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Half a World:
Regional inequality in five great federations

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The paper studies regional (spatial) inequality in five most populous countries in the world: China, India, the United States of America, Indonesia and Brazil in the period 1980-2000. They are all federations composed of entities (states or provinces) with substantial autonomy. Two types of regional inequalities are considered: Concept 1 inequality which is inequality between mean incomes (GDPs per capita) of states/provinces and Concert 2 inequality which is inequality between population-weighted regional mean incomes. The first inequality speaks to the issues of income convergence, the second, to the issue of overall inequality as perceived by citizens within a nation. China and India show rising inequality in terms of both concepts in the decade of the 1990's; Indonesia, on the contrary, displays decreasing inequality in both from the early 1980's up to the Asian crisis. Overall, we find that openness is negatively associated with Concept 1 regional inequality, and positively with Concept 2 inequality. Openness thus seems to help poorer regions (within nations) to catch up, but also leads to disparity in outcomes for populous states with some getting ahead and others falling behind. Maharashtra vs. Bihar, and Shandong vs. Sichuan provide nice examples of such outcomes in India and China. Higher inflation and higher real interest rate are also associated with greater Concept 2 regional inequality.

Key words: China, India, USA, Brazil, Indonesia, regional inequality, world inequality
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1. Introduction

Global inequality is strongly influenced by what happens to populous countries, both to their average income levels, and inequality within each country. If we look at the former, fast growth rates of China and more recently of India, by reducing their relative income distance from the United States and other rich countries, have lowered global inequality. Fast (average) growth in these nations is certainty the most important element contributing both to lower global inequality and lower global poverty. At the same time however within these nations, there are increasing cleavages: some provinces grow faster than others, so mean income differences between the provinces increase. In addition, the process of growth is accompanied in both China and India by increasing inequality between individuals in the country as well as within most provinces and states (see for example, Jha (no date) for India; Chen and Wang (2001) for China).

The objective of this paper is to explore the subnational changes in five most populous countries in the world: China, India, United States, Indonesia, and Brazil. We examine these changes for three reasons. First, as already mentioned, subnational changes are important because of the number of people involved they are a significant determinants of global inequality. To see this, replace China with its component provinces; then, rising differences in mean incomes between various provinces will add to global inequality at the same time as the diminishing relative distance between various provincial incomes and incomes of rich countries will reduce world inequality. The second reason lies in what subnational changes imply for national unity. One of the concerns of the Chinese leadership is how rising income differences between the prosperous coastal provinces and the less dynamic North East may affect China's political unity (see Renard, 2002). The third reason to look at the subnational level is that it provides us with some lessons regarding what we might expect at the global level were most of the obstacles to the free circulation of labor, capital and goods to be lifted. For obviously although these obstacles still exist in a number of countries even between their constituent units, they are dramatically lower than between the nations. For example, shipment of goods between different Indian states is, in some cases, still subject to fees or

border check but this is a far cry from the obstacles to international trade. Similarly, labor mobility in China is formally restricted as people need to have a permit in order to live in large cities but these rules are most often ignored, and even if they were fully implemented, the rules are much less stringent than the rules governing circulation of labor between nations. It is thus important to find out whether a generally unhindered movement of goods, labor and capital leads provinces toward convergence in their mean incomes or not.

A comparison between subnational inequalities in these five countries is meaningful despite the fact that the number and size of regional units vary. If states and provinces were based on randomly drawn border lines, it could be indeed argued that greater regional inequality in one country is simply an artifact, possibly due to the way such regional units are defined. However, in most or all cases with which we deal here, provinces/states possess both a significant amount of autonomy and specificity. Inequality between them thus does have a bearing on the issues of horizontal equity, and particularly so where states differ in their religious and ethnic composition.

The structure of the paper is as follows. In Section 2, we present some data that show the importance of the five countries in total world income and population as well as the importance of the differences between their mean incomes for explaining global inequality. In Section 3, we move to the subnational level of analysis, and present a brief review of the literature dealing with the issue of regional inequality in the five countries. In Sections 4 and 5, we look at the evolution of the differences between mean incomes of the regions during the last twenty years in each of the five nations.[2] It is here that we address the issues of income convergence or divergence within each country. In Section 6, we look at the differences in mean regional incomes but now with each region weighted by its population share. Once we weigh them by their populations, we come closer to explaining the actual "feeling" of inequality within each nation particularly

[2] We use the term "region" to indicate a subnational unit whether its exact appellation is "state" or "province" or "republic"; the term "nation" or "country" is used to designate the subjects of international laws, that is the five countries included in the analysis here.

when differences in mean regional incomes coincide with other horizontal cleavages like ethnicity or religion. We also come closer to explaining the overall national inequality between individuals for the only part which is not included now is the part of inequality—at times substantial, it is true—which is due to inter-personal income differences within each region. In Section 7, we try to identify the policies or factors at the national level which might explain the process of regional convergence or divergence; in other words, we try to find some regularities explaining why regions are converging or diverging. Section 8 presents conclusions.

2. The importance of the five countries in the world

Table 1 shows the share of the five most populous countries in world population and income in 1980, 1990 and 2000. Their share in world population has throughout remained at just above one-half. However, their share in world output has expanded from being a bit over one-third to 44 percent.

Table 1.Share of the five largest countries in world population and world income (in percent)

	1980	1990	2000
Share in world population	51.7	50.6	50.8
Share in world PPP output	34.3	36.6	44.0

The increase in the five countries' share in world income was driven by the growth (compared to world mean income) of all countries save Brazil (Table 2). The most extraordinary was of course China's growth. In 1980, China's GDP per capita was just under 17 percent of the world average. In 2000, it was in excess of 60 percent. The United States likewise grew faster than world mean income: its GDP per capita was 4.3 times greater than the world mean in 1980, while in 2000, it was almost 4.6 times as high.

Table 2. The five large countries' GDPs per capita compared to the world mean

	1980	1990	2000	Change (1980-2000)
India	0.164	0.206	0.246	+0.082
China	0.169	0.307	0.602	+0.433
Indonesia	0.364	0.495	0.527	+0.163
Brazil	1.029	0.869	0.822	-0.207
United States	4.308	4.470	4.579	+0.271

Note: All calculations done for GDP per capita expressed in 1995 international (PPP) dollars.

Being populous, these countries will obviously influence, sometimes decisively, what happens to global inequality. However when we address the issues of global inequality we have to be very careful in what exactly we are measuring. The first concept of inequality (dubbed Concept 1 by Milanovic, 2004)) measures differences in mean incomes between countries. No weighting is involved here and each country counts the same. This concept is important if we are interested if there is unconditional divergence or convergence of mean (countries') incomes in the world, or as we shall see in Section 4 below, if there is such a convergence between regional incomes at the level of each nation.

Concept 2 inequality is different. It likewise takes mean national incomes but weighs them by countries' populations. Now, of course, our five countries will matter a lot because, as we have just seen, they account for almost one-half of world income and population. But when we use Concept 2 inequality, we of course disregard the entire inequality due to the differences in incomes within nations, that is we assume that each individual has the mean income of his/her country. The Concept 3 inequality (inequality between all individuals in the world) is underestimated by the Concept 2 inequality. Yet, if differences in mean incomes between populous countries are large –as they indeed are—then Concept 2 inequality would tend to explain a lot of Concept 3 inequality. As a matter of fact, about ¾ of Concept 3 inequality is accounted by differences in mean incomes between nations (Milanovic, 2002 and 2004).

Table 3 shows that the interactions between the five countries alone (that is, disregarding their interactions with other counties) account for between a fifth and a third of total Concept 2 inequality in the world. It is important to explain how these calculations are done. Consider the Gini coefficient. In the case of Concept 2 inequality, it is equal to

$$\frac{1}{\mu}\sum_{i}^{n}\sum_{j>i}^{n}(y_j - y_i)pip_j \qquad (1)$$

where y_i = GDP per capita of *i*-th country (and $y_j > y_i$), p_i = population share of *i*-th country, and μ = mean world income. Thus, Gini 2 (world) is calculated by taking the absolute differences in mean incomes between all countries in the world, normalizing them by world mean income and weighing by population shares. To calculate the part due to the five countries we "extract" only those individual inter-country terms (ICT), that is $\frac{1}{\mu}(y_j - y_i)p_ip_j$ where both *i* and *j* are belong to "our" five countries. Thus, for example, in 1980, the US GDP per capita was $PPP 21,755 and China's $PPP 852. The difference between the two amounted to $PPP 20,900. In terms of world mean income (which was then $5,050), the difference was 4.13. This is in turn weighted by US and Chinese population shares (0.054 and 0.234 respectively), and the obtained value 5.3 Gini points represents the contribution to Concept 2 world Gini of the difference in mean incomes between the United States and China. The same calculation is repeated for all five countries (there is in total 10 such calculations). The sum gives the total amount of direct contribution due to the interaction between the five countries (differences in their mean incomes). As Table 3 shows, it did not change much in the last twenty years: it oscillated around 11 Gini points throughout.

Note however that these calculations leave out all the similar interactions between each of our five countries and the rest of the world (say, China vs. Germany, or US vs. Nigeria, or India vs. Senegal etc.) which also contribute to world inequality. If we then add all of these contributions, we notice that they have declined from almost 17 Gini

points in 1980 to 14 Gini points in 2000. The decline was almost entirely due to China's fast growth that diminished the distance and hence the inequality terms between it and the rest of the (rich) world. Overall the five largest countries contribute around one-half of total global Concept 2 inequality as measured by the Gini coefficient.

Differently, we can measure inequality by using the Theil index. The Theil index for Concept 2 inequality can be written:

$$\sum_{i=1}^{n} p_i \frac{y_i}{\mu} \ln \frac{yi}{\mu} \qquad (2)$$

Here we take the same approach: we "extract" only the $pi \frac{yi}{\mu} \ln \frac{yi}{\mu}$ terms belonging to our five countries. There are no interactions between countries' mean incomes. The contribution of the US is obtained (again using the 1980 data) as the product of its population share (0.054) with its income relative to world mean (20,900/5050=4.308) times the log of the last amount. To get the total contribution of the five countries, we simply add such amounts. [3] Their contribution to the global Theil-measured Concept 2 inequality varies between one-third in 1980 and 37 percent in 2000 (Table 3).

In conclusion, the five largest countries "explain" between 37 (using Theil) and 50 percent (using Gini) of global Concept 2 inequality.

[3] Unlike the Gini coefficient which is based on bilateral comparisons of income between all countries and allows us thus to distinguish the contribution of each and every pair of countries, Theil index just sums individual countries' contributions. In other words, it cannot distinguish between the contribution due to the interaction between the five countries themselves, and the five countries and the rest of the world.

Table 3. Direct and total contribution of the five largest countries to Concept 2 global inequality

	1980	1990	2000
Gini			
Concept 2 Gini (world)	54.1	52.9	50.2
Interaction between the five countries (Gini points)	11.6	10.8	11.3
Interaction of the five with other countries (Gini points)	16.9	15.6	14.0
Total percentage contribution	53	50	50
Theil entropy			
Concept 2 Theil (world)	63.3	59.8	52.3
Contribution of five largest countries (Theil points)	21.0	17.8	19.4
Percentage contribution	33	30	37

Note: Concept 2 inequality is inequality between mean countries' GDPs per capita weighted by countries' populations.

3. A brief review of regional (within-country) inequality studies[4]

The issues we address here—Concept 1 and Concept 2 inequality—have been, in a slightly different context, addressed before. This was done in two contexts. The first is the issue of regional inequality within countries. There are two views in the literature that are often juxtaposed. The first is due to Williamson (1965) who argued that in the early stages of economic development, regional inequality would tend to rise as growth occurs in discrete locales, but that later inequalities will decline as equilibrating forces such as better infrastructure, technological diffusion, decreasing returns to capital in richer and high-wage areas, diseconomies of agglomeration etc. become stronger. Thus, regional inequality is expected to follow an inverted U shape as income level grows. Williamson's reasoning is closely related to the idea of the Kuznets curve where similar development although not in spatial terms produces first an increase and then a decline in inequality. It is also based on neoclassical (Solow-type) assumptions which include decreasing marginal returns. A different view has been proposed more recently within the context of the new economic geography school (Krugman and Venables, 1995) and endogenous growth (Romer 1986; see also a recent review by Easterly and Levine 2002). There the argument is that that increasing returns to scale and thus advantages of agglomeration of capital and knowledge will tend to perpetuate, or even increase, spatial inequalities. Yet in Krugman and Venables (1995), decreasing transportation costs may play an offsetting role: assume that transportation costs are zero, then the advantage of cheap labor in less developed countries (or regions) will, to some extent, tend to offset the advantages of increasing returns to scale.

The key difference between these two approaches seems not to lie in their view of the short-run developments, where they all, including the earlier development theories such as Myrdal's (1957), Rosenstein-Rodan's (1943), Hirschmann (1958) or Perroux (1970; 1988), seem to agree that growth is disequalizing, but in the view of the long-run developments where either traditional neoclassical assumptions dominate—rendering

[4] Since we deal with *regional* inequality, we do not review studies of the most common Concept 3 (inter-personal) inequality.

growth ultimately equalizing in spatial terms as well—or where such assumptions are rejected or made less potent thus weakening the forces which make for spatial equality in the long-run. [5] Recently, the short- and long-run aspects have been combined in a paper by Petrakos, Rodriguez-Pose and Roviolis (2003), which looks at the regional inequalities within the European Union (with several regions defined within each country). The authors find that that the short-term effects of growth are disequalizing in the sense that higher growth rate tends to increase regional inequality (controlling for all other country-relevant attributes), while higher income *level* is associated with lower regional inequality. The authors interpret the second finding as implying the long-run equilibrating effects of growth along the lines of the Solow and Williamson models. Their measure of regional inequality, as in several other papers (e.g. Akita and Kataoka (2003) regarding Japan; Akita and Kawamura (1992) regarding Indonesia and China; Bhalla, Yao and Zhang (2003) and Kanbur and Zhang (2003) for China) is the population-weighted coefficient of variation or population weighted Theil index. This is what we called Concept 2 inequality, and the justification for using Concept 2 (rather than Concept 1) inequality is that it reflects regional inequality as experienced by an "average" person; in other words, regional divergence which may be due to a few sparsely populated regions' either very fast or very slow growth is rather irrelevant for the actual feeling of spatial (horizontal) inequality as experienced by the people in the country.

But the issue of regional inequality—using Concept 1 inequality—has also recently received quite a lot of prominence due to the popularity enjoyed by the so-called growth convergence literature. While the convergence issues have originally been defined and studied at the level of countries (that is, convergence of national economies), they have recently been studied at the level of subnational regions. For the countries included here, such papers are Zhang, Liu and Yao (2001) for China, Azzoni (2001) for Brazil, Ram (1992) for the United States, and Jha (no date) and Dreze and Srinivasan (2000) for

[5] There is an obvious link between these views, as couched in terns of regional developmests within individual countries and regional developments in the world as in Krugman and Venables (1995) or Krugman (1991).

India.[6] The rationale for the interest in Concept 1 inequality is very different from the interest in Concept 2 inequality. The issue of convergence of (unweighted) regions within a country, or (unweighted) countries in the world, addresses the problem of whether the same or similar economic policies produce similar results or not. Consider the example of a country which has a single national economic policy, that is where there is no significant regional freedom of economic policy-making. Suppose that Concept 2 regional inequality is decreasing. But if we still find that Concept 1 inequality is increasing, it raises the interesting question of what characteristics enjoyed by some regions are responsible for their not catching up (or for their growing too fast). Thus both Concept 1 and Concept 2 inequality are of interest.

We shall now briefly review some of key (representative) regional inequality studies that deal with the five great federations included here. Other papers which deal with these countries will be mentioned in Chapters 5-7 when we present our results. The studies of China are the most numerous. There are two reasons for this. First, the extremely fast growth of Chinese economy over the last quarter century has been associated with increasing regional inequalities. This has obvious implications both for political stability and for economic theory, that is for figuring out why and how certain regions grow and others don't, and whether the dominant feature of China's inequality is rural vs. urban inequality or inter-provincial inequality. The consensus seems to be that it is the former. [7] For example, Bhalla, Yao and Zhang (2003) calculate inequality in per capita consumption across provincial and urban-rural partitions (that is, they use data for mean annual incomes for rural and urban areas for each province, that is 28 provinces times 2 = 56 observations[8]) and find that in 1995, more than ¾ of thus calculated Theil-based

[6] For other countries, see Goerlich and Mas (2001) for Spanish provinces, Yemtsov (2002) for the subjects of the Russian federation.

[7] When it comes to inter-provincial inequality, it seems to be more the case of "club" inequality, that is of three clubs (East, West, Center) diverging from each other. See Annex 2 below; alsoYao and Zhang (2001).

[8] More exactly, they have the data on mean per capita consumption of peasants and non-peasants (by province) as obtained from Chinese household surveys. They interpret peasant consumoption to be rural, and likewise non-peasant to be equivalent to urban (see Bhalla et al, p. 945). See Annex 2.

Concept 2 inequality is accounted for by the rural-urban split.[9] This is a result similar to the one obtained by Kanbur and Zhang (2003) who find that the same urban-rural split (that is, the difference between the mean urban and the mean rural income) explains 56 percent of Concept 2 inequality (calculated from the same 56 observations).[10] The results of these two studies and a few others are compared in Annex 2.

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The second reason lies in the lack of individual-level data on income inequality in China, that is lack of data on Concept 3 inequality. Concept 2 regional inequality can be used, if our partitioning is sufficiently fine, to approximate the evolution in Concept 3 inequality. In other words, if we think that most of inequality is spatial, and use a very fine partition (that is, divide the country in meaningful but also numerous regional units) then thus calculated Concept 2 inequality should approximate, if not necessarily the level then the evolution, of Concept 3 inequality. To see this consider that, at the extreme, every individual can be treated as a "region": then Concept 2 inequality collapses into Concept 3 inequality. This was, for example, the approach underlying Kanbur and Zhang (2003) paper on regional inequality in China. As in the Bhalla et al. (2003), Kanbur and Zhang divide China into 28 provinces and each of the provinces into its rural and urban areas. They have the data for mean incomes within each of thus defined 56 regions, and this annually for the period 1952-2000. They calculate Concept 2 inequality from these means, find also that the rural-urban split accounts for the bulk of total inequality (much more than the inland-coastal split)[11] but use the Concept 2 inequality as a proxy for the Concept 3 inequality. Then they try to relate changes in Concept 2 inequality levels over the last 50 years to various policy episodes (Great Leap Forward, Cultural Revolution, agricultural liberalization, urban and industrial liberalization etc.) They find that the Concept 2 inequality, with this relatively fine partition, amounts in 2000 to a Gini of 37.2

[9] It is notable that the share of the urban-rural difference in total appears constantly high, that is between 70 and 80 percent, from 1952 to the end of century (see Bhalla et al (2003, Table 2, p. 947)).

[10] Why these two results are not the same is puzzling.

[11] Although after 1993, there is a rapid increase in the within-urban and within-rural components indicating that there is a widening income differentiation *within* urban and *within* rural areas as well.

which, of course, sets a rather high lower bound to total personal size income inequality in China.[12]

As for other countries, Jha (no date), in a study of India's inequality over the last fifty years looks at the issue of Concept 1 convergence between the states and concludes that divergence has been more common and has accelerated since the reforms in the early 1990's. Ram (1992), and Barro and Sala-i-Martin (1992) have done similar analysis for the United States. Ram (1992) finds a steadily decreasing inter-state inequality from 1950 to 1980 and an increase in the next decade.

As this brief review shows, regional inequality studies fall into three categories that closely match our three concepts of inequality. Many of them, in the wake of the convergence literature, deal with Concept 1 inequality. Others, perhaps equally numerous, deal with Concept 2 inequality—regional or horizontal inequality as actually "experienced" by the population. Finally, some use regional partition (Concept 2 inequality) as a proxy for Concept 3 inequality.

It should be noted that the work on the regional inequality is not facilitated by the absence of an accepted or clear terminology. The results are often impenetrable because the same term, say "regional inequality" may be used to represent Concept 1 or Concept 2 inequality. Even the term "region" is sometimes used for the smallest units (say, states in a country) and, perhaps in the same paper, for the agglomeration of several such units into a larger whole which is still not national level (thus, for example, authors often write of China's three regions: East, Center and West, *and* of China's regions, meaning in the latter case provinces). As a consequence, "regional inequality" might mean either one of the four combinations: Concept 1 or Concept 2 inequality, or inequality between the provinces or inequality between agglomerations of provinces, that is larger "regions." Moreover, the share of the between (inter-regional) component is quite different—even if

[12] When we use regional GDP per capita as welfare indicator (as here) to derive Concept 2 inequality, its value cannot be fully taken as the lower bound of Conmcept 3 inequality because of likely transfers between the regions. This is different from the analysis on the global level when redistributive transfers between the countries are minimal.

the partitions are the same—if we is the "between" share in total interpersonal (Concept 3) inequality or in Concept 2 inequality.[13]

Even the measures of inequality are often opaque. While many authors use Theil indexes because of their decomposition properties, it is not always clear if Theil (1) also known as Theil entropy measure, or Theil (0) also known as mean log deviation index is used. While the use of one or another Theil index does not have an impact on results within each individual study (since the measures move almost always the same way), it does render difficult comparison of the absolute values of inequality measures from several different studies.[14] We have tried to be as clear as possible in our terminology here and to the risk of being repetitive will use "Concept 1" and "Concept 2" inequality often in order to avoid possible misunderstanding. Similarly, we shall try to be clear about the "partition" we use: states (provinces) adding up to a nation, or states (provinces) adding up to regions which then add up to a nation.

[13] For example, in a very detailed summary of the results of the "between" component in different country studies given in Sharrocks and Wan (2004, Table 1A), total inequality against which the "between" component is meaasured is sometimes Concept 2 and sometimes Concept 3 inequality.

[14] Yet another problem seems to be that some authors use natural logs and others use logs with the base of 10. Again, this does not matter for individual studies, but does matter for comparative work.

4. The five federations: descriptive statistics and Concept 1 inequality

The analysis of each individual country's inequality is conducted on the basis of regional GDPs per capita expressed in nominal prices. Thus, inequality between regions calculated for each individual year is inequality between regional nominal incomes. [15] Clearly, to the extent that there are price differences within a country and price levels are higher in richer regions, such inequality statistics will tend to overestimate intra-regional inequality.

In order to adjust for that and also to allow for comparison between regions belonging to different counties, all regional GDPs are also expressed in real terms. First, they are expressed in real units of the domestic currency and then converted into the 1995 international dollars ($PPP). The typical pattern of conversion is the one for China as expressed in equation (1) where Y denotes provincial GDP per capita, r = real provincial growth rate, DD = country-wide deflator, and PPP = PPP-equivalent dollar exchange rate. We have, from the Chinese statistics, real annual provincial growth rates expressed in 1978 all-China prices. This means that real income of region *i*, country *j* (=China here) and year *t* (subsequent to 1978) is obtained by applying real growth rates to the nominal 1978 regional income. Note that the application of real growth rates from region to region implies that differences in annual inflation between the regions are accounted for. This amount, that is provincial income in year *t* expressed in 1978 prices (the denominator in equation 1) is then, using the country-wide deflator between 1978 and 1995 ($DD_{j,78,95}$), converted into all-China 1995 prices.[16] This is finally converted into international dollars by using the 1995 purchasing power exchange rate of that country (obtained from the World Bank data).

$$Y_{i,j,t,95,\$} = \frac{Y_{i,j,t-1,78,d} * (1 + r_{i,j,t})}{DD_{j(78,95)}} * PPP_{95} \qquad (1)$$

[15] Except in Indonesia for which we have only real provincial incomes.

[16] Note that the deflator has only country (*j*) subscript.

where the subscript *d* denotes domestic constant prices, and subscript *$* international prices.

A slightly different approach is used for the US regions. Nominal incomes (year *t* expressed in dollars of the same year) are converted using the overall country's deflator (DDj) which converts *t* year's dollars into the 1995 dollars. This implies that price differences across US states are non-existent. Since the US prices are, by construction, made to equal to international prices, the PPP convertor is equal to 1 (equation 2)

$$Y_{i,j,t,95,\$} = \frac{Y_{i,j,t,t,,\$}}{DD_{j(t,95)}} * 1 \qquad (2)$$

Table 4 shows our coverage of the five countries. More detailed information regarding countries' administrative structure and our data coverage is given in Annex 1.

Table 4. Regions in the five countries: descriptive statistics

	China	India	USA	Brazil	Indonesia
Period included	1978-2001	1980-2000	1977-2001	1985-2001	1983-2001
Welfare indicator	GDP per capita	GDP per capita	GDP per capita	GDP per capita	GDP per capita
Constant prices (year)	1978	1980-81	1995	1985	1983
Number of regions included in the study	27	14	50	26	26
Total number of regions in the country	30	25	50	26	26
Special regions, not included above (approx. population in m)	Hong Kong, Macau, 7 million	All Union territories (Delhi etc.), 11 million	District of Columbia, Pacific and Caribbean possessions, 5 million 3/	Federal District, 2 million	---
Disputed territories (not included)	Taiwan	Parts of Kashmir belonging to Pakistan and China	---	---	East Timor 3/
Total population (million; in 2000) 1/	1,271	1,033	283	172	213
Population coverage (in percent; 2000) 2/	99	92	100	99	100
Most populous region (million, 2000)	114.2 (Sichuan)	170.6 (Uttar Pradesh)	34.0 (California)	37.1 (Sao Paulo)	35.7 (West Java)
Least populous region (million, 2000)	5.6 (Ningxia)	20.6 (Haryana)	0.5 (Wyoming)	0.3 (Roraima)	1.2 (Maluku)
Richest region (year 2000; in tho. 1995 international dollars)	21.7 (Shanghai)	3.1 (Maharashtra)	42.0 (Connecticut)	9.1 (Sao Paulo)	13.7 (East Kalimantan)
Poorest region (year 2000; in tho. 1995 international dollars)	1.6 (Guizhou)	0.7 (Bihar)	20.0 (West Virginia)	1.3 (Maranhao)	1.1 (East Nusa Tenggara)
Ratio: richest-poorest region (2000)	13.6	4.4	2.1	7.0	12.5
Median region by income (year 2000; in tho. 1995 international dollars)	3.3 (Anhui)	1.7 (Kerala)	28.8 (Pennsylvania)	3.1 (Pernambuco)	2.4 (East Java)
GDP per capita (year 2000; in tho. 1995 international dollars)	4.1	1.7	31.5	5.7	3.6

Note: For the purposes of comparison, GDP per capita is always expressed in 1995 international dollars. No region-specific PPP rates are used (e.g. all regions of a given country have their GDP per capita converted into $PPP using a single exchange rate). Full list of included regions is given in Annex 1.

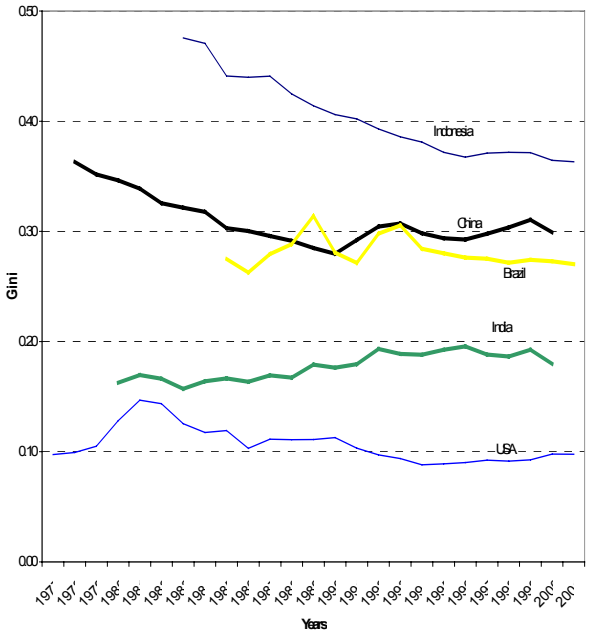
1/ Excludes disputed regions as well as Hong Kong and Macau in the case of China. 2/ Population in regions included in the study divided by total population as defined here. 3/ Pacific and Caribbean possessions include 12 territories only 5 of which (Puerto Rico, Guam, US Virgin Islands, American

Samoa and Mariana Islands) have resident population apart from the military. Their total population is 4.4 million (see http://www.infoplease.com/ipa/A0108295.html). 3/ East Timor was included in the Indonesian data until independence in 1999. For consistency, we have excluded it throughout.

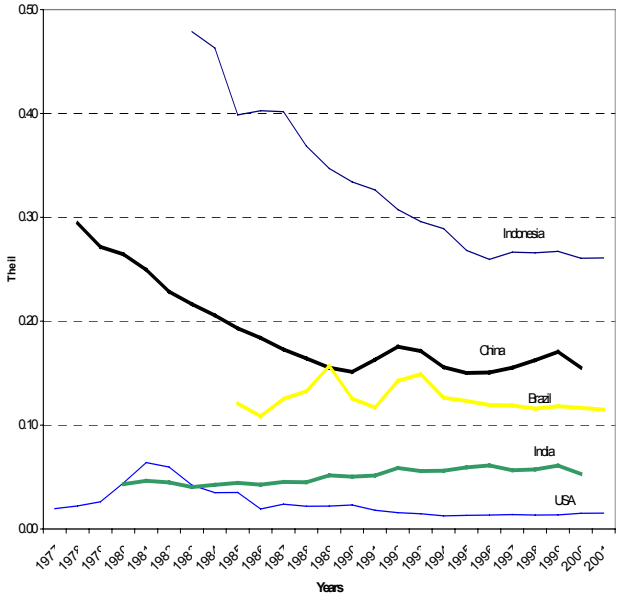
Figure 1 shows Concept 1 inequality for the five countries.

Figure 1. Concept 1 (unweighted inter-regional inequality) in the five countries

Gini



Theil



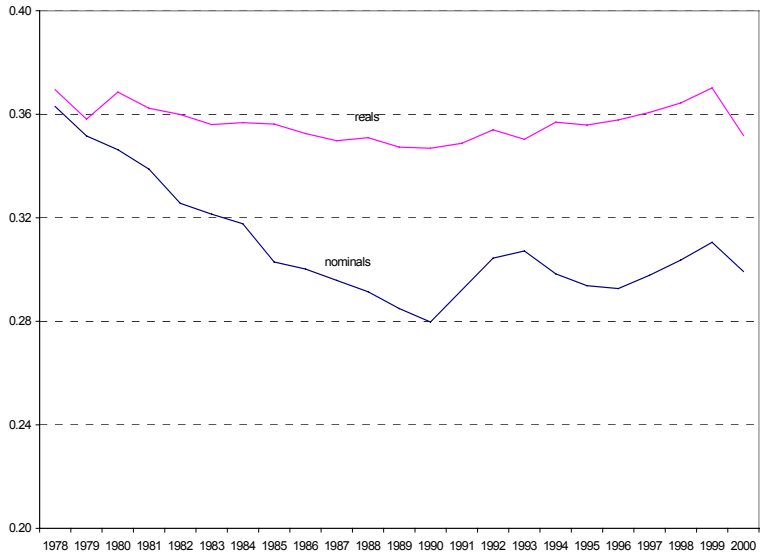
Note: Concept 1 inequality is calculated in nominal terms (except for Indonesia where we have real data only).

We see that the level of inter-regional inequality is much higher in Indonesia than elsewhere, that next come China and Brazil, followed by India and than the lowest level of inter-regional inequality is in the United States, despite the fact that the US has the highest number of states and that there is a presumption that Concept 1 inequality will increase with greater number of partitions (see Proposition 1 in Shorrocks and Wan, 2004). As we can see from Figure 1, the Concept 1 Gini is almost 40 for Indonesia, for China and Brazil, it is between 25 and 30, for India, it is approaching 20 and for the United States is it around 10. The ranking of the countries is the same if we use Theil index.

But the figures also reveal very different time patterns in the evolution of Concept 1 inequality. Indonesia and China which have the highest levels of inequality display also significant reductions throughout the 1980's. For China, the period of regional equalization comes to a close around 1990 and is reversed afterwards, for Indonesia, it continues until the mid-1990's. Brazil does not show any noticeable trend. In the case of India, regional inequality seems to be steadily rising almost the entire period. Finally, the United States which has the lowest level of inter-regional differences, shows a burst of increased inequality in the early 1980s, followed by a sustained if weak reduction since. Overall, regional inequality levels in the five countries are now (at the turn of the century) much more similar than twenty years ago. This is obvious from Figure 1 where (in terms of the Gini) the dispersal was between 10 and 50 in the early- or mid-1980s, and has by year 2000 shrunk to between 10 and about 35.

When we look at the evolution of inter-regional inequality within a country, we need to distinguish between inter-regional inequality calculated in nominal and real prices. As discussed earlier, the former is simply a comparison of regional nominal GDPs per capita; the latter is calculated based on GDP per capita and a price structure of a given year which is then "augmented" by annual real growth rates. The results presented in Figure 1 are based on nominal magnitudes with the exception of Indonesia where we had access to real data only. However, in China and India nominal and real inequality measures do not move in parallel.

Figure 2. China: Concept 1 inequality calculated in nominal and real terms (1978 prices)



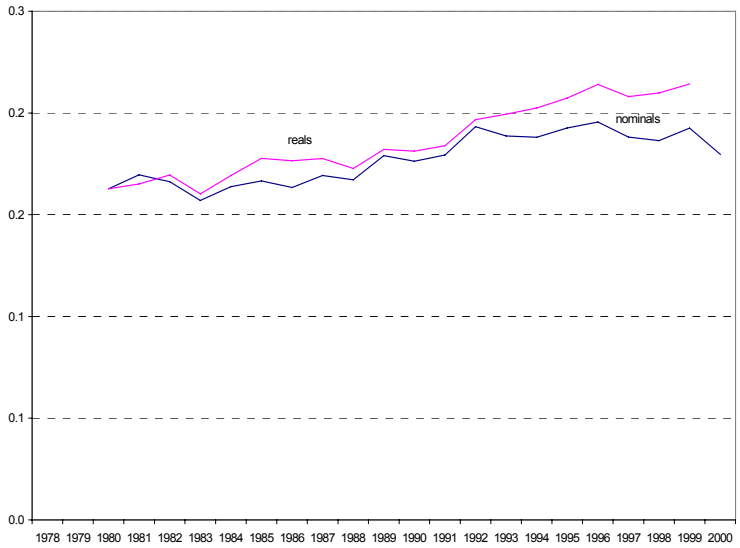
Note: Provinces of Qinghai and Hainan (populations of respectively 5 and 7 million) are not included in the calculations based on real GDP per capita due to the lack of data. They are included in the nominal GDP data series though.

Figure 2 shows very different evolutions of the two inequalities in the case of China. If we look at nominal differences in GDP per capita, we note a strong reduction in inter-provincial inequality up to 1990, and a slightly increased level since. The decline in nominal inequalities (which is even more dramatic if we look at the Theil than at the Gini measure and which thus implies that the catch up has been particularly strong for the poor provinces) coincides with the period of agricultural liberalization. Since 1990, approximately around the time when China enters more substantial liberalization in the urban sector, this trend is reversed. However if we look at inter-provincial inequality in real terms, we see that it remained around Gini of 35 throughout the entire period. The implication of these different movements in real and nominal Gini and Theil is that there has been a price catch up of the poorer provinces. In other words, if in 1978, the poorer provinces had a lower price level,[17] then while their real growth rates did not systematically differ from those of the rich provinces, their relative price level must have

[17] This is a very sensible supposition although we cannot prove it since Chinese statistics publish only provincial CPIs but do not provide provincial price levels.

risen in order to observe a decline in nominal inter-provincial inequality. After 1990, the two measures move the same way indicating that the price catch-up has stopped.

Figure 3. India: Concept 1 inequality calculated in nominal and real terms (1980-81 prices)



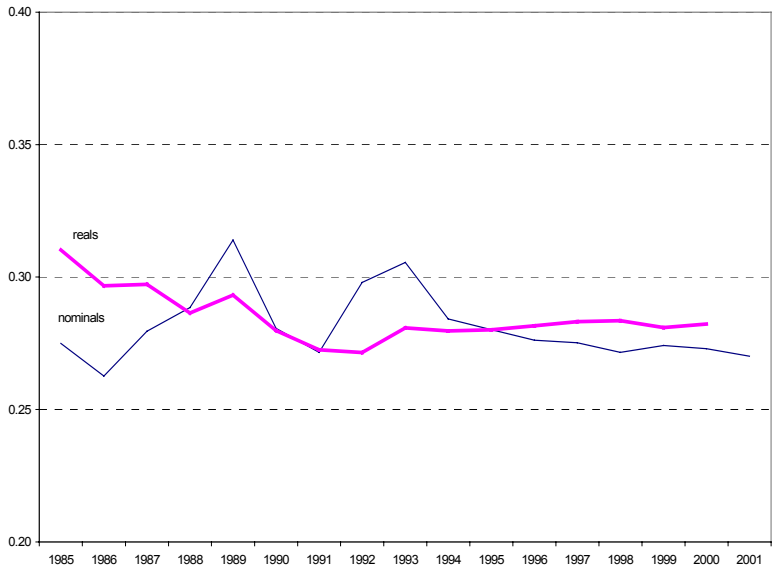
Note: The data on 1999 real GDPs per capita are incomplete and hence not included.

In India, both real- and nominal-based Concept 1 inequality was rising during the last twenty years (Figure 3). However, the same phenomenon of the poorer states' catch-up in terms of price levels is obvious here too as real-based inter-state inequality is higher than the inequality calculated from nominal state GDPs per capita.

In Brazil, inter-state inequality moves up during the periods of high and volatile inflation: between 1986 and 1990 inflation accelerated from 150 percent annually to almost 3000 percent and inter-state inequality, measured by nominal GDPs per capita, rose. (However inequality measured in real terms stayed constant). Deceleration of inflation in 1991 was accompanied by a decline in inter-state income differences. But during the next three years as inflation accelerated again (from 400 percent in 1991 to more than 2000 in 1994), nominal inter-state inequality rose again. This is an evolution very similar to what we observe for the United States where also inter-state inequality rose during the inflationary period 1977-1981. In both cases, it seems that nominal GDPs

per capita are very differently affected from state to state when inflation ids high. This is not unexpected. We know that high inflation and hyperinflation are accompanied by greater price volatility, that is real prices of goods and services vary more in high inflation environments (see Parks (1978) and for more recent evidence, Dabus (2000)). It is then not surprising that different states—which produce different output mixes—will also tend to be affected more unevenly when inflation is high than when it is low.

Figure 4. Brazil: Concept 1 inequality calculated in nominal and real terms (1995 prices)



Note: The state of Tocantins, due to lack of data, is not included in years 1985-1988.

Figure 5 shows the distribution of regional GDPs per capita (expressed in 1995 international dollars) in the five countries, in the first year for which the data are available and in 2000. Consider first the United States and Indonesia which, as we have seen, have witnessed a reduction of inter-regional inequalities. This trend is reflected in Figures (a) and (e) by a much smaller and less lengthy right-end tail at the end of the period. In 2000, the US distribution of regional GDPs per capita is almost exactly lognormal, the right skewness having disappeared. In Indonesia too there was a rightward shift of the distribution (regions becoming richer) but the two very richest regions have not gained

too much. For example, East Kalamantan which was the second richest province in 1983 has seen its per capita income increase from about $PPP10,400 to $PPP 13,700; the richest province in 1983 was Riau with $10,800 but in 2000 Riau's GDP per capita was only $PPP 9,300 (and it was still the second richest province). Contrast this with more than the doubling of real incomes in the very poorest provinces in Indonesia: East and West Nusa Tenggara where incomes in 1983 were at around $600 per capita and increased to between $PPP 1200 and $PPP 1500 in the tear 2000. Lampung, the third poorest province went from $PPP 700 to $PPP 1700. Thus, regional differences in Indonesia decreased a lot—and as we have seen in the previous section this was a long-run process.

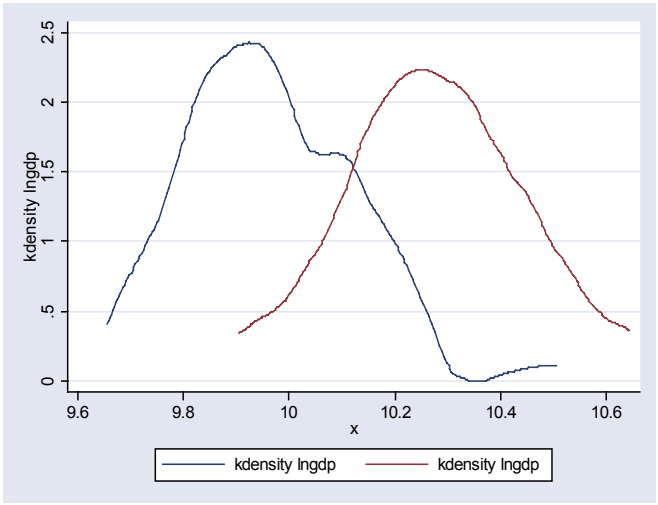
For China, we see a remarkable rightward shift of the distribution as all of the provinces became richer. There was also a complicated process that, on the one hand, led to much less clustering of the provinces (note the much lower height of the mode in 2000 than in 1980) while on the other hand, the rich provinces which in 1980 seemed to be clear outliers are less so now. Shanghai's (the richest region) GDP per capita has decreased from being almost 7 times as high as the all-China mean in 1980 to being 5.4 times as high. Figure 5 (b) reflects this by a lower right-end skewness and greater kurtosis (the thickness of the right-end tail).

Distribution of Indian states has changed in a similar way to that of China even if the rightward shift of all is not nearly as impressive. However here too the height of the mode of the distribution is less in 1999 than in 1980, that is clustering is less which, of course, contributes to regional inequality.

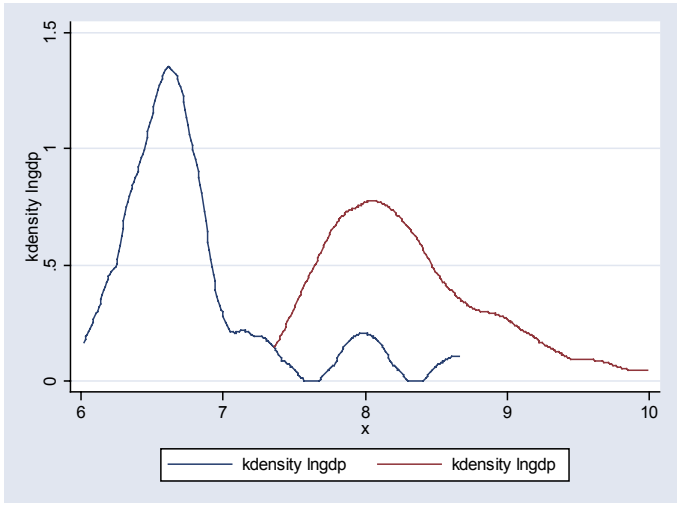
The least change is apparent in the case of Brazil where the distribution moved slightly to the right (as the country did register modest growth between 1985 and 2000) and the distribution of states GDPs per capita remained rather unchanged.

Figure 5. Distribution of regions circa 1980 and 2000
by their ln GDP per capita in ’95 international dollars

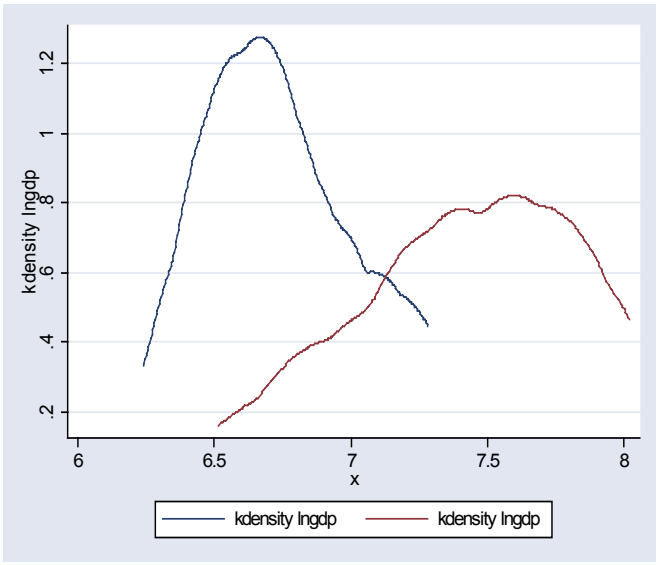
United States, 1980 and 2000



China, 1980-2000



India, 1980 and 1999



Brazil, 1985 and 2000

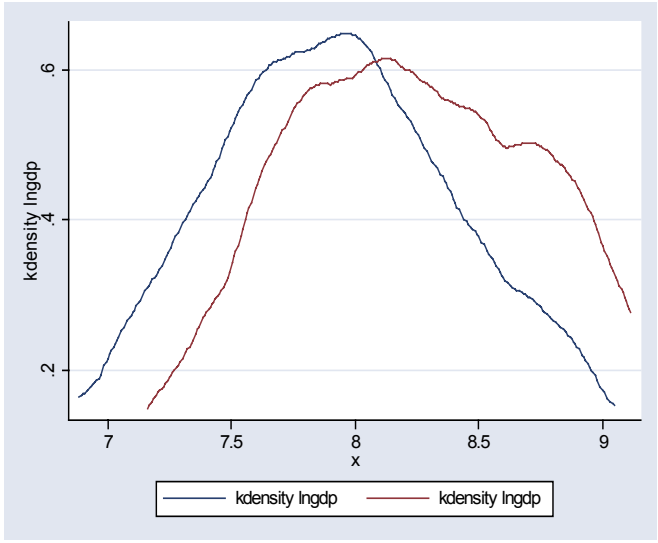
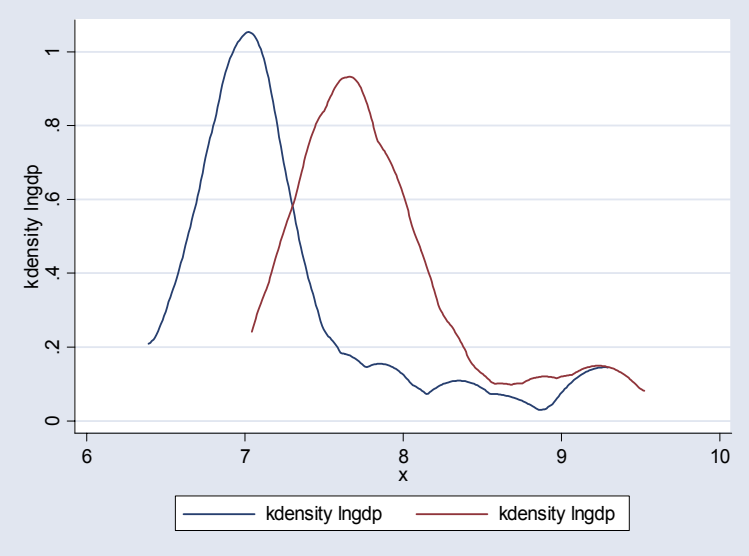


Figure 5 (continued)

Indonesia, 1983 and 2000



Note: Data for the United States do not include Alaska. Density functions are drawn using the optimal (Epannichikov) bandwidth.

5. Identifying periods of regional convergence and divergence

In this section we look some more at the issue of regional convergence and divergence using Concept 1 definition. The simplest approach is to look for the existence of unconditional convergence. In this case, regional rates of growth over a period (generally, five-years) are regressed on initial regional income levels as in (3)

$$\ln y_{it} - \ln y_{i,t-5} = \beta_0 + \beta_1 y_{i,t-5} + e_{it} \qquad (3)$$

where as before *i* is i-th region, *t* is time, y = real GDP per capita, and the sign of the coefficient β_1 indicates presence or absence of unconditional convergence. The regression is calculated, of course, for each country and for all years. The latter is done in order to avoid biasing the results through choice of the time period and stage of the economic cycle. Petrakos et al. (2002, p. 4) for example show how, using the same data, the choice of different time intervals may yield either convergence or divergence.[18]

Figure 6 displays the values of the β_1 coefficient. The value of (say) –0.02 for year *t* means that each ten percent increase in the initial GDP per capita (that is, in year *t-5*) is associated with 0.2 percent slower annual growth over the next five years. What we readily notice from the results in Figure 6 where the β values are charted together with their 95 confidence intervals is that in most cases we cannot accept—at conventional levels of significance—the hypothesis of unconditional convergence or divergence. For both China and India, it is only towards the mid- or late- 1990's that there is enough evidence to accept the hypothesis of unconditional divergence.[19] Thus, in China, it was growth over the five-year period ending in 1999 that was disequalizing.[20] For India, it is

[18] In addition, even the interpretation of $\beta<0$ as indicating convergence is doubtful since β will be negatively biased (the Galton's fallacy). For a discussion see Bliss (1999). However we follow the rest of the literature in interpreting results of (3) as indicating the presence or absence of convergence.

[19] Although there again, the 95 lower bound is just hovering around the value of zero.

[20] Zhang, Liu and Yao (2001) look at the convergence of China's three large regions (East, Central and West). They find some evidence for conditional convergence to own steady-states as growth rates of East and West are negatively related to their income levels (see Table 1, p. 247). However, unconditionally East and West seem to be diverging.

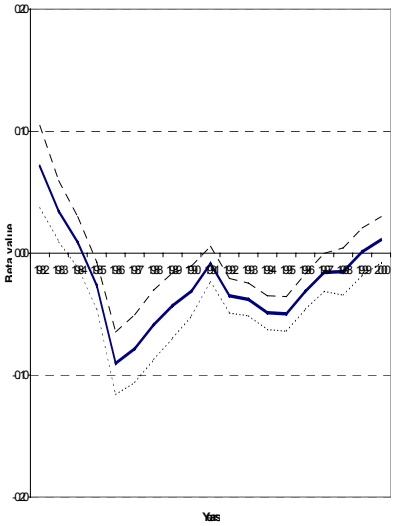
the period from 1991 onwards. For Brazil, there is evidence of convergence in the period between 1985 and 1992.

The United States displays the most interesting feature. A period of unconditional divergence in the late 1970s-early 1980s is followed by a very long period lasting two decades of almost uninterrupted unconditional convergence (except for the recession in 1990-91). Moreover, the divergence in the late 1970s-early 1980s is solely due to the huge increase in GDP per capita in Alaska, the result of the tripling of oil prices in the 1979. If we eliminate Alaska, conditional divergence in the early 1980's evaporates. What is remarkable about the US experience is that in the United States the level of Concept 1 inequality is already by far the lowest (see Figure 1) and it has still experienced sustained regional convergence during the last quarter of century.

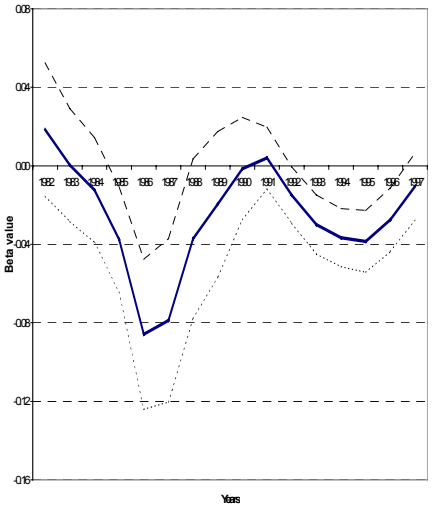
Figure 6. Unconditional β regional convergence or divergence

(β coefficient with the 95 confidence interval)

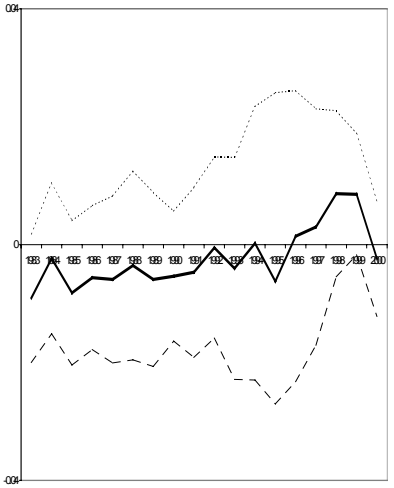
United States



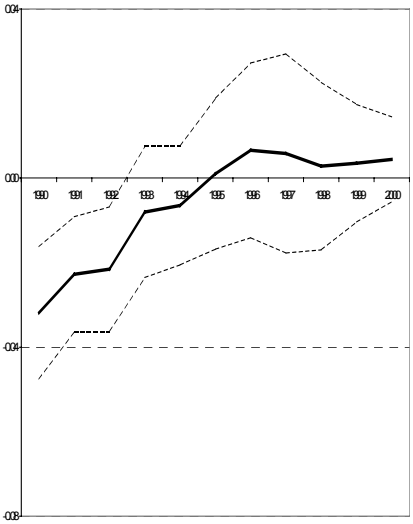
United States w/o Alaska



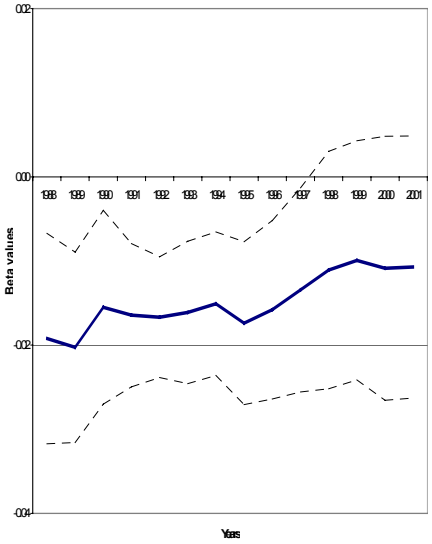
China



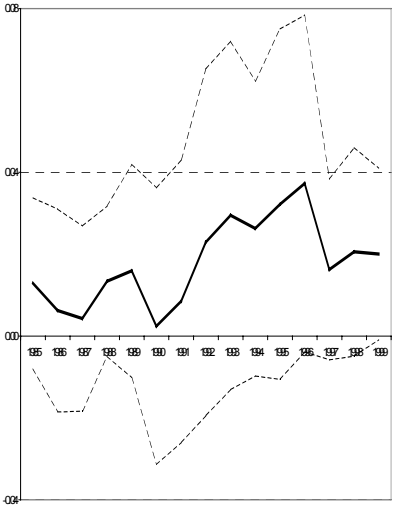
Brazil



Indonesia



India



Note: the regression is ROG(t-5,t)=β0+β1 log GDP (t-5) where ROG=annualized per capita growth rate between t-5 and t, and GDP = real GDP per capita in year t-5 (all expressed in constant international 1995 dollars).

The only other country that shows sustained convergence in Indonesia. Regional convergence continues until the period of Asian crisis, that is, it comes to a close in the five-year period ending in 1998.

Table 5 summarizes the periods of unconditional convergence/divergence. As mentioned above, the 1990's were the period of divergence for India and China. Both Indonesia and the United States experienced a very long period of convergence which has recently come to an end. Brazil has experienced an early period of convergence (late 1980s) but no significant change either way after then. In Section 7, we shall try to relate these intra-national developments to macro economic and policy changes, in other words, to see whether we can find economic variables that "explain" convergence or divergence of regions within a single nation state.

Table 5. Periods of unconditional convergence or divergence

	United States	China	India	Brazil	Indonesia
Convergence	1982-96			1985-92	1983-97
Divergence		1994-99	1991-99		

Note: Divergence/convergence is accepted only if the β coefficient in (3) is significantly positive/negative at the 5 percent level.

6. Concept 2 regional inequality

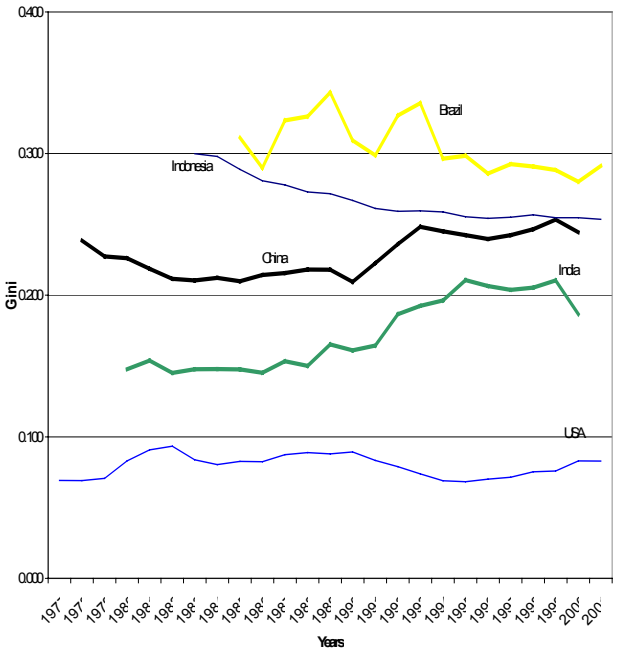
In principle population-weighted inequality (Concept 2) is interesting mostly as a stepping stone, or a lower bound to "true" inequality between individuals. As mentioned before, it also reflects the "feeling" of inequality within a country much better than the unweighted Concept 1, particularly when regional inequalities coincide with other types of horizontal cleavages. Changes in the population-weighted inequality are important for two additional reasons. First, we may want to see whether inequality is driven by the differing population growth rates between the regions. For example, increasing Concept 2 inequality (and very likely increasing inter-personal inequality) may be due to migration of the population into faster growing or richer regions.

Secondly, an interesting issue is whether there is correlation between growth rates and population size of different regions. This is in turn relevant for two reasons. Assuming for the moment that there is no migration between the regions, the evidence of a positive relationship between population and growth may help shed additional light on the issue of increasing returns to scale: greater population may help growth if it delays the onset of diminishing marginal returns. Second, higher growth in more populous regions has obvious (positive) implications for the reduction in poverty. If growth rates tend to be higher in more populous regions then everything else being the same, poverty reduction will be greater.

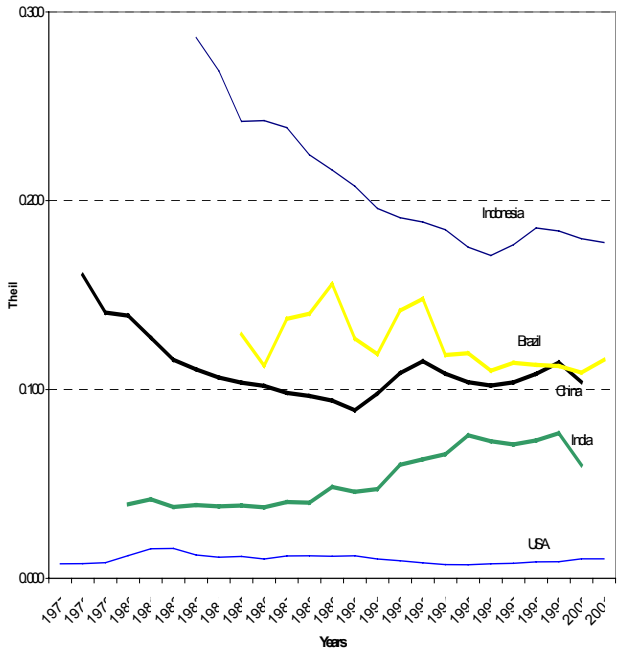
We now turn to these two issues: (i) the influence of uneven regional population growth on Concept 2 inequality, and (ii) the association between regional population size and per capita GDP growth. But before we do so, we need to quickly look at the results of Concept 2 inequality for the five countries. They are displayed in Figure 7.

Figure 7. Concept 2 (population-weighted inter-regional inequality) in the five countries

Gini



Theil



Note: Based on nominal state-level GDP per capita except for Indonesia where only real data are available.

Brazil shows the highest inequality with the Gini of about 30. As mentioned before, Concept 2 inequality sets the lower bound to inter-personal (Concept 3) inequality. This means that—were all individual within each state of Brazil to have the same incomes—overall inequality in Brazil would still be substantial. Indonesia and China have Ginis of about 25, India about 20 and the US less than 10. The ranking of the countries is unchanged throughout the period. In India and China, inequality was generally on the rise, in Indonesia and somewhat less in Brazil, on the decline. The decline for Indonesia is much clearer if we look at Theil (right-hand panel) than at the Gini. Similarly for China too, regional inequality measured by Theil exhibits a downward trend in the 1980's. There is thus—in the case of China—a difference between the results obtained using Gini and Theil, indicating that the period of the 1980s must have been

characterized by the catch-up of the poorest (population-weighted) provinces. [21] Because of the importance of China, we address more fully the issue of China's Concept 2 inequality in Annex 2. However, for India there is a strong increase in Concept 2 inequality in the period of the 1990's whether we use Gini or Theil.

We move now to decompose the change in Gini between the first and the end-year for each country. Table 6 compares Concept 2 inequality around year 1980 and in the year 2000 and shows what Concept 2 inequality would have been if the state/provincial distribution of population had remained unchanged (see column 3). The difference between the actual inequality in the year 2000 and this hypothetical inequality is due to the differential population growth rates between the states. As column 5 in Table 6 illustrates, population change has in all the countries been unequalizing, that is the change in population composition across the states/provinces has been such as to contribute to higher regional (Concept 2) inequality. The effect ranges from hardly significant at all in the United Stares and India to very substantial in Brazil, and particularly so in Indonesia. Concept 2 regional inequality in Indonesia decreased from a Gini of 30 in the first year for which we have the data (1983) to 25.4 in the year 2000. But the decline would have been even sharper, to a Gini to 22.6. had not the population change been unequalizing. The three richest provinces in 2000 (East Kalimantan, Riau and Jakarta) contained 4 percent of Indonesia's population versus only 2.8 percent in 1983; provinces with income below the median also had about 1.5 percent greater population share in 2000 than in 1983. Thus, there was some "emptying out" of the provinces with the middling level of income. Similarly, in China, population increase was above average both in the poor and populous Gansu and Yunnan as well as in the three richest entities Shanghai, Beijing and Tianjin.[22]

One has to be careful however in the interpretation of the population change. It is true, in an accounting sense, that had the composition of population by state remained

[21] This is because Theil is more sensitive than the Gini to what happens at the tails of distribution.

[22] While all-China population increased by 32 percent between 1978 and 2000, (registered) population of Shanghai increased by 52 percent, that of Beijing by 63 percent and of Tianjin by 38 percent.

the same as in the 1980's, regional inequality would have been less in all five countries. However, this takes the per capita incomes by state as given. But in a deeper sense this is wrong. This is because population might have moved in response to higher wages in richer states bringing –let us suppose—in the process the per capita income in the richer states down. Without such an equilibrating movement of labor, inequalities might have been even greater. Thus for a more meaningful analysis, we would need information on natural vs. mechanical population changes by state/province.

Table 6. Concept 2 Gini coefficients with actual and hypothetical populations and income

	(1) Actual (circa)1980 Concept 2 inequality	(2) Actual 2000 Concept 2 inequality	(3) 2000 Concept 2 inequality if population composition were as in (circa) 1980	(4) Actual change (2)-(1)	(5) Population effect (2)-(3)	(6) 2000 Concept 2 inequality if GDP per capita growth rates were the same	(7) Differential growth effect (2)-(6)	(8) Interaction term (4)-(5)-(6)
USA	6.9	8.3	8.2	+1.3	+0.1	7.2	+1.1	+0.1
China	23.9	24.4	23.8	+0.5	+0.6	24.7	-0.3	+0.2
India	14.8	18.7	18.6	+3.9	+0.1	15.0	+3.7	+0.1
Brazil	31.1	28.0	27.2	-3.1	+0.8	31.3	-3.3	+0.6
Indonesia	30.0	25.4	22.6	-4.6	+2.8	35.6	-10.2	-2.8

Note: The "circa 1980" means the first year for which the data are available: it is 1977 for the United States, 1978 for China, 1980 for India, 1985 for Brazil and 1983 for Indonesia. All Concept2 Ginis calculated from nominal data except for Indonesia.

We turn next to the contribution of differential growth rates to the change in Concept 2 inequality. Column 6 shows what would have been Concept 2 inequality in 2000 had all regions in the country grown at the same rate (and population been as it really was in 2000). Column 7 shows that different growth rates between the states/provinces added to inequality in India (+3.7 Gini points) and the United States (+1.1 point). Their impact in China was negligible, while in Brazil, and particularly in Indonesia, differential growth had a strong equalizing effect. In Indonesia, where both the population and the growth effects were the strongest, movement of population had a disequalizing effect (as provinces at both ends of income distribution increased their population shares) while differential growth has had an equalizing (convergence) effect. The latter is not a surprising result because we have already seen (Section 5) that Indonesia is the only country which exhibited strong regional convergence through almost the entire period under consideration.

The equalizing effect of differential growth rates can occur for two reasons however. First, poorer regions may grow at faster rates than the rich. This is what we studied above in Sections 4 and 5 dealing with income convergence. Second, although there may be no income convergence among the regions as such, there could be a sort of income convergence among the populous regions which, bearing in mind the importance of populous regions for Concept 2 inequality, would tend to reduce inequality. To explain: assume that populous regions are uniformly distributed across income distribution and that there is zero correlation between growth rates and initial incomes. However, within the subgroup of populous regions, correlation between initial income and growth may be negative. These regions' incomes will therefore become more clustered, and since it is them who "matter" for Concept 2 inequality, it will go down. [23]

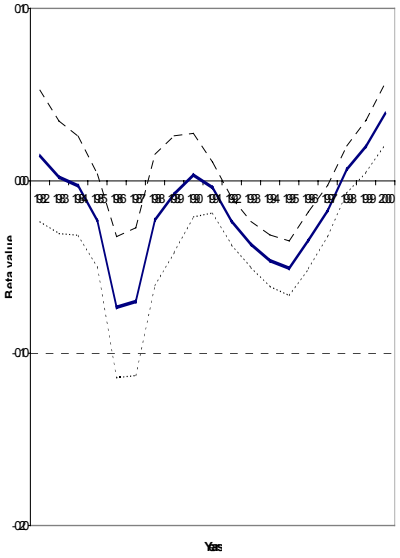
[23] Suppose that there are two rich and small regions called A and B, and two poor and populous regions called C and D. Let there be no income convergence, and let A and C grow at high positive rates, and B and D decline. Now, Concept 2 inequality will increase since the two key regions which, because of their sizes determine what happens to Concept 2 inequality, will have become dissimilar. Note that this takes place while there is neither income divergence, not a relationsahip between population size and growth—but simply income divergence between populous regions.

To check the second possibility we proceed to running regressions such as (3) but inclusive of population weights. Figure 8 shows the results; it is the equivalent of the unweighted results presented in Figure 6 above. The results are similar to those we obtained for Concept 1 convergence but are stronger in the sense that convergence or divergence episodes are less unambiguous. The clearest results are for India and Indonesia. India shows statistically significant regional divergence since the early 1990's. Indonesia, on the contrary, statistically significant regional convergence all the way to mid-1990's. Brazil too was converging in terms of population-weighted GDPs per capita until the mid-1990's. The United States has had a long period of convergence in the 1990's, and a shorter one between 1982 and 1987. Finally, for China, it is only in the five-year period ending in 1999, that we come close to having a statistically significant regional convergence. For the rest of the time, the results are inconclusive.

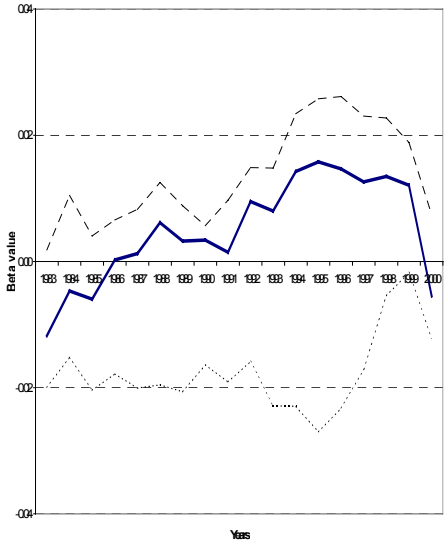
Consider now what is behind these results. As mentioned before, Concept 2 convergence or divergence is in reality a convergence or divergence within the subset of populous regions. The difference in outcomes among the most populous states is very clear in the case of India. Consider the three most populous Indian states: Uttar Pradesh (population 170 million in 1999), Bihar (107 million) and Maharashtra (95 million). Between 1990 and 1999, GDP per capita in Maharashtra that was the richest of the three states increased by 60 percent (in real terms). Meanwhile, in Bihar—which is the poorest state in India—GDP per capita remained the same. Finally, Uttar Pradesh—which has the median level of income among the states—saw its GDP per capita increase by about 15 percent. The situation is similar in China. The three largest provinces are Sichuan (population 114 million in 2000), Henan (92 million) and Shandong (91 million). During the decade of the nineties, Shandong which was the richest of the three in 1990 had its real GDP per capita triple. Henan's GDP per capita increased by 2½ times, and Sichuan's (which was the poorest of the three provinces) doubled. And then consider, in contrast, the three most populous Indonesian provinces: West Java (36 million in 2000), East Java (35 million) and central Java (31 million). Their GDPs per capita in 1983 were fairly close to each other and, taking the richest as the numeraire, could be written as 1, 0.97 and 0.74. In 2000, they were even more clustered at 1, 0.93 and 0.84.

Figure 8. Unconditional β regional population-weighted convergence or divergence
(β coefficient with the 95 confidence interval)

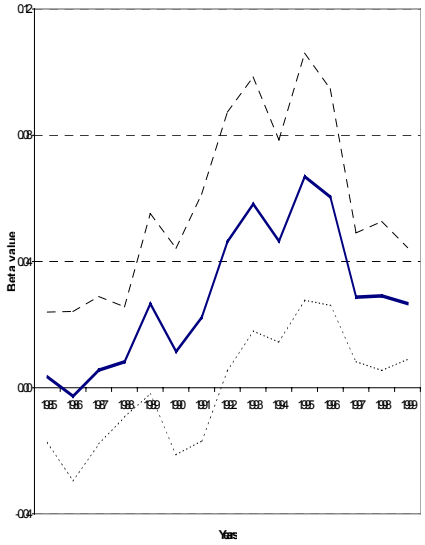
United States



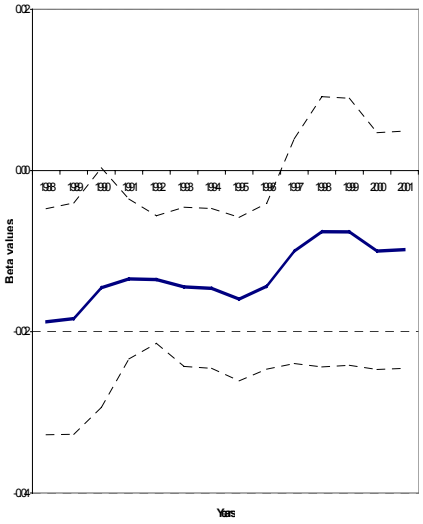
China



India



Indonesia



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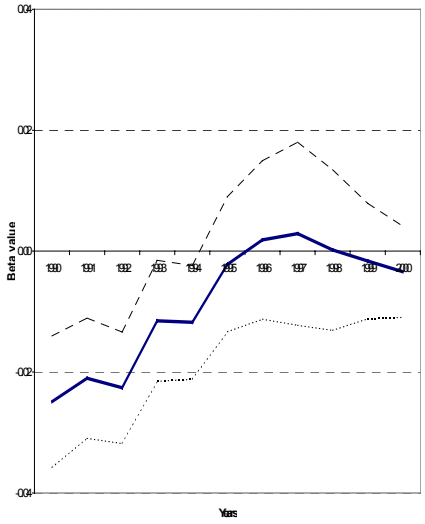

7. How to explain changes in inter-regional inequality?

As we have seen, levels of inter-regional inequality are quite different in the five countries. Indonesia and Brazil have the highest level of inequality. They are followed by China. India is in the middle but is the only country showing a consistent increase in inter-regional inequality while the United States displays the most uniform levels of GDP per capita between its components. We shall try to explain within-national convergence or divergence in more general terms, that is by looking at the variables of interest that might add or reduce inter-regional inequalities. These variables are not easy to identify in general because of countries' specificities. Thus, for example, the same overall growth rate might produce regional divergence in one case, and regional convergence in another depending on what drives growth. When growth is narrow-based as in case of oil production, the differences between regions (oil-rich and the rest) are likely to increase. When growth is broad-based, or is fuelled by agricultural growth (as in the case of China during the early liberalization), growth can be expected to help convergence as poorer (and agricultural) regions catch up with rich regions. The general presumption—as we have seen from Williamson's (1965) hypothesis—is that growth will tend to be regionally disequalizing (even if ultimately higher income may be associated with lower inequalities). We may thus expect growth rate to be positively related to regional inequality. It is also a finding obtained by Petrakos et al . (2003) in their study of regional inequality in the European Union. The same results are further reported in the case of Indonesia by Akita and Kawamura (2002, p.12) who find that the period of fast growth between 1993 and 1996 was associated with a slightly increasing Concept 2 inequality while the crisis led to a decline in regional inequality (p.16).[24] In a long-run 1939-95 study of Brazil's regional inequality Azzoni (2001, p. 144) finds the same relationship.

Similarly, the effect of greater openness (trade to GDP ratio) may be ambiguous. Openness can help the already rich regions, or can create income gaps where none existed. But it can also help poorer regions whose output (e.g. agricultural goods) was

[24] These results differ from those reported above in Figure 7 and are based on a much more detailed partitioning than ours. Akira and Kawamura had access to the GDPs per capita data from about 300 disctricts vs. our results which are based on the data from 26 provinces.

artificially held down through price controls. On the other hand, one can argue that there may be certain policies associated with globalization whose effects are less likely to be ambivalent. They include policies of financial liberalization and higher interest rate that tend to favor rich households. To the extent that rich people are concentrated in certain areas, such policies will increase spatial inequality. As for the empirical results, they span the entire gamut. Kanbur and Zhang (2003) find that openness was associated with rising inequality in China. Zhang and Zhang (2003) similarly decompose Concept 1 inequality between China's states and find that about 20 percent of differences in provincial GDPs per capita can be ascribed to differences in trade shares (p. 57).[25] Petrakos et al. (2002, p. 19) however find that openness (defined as regional integration within the European Union[26]) did not have a uniform impact on all EU countries: in some it was associated with greater regional inequality, in others by smaller, and in some had no statistically significant effect at all. Wei and Wu (2001) using urban/rural ratios of mean income for more than 100 cities and their adjoining areas in China find that in the period 1988-93 increased openness tended to reduce the urban/rural ratio. Since urban/rural differences are perhaps the principal explanation for regional inequality in China (see Annex 2), increased openness would seem to reduce regional inequality.

Visual inspection of Figure 9 which displays the relationship between openness and Concept 1 inequality shows that all of our five countries (with the exception of Indonesia), have, as we would expect, relatively low openness. The graph also shows that in China, increased openness was not associated with increased regional inequality while, on the contrary, in India, this seems to be clearly the case. At the other extreme is Indonesia where increased openness was associated with a decrease in regional inequality. Finally in Brazil and the United States, there was no apparent relationship between openness and regional inequality. The conclusion is that the country experiences differ and that openness as such may not have the same discernable effects on countries

[25] Their approach is interesting because they run production functions of the same form for all provinces. One of the arguments in the production function is trade ratio (in addition to education, domestic and foreign capital accumulation etc.) Then log variance of GDPs per capita is decomposed and the regression coefficients times the covariance between income and each argument gives an estimate of that particular argument's contribution to inter-provincial income inequality.

regardless of their level of development, type of economic institutions, and other macro economic policies.

A somewhat different picture however emerges when we look at the relationship between Concept 2 inequality and openness (Figure 10). It is now very clear that in both China and India, increased openness was associated with greater regional inequality. In Indonesia, the relationship is the opposite and in Brazil and the US the correlations seems non-existent.

[26] And measured as share of European trade in country's total trade.

Figure 9. The relationship between openness and Concept 1 inequality

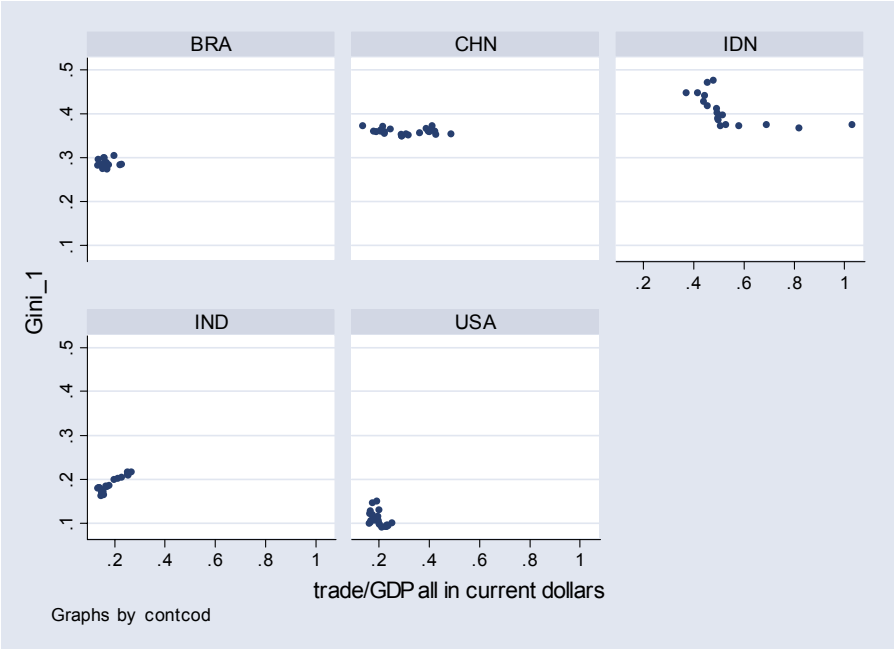

Figure 10. The relationship between openness and Concept 2 inequality

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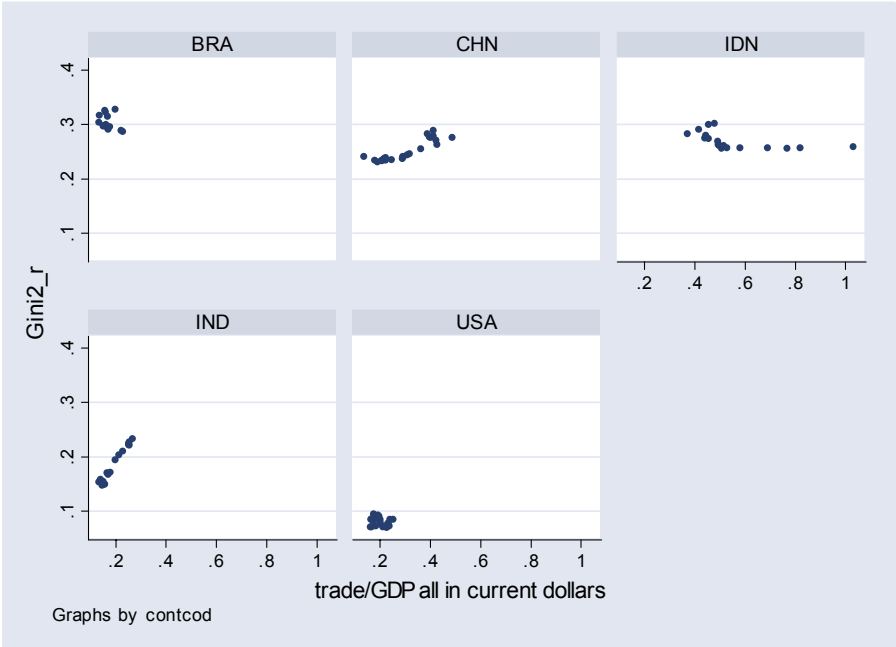


We then run the following fixed-effect panel regressions for both Gini1 and Gini2, and Theil1 and Theil2:

$$G/T_{it} = \beta_0 + \beta_1 ROG_i t + \beta_2 \ln GDP_{it} + \beta_3 OPEN_i t + \beta_4 RINT_i t + \beta_5 INFL_i t + u_{it} \qquad (4)$$

where *i* denotes country, *t* = year, and G = Gini coefficient, T = Theil index, ROG = real annual rate of growth of per capita GDP, GDP = level of GDP per capita (expressed in logs), RINT = real interest rate (on deposits) in percent per annum, INFL = the average annual rate of inflation proxied by the change in consumer price index. It is an unbalanced panel since the number of observations for each country is not the same (e.g. for China we have the data for the 1978-2000 period, but for Indonesia only for 1983 to 2001). Since there are certainly fixed country-specific effects for which we cannot control, we use the fixed effects model. It is unlikely that regional inequality would have much of a reverse effect on our RHS variables, so we do not instrument.

The results of regression (4) are shown in Table 7. We show the results for Gini1 and Theil1 calculated from real values, and Gini2 and Theil2 from nominal values. There are substantive reasons for this. Concept 1 deals with the issue of poor regions' or countries' catch-up, that is of whether poor countries or regions experience faster real growth. Then, an index of inequality based on differences in real incomes between the regions is appropriate. Concept 2 however approximates the actual inequality between individuals (note that it is no longer regions, but individuals that are de facto units of observations even if we lack their incomes). Hence it is the difference in nominal incomes within a nation at a point in time which reflects this inequality.

Regarding Concept 1 inequality, the results show that (for Theil) both level of income and openness enter negatively, that is are associated with reduction in inter-regional income differences. Contrary to several other studies, we do not find evidence that higher rate of growth has a disequalizing effect on regional incomes. Moreover, if we use the Gini coefficient, no variable is statistically significant and the quality of results is

weak. The situation is different when we move to the determinants of Concept 2 regional inequality. There, according to both Gini and Theil, openness is shown to result in greater regional inequality. For example, a ten GDP point increase in the trade/GDP ratio is associated with an inequality increase of 1.8 Gini points. This is not negligible. Similarly, higher inflation and higher real interest rate are both associated with greater regional (population-weighted) inequality. Doubling of inflation increases the inter-regional Gini 0.6 points. The quality of the Concept 2 regressions is also much better: the withn-R^2 is slightly above 0.5. In conclusion, regional inequality seems to rise in response to high inflation, high real interest rates, and high openness. None of that is very surprising. Trade tends to be regionally concentrated; so are assets (held by people in wealthy regions) and an increase in the rate of return on those assets increases regional disparities too. Finally, high inflation due to variability in real prices which it entails and differences in regional product mixes will tend to influence incomes of different regions differently. What is interesting however is that there is again no evidence that higher growth is unequalizing.

Table 7. Determinants of regional inequality

	Gini1	Theil1	Gini2	Theil2
ROG	-0.006 (0.93)	0.002 (0.98)	-0.041 (0.53)	0.006 (0.88)
(ln) GDP per capita	-0.009 (0.56)	-0.039 (0.05)*	0.022 (0.25)	0.001 (0.96)
Openness	-0.064 (0.08)	-0.113 (0.02)*	0.181 (0.03)*	0.139 (0.01)**
(ln) Inflation	0.0004 (0.85)	-0.002 (0.48)	0.006 (0.001)**	0.003 (0.001)**
Real interest	-0.008 (0.90)	0.011 (0.89)	0.057 (0.26)	0.063 (0.05)*
Constant	0.343** (0.01)	0.516** (0.00)	-0.062 (0.68)	0.018 (0.86)
R^2 within	0.13	0.32	0.51	0.5
F	2.3 (0.05)	7.1 (0.00)	12.2 (0.000)	11.6 (0.00)
No. of observations	84	84	68	68

Note: p values between brackets. Coefficients significant at 5 percent or less are shaded. Real interest = real annual rate of interest in percent pa. divided by 1000. Inflation = ln (1+annual inflation rate in percent). Openness = trade/GDP (in nominal US dollars). GDP per capita = ln GDP per capita in 1995 international dollars. ROG = annual rate of growth of GDP per capita (expressed in fractions, e.g. 3 percent is 0.03). Gini and Theil in percent. Gini2 and Theil2 regressions do not include Indonesia for which we do not have nominal regional GDP per capita data. Gini and Theil are expressed as ratios. All regressions are fixed effect.

8. Conclusions

India and Indonesia bracket the changes. India, in the decade of the 1990's displays consistently increasing regional inequality of both Concept 1 and 2 types—whether it is measured by the Gini or by the Theil index. The largest states (Maharashtra, Uttar Pradesh and Bihar) are strongly diverging in their incomes, and generally richer states have registered faster growth. There was similarly income divergence among the populous states. On the other end of the spectrum is Indonesia where regional income convergence was almost uninterrupted between 1983 and the Asian crisis, and so was the reduction in Concept 2 inequality. Yet, one has to keep in mind that India still has the lowest Concept 1 and 2 inequality of any country considered here save for the United States while Indonesia is the most unequal of the five countries in both types of measures.[27] Thus, the "positive" evolution in Indonesia and the "negative" one in India need to be qualified.

Indonesia, Brazil and China also show some emptying out of the middle-income level provinces—and an increase in the population shares living in either rich or poor provinces/states.

China, a country on which most studies of regional inequality have been written, displays strong regional income convergence during the 1980's which coincides with the period of pro-poor agricultural reforms. This process of Concept 1 convergence comes to an end in the 1990's with provincial mean incomes growing at relatively similar rates since. Despite Concept 1 stability, Concept 2 inequality has increased in the 1990's almost as much as in India while its level is throughout greater. The increase in Concept 2 inequality was driven by the income divergence in the second half of the 1990's between several populous provinces. Again, while in India, there is a contrast between Maharashtra and Bihar, in China, the contrast is between Shandong and Sichuan. In that sense China and India do display similar changes in the last decade: while Concept 1 Ginis have only moderately increased (indicating only a slight regional income

[27] Except for Brazil according to Concept 2 Gini.

divergence) Concept 2 inequalities have gone up by much more driven by unevenness in outcomes for the large states or provinces.

The United States, despite being regionally most homogeneous, has generally displayed tendency toward income convergence according to both inequality concepts.

Brazil shows least consistent change. There is only a slight change in both Concept 1 and Concept 2 inequality, but it is overshadowed by a cyclical effect of inflation. It is therefore difficult to see whether there is any trend. However, Brazil has the highest Concept 2 Gini inequality. To see how large that inequality is, one need simply realize that were all incomes within each province absolutely equally distributed, Brazil's overall Gini would still be around 30, a moderate nation-wide inequality level.

For all countries as a whole, we find that greater openness (trade/GDP ratio) is associated with lower inter-regional inequality when measured by Concept 1 and higher inter-regional inequality when measured by Concept 2. This means that openness might help growth of poorer regions within each individual country (that is, help convergence) but at the same time might lead to a divergence in outcomes among the most populous regions. Some of them may pull ahead, others fall back, and this in turn raises regional (and possibly inter-personal) inequality. At the national level, we thus detect a process directly opposite to the one noticed for the world as a whole where Concept 1 inequality has increased during the last quarter of century (as poor countries have tended to lag in growth rates behind the rich), while Concept 2 inequality has gone down driven by exceptional performances of China and India. Finally, we also find that regional inequality (Concept 2) is increased by high inflation and high real interest rates—none of which is surprising.

The difference in the effect of openness on two kinds of inequality (Concept 1 and 2) is interesting first, because it shows us that—within countries—openness seems to help the process of poor regions' catch-up. But on the other hand, it suggests the presence of a more complicated story where either populous regions diverge among themselves or

people move out of the regions with middling levels of income (some perhaps migrating to richer regions while those in the poor regions remain stuck there) thus emptying out the middle and contributing to higher regional population-weighted inequality. Because the latter provides a better approximation to actual regional inequality than Concept 2 as well as to how people perceive horizontal inequity, the link between greater openness and greater inequality may, despite convergence in Concept 1, be deemed stronger both in actual fact and in popular perception.

Global inequality changes and inequality changes in the five most populous countries in the world during the last two decades have indeed been quite dramatic but also extremely complex. Note the following facts. While at the level of these countries, we find some evidence for the narrowing of (unweighted) inter-regional income differences, Concept 2 inequality however tended to rise in the two most important countries (India and China). But at the global level, a process directly opposite to the one at the national level was simultaneously taking place. It consisted of widening income differences between the countries and a reduction in Concept 2 inequality thanks mostly to China's phenomenal growth. Even without addressing the most difficult task of measurement of inter-personal inequality at the global level, one can easily see how contradictory are recent changes in different facets of inequality and how inadequate are simple answers regarding both the direction of change and even more so regarding the causality. In other words, when we ask a question as apparently simple as "what was a change in inequality in X", we need to define very carefully what we mean by inequality since its different versions may easily move in the opposite directions.

Annex 1. Administrative organization of the five countries and data coverage

China

China is officially administratively divided into 34 regional units: 23 provinces (including Taiwan that the Chinese government considers as its province), 2 special administrative regions (Hong Kong and Macau), 5 autonomous regions (Guangxi, Inner Mongolia, Ningxia, Xinjiang and Tibet) and 4 municipalities (Beijing, Shanghai, Tianjin and Chongqing). The autonomous regions differ from the rest because of the presence of significant non-Han minorities in them. We are not including in the analysis Taiwan since it is a disputed region, and Hong Kong and Macau because the GDP data for them are not shown together with other regions. In addition, Chongqing acquired the status of a separate unit (municipality) only in 1997 and in our data is included together with Sichuan. This therefore gives us 30 regional units which for simplicity we call "provinces." Out of these thirty, full data sets (both nominal and real GDPs) are available for 27 provinces which represent 99 percent of Chinese population (not counting Taiwan and Hong Kong). For two provinces (Qinghai and Hainan), nominal GDP is available from 1985 onwards. [28] Hence in calculations with nominal values, 29 provinces are included. Finally, for Tibet neither real nor nominal GDP data are available.

A note is in order regarding Chinese GDP data. As is well known, all-China GDP data are the subject of a long academic dispute. There are many views (Maddison, 2003, p. 151; Maddison, 1998; Heston, 2001) that Chinese official statistics exaggerate the level and rate of growth of the economy. While we tend to believe that these authors do have a point and that the total GDP correction does make sense, the only source of *regional* Chinese statistics is the official State Statistics Bureau. We thus use official regional and nation-wide statistics for the entire 1978-2001 period. But another problem then becomes apparent. Until 1994, the sum of provincial GDPs is approximately equal

[28] Hainan became a separate province in 1988. Previously it was part of Guangdong province.

to the official value of the nation-wide GDP. The discrepancy is within a very narrow range of 1-2 percentage points possibly due to the mistakes of classification. But after 1994, the sum of provincial GDPs is systematically greater (up to 15 percent) than the nation-wide GDP. It is unclear what the source of this large discrepancy is. We have no choice but to use the official regional data even if they are overestimated. Since we study inter-regional inequality, so long as the data are about equally overestimated for all provinces, there will be no bias in our measures of inter-regional inequality.

India

India was until the year 2000 administratively divided into 25 states and 7 Union territories. The Union territories are very small with the exception of the federal capital of Delhi. In total they account for about 11 million people or a little over 1 percent of total population (in the 1991 census). Out of 25 states, we have GDP per capita data for 14 states. These are the largest states comprising 92 percent of total Indian population in 2000. Of the states for which we do not have the data, the largest are Assam, and Jammu and Kashmir (respectively 23 and 8 million according to the 1991 census). The disputed parts of Kashmir are also omitted from the analysis (the data for them are included in Chinese and Pakistani statistics).

In 2000, three new states were created. They are Uttaranchal or Uttarkhand (population of 4 million), carved out of Uttar Pradesh (170 million before the split), Jharkhand (population of 15 million) carved out of Bihar (107 million before the split), and Chhattisgargh (population of 19 million) carved out of Madhya Pradesh (79 million before the split). All three are based on ethnic distinctiveness from their "mother" states. In our data for 2000, these states are included as part of their "mother" states.

United States

United States is administratively divided in 50 states and 1 federal district (the federal capital of Washington). United States also controls some 12 Commonwealths and territories out of which Puerto Rico is the largest (3.7 million people). Our data cover the

50 states and the District of Columbia. However, the latter, due to its peculiarities,[29] is not included in the analysis which thus bears only on the 50 federal units. Since District's population is only about 600,000 people, our coverage of the United States is almost complete.

Brazil

Brazil is administratively divided in 26 states and 1 federal district (the federal capital of Brasilia). Our data include all states with the exception of Tocantins for the years 1985-88. The federal district of Brasilia (population 2 million) is not included. Thus the population coverage is about 99 percent. [30]

Indonesia

Indonesia is administratively divided in 26 provinces. Before East Timor's independence in 1999, there were 27 provinces. The data for East Timor are available for the entire period during which it was an Indonesian province, but for the reasons of comparability, we have omitted it from our calculations throughout the entire period. The population coverage of Indonesia is thus 100 percent.

[29] For example, District's GDP per capita is unrealistically high, at more than $PPP 90,000. This is due to the fact that many businesses are registered in the District while people who work or own them live just outside the borders of the District.

[30] The state level value added data for Brazil (available at Instituto Braseleiro de Geografia e Estatistrica, http://www.ibge.gov.br/english/estatistica/economia/contasregionais/default.shtm) display some of the same problems as in China. The sum of state value added in some years (in the second half of the 1980's) exceeds the Brazil-wide GDP by a few percentage points, while in the more recent years, its sum falls short by as much as 10 percentage points of the official Brazil's total GDP. However, part of that difference may be expained by the fact that state data do not include the federal territory of Brasilia.

Annex 2. Regional inequality in China

China at the end of the 20th century: different regional inequality break-downs
(Concept 2 inequality throughout)

	Akira and Kawamura (2002)	Kanbur and Zhang (2003)	Modified Kanbur and Zhang (2003)	Bhalla, Yao and Zhang (2003)	Milanovic (here)
Year	1998	2000	2000	1995	2000
Welfare concept	GDP per capita	Mean real per capita consumption 1/	Mean real per capita consumption 1/	Mean real per capita consumption 2/	GDP per capita
Smallest unit with data	District level GDP per capita	Rural/urban	Rural/urban	Rural/urban (=peasant/non-peasant)	Provincial GDP per capita
Aggregation	By province (26) and by regions (3)	By province (28)	By province (28)	By province (28)	---
Total number of observations (per year)	335	56	56	56	29
Concept 2 Theil 3/	24.9	24.8	24.8	13.9	10.4
(which Theil?)	Theil (1)	Theil (0)	Theil(0)	Theil (1)	Theil (1)
Between 3 large regions	6.6 (27)				
Between provinces (within each region)	2.8 (11)				
Between 28 provinces alone	9.4 (38)		10.9 (44)	11.0	10.4 (100)
Within provinces (between districts)	15.6 (62)				
Within provinces (between rural and urban)			13.9 (56)		
Between overall rural and urban mean		13.9 (56)		10.4 (75)	
Within rural areas, and within urban areas		10.9 (44)		6.1 (25)	
Within rural areas				3.8 (21)	
Within urban areas				2.3 (4)	
Concept 2 Gini 3/	n.a.	37.2	n.a.	n.a.	24.4

Sources: Takahiro and Kawamura (2002, Table 1, p. 26). Kanbur and Zhang (2003, Table 2, p. 27). Bhalla, Yao and Zhang (2003, Table 2, p. 947).

Modified Kanbur Zhang consists of taking Kanbur and Zhang data and applying somewhat different partitions (for explanation, see the text below).

1/ In 1983 prices. 2/ In 1990 prices, using provincial price deflators. 3/ Based on the most detailed partition used in the paper, e.g. 335 observations in Akira and Kawamura paper etc.

Note: Theil (1) is Theil entropy index. Theil (0) is mean log deviation index. The definitions are:

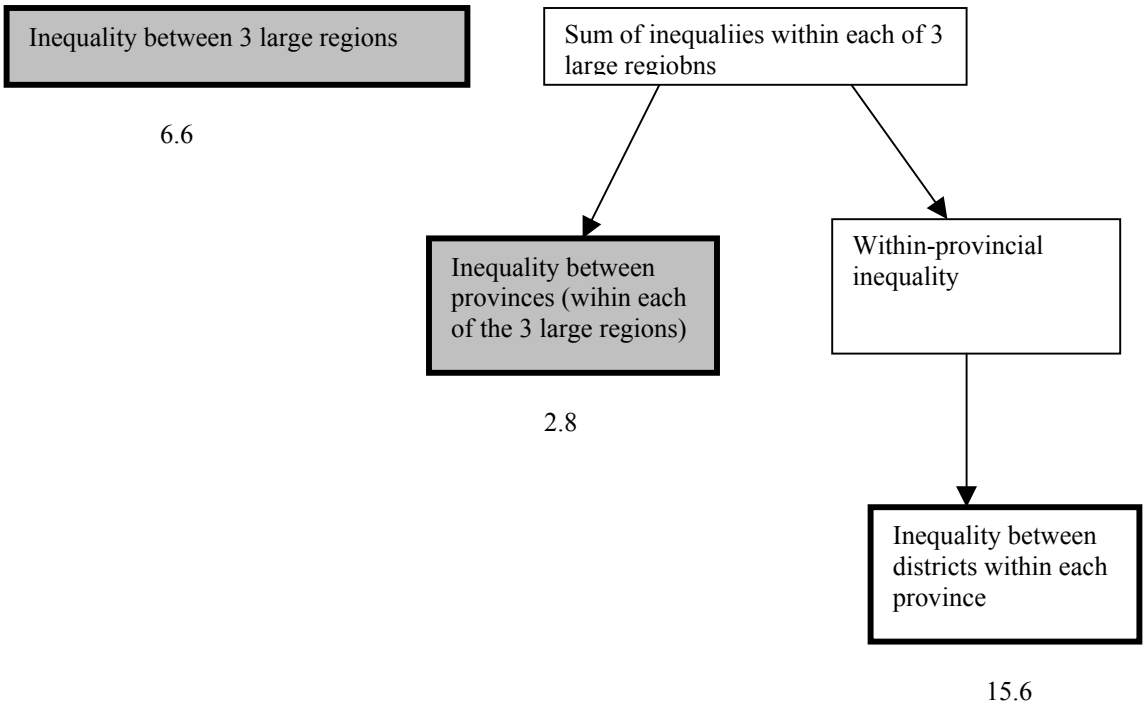
$$Theil\_1 = \sum_{i=1}^{n} p_i \frac{y_i}{\mu} \log \frac{y_i}{\mu}$$

$$Theil\_0 = \sum_{i=1}^{n} p_i \log \frac{\mu}{y_i}$$

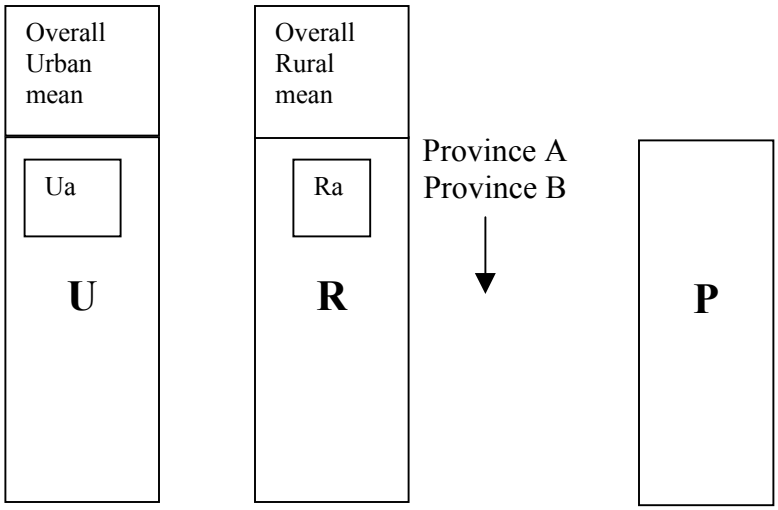
Note: The Kanbur and Zhang (2003) and Bhalla, Yao and Zhang (2003) results should be very similar since their welfare concepts and the aggregations/partitions are practically the same. And indeed, for the year 1995 (last year in Bhalla et al.) Kanbur and Zhang report a Concept 2 Theil of 17.7 while Bhalla et. al. have obtain a Theil of 16.5 (see the results in the Table here). However, inexplicably, in their paper Bhalla et. all (Table 2, p. 947) show the total Concept 2 Theil of 13.87 while the sum of the three element into which the Theil is decomposed yields 16.54. I think that the latter amount is correct.

The decomposition rules can be also presented graphically. In the Akita and Kawamura (2002) paper, total inequality is the sum of three inequalities given in "bolded" boxes with their respective values in the year 2000 given underneath the boxes. We can now easily see that provinces *within* each of the three large regions are fairly homogeneous (in terms of per capita income) and that the bulk of inequality is concentrated at the provincial level (differences in incomes between districts) and between the three large regions (East, Central, West)

China =



Kanbur and Zhang (2003) decomposition has three components:

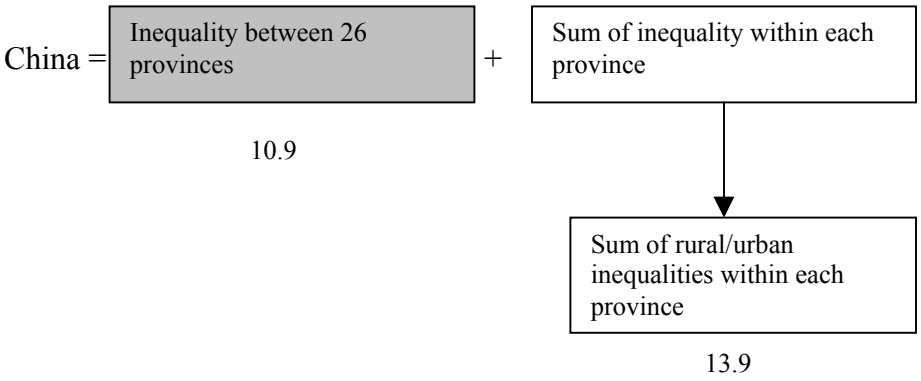


(1) Difference between the overall rural and urban mean, (2) inequality within the urban means (area **U**), and (3) inequality within the rural means (area **R**). The component (1) is equal to 13.9 Theil points, the sum of components (2) and (3) is equal to 10.9 Theil points.

A modified Kanbur-Zhang (K-Zh) decomposition which we use here is to break inequality by provinces. Then, the component (1) is inequality between all provincial (total) means, and the component (2) is the sum of all inequalities between provincial rural and urban means, that is inequality between Ua and Ra, plus inequality between Ub and Rb and so forth. The component (1) amounts to 10.9 Theil points, [31] the sum of rural-to-urban inequalities within provinces amounts to 13.9 Theil points.

[31] Note that because of Theil's exact decomposition property, inequality among Ps must be equal to inequality among U's plus inequality among R's, that is the sum of Kanbur and Zhang's components (2) and (3) must be equal to our component (1).

The results of the modified Kanbur and Zhang (K-Zh) decomposition can then be represented as



These two decompositions suggest the following. First, note that the sum of two shaded boxes in the Akura and Kawamura (AK) decomposition equals (by definition) the shaded box in the modified Kanbur and Zhang decomposition.[32] But while for Akira and Kawamura, the importance of the two shaded boxes adds to 9.4 Theil points, the shaded box in the (modified) Kanbur and Zhang decomposition amounts to 10.9 Theil points. The difference must be due to the use GDP per capita in one study vs. expenditure per capita from household surveys in another.

Second, from the Akira and Kawamura decomposition, we can conclude that most of regional inequality in China is found between the three large regions and within provinces (in other words, provinces contain districts with fairly unequal average incomes). But, the Kanbur and Zhang decomposition suggests that these districts are not random, that is they are not randomly poor or rich. The main line of differentiation goes between rural and urban areas. For while AK decomposition shows that inequality between districts (within all provinces) equals 15.6 Theil points, the K-Zh decomposition

[32] This must be true for Theil (which both authors use) because of its decomposability.

shows that 13.9 out of these 15.6 Theil points is due to the differences between mean rural and mean urban incomes.[33]

Thus, in conclusion, we can say that if we break China into a very fine regional partition, about 40 percent of thus calculated Concept 2 inequality is due to differences in incomes between provinces. The bulk of the remaining 60 percent is due to the differences in mean urban and rural income within provinces.

[33] Abstracting from the fact that the things are not fully comparable because A-K use GDP per capita while K-Zh use household survey data.

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