On the other hand, in the same decades most countries of the periphery managed to achieve a sharp increase in literacy (and some other important indicators of the human capital development), which, on the one hand, stimulated the GDP growth, and, on the other hand, contributed to a very significant decrease of fertility and population growth rates. As a result, in the early 1970s the per capita GDP growth caught up with the ones in the core, and since the late 1980s the average GDP growth of the periphery began to exceed more and more the one of the core. As a result the relative gap between the per capita GDP of the core and periphery began to decrease.

Note that the slowdown of economic growth rates in the core and the acceleration of growth rates in the periphery were accompanied (and to a considerable extent were caused) by the following processes-trends: 1*a*) the decrease of the share of investments in the GDP of the core (since the early 1970s); 1*b*) the increase in the share of investments in the GDP of the periphery (since the early 1990s); 2*a*) the decrease of the macroeconomic effectiveness of the investments[7] for the core (since the late 1960s); 2*b*) the increase in the macroeconomic effectiveness of the World System periphery (since the early 1990s) (see Figs 6 and 7).

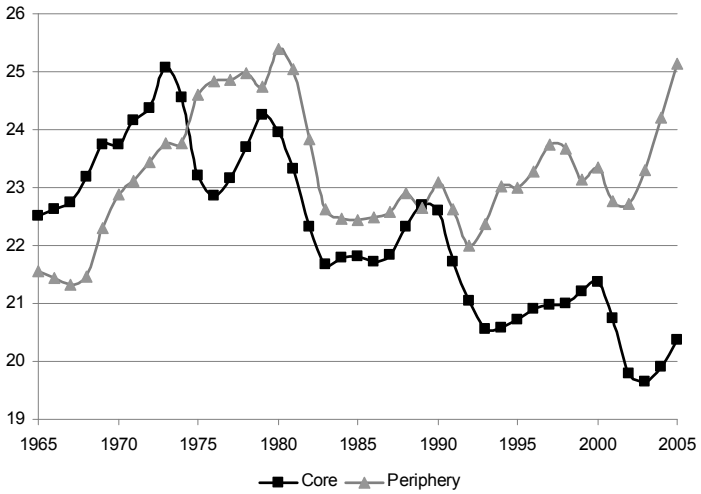

Fig. 6. Dynamics of the share of investments in the GDP of the core and periphery, %, 1965–2005

Note: The World System core was identified for the calculations presented in this diagram with the high-income OECD countries, whereas the World System periphery was identified with the rest of the world.
Source: Malkov *et al.* 2010: 240, Fig. 6. *Data source for the calculations*: World Bank 2010. Seven-year moving averages (with consecutive decrease of the smoothing window at the edges).

Thus, the results of our previous research suggested the presence of semi-unconditional divergence between 1800 and the late 1960s, the situation of the absence of either salient unconditional divergence or unconditional convergence for the 1970s and 1980s, and the presence of semi-unconditional convergence for the 1990s and 2000s.

Fig. 7. Dynamics of the effectiveness of investments in the GDP of the core and periphery, 1965–2005

Note: The World System core was identified for the calculations presented in this diagram with the high-income OECD countries, whereas the World System periphery was identified with the rest of the world.
Source: Malkov *et al.* 2010: 242, Fig. 8. *Data source for the calculations*: World Bank 2010. Seven-year moving averages (with consecutive decrease of the smoothing window at the edges).

Note that most empirical tests of unconditional convergence hypothesis have been carried out on the basis of the data for the 1970s and 1980s (where we would not expect to find any unconditional convergence anyway) (see, *e.g.*, Barro 1991; Mankiw, Romer, and Weil 1992; Sala-i-Martin 1996; Bianchi 1997; Lee, Pesaran, and Smith 1997), or on the basis of such datasets where the post-1990 convergence phase was counterbalanced by earlier divergence periods (see, *e.g.*, Sachs *et al.* 1995; Acemoglu 2009). In addition, in the early 1990s the overall convergence pattern was strongly obscured by the very low (and quite often negative) per capita GDP growth rates in the post-communist economies of Eastern Europe and the former Soviet Union that were at that time in the arduous phase of transition to the market economy. Hence, as we would expect, those tests did not find any unconditional convergence. Naturally, datasets with heavy presence of the pre-1970s data rather suggested the presence of the divergence pattern.

Against this background we expected to find clear evidence for the general divergence pattern for the 1950s and 1960s, and the presence of the general convergence pattern for 1998–2008.

5. Tests

We first operationalized this hypothesis in the following way. We expected that in the 1950s and 1960s the low-income countries of 1950[8] should have had significantly *lower* per capita GDP growth rates than the middle- and high-income countries of 1950[9]; whereas in 1998–2008 the low-income countries of 1998[10] should have had significantly *higher* per capita GDP growth rates than the middle- and high-income countries of 1998.[11]

The test has provided unequivocally positive results (see Table 1).

Table 1

Comparison between per capita GDP growth rates in low-income *vs.* middle- and high-income countries in 1950–1970 and in 1998–2008

1950–1970									
	GDP in 1950	Population in 1950	Per capita GDP in 1950	GDP in 1970	Population in 1970	Per capita GDP in 1970	Average annual GDP growth rate in 1950–1970	Average annual population growth rate in 1950–1970	Average annual per capita GDP growth rate in 1950–1970
Low-income countries	$1127 bln	1819.7 mln	$619	$2937 bln	2756.4 mln	$1065	4.91 %	2.10 %	**2.75 %**
Middle- and high-income countries	$3696 bln	735.3 mln	$5025	$9465 bln	966.4 mln	$9794	4.82 %	1.38 %	**3.39 %**
1998–2008									
	GDP in 1998	Population in 1998	Per capita GDP in 1998	GDP in 2008	Population in 2008	Per capita GDP in 2008	Average annual GDP growth rate in 1950–1970	Average annual population growth rate in 1950–1970	Average annual per capita GDP growth rate in 1998–2008
Low-income countries	$10,252 bln	4372 mln	$2345	$20,398 bln	5013 mln	$4069	7.12 %	1.38 %	**5.67 %**
Middle- and high-income countries	$23,770 bln	1585 mln	$14997	$30,904 bln	1717 mln	$17,995	2.66 %	0.81 %	**1.84 %**

Note: After Maddison GDP is measured in 1990 international dollars, PPP.
Data source: Maddison 2010.

As we see, in the 1950s and 1960s (apparently belonging to the 'divergence era') the average per capita GDP growth rates among the high- and middle-income countries were significantly higher than among the low-income countries, whereas in 1998–2008 the average per capita GDP growth rates among the low-income countries exceeded by far the ones of the high- and middle-income countries.

At the next stage, we operationalized the divergence/convergence hypothesis in another (and rather frequently applied) way – correlating the per capita GDP at the start of a certain period with the average per capita GDP growth rates during the respective pe-

riod (whereas a significant negative correlation among the countries of the world is interpreted as evidence for unconditional convergence, a significant positive one is regarded as evidence for unconditional divergence, and the absence of any significant correlation is interpreted as evidence for absence of either unconditional convergence, or unconditional divergence).

Actually, our first tests looked to be congruent with the findings of the earlier mainstream students of convergence who insist on the absence of unconditional convergence (which imply that the overall relative gap between the poor and rich countries remains pretty stable). Indeed these tests confirmed the absence of any significant unconditional convergence in 1998–2008 (see Figs 8–9).

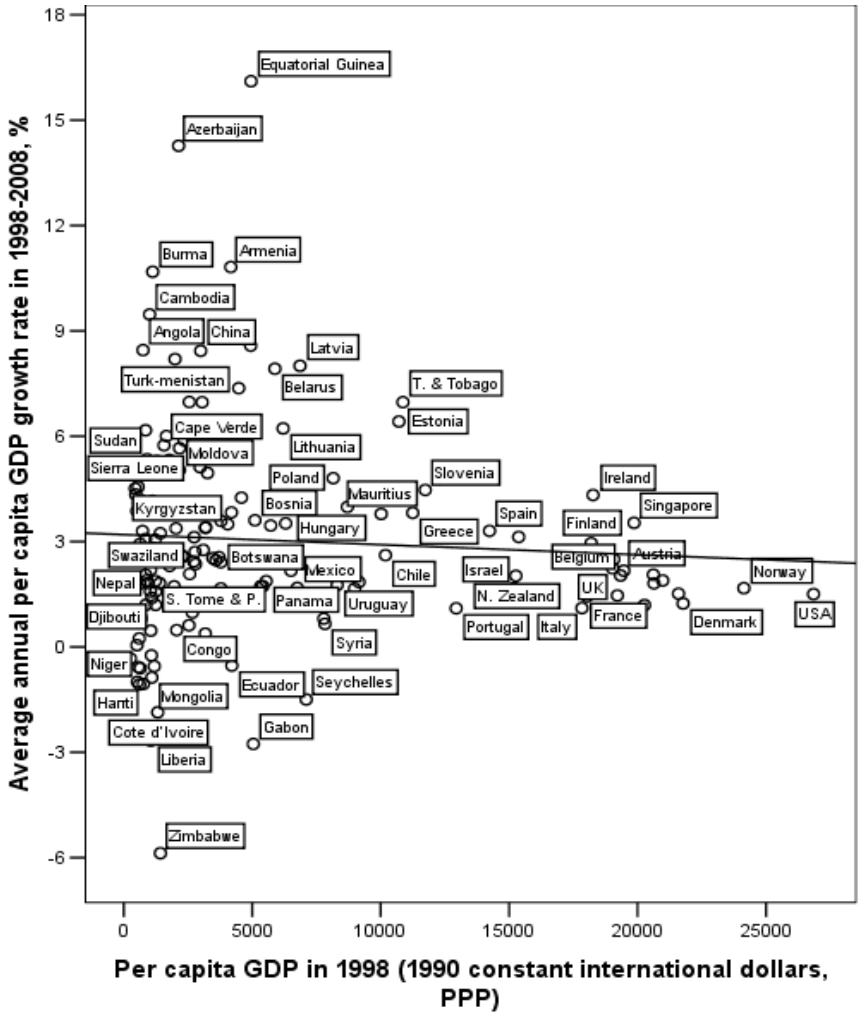

Fig. 8. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For all countries of the world (Maddison 2010 dataset). Scatterplot with fitted regression line

Note: $r = -0.062$, $p = 0.45$. *Source:* Maddison 2010.

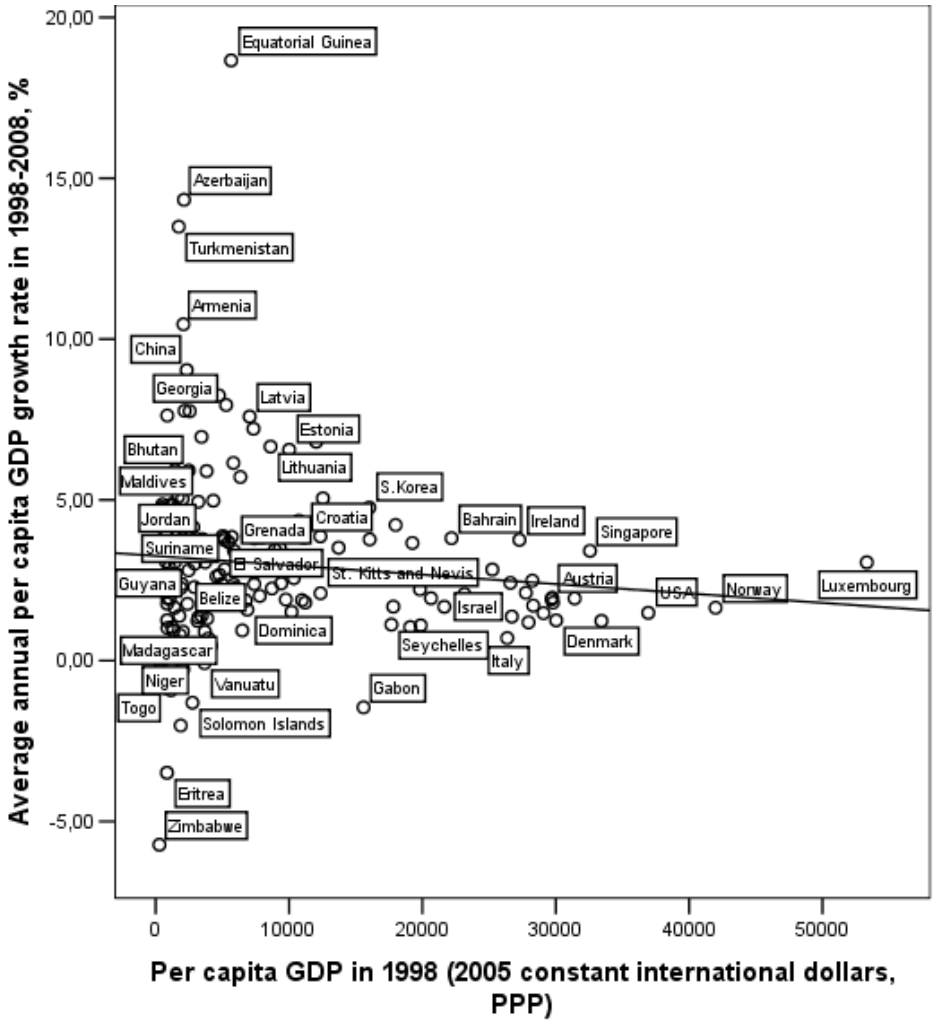

Fig. 9. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For all countries of the world (World Bank 2010 dataset). Scatterplot with fitted regression line

Note: $r = -0.101$, $p = 0.191$. *Source:* World Bank 2010.

As we see, in both cases the correlation is in the predicted direction – it is negative, which should apparently indicate just unconditional convergence; but in both cases this correlation is very weak and totally insignificant, which should, at the face of it, indicate that the unconditional convergence hypothesis has been rejected once again.

What is more, the test did not confirm the presence of unconditional divergence in 1950–1970 either (see Fig. 10).[12]

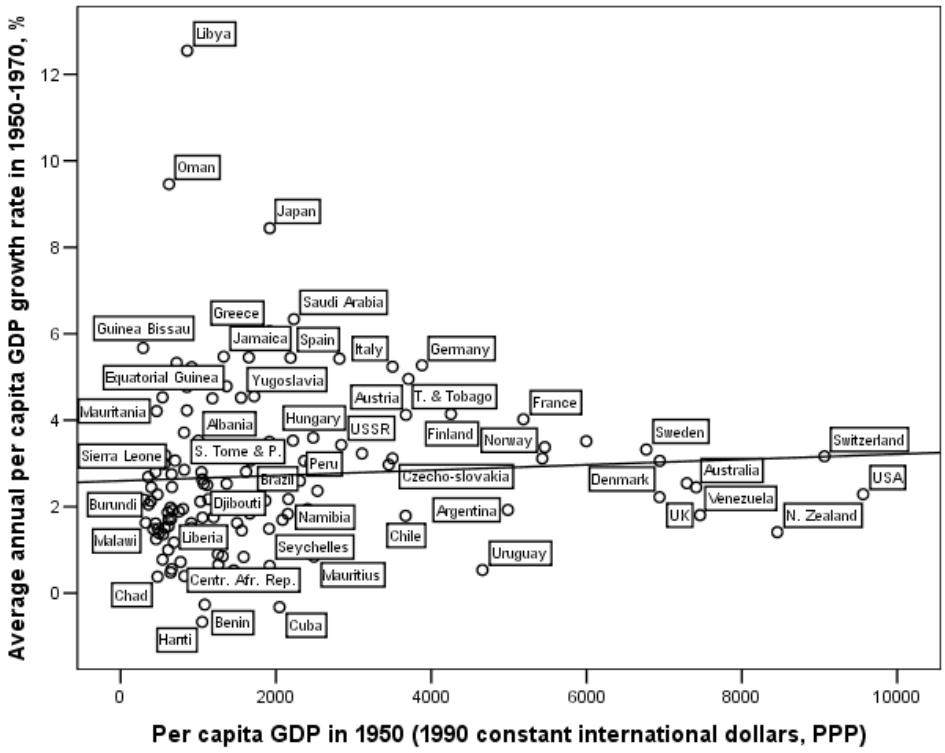

Fig. 10. Correlation between per capita GDP in 1950 and average annual per capita GDP growth rates in 1950–1970. For all countries of the world (Maddison 2010 dataset). Scatterplot with fitted regression line

Note: $r = 0.066$, $p = 0.453$, omitting small oil-exporting countries of the Persian Gulf. *Source:* Maddison 2010.

However, a rather simple analysis of Figs 8–10 indicates that the absence of correlation in both cases is a result of a negative correlation between the initial value of per capita GDP and the modulus (absolute value) of deviation from the world average per capita GDP growth rate in the subsequent period (see, *e.g.*, Fig. 11).

For example, in Maddison's dataset among the countries with per capita GDP (for 1998) exceeding $15,000 the standard deviation for the average annual per capita GDP growth rate (in 1998–2008) equals 0.82, for the countries with $5,000–15,000 it is almost three times higher (2.35), and for the countries with per capita GDP lower than $5,000 it is more than four times higher (3.37). In the World Development Indicators dataset among the countries with per capita GDP (for 1998) exceeding $20,000 the standard deviation for the average annual per capita GDP growth rate (in 1998–2008) also equals 0.82, for the countries with $10,000–20,000 it is more than twice higher (1.95), and for the countries with per capita GDP lower than $10,000 it is four times higher (3.24).

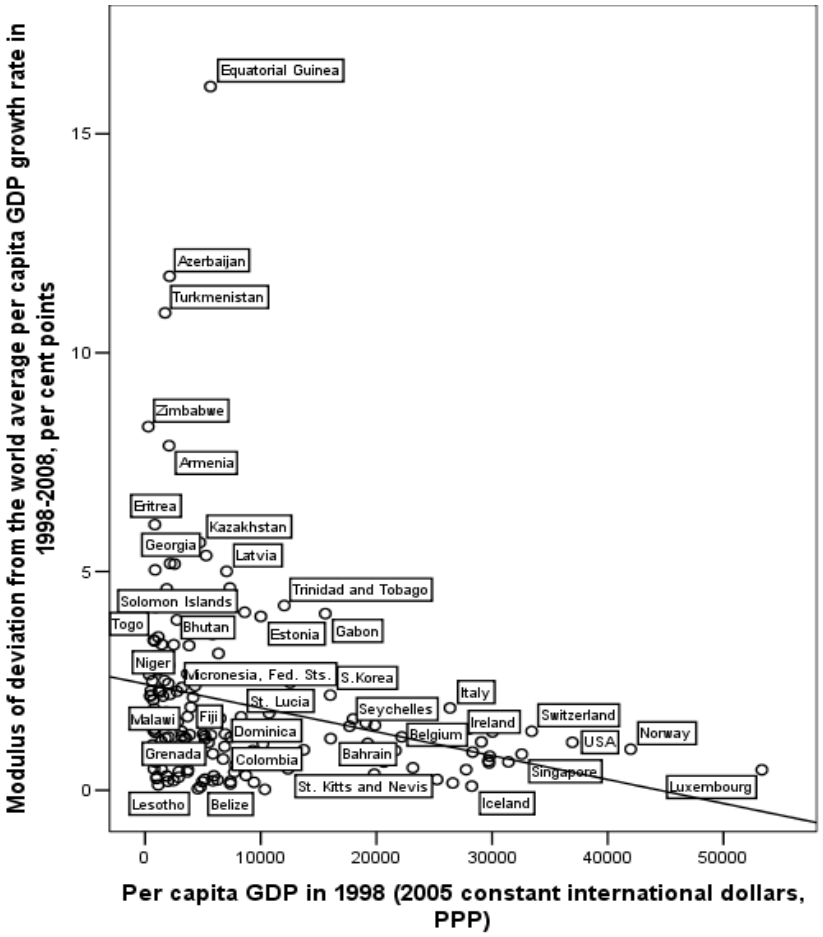

Fig. 11. Correlation between per capita GDP in 1998 and the modulus (absolute value) of deviation from the world average per capita GDP annual growth rate in 1998–2008. For all the countries of the world (World Bank 2010 dataset). Scatterplot with fitted regression line

Note: $r = -0.254$, $p = 0.001$. *Data source*: World Bank 2010.

As a result we get a typical 'fir-tree' scatterplot for the correlation between the initial value of per capita GDP and average annual per capita GDP growth rates in the subsequent period indicating the absence of any significant correlation (and hence the absence of either general divergence or convergence).

Note that the above-mentioned huge variation in the average annual growth rates among low-income countries is produced mostly by smaller economies. For example, in the WDI dataset among smaller[13] low-income[14] economies the standard deviation for the average annual per capita GDP growth rate (in 1998–2008) equals 3.54, whereas for larger[15] low-income economies it is much smaller (2.01). In Maddison's dataset among smaller[16] low-income[17] economies the standard deviation for the average annual per capita GDP growth rate (in 1998–2008) equals 3.53, whereas for larger[18] low-income economies it is also much smaller (2.15).

Of course, this is not really surprising. Indeed, it is quite natural that larger economies tend to be more stable, whereas it is smaller economies that are more likely to experience dramatic (both positive and negative) growth rates – either particularly precipitous declines, or especially sweeping upswings.

Hence, against the above-described background it would seem a rather logical suggestion to leave in the sample larger countries (comprising overwhelming majority of the world population, and producing almost all of the world GDP), which apparently could reveal underlying patterns of general divergence/convergence obscured by 'information noise' produced by smaller economies.

This hypothesis worked surprisingly well (see Table 3 below). The convergence pattern became clearly visible as soon as we left in the sample countries with total GDP values (for 1998) of no less than $10 billion.[19] Note that these countries produce more than 98 % of the whole world GDP and comprise more than 96 % of all population of the world (for 1998). As we see, after 1998 the 'absence of convergence' illusion is produced by a few dozen of small economies encompassing a very small fraction of the world population and producing a negligible percentage of the world GDP. As soon as we leave in the samples countries with total GDP values of no less than $10 billion, we immediately find significant negative correlation between per capita GDP in 1998 and per capita GDP growth rates in 1998–2008 in both datasets (see Table 3).[20] This negative correlation becomes much stronger and more significant as soon as we raise the cut-off level up to $20 billion.[21] It further strengthens with the increase in cut-off level up to $30 billion,[22] and becomes rather strong and unequivocally significant when we leave in the samples countries with total GDP values of no less than $40 billion (note that the respective 67 countries produce 96 % of all the world GDP and comprise more than 86 % of all the world population for 1998[23]) – see Fig. 12.

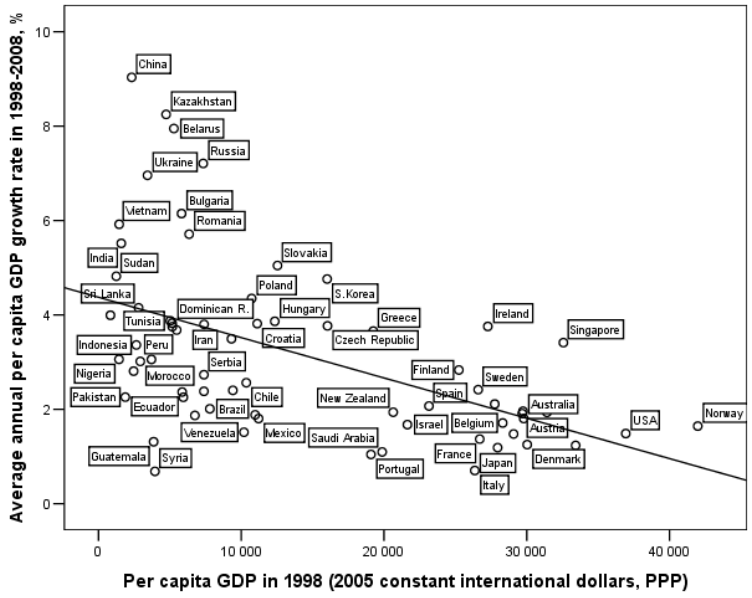

Fig. 12. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For countries with total GDP volumes of no less than $40 billion (for 1998). Scatterplot with fitted regression line

Note: $r = -0.51$, $p < 0.0001$. *Source:* World Bank 2010.

The convergence in this sample of countries comprising the overwhelming majority of the world population and producing almost all the world GDP is perfectly visible. Actually there is only one absolute outlier (a low-income economy with economic growth rates lower than in any developed economy) in the sample – Syria. As will be seen below, when we leave in the sample larger economies only, we shall confront an even clearer unconditional convergence pattern without any salient outliers at all.

The negative correlation between per capita GDP in 1998 and per capita GDP growth rates in 1998–2008 rises further when we leave in the samples countries with total GDP volumes (for 1998) of no less than $50 billion[24] and reaches –0.550 (for the World Bank dataset), as soon as we raise the cut-off level up to $75 billion (note that the respective 54 countries still produce 94 % of all the world GDP and comprise *c.*84 % of all the world population [for 1998]) – see Fig. 13.

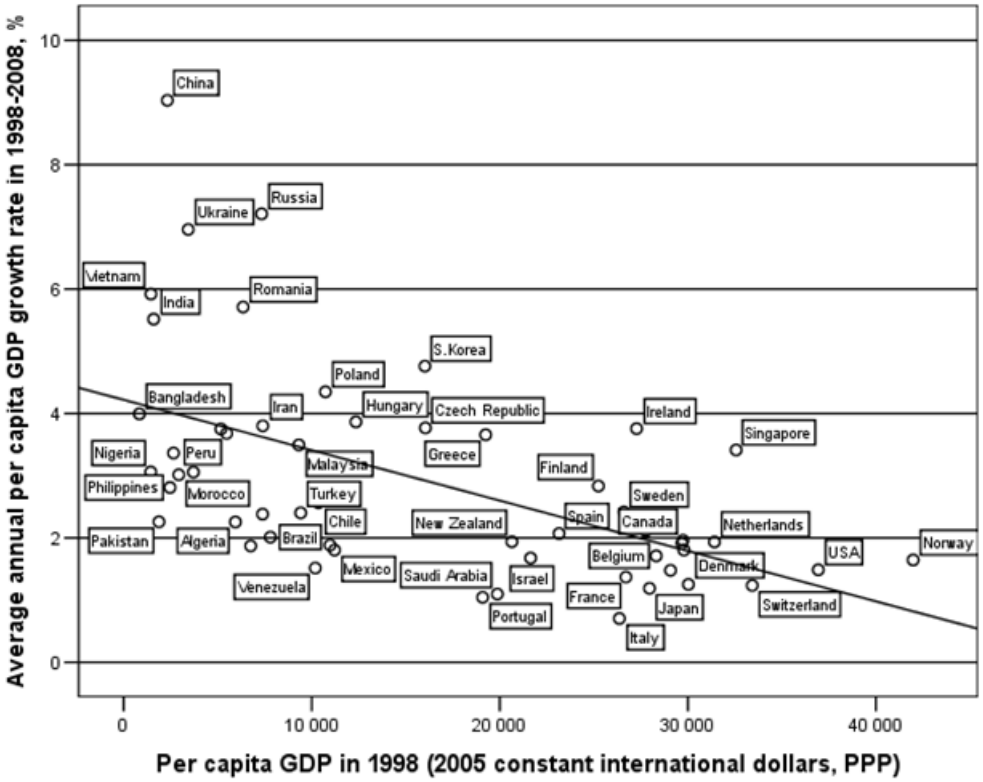

Fig. 13. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For countries with total GDP volumes of no less than $75 billion (for 1998). Scatterplot with fitted regression line

Note: $r = -0.55$, $p < 0.0001$. *Source*: World Bank 2010.

In fact, Fig. 13 suggests that we are dealing here not with a simple linear relationship between the two variables in question, but rather with a power-law one. Indeed, our mathematical analysis has supported this supposition (see Figs 14–15 and Table 2).

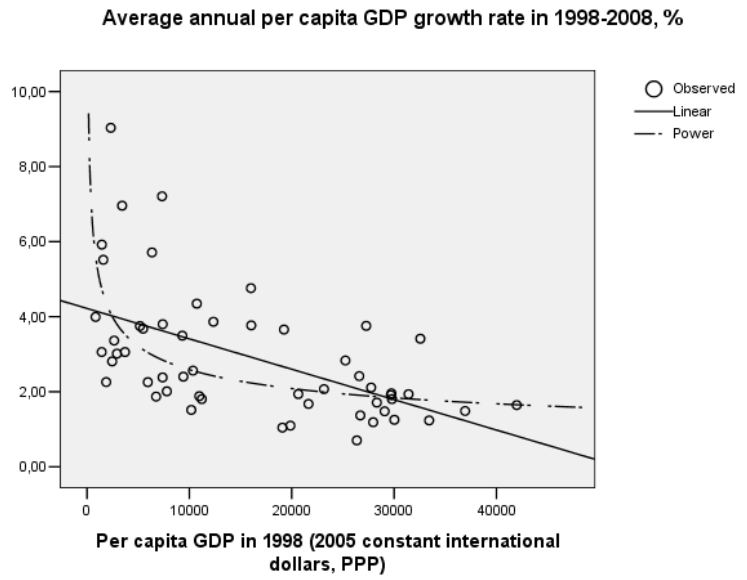

Fig. 14. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For countries with total GDP volumes of no less than $75 billion (for 1998). Comparison between linear and power-law models (double natural scale)

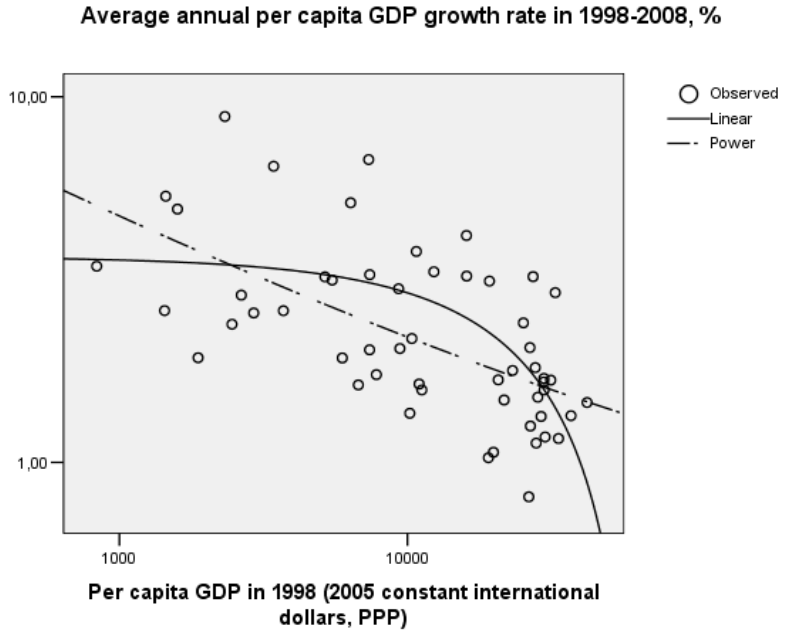

Fig. 15. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For countries with total GDP volumes of no less than $75 billion (for 1998). Comparison between linear and power-law models (double logarithmic scale)

Table 2

Comparison between linear and power-law models for countries with total GDP volumes of no less than $75 billion

Model Summary and Parameter Estimates

Dependent Variable: Average annual per capita GDP growth rate in 1998-2008, %

	Model Summary					Parameter Estimates	
Equation	R Square	F	df1	df2	Sig.	Constant	b1
Linear	,303	22,608	1	52	,000	4,219	-8,1E-005
Power	,356	28,720	1	52	,000	45,898	-,312

The independent variable is Per capita GDP in 1998 (2005 constant international dollars, PPP).

As we see, the linear model in this case accounts for 30 % of the variation, whereas the power-law models accounts for 36 %. As a result, the post-1998 convergence pattern is better visible in double logarithmic scale, which will be employed thereafter, starting with Fig. 16.

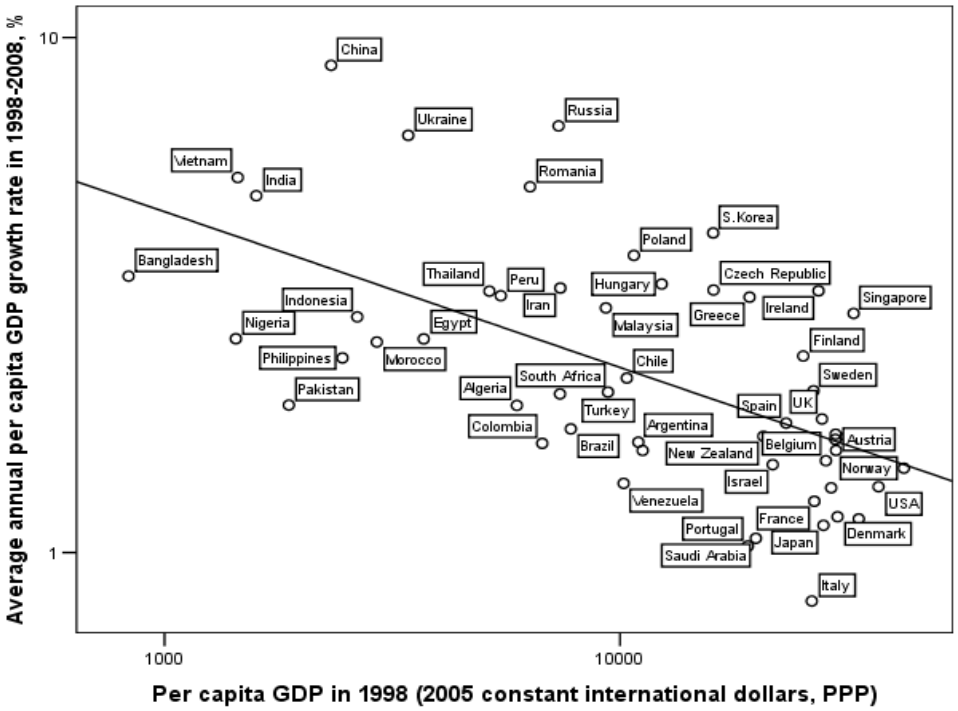

Fig. 16. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For countries with total GDP volumes of no less than $75 billion (for 1998) (double logarithmic scale). Scatterplot with fitted power-law regression line

Note: $r = -0.55$, $p < 0.0001$. $R^2 = 0.303$ (linear model); $R^2 = 0.356$ (power-law model). *Data source:* World Bank 2010.

In no way does the growth of the correlation in question stop at the $75 billion point. It grows further when we move to $100[25] and 200 billion levels (see Fig. 17).

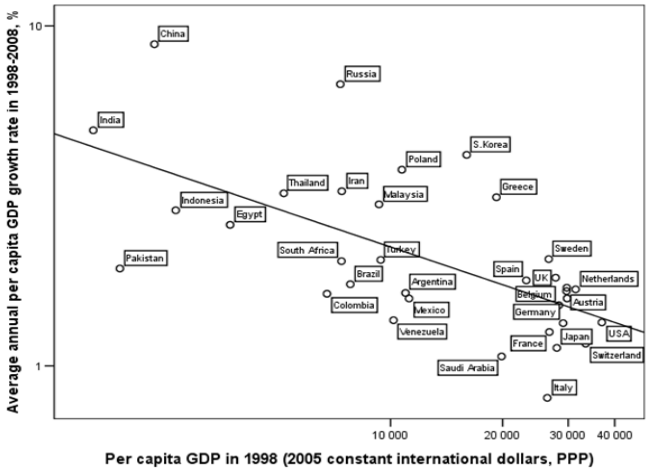

Fig. 17. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For countries with total GDP volumes of no less than $200 billion (for 1998) (double logarithmic scale). Scatterplot with fitted power-law regression line

Note: $r = -0.564$, $p = 0.001$. $R^2 = 0.32$ (linear model); $R^2 = 0.40$ (power-law model). *Data source*: World Bank 2010.

The rise of the strength of the negative correlation between per capita GDP in 1998 and per capita GDP growth rates in 1998–2008 does not stop at $200 billion cut-off point. It increases further when we move to $300 billion[26], and becomes unequivocally strong beyond $400 billion (see Table 3 and Fig. 18).

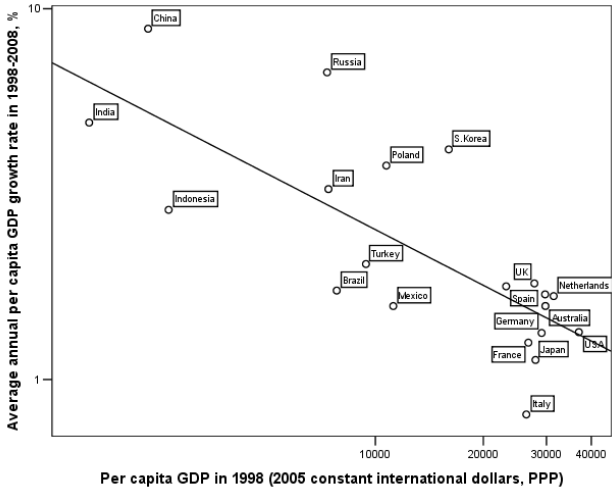

Fig. 18. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For countries with total GDP volumes of no less than $400 billion(for 1998) (double logarithmic scale). Scatterplot with fitted power-law regression line

Note: $r = -0.7$, $p = 0.001$. $R^2 = 0.49$ (linear model); $R^2 = 0.56$ (power-law model). *Data source:* World Bank 2010.

The rise of the correlation strength with the increase in cut-off levels is observed even further. For the World Bank 2010 dataset it increases to – 0.72 when we leave in the sample the economies with no less than $600 billion of total GDP, and it arrives at – 0.757 level[27] for the largest economies with no less than $750 billion of total GDP.

It does not appear to be reasonable to move beyond this point, as by this point we already have only 13 countries in the World Bank dataset and we have just 9 countries in Maddison's one. However, even these 9 countries still encompass more than a half of the world population and produce almost two thirds of the world GDP.

Table 3

Correlations between per capita GDP in 1998 and per capita GDP growth rates in 1998–2008

World Bank 2010 Dataset					
Countries with GDP in 1998 no less than *(in constant 2005 international $, PPP)*	Correlation between per capita GDP in 1998 and per capita GDP growth rates in 1998–2008 (Pearson's *r*)	Sig. (two-tailed)	Number of countries	Percentage of the world GDP produced by these countries	Percentage of the world population living in these countries
$10 billion	– 0.275	0.004	108	97.7 %	94.2 %
$20 billion	– 0.329	0.002	85	96.9 %	90.8 %
$30 billion	– 0.406	0.0002	77	96.3 %	89.1 %
$40 billion	– 0.510	<0.0001	67	95.6 %	86.2 %
$50 billion	– 0.514	<0.0001	62	95.0 %	84.9 %
$75 billion	– 0.550	<0.0001	54	93.7 %	83.4 %
$100 billion	– 0.554	<0.0001	52	93.4 %	82.9 %
$200 billion	– 0.564	0.001	34	86.6 %	72.5 %
$300 billion	– 0.644	0.001	24	81.1 %	66.9 %
$400 billion	– 0.700	0.001	20	77.9 %	64.3 %
$600 billion	– 0.720	0.002	15	72.3 %	58.6 %
$750 billion	– 0.757	0.003	13	69.3 %	56.7 %
Maddison 2010 Dataset					
Countries with GDP in 1998 no less than *(in constant 1990 international $, PPP)*	Correlation between per capita GDP in 1998 and per capita GDP growth rates in 1998–2008 (Pearson's *r*)	Sig. (two-tailed)	Number of countries	Percentage of the world GDP produced by these countries (for 1998)	Percentage of the world population living in these countries (for 1998)
1	2	3	4	5	6
$10 billion	– 0.184	0.05	109	98.3 %	96.1 %
$20 billion	– 0.281	0.009	85	97.3 %	92.1 %
$30 billion	– 0.401	0.001	69	96.1 %	88.6 %
$40 billion	– 0.422	0.0005	65	95.7 %	86.7 %
$50 billion	– 0.446	0.0003	61	95.2 %	85,5 %
$75 billion	– 0.493	0.0002	54	93.9 %	84.1 %
$100 billion	– 0.526	0.0002	45	91.7 %	81.6 %
$200 billion	– 0.537	0.005	26	83.5 %	69.7 %

Table 3 continned

1	2	3	4	5	6
$300 billion	– 0.623	0.003	21	79.9 %	64.6 %
$400 billion	– 0.630	0.009	16	74.8 %	62.0 %
$600 billion	– 0.680	0.01	13	70.1 %	59.5 %
$750 billion	– 0.741	0.02	9	62.5 %	51.4 %

Note that the general convergence pattern of 1998–2008 may be also detected if we leave in our sample the countries with population of no less than 50 million[28] (see Fig. 19).

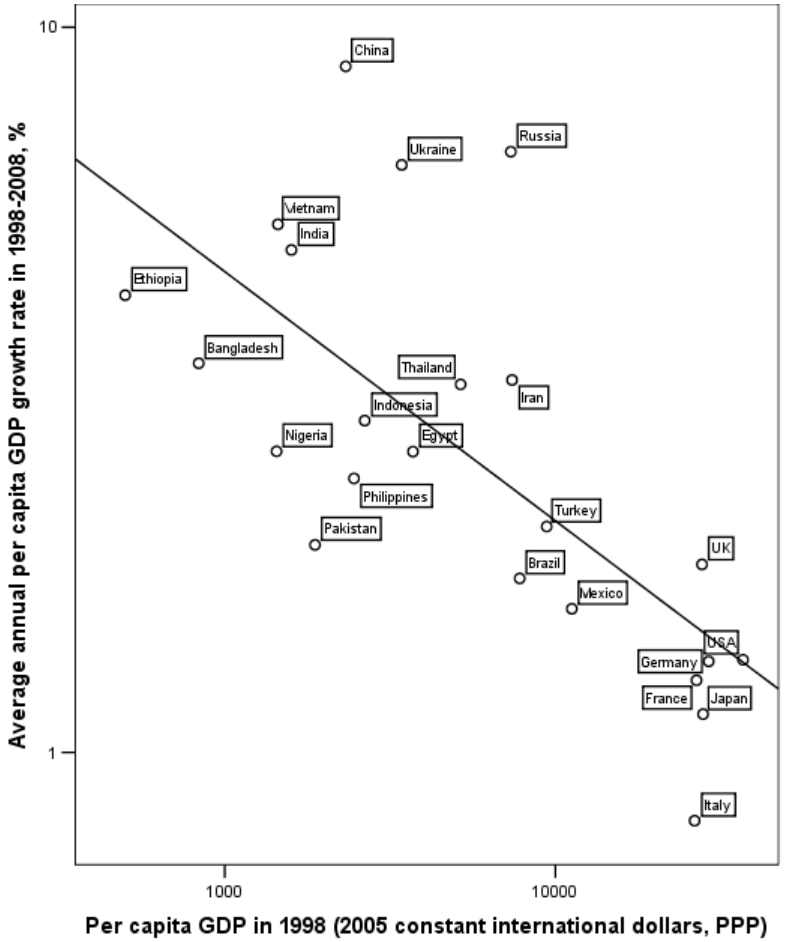

Fig. 19. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1950–1970. For countries with population of no less than 50 million (in 1998) (double logarithmic scale). Scatterplot with fitted power-law regression line

Note: $r = -0.62$, $p = 0.002$. $R^2 = 0.38$ (linear model); $R^2 = 0.51$ (power-law model), $p = 0.0001$.
Source: World Bank 2010.

6. Discussion

Thus for the period after 1998 we find rather strong evidence for the unconditional convergence among all the larger countries comprising the overwhelming majority of the world population and producing the overwhelming part of the world GDP.

Note that our findings are not as incongruent with the results of the previous convergence research as one may think. Indeed this research did not deny the convergence phenomenon *per se*, but rather insisted on its conditionality, whereas the main conditions of the convergence with the high-income economies were identified, first of all, as (1) a sufficiently high level of development of the human capital (comparable with the one of the high-income economies) (*e.g.*, Barro 1991; Mankiw, Romer, and Weil 1992; Cohen 1996); (2) a sufficient degree of economic openness (*e.g.*, Ben-David 1993: 653; Sachs *et al.* 1995: 199; *etc.*); (3) a sufficient degree of law and order (*e.g.*, Milanovic 2005; Owen, Videras, and Davis 2009).

By 1998 all the major developing economies of the world satisfied those conditions much better than they did in the divergence era. Sachs and Warner might not be entirely satisfied yet with the degree of economic openness of, say, Russia, China, or Ethiopia. But they would hardly argue against the point that Chinese and Russian economies are *radically* more open now than they were in the 1960s, whereas the Ethiopian economy is radically more open now than it was in the late 1970s. On the other hand, the evidence that we present suggests that Sachs *et al.* (1995) appear to have exaggerated the degree of economic openness that is necessary for the convergence phenomenon to develop.

We believe that of special importance is the fact that between 1950–1960 and the late 1990s we observe a radical decrease of the gap between the 'First' and 'Third' world with respect to the level of development of the human capital (see Figs 20–21).

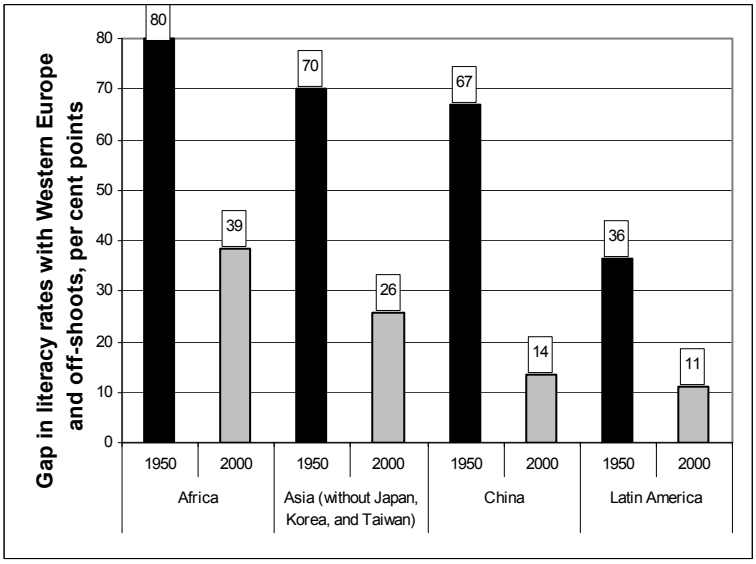

Fig. 20. Decrease of the gap between the Western Europe (and off-shoots) and the main Third World macroregions/countries with respect to the literacy rates, per cent points, 1950–2000

Data source: Morrison and Murtin 2006.

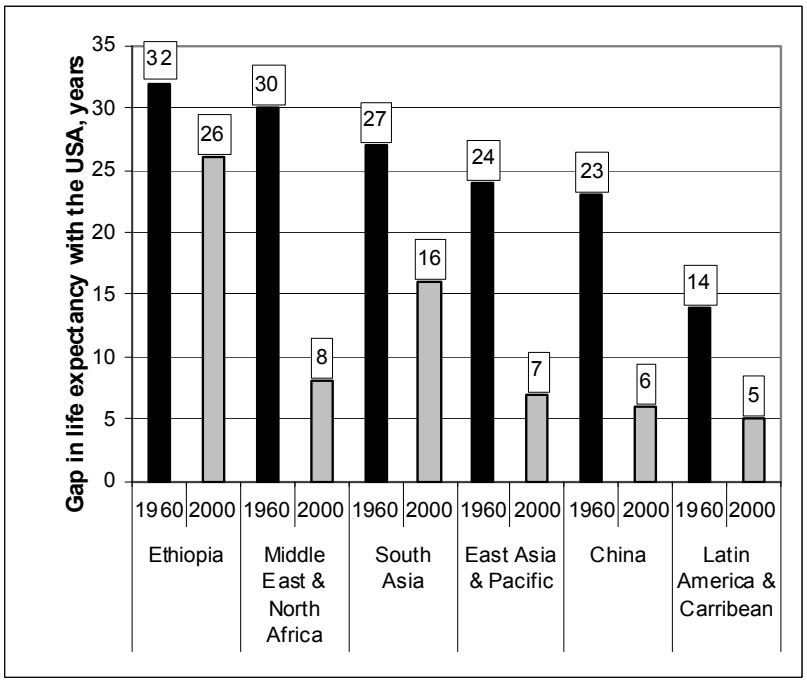

Fig. 21. Decrease of the gap between the USA and some Third world regions/countries with respect to the life expectancy, 1960–2000

Data source: World Bank 2010.

Thus the switch from the conditional to unconditional convergence pattern that we appear to be recently observing seems to be accounted for by the point that by the late 1990s all the major countries and economies of the world began to satisfy (more or less) the major conditions of the conditional convergence.

7. Conclusions

1. It does not appear reasonable to try to find the only and for ever answer to the question 'Is there an unconditional convergence?' In general, such an unspecific question does not appear to be correct at all. The point is that the answer to this question would be very different depending on the period of the World System history to which the question refers.

2. As we could see, the 1950s and 1960s were characterized by a pattern of general divergence, whereas in 1998–2008 a pattern of general convergence definitely prevailed.

3. For 1998–2008 a pattern of unconditional convergence can be detected for all the large countries (with population of no less than 50 million in 1998). It can be also detected for all the middle and large economies of the world.

4. These conclusions are not as incongruent with the results of the previous convergence research as one may think. In fact, this research did not deny the convergence phenomenon *per se*, but rather insisted on its conditionality, whereas we suggest that the world-wide switch from the conditional to unconditional convergence pattern

that we appear to be recently observing seems to be accounted for by the point that by the late 1990s all the major developing countries and economies of the world began to satisfy (more or less) the major conditions of the conditional convergence.

NOTES

[1] As Abel and Bernanke (2005: 235) state, the 'spirit' of Solow's model supports the idea of generality of convergence.

[2] Much the same conclusion was made by Ben-David, who stated that there existed 'a strong link between the timing of trade reform and income convergence among countries' (Ben-David 1993: 653).

[3] Note that Sachs *et al.* quite remarkably state at this point: 'This is now changing with the spread of trade liberalization programs, so that presumably the tendencies toward convergence will be markedly strengthened' (Sachs *et al*. 1995: 3).

[4] Which in our previous research was operationalized to consist of Western Europe, Western European off-shoots, and Japan.

[5] Thus, excluding the former Soviet Union, and the former Communist countries of the Eastern Europe (the Second World). For our analysis these countries could not be included into the core due to a relatively low level of their economic development, on the other hand they could not be included in the Third World due to their high advancement in demographic transition (incomparable to the Third World, but quite comparable with the First World).

[6] We have suggested accordingly that Protestantism has indeed influenced positively the capitalist development of respective social systems not so much through the 'Protestant ethics' (as was suggested by Weber 2003 [1905]) but rather through the promotion of literacy (Korotayev, Malkov, and Khaltourina 2006: 87–91).

[7] Calculated in dollars of GDP growth per a dollar of investments.

[8] Which were operationalized as the ones with per capita GDP in 1950 less than 20 % of the USA in 1950.

[9] Which were operationalized as the ones with per capita GDP in 1950 **no** less than 20 % of the USA in 1950.

[10] Which were operationalized as the ones with per capita GDP in 1998 less than 20 % of the USA in 1998.

[11] Which were operationalized as the ones with per capita GDP in 1998 **no** less than 20 % of the USA in 1998.

[12] The phenomenon of unconditional divergence will be treated in more detail below in Appendix 2.

[13] With less than 40 billion of GDP (in 2005 dollars, PPP) in 1998.

[14] With per capita GDP in 1998 less than $10,000.

[15] With more than 40 billion of GDP (in 2005 dollars, PPP) in 1998.

[16] With less than 75 billion of GDP (in 1990 international dollars, PPP) in 1998.

[17] With per capita GDP in 1998 less than $10,000.

[18] With more than 75 billion of GDP (in 1990 international dollars, PPP) in 1998.

[19] Note that World Bank 2010 and Maddison 2010 use somehow different units of measurement for GDP (in PPP). The former employs 2005 constant international dollars (PPP), whereas the latter uses 1990 international dollars. However, for the sake of simplicity we decided to use the same cut-off levels for both datasets.

[20] $r = -0.275$, $p = 0.004$ (two-tailed throughout) for World Bank 2010, and $r = -0.184$, $p = 0.05$ for Maddison 2010.

[21] $r = -0.329$, $p = 0.002$ for World Bank 2010, and $r = -0.281$, $p = 0.009$ for Maddison 2010.

[22] $r = -0.406$, $p = 0.0002$ for World Bank 2010, and $r = -0.401$, $p = 0.001$ for Maddison 2010.

[23] $r = -0.514$, $p < 0.0001$ for World Bank 2010, and $r = -0.446$, $p = 0.0002$ for Maddison 2010.

[24] $r = -0.554$, $p < 0.0001$ for World Bank 2010, and $r = -0.526$, $p = 0.0002$ for Maddison 2010.

[25] $r = -0.644$, $p = 0.001$ for World Bank 2010, and $r = -0.623$, $p = 0.003$ for Maddison 2010.

[26] $R^2 = 0.57$ (linear model); $R^2 = 0.67$ (power-law model).

[27] Note that respective countries comprise three quarters of the world population and produce more than 91 % of the world GDP. Note also that this approach is quite congruent with Sala-i-Martin's reasoning regarding the straightforward use in the convergence/divergence studies of individual 'countries as their unit of analysis. This is the correct approach when, for example, one tries to test theories of economic growth because aggregate growth theories tend to predict that growth depends on "national factors" such as policies, institutions, and other elements determined at the economy wide level. To the extent that those determinants are independent across nations, each country can be correctly treated as an independent data point of an economic "experiment". Using countries as units of analysis, however, is not useful if one worries about human welfare because different countries have different population sizes. After all, there is no reason to down-weight the well-being of a Chinese peasant relative to a Senegalese farmer just because the population in China is larger than that of Senegal' (Sala-i-Martin 2006: 352).

[28] Though, naturally, the exponent b1 in the power-law model in case of divergence pattern is positive, whereas in case of convergence pattern it is negative.

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Appendix 1

Is unconditional convergence observed after 1998 among middle economies?

The negative correlation between per capita GDP in 1998 and economic growth rates in 1998–2008 for large economies is so stronger than for the sample comprising both large and middle economies, that it seems natural to wonder if the significant medium-strength correlation in the latter sample is not just an artifact of the very strong unconditional convergence observed after 1998 among the large economies. Hence, it seems necessary to test if the unconditional convergence was observed in 1998–2008 among the medium-size economies. We have tested the respective hypothesis with respect to the economies with 1998 GDP in the range between $40 billion and $200 billion. The results of this test are presented below in Fig. 22.

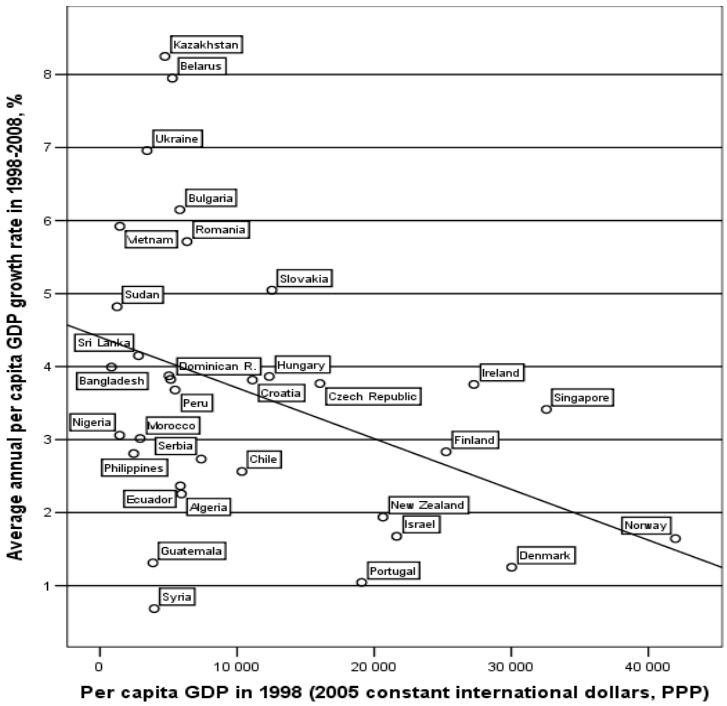

Fig. 22. Correlation between per capita GDP in 1998 and average annual per capita GDP growth rates in 1998–2008. For medium-size economies (with total GDP volumes in the range between $40 billion and $200 billion T (for 1998). Scatterplot with fitted regression line

Note: $r = -0.39$, $p = 0.03$. *Source:* World Bank 2010.

As we see, the unconditional convergence pattern is observed after 1998 for medium-size economies quite clearly. The negative correlation for this sample is statistically significant and quite strong; however, of course, the unconditional convergence pattern is here much weaker (and less significant) than the one observed for large economies (let us recollect that, *e.g.*, for economies with more than $400 billion of total GDP it reaches the level of – 0.7 with significance of 0.002).

Appendix 2

General divergence pattern of 1950–1970

A rather special pattern of general divergence in 1950–1970 becomes visible quite clearly as soon as we leave in the sample countries with population (in 1950) of no less than 20 million (see Fig. 23).

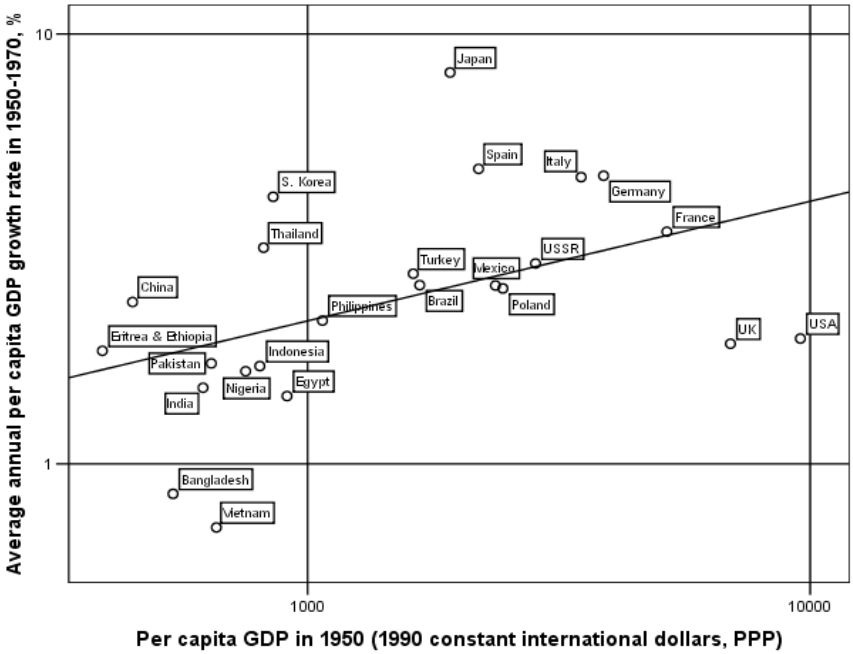

Fig. 23. Correlation between per capita GDP in 1950 and average annual per capita GDP growth rates in 1950–1970. For countries with population of no less than 20 million (double logarithmic scale). Scatterplot with fitted power-law regression line

Note: $R^2 = 0.21$ (power-law model), $p = 0.025$. *Data source*: Maddison 2010.

It can be seen rather clearly that the general pattern is composed of two sub-patterns:

1) a rather strong divergence among the low- and middle-income countries (see Fig. 24);

2) a rather strong convergence among the middle- and high-income countries (see Fig. 25).

In fact, this was the combination of the above-mentioned patterns that led to the formation by the late 1960s of the famous 'twin peaked' distribution (Quah 1996a, 1997; Jones 1997b).

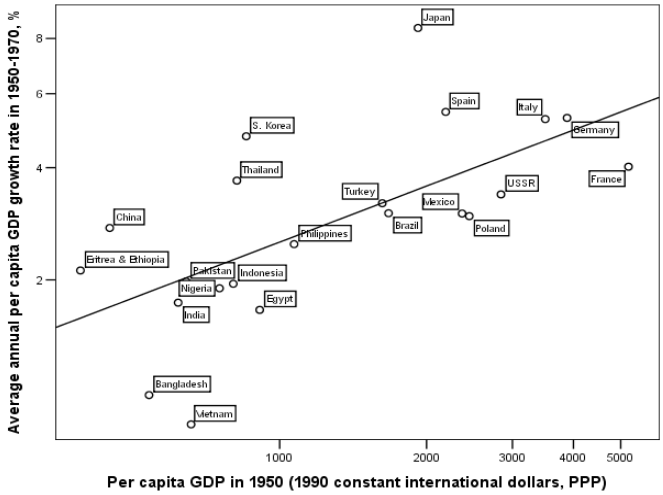

Fig. 24. Correlation between per capita GDP in 1950 and average annual per capita GDP growth rates in 1950–1970. For low- and middle-income countries with population of no less than 20 million (in 1950) (double logarithmic scale). Scatterplot with fitted power-law regression line

Note: $r = -0.56$, $p = 0.09$. $R^2 = 0.31$ (linear model); $R^2 = 0.40$ (power-law model), $p = 0.05$. We denote as 'low-income countries' the ones with per capita GDP in 1950 less than 20 % of the USA in 1950. We denote as 'middle-income countries' the ones with per capita GDP in 1950 between 20 and 60 % of the USA in 1950. *Data source*: Maddison 2010.

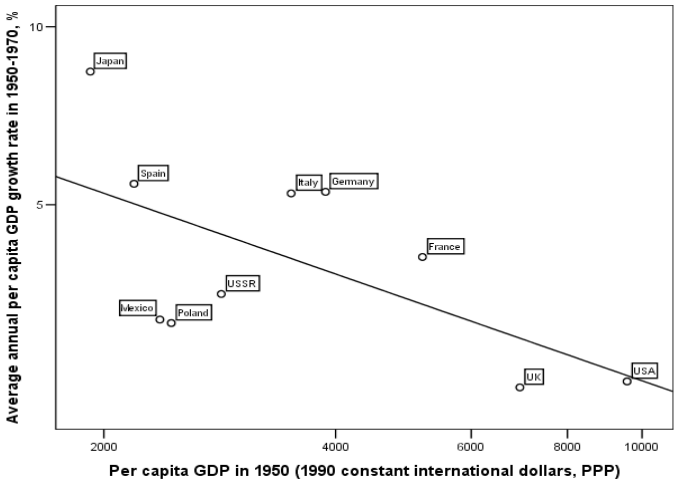

Fig. 25. Correlation between per capita GDP in 1950 and average annual per capita GDP growth rates in 1950–1970. For middle- and high-income countries with population of no less than 20 million (in 1950) (double logarithmic scale). Scatterplot with fitted power-law regression line

Note: $r = +0.53$, $p = 0.01$. $R^2 = 0.28$ (linear model); $R^2 = 0.40$ (power-law model), $p = 0.002$. We denote as 'high-income countries' the ones with per capita GDP in 1950 no less than 60 % of the USA in 1950. *Data source*: Maddison 2010.

Note also that for 1950–1970 both divergence (though, naturally, the exponent b1 in the power-law model in case of divergence pattern is positive, whereas in case of convergence pattern it is negative) and convergence patterns are again described more accurately by power-law rather than linear models (see Figs 24–25 above as well as Table 4 and Fig. 26 below):

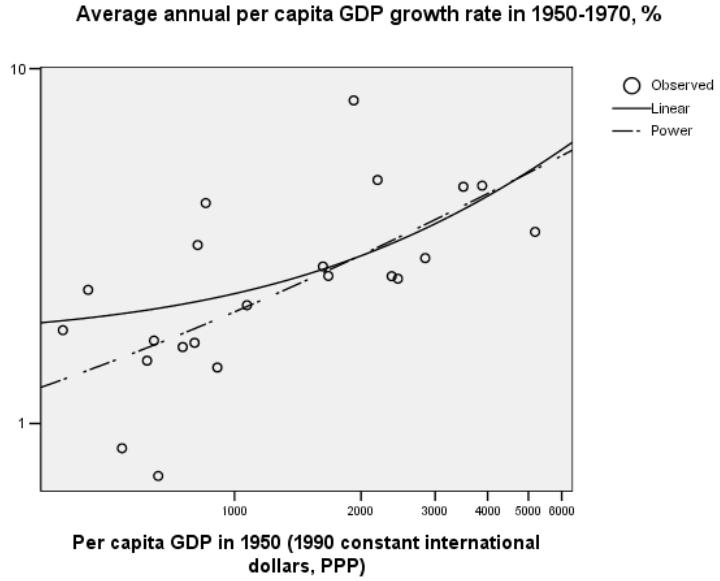

Fig. 26. Correlation between per capita GDP in 1950 and average annual per capita GDP growth rates in 1950–1970. For low- and middle-income countries with population of no less than 20 million (in 1950). Comparison between linear and power-law models (double logarithmic scale)

Table 4

Comparison between linear and power-law models for low- and middle-income countries with population of no less than 20 million (in 1950)

Model Summary and Parameter Estimates

Dependent Variable: Average annual per capita GDP growth rate in 1950–1970, %

Equation	Model Summary					Parameter estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	,282	7,845	1	20	,011	1,988	,001
Power	,400	13,347	1	20	,002	,063	,529

The independent variable is Per capita GDP in 1950 (1990 constant international dollars, PPP).