.711	0.500

Source: Author's calculations.

greater than 0.5 means that, on average, people in the base region *i* are richer compared with people in other regions. The opposite occurs for values lower than 0.5. In 2009, for example, people living in North America and in North Europe would rank—on average—around or above the 95th percentile of the distributions of all African regions. Since $F_{ji} + F_{ij} = 1$, most African people would rank in the lowest decile of the distribution of the richest world. In particular, compared with North America, South African people would rank at the 5.7th percentile (thus, in the middle of the lowest decile), while compared with North Europe, they would rank at the 1.8th percentile of the corresponding income distribution. The same argument holds for all African regions, and even more for Central West and East Africa. It is also interesting to note that, despite the rapid growth of the Chinese economy, the average rank of an East Asian individual in the North European income distribution would be at the 7.7th percentile, which implies that the average rank of a North European would be at the 92.3rd percentile.

Some African regions would instead perform better compared with Asian and Latin American regions (Central and South America). In particular, the average rank of a North African in the East Asian distribution would be at the 45.2nd percentile, which increases to the 70.4th percentile when considering the distribution of the South Central Asian region. The main reason is that even though the average income of this region is higher than the average income in North Africa, there are masses of people in India, Bangladesh, and Pakistan that have a very low rank in the world income distribution. This same rank would be 53.8th percentile in Central America and 42nd percentile in South America.

The situation was again almost the same in 1970. The position of North American and North European people with respect to all African regions was already above the 95th percentile. The Chinese growth, however, has had an impact, as in 1970 the average rank of an East Asian individual in the North European distribution was at the 3.9th percentile (against the 7.7th percentile in 2009); while North African people have slightly climbed positions compared to Latin America (Central and South America). Thus, in the last decade, China moved fast but the rest of the world did not move significantly.

4. Robustness of Results

4.1. *Comparisons with Other Studies*

In order to check the robustness of results, the top graph of Figure 4 reports the comparison between our estimates (for both total and between inequality) and other studies with long time series (Sala-i-Martin, 2006; Pinkovskiy and Sala-i-Martin, 2009). With regard to *total* inequality, the recent paper by Pinkovskiy and Sala-i-Martin (2009) (henceforth PS) gives the profile identified by the white box until 2006. Our estimates (the continuous line) give a higher level of total inequality, yet the declining profile strongly mimics the PS estimations, with the possible exception of the second half of the 1990s. The different number of countries covered (138 countries in Sala-i-Martin, 2006) does not significantly affect the levels of between country inequality.

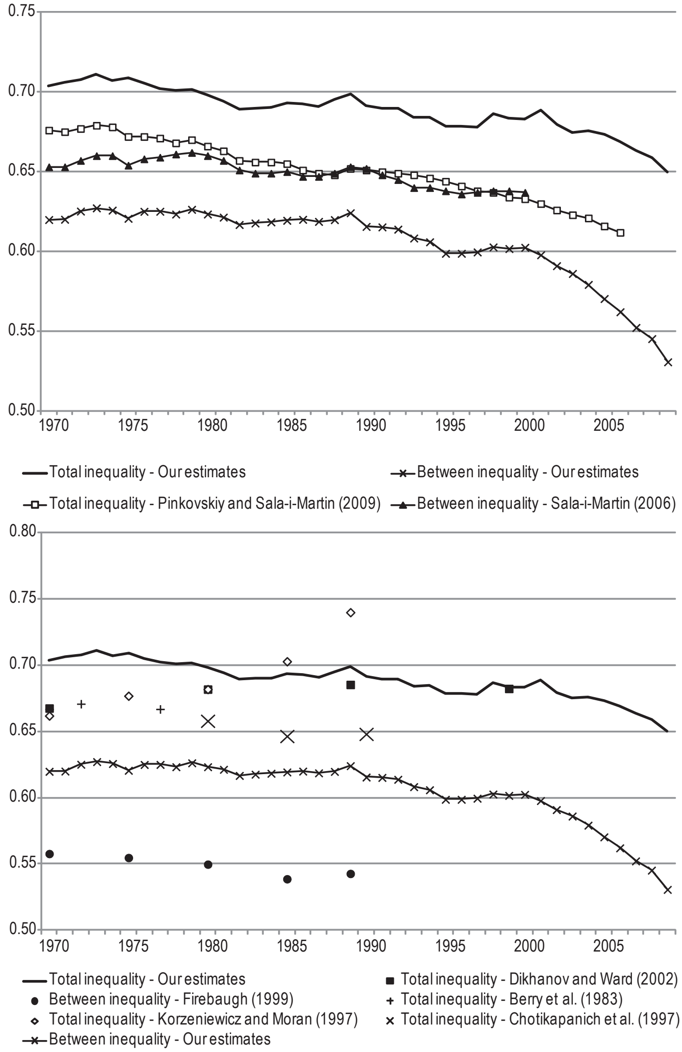

Figure 4. Total and Between Inequality: Comparisons with Other Studies
Source: Author's calculations.

In the bottom graph, the comparison is instead made among our estimates (the continuous lines) and the available scattered points in other studies (Chotikapanich *et al*., 1997; Korzeniewicz and Moran, 1997; Berry *et al*., 1983; Firebaugh, 1999; Dikhanov and Ward, 2002). Although the number of points is small, it seems that the only divergent series, compared to our estimates, is that reported by Korzeniewicz and Moran (1997), which is however also divergent with respect to other studies.

Unfortunately, no comparable series of WI are available that may validate our estimates of both the standard WI and of the overlapping factor. Two point estimates of WI are available in Milanovic (2002), 0.013 both in 1988 and in 1993, against our almost identical 0.014 in 1988 and 0.013 in 1993.[12]

Some support to the quality of our assumption also arises from the comparisons among income shares reported in Table 5. Our simulated world income distribution fits pretty well with the results obtained by Milanovic (2010) for 2005 using national household surveys. Discrepancies among other studies and our estimates are also not huge (Morrisson and Murtin, 2011; Ortiz and Cummins, 2011) and surely not greater than discrepancies that sometimes arise among different studies in the same year, as in Chotikapanich *et al.* (1997) and Korzeniewicz and Moran (1997), for both 1980 and 1990.

4.2. *Rural and Urban China*

As the most populous country, China shows wide differences among rural and urban areas, in terms of both mean income and income growth. This issue may not be without potential consequences for both BI and WI. On the one hand, if rural China has a lower mean income than the country average, this can contribute to a greater BI. On the other hand, if the income distribution of each area is relatively more homogeneous, their Gini coefficients should be lower than the Gini coefficient of the overall country, which means that WI could be lower.

In order to take into account this issue, one must have information on the distribution of population among areas as well as on the size of the corresponding mean incomes. This is enough to recalculate BI. With regard to WI, Gini coefficients of rural and urban areas are also required. Table 6 reports the essential data for this analysis, which now spans from 1981 to 2009, and is mostly based on the series of mean incomes reported in Chen and Ravallion (2007) until 2001, on Chow (2006) for 2002 and 2003, on Yang *et al.* (2010) for 2004 and 2005, and on other official data from 2006 to 2009, on the series of rural and urban Gini coefficients as calculated in Chen *et al.* (2010), and on extrapolations of Gini coefficients from 2007 to 2009. With this information, the procedure followed in Appendix B to estimate WI can be replicated by assuming that urban China and rural China are two separate countries. To test the correspondence of these distributions with other empirical evidence, the far right panel of Table 6 reports data on the cumulative percentages of income in both urban and rural areas available in Gustafsson *et al.* (2008) for 2002—columns (9) and (11)—and according to our estimates in the same year—columns (10) and (12). The similarities between available data and our estimates are striking, which is further support to the power of the method.

As expected, measured BI is slightly higher when China is split in two parts, and the distance with respect to BI when China is a single country is more pronounced in recent times, which is mostly due to the enlarged gap between rural and urban mean incomes. Indeed, rural China includes a mass of people that is

[12]This similarity is however achieved with a different number of countries (91 in Milanovic, 2002; 164 in 1988, and 186 in 1993 in the present study). This is explained by the fact that the missing countries in Milanovic (2002) represent a smaller share of both total population and income, which means that their combined weight and contribution to within inequality is small. Repeating the exercise with the same countries as in Milanovic (2002) does not significantly alter the results.

TABLE 5

INCOME SHARES: COMPARISONS WITH OTHER STUDIES

	Milanovic (2010)	Chotikapanich *et al.* (1997)			Dikhanov and Ward (2002)				Berry *et al.* (1983)			Korzeniewicz and Moran (1997)					Milanovic (2002) (*)	
Deciles	2005	1980	1985	1990	1970	1980	1990	1999	1970	1972	1977	1970	1975	1980	1985	1990	1988	1993
1	0.4	2.2	2.4	2.5	0.5	0.5	0.5	0.5	0.7	0.6	0.7	2.2	2.1	1.7	1.8	1.4	0.9	0.8
2	0.8				0.9	0.8	0.9	1.0	1.1	1.0	1.1						2.3	2.0
3	1.2	3.9	4.4	4.3	1.2	1.1	1.3	1.5	1.4	1.4	1.5	2.8	2.5	2.2	2.3	1.8		
4	1.7				1.6	1.5	1.7	2.1	1.8	1.8	1.9							
5	2.4	6.1	6.7	6.8	2.3	2.1	2.3	2.7	2.4	2.3	2.4	3.8	3.7	5.5	3.3	2.1	9.6	8.5
6	3.6				3.6	3.3	3.3	3.7	3.7	3.6	3.6							
7	5.7	15.1	14.9	14.6	7.1	6.4	5.6	5.3	6.5	6.4	6.4	21.3	16.4	18.3	15.4	11.3		
8	8.8				12.8	12.5	11.0	9.2	11.9	11.7	11.7							
9	19.8	72.6	71.6	71.9	21.4	21.8	20.9	19.6	20.1	20.2	20.2	70.0	75.4	75.4	77.3	83.4		
10	55.5				48.5	50.0	52.4	54.3	50.5	51.0	50.6							
Bottom 75																	25.9	22.3
Bottom 85																	41.0	37.1
Top decile																	46.9	50.8
Top ventile	37.2																31.2	33.7
Top percentile																	9.3	9.5

Our Estimates

	2005	1980	1985	1990	1970	1980	1990	1999	1970	1972	1977	1970	1975	1980	1985	1990	1988	1993
1	0.4	1.5	1.6	1.6	0.6	0.5	0.5	0.5	0.6	0.5	0.6	1.5	1.4	1.5	1.6	1.6	0.5	0.5
2	1.0				0.9	1.0	1.0	1.0	0.9	0.9	1.0						1.6	1.6
3	1.5	3.0	3.4	3.3	1.3	1.3	1.5	1.5	1.3	1.2	1.3	2.9	2.8	3.0	3.4	3.3		
4	2.1				1.6	1.7	1.9	1.9	1.6	1.5	1.6							
5	2.9	4.9	5.5	5.6	2.0	2.1	24	2.4	2.0	2.0	2.0	4.8	4.8	4.9	5.5	5.6	7.3	7.8
6	4.1				2.8	2.8	3.2	3.2	2.8	2.7	2.6							
7	6.0	14.7	13.8	14.2	4.5	4.4	4.7	4.7	4.5	4.4	4.4	14.5	14.6	14.7	13.8	14.2		
8	10.1				10.0	10.3	9.5	9.5	10.0	10.2	10.4							
9	19.5	75.9	75.7	75.3	21.4	22.0	21.0	21.0	21.4	21.9	21.9	76.3	76.5	75.9	75.7	75.3		
10	52.5				54.9	53.9	54.3	54.3	54.9	54.7	54.3							
Bottom 75																	18.5	20.2
Bottom 55																	32.5	33.6
Top decile																	57.9	57.1
Top ventile	35.6																36.7	36.3
Top percentile																	12.5	12.6

(*) Data associated to deciles refer to cumulative shares. For example at decille 5, 9.6 is the cumulative share of income owned by the bottom 50 per cent of the population.

Source: Author's calculations.

TABLE 6

Data for Urban and Rural China

	Urban Population Share (1)	Rural Population Share (2)	PPP GDP (3)	Urban PPP GDP (4)	Rural PPP GDP (5)	Gini Urban (6)	Gini Rural (7)	Gini National (8)	Deciles	Cumulative Percentage of Income, Urban China (9)	Cumulative Percentage of Income, Urban China (10)	Cumulative Percentage of Income, Urban China (11)	Cumulative Percentage of Income, Urban China 2002 (12)
1981	0.203	0.797	1,232	1,957	1,047	0.150	0.241	0.201	1	0.030	0.031	0.027	0.025
1982	0.210	0.790	1,311	1,914	1,152	0.150	0.232	0.204	2	0.076	0.077	0.069	0.065
1983	0.216	0.784	1,404	1,926	1,259	0.150	0.246	0.226	3	0.134	0.134	0.121	0.116
1984	0.223	0.777	1,530	2,085	1,371	0.160	0.244	0.218	4	0.201	0.201	0.183	0.178
1985	0.230	0.770	1,606	1,982	1,493	0.190	0.307	0.249	5	0.281	0.280	0.257	0.251
1986	0.239	0.761	1,672	2,170	1,516	0.190	0.304	0.239	6	0.371	0.370	0.343	0.338
1987	0.248	0.752	1,801	2,282	1,642	0.200	0.289	0.245	7	0.476	0.476	0.442	0.442
1988	0.256	0.744	1,830	2,224	1,693	0.230	0.305	0.284	8	0.599	0.602	0.563	0.568
1989	0.265	0.735	1,775	2,306	1,583	0.230	0.319	0.266	9	0.753	0.757	0.716	0.729
1990	0.274	0.726	1,807	2,551	1,527	0.230	0.310	0.287	10	1.000	1.000	1.000	1.000
1991	0.282	0.718	1,888	2,711	1,565	0.240	0.307	0.276					
1992	0.290	0.710	2,028	2,904	1,670	0.250	0.313	0.309					
1993	0.298	0.702	2,190	3,195	1,763	0.270	0.329	0.295					
1994	0.306	0.694	2,402	3,488	1,923	0.300	0.321	0.315					
1995	0.314	0.686	2,748	3,882	2,229	0.280	0.342	0.316					
1996	0.323	0.677	2,824	3,744	2,385	0.284	0.323	0.318					
1997	0.332	0.668	2,995	3,878	2,557	0.292	0.329	0.284					
1998	0.340	0.660	2,997	3,874	2,544	0.300	0.337	0.367					
1999	0.349	0.651	3,088	4,076	2,557	0.295	0.336	0.350					
2000	0.358	0.642	3,261	4,349	2,654	0.319	0.354	0.324					
2001	0.367	0.633	3,450	4,661	2,747	0.323	0.360	0.448					
2002	0.376	0.624	3,839	6,656	2,139	0.320	0.365	0.381					
2003	0.386	0.614	4,207	7,308	2,262	0.340	0.368	0.371					
2004	0.395	0.605	4,677	8,016	2,498	0.325	0.369	0.469					
2005	0.404	0.596	5,218	8,861	2,749	0.320	0.375	0.513					
2006	0.413	0.587	5,869	9,913	3,024	0.336	0.374	0.517					
2007	0.422	0.578	6,606	11,092	3,331	0.352	0.377	0.520					
2008	0.431	0.569	6,996	11,606	3,504	0.368	0.379	0.521					
2009	0.440	0.560	7,431	12,224	3,664	0.385	0.382	0.520					

(1) Data from www.indexmundi.com/facts/china/urban-population; (2) Complement to (1); (3) PPP converted GDP per capita in PWT 7.0; (4) Our estimates on the basis of rural and urban mean incomes and rural-urban income gaps, values in international dollars 2005; (5) Our estimates on the basis of rural and urban mean incomes and rural-urban income gaps, values in international dollars 2005; (6)–(7) Data from Chen *et al.* (2010) from 1981 to 2006; extrapolation on the basis of the previous trends from 2007 to 2009; (8) Our estimates; (9) Chen *et al.* (2010); (10) Our estimates; (11) Chen *et al.* (2010); (12) Our estimates.

poorer than the average; urban China, instead, includes a mass of people whose income grows much faster than that of relatively poor countries. Overall, however, the differences are not dramatic and the trend of inequality is basically the same.

WI also maintains its increasing trend, but the level is significantly lower when China is split in two countries. This is easily explained by the fact that both urban and rural China have Gini coefficients that are below the Gini coefficient of the whole country. Thus, when weighted by population and income shares, their contribution to WI declines. In any case, even after controlling for rural and urban China, BI declines, while WI increases, i.e. the general result holds.

4.3. *The Inequality Aversion Parameter in the Gini Index and the Issue of Relative Inequality*

The use of the ANOGI decomposition has focused on global inequality as measured by the Gini coefficient. One must be aware that the use of this inequality index embodies two normative viewpoints that may not be universally shared. The first refers to the fact that the standard Gini index is a particular case of the generalized Gini index (Weymark, 1981; Yitzhaki, 1983), that in covariance terms is as expressed by $G(v) = -\frac{v}{y} Cov\left(y, (1-F(y))^{v-1}\right)$. More specifically, the standard Gini index is obtained when $v = 2$. Increasing v means focusing more on inequality located in a progressively lower fraction of the income distribution.

The second normative viewpoint is the relative nature of inequality as measured by the Gini coefficient (Atkinson and Brandolini, 2004; Ravallion, 2004; Bosmans *et al.*, 2011). As shown by Atkinson and Brandolini (2004), by switching to measures of absolute or intermediate inequality, results may change significantly. To this purpose, and to stay as close as possible to the structure of the previous analysis, consider the class of intermediate Gini coefficients proposed by Bossert and Pfingsten (1990), by which an intermediate measure of relative Gini inequality G_θ may be obtained as $G_\theta = \frac{\bar{y}}{1-\theta+\theta\bar{y}} G$, where $0 \le \theta \le 1$ is a parameter. When $\theta = 1$, G_θ collapses to the standard Gini index G. When $\theta = 0$, instead, $G_\theta = \bar{y}G$, which is the absolute version of the Gini index. For any intermediate value, the Gini index becomes an intermediate index of inequality (neither fully relative nor fully absolute).

With regard to the first point, total inequality has been recalculated by using $v = 3$. Levels of inequality are higher than those reported in Table 1 (more weight is given to the lowest part of the income distribution), but the declining trend is the same over the years, even though less pronounced that in the case of the standard Gini index.[13]

With regard to the second normative viewpoint, the previous formula is applied by experimenting with various levels of θ. The main conclusion is that inequality would increase only when considering the absolute view of inequality ($\theta = 0$). The explanation is due to the fact that world average income increases faster than how inequality declines, which means that absolute gaps may

[13]Data are not reported in the table.

increase.[14] However, the whole class of relative inequality indices would restore the declining profile estimated with the standard version of the Gini coefficient. This outcome is partially in line with Atkinson and Brandolini (2004), where—ignoring within-country disparities—inequality would fall when adopting a relative view of inequality, while it would increase with other measures. But it is not in line with their results when WI is adjusted for, as in this case inequality would increase. In this latter case, however, data are not fully comparable, as the time span extends only from 1970 to 1992.

Thus, the suggestion by Bosmans *et al.* (2011, p. 8) that "if one holds the view that not only relative inequality matters, but also absolute inequality and the views in between, then there is much more support for the judgement that inequality has increased during the considered period than there is for the judgement that it has decreased" finds only partial support and it is strictly confined to the absolute measures of inequality.

Yet, the issue remains that relativist and absolutist measures may give diverging outcomes (Ravallion, 2004); results must therefore be taken with caution, possibly implementing, as in our case, a sensitivity analysis. Our findings, however, are mostly uniform across different degrees of relative inequality.

5. Conclusions

Our analysis shows some insightful facts. While BI is shown to have a significant decline in the last decade, WI follows an opposite trend, even though at a smaller scale. China plays a fundamental role in both cases. On the one hand, the powerful convergence force associated to the reduction of the Chinese gap with richer countries pushes BI down; on the other hand, the powerful divergence force associated to the enlargement of the Chinese gap with poorer countries pushes BI upward. Furthermore, the increasing dispersion of incomes between rural and urban China increases the weight of the Chinese WI, pushing WI also upward. As a result, total inequality is receiving a series of contrasting forces that are expected to change over the next years depending on how the Chinese growth will evolve compared with the rest of the world.

However, apart from this fundamental role played by China, the world distribution of income 40 years ago does not appear fundamentally changed in most recent times. African countries had and still have nothing in common with advanced economies. The ranking matrix has shown that most African people rank in the lowest decile of the income distributions of the richest countries in the world now as well as in 1970. Furthermore, the analysis of the overlapping coefficient has shown that they still form almost a perfect stratum with respect to the richest countries, despite the fact that, as suggested by the overlapping matrix, countries' income distributions are becoming more intertwined. This lower stratification that is observed over time means that the corresponding decline in BI deteriorates the quality of groupings by average incomes.

[14]Experimenting with the same level of real income as of 1970 or as of 2009 would indeed also give a declining profile in the absolute case.

Finally, the fact that total inequality has slightly declined over time is not necessarily an indicator that world resources are better shared, if gains are heavily concentrated in one specific area. In 2009, the Gini coefficient of world income is still measured around 0.65, which is a level of inequality that would probably be intolerable in any single country. Indeed, despite the rapid growth of a few Asian countries, the rest of the world is not significantly moving; South American and South Central Asian regions are more or less on the same relative position they were 40 years ago; African regions, in relative terms, are in some cases worse now than before; while Europe, North America, and Oceania perpetuate their "splendid isolation." Since from 1970 to 2009 a significant and persistent globalization wave has characterized the functioning of the economic systems, one may cast some doubts about how the potential benefits of this structural change have (or still have not) spread across countries.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Appendix A
Table A.1: Normalised gaps and contributions to Gini coefficients—PPP per capita GDP in US dollars
Appendix B
Table B.1: Gini coefficients and per capita incomes, fixed effects estimation
Figure B.1: Within inequality with Gini coefficients from alternative sources