Measurement of the National and Regional Convergence in the EU
Defining a More General Convergence Indicator

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In my articles, what were published in 2004 and 2006 (Kertész, 2004), I represented the so-called trade-off theory, which analyses the latest international experience referring to the real convergence, thus to the catching-up of the average income per capita. This theory describes that there is a trade-off between the national and regional convergence, independently from the applied economic policy. In other words, when the catching-up of a national economy accelerates, the more developed regions within the country will develop faster, while the less developed ones slower resulting an increased dispersion of the incomes per capita.

The trade-off theory was developed as a kind of synthesis of the neoclassical and the endogenous growth theories and the agglomeration theories. The trade-off theory can be also considered as a synthesis developed from a thesis-antithesis due to the fact, that the growth theories and the agglomeration theories determine absolutely different conclusions in respect of the realisation of real convergence. According to the standpoint of the neoclassical growth theory school started up by the famous Robert Solow's article of 1956 (Solow, 1956), the real convergence (= approaching, catching-up of the per capita GDPs) is attained automatically and the economic policy is not able to influence the long-term growth trend, but such influence is exerted only by the technological development rate fixed as an exogenous variable. At the same time, according to the view of the so-called endogenous growth theory school (Romer, 1986; Lucas, 1988; Rebelo, 1992; Romer, 1994) the technological development rate is not an exogenous variable, but it can be effected by the size of the human capital, which can be influenced by the economic policy, as well, because the accumulation of the human capital may be able to provide constant capital returns instead of decreasing ones. According to these theories, only a conditional β-convergence is realised and the national economies converge not to the same growth path (Barro, 1991; Mankiw, Romer & Weil, 1992; Sala-i-Martin, 1994). However, the agglomeration theory school takes an opposite view in relation to both neoclassical and endogenous growth theories, saying that the real convergence is not realised between the individual regions even in long term. The "agglomeration theory school" is a collective term including the new economic geography founded by *Krugman* (1990) and the cluster theory set up by *Porter* (1998) as its most outstanding two trends. These theories prove the regional divergences partially by the positive external spill over effects and economies of scale accompanying agglomeration development, and partially by the regional empirical experiences, thus by the significant and permanent regional differences (sometimes showing even diverging trends), which can be observed even within the national economies.

The so-called trade-off theory represents a kind of synthesis of the three theories arriving at different conclusions. According to this theory the guiding trend is the conditional β-convergence, thus the catching up depends on economic policies and country specific factors, but there is a trade-off between the convergence tendencies

of the national and regional level of the economy (European Comission, 2000; Dall'erba & Hewings, 2003; Paas & Schlitte, 2006; Geppert & Stephan, 2008; Martin, 2009). In other words, in case a less developed national economy starts to converge to the international average, an increase of dispersion will be experienced among the domestic regions within the national economy, thus the more developed regions will grow faster than the less developed ones. Tendencies of the European Union are appropriate for checking and analysing this theory, as reliable statistical data of a quite long period are available and also the member countries and regions are adequately heterogeneous in respect of their levels and trends of GDP per capita. The empirical experiences clearly show that the above mentioned trade-off process occurred in every less developed member country, independently from their economic situations and policies (see the diagrams in the annex).

The main objective of this article is to introduce a new macroeconomic-regional convergence indicator, which can measure and evaluates the catching-up process of an EU member country better than the national GDP per capita index. As the success of a country depends not only on the average catching-up rate of the whole national economy, but also on the extent of the regional dispersion of income levels within the country, it seems purposeful to establish a more general and more sophisticated catch-up indicator that measures both national and regional convergences. Such an indicator would better reflect and would make more measurable the success of economic policies.

First step – an auxiliary indicator: convergence-elasticity of the regional dispersion

The diagrams included in the annex show the catching-up trends of 12 member countries. As you can see in the figures, in respect of GDP per capita catching-up could be experienced in relation to the EU-27 average in all the less developed member countries during the last one – one and a half decades, and this catching-up was everywhere – except in Spain – accompanied by increases in the regional differences. Additionally, you can also see from the data that the lower was the starting development level of a given country and the faster was the national economic catching-up, the higher was the increase in the regional differences. Catching-up of national economies (real convergence) starting from the lowest development level (Bulgaria, Romania, Latvia, Lithuania and Estonia) led to the fastest regional divergence. The countries starting from a medium development level (Slovakia and Poland) and being able to achieve a moderate rate of national convergence faced a moderate rate of regional divergence. While the countries, which started from a relatively high development level (Greece, Portugal, Slovenia and the Czech Republic) continued their national development at a slower rate, but in the meantime the divergence among the regions became also a slow process. Spain – the most developed country among the 12 examined ones – was the only country where the national and regional convergence could be realised simultaneously since the end of 1990ies, but earlier, when its GDP per capita was still lower than 90% of the EU-27 average, the trade-off symptom could be experienced in Spain, as well.

As the welfare is effected not only by the average income per capita in the whole national economy, but also by the regional dispersion of income levels, reduction of regional differences is also a generally accepted objective of economic policies. For this reason, in order to measure the success of the economic political measures more

effectively, it is reasonable to develop a new macroeconomic indicator which besides the catching-up rate of the national economy measures the level and change of the regional income differences, as well. As a first step let's define auxiliary indicators, four types of catching-up elasticities of regional dispersion. The catching-up elasticity of the regional dispersion can show the following:

1) It can measure the percentage point change in regional dispersion due to one percentage point catching-up of the national economy; As a formula:

$$\varepsilon_c = \frac{\Delta\sigma}{\Delta(\frac{Y}{Y_{EU27}})}$$

In the denominator the Y/Y_{EU27} fraction shows the development rate of the given country comparing to the 27 member states of the EU when the comparison is calculated with the GDP per capita on purchasing power parity basis. In the numerator σ represents the value of statistical dispersion of the given country in respect of GDP per capita among its NTUS 3 regions[1]. And finally, the Δ sign certainly means the changes in time.

2) It can measure percentage change in regional dispersion due to one percentage catching-up of the national economy.

According to definition the terms, the units of measurement and the formula are completely the same as under point 1), the only difference is that in this case the development rate and the change in dispersion is given in percentage and not in percentage points. Accordingly, in case the GDP per capita of a country catches up from 50% to 51% in relation to the EU27 average, not 1% will be shown in the denominator of the formula (as according to Point 1)), but 2% because in relation to 50 the 1 means a 2% increase. In the numerator the change of the dispersion in percentage can be interpreted similarly.

3) It can measure the percentage point lag of the less developed NUTS 3 regions (lower half) from the national average due to one percentage point catching-up of the national economy.

4) It can measure the percentage lag of the less developed NUTS 3 regions (lower half) from the national average due to one percentage catching-up of the national economy.

The elasticity indicators described under points 3) and 4) measure only the lag of the less developed half part of the regions and not the dispersion of the NUTS 3 regions. Naturally, these definitions could be applied not only referring to the lower half of the NUTS 3 regions, but also to its lower third, quarter etc. The difference between the definitions described under points 3) and 4) is the same as between the points 1) and 2), namely that the changes of the national economy catch-up and the regional dispersion are measured in percentage instead of percentage points.

Before overviewing the trends of the above defined elasticity indicators in the EU member countries being in the process of catching-up, it is purposeful to ascertain the methodical-analysis aspect that the changes of data should be analysed in long

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[1] The Statistical Purpose Nomenclature of Territorial Units (in French: Nomenclature des Unités Territoriales Statistiques) was developed by Eurostat in 1988 in order to make the regional data of EU member countries more comparable as in the individual member countries the traditionally developed public administration units significantly differ from each other both in size and in number of population. The objective of the NUTS system is to standardise the regions both in size and in population number, bringing them closer to each other and making them similar within the European Union. (In Hungary the NUTS1 level is made up of three parts of the country: Trans-Danube region, Central Hungarian region and the Hungarian Plain region. Seven statistical regions complies with the NUTS 2 level, while the county system is positioned at the NUTS 3 level.)

term only; but not in time series, thus not as a chain index. The reason for it is partially that the trade-off theory itself developed from the growth theories (Solow model vs endogenous growth theories) and the agglomeration theory (Kertész, 2004), which can be interpreted in very long term only. Also, in short term the effect of the statistical errors, the accidental external factors, and the cyclical fluctuations can be extremely large and may deviate the indicators from the long-term trends. Furthermore, the structural political measures (e.g. development/decentralisation of infrastructure, human capital or technology, etc.) have effects only in long-term, thus they can be evaluated only in a long time perspective. Due to these reasons, a time series type analysis, thus an analysis of year–to-year changes of catch-up elasticities would not have too much economic sense, but it could lead to false conclusions.

Using the Eurostat data of the last one and a half decades, illustrated in diagrams in the annex, it is possible to calculate the average degree of the four types of catch-up elasticities in the 12 member countries. (In Table 1 the lengths of the data lines were different in different countries, but it did not distort the final result as the elasticity indices are standardised.) As it can be seen in the table, the four calculated elasticity indices show the same order among the countries and differences can be found only in the ratios among the indices. When introducing a new indicator it may be the most purposeful to propose the application of that type, which has the most significance in economic policy, which is the easiest to interpret both in practice and in public communication, and for which the data are available in the largest scope and most promptly. Based on these aspects, I would propose to use the version of the first column, where the elasticity of dispersion was expressed in percentage points.[2] From a theoretical point of view it is useful to ascertain that several indicators can be defined, and these would lead to similar order of the countries and similar conclusions. However, taking into consideration the aspects of practical use, in empirical analysis it is reasonable to select one indicator only. In the remaining part of the article we will work with the first auxiliary indicator, which hereinafter will be called as convergence elasticity of regional dispersion (in short form: convergence elasticity). Following the traditions of economics, let's mark it with ε_c.

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[2] Reasons for that:
- The dispersion indices are more relevant in economic sense than the lag of a block (e.g. of the lower half) of the regions.
- Dispersion indices are directly published by Eurostat, while the catch-up data of the lower half, third, quarter etc. of the regions are not published (they could be calculated only from the regional GDP data).
- Changes in percentage points can be more quickly and easily imagined, visualised, analysed than the percentage changes in percentages, and for this reason the indicator may be widely used not only within the theoretical analysts.

Table 1

	Elasticities			
	Dispersion of NUTS 3 regions		Lower half of NUTS 3 regions	
	in percentage points	in percentage	in percentage points	in percentage
Bulgaria	1.36	1.31	-0.67	-0.18
Romania	1.43	2.41	-0.73	-0.24
Estonia	0.55	0.61	-0.29	-0.11
Latvia	0.62	0.55	-0.30	-0.09
Lithuania	0.84	0.79	-0.40	-0.12
Slovakia	0.29	0.42	-0.14	-0.07
Poland	0.21	0.28	-0.11	-0.05
Czech Republic	1.90	6.28	-0.94	-0.66
Slovenia	0.28	0.99	-0.25	-0.15
Greece	1.07	5.52	-0.53	-0.41
Portugal	0.07	0.01	-0.01	0
Spain	-0.23	-0.78	+0.09	+0.09
Evaluation of data	the lower, the better	the lower, the better	the larger, the better	the larger, the better

Source: own calculations based on Eurostat data

Speed of General Convergence

Knowing the trade-off theory, and in the light of the empirical experience that in mid-term the national convergence can occur only together with regional divergence, it becomes especially important to determine the rate of the so-called "general convergence". Thus, we can attempt to define a more general convergence indicator, which reflects both national and regional convergence processes.

However, it is also clear, that for international comparison of countries, for analysis of catching-up processes, it is not enough to compare only the above described elasticity indices, as such a comparison does not show either the level of regional dispersions, or the growth rate of the national economies. If for the illustration of this fact we look at the data of Table 1, we see that from the aspect of elasticity Portugal stands at the second place right after Spain, because the regional differences did not increase in Portugal. However, this fact in itself does not take into consideration the drawbacks that in Portugal the level of regional dispersion stagnated at a not low level and also that during the subject period the convergence of national economy was hardly experienced. But in case we want to analyse the overall success of a country, it is obvious that these latter facts should be also taken into consideration (in this way a more realistic evaluation would put e.g. Portugal to a farther back position within the success rank of the countries). That means that the general convergence rate of a country should basically depend on three items:
  ⇨ convergence rate of national economy;
  ⇨ relation between the convergence of the national economy and change in regional dispersion, thus the convergence elasticity of regional dispersion;
  ⇨ average level of regional dispersion (it is not the same if the regional dispersion stagnates or changes at a high or low level).

According to my proposal the above three aspects can be used for the definition of the speed of general convergence as follows:

$$SGC = \frac{\text{Annual average speed of national economic convergence in percentage points}}{(1 + \text{convergence elasticity}) \cdot \left(\dfrac{\text{Average dispersion level of NUTS3 regions within the national economy}}{\text{Average dispersion level of NUTS3 regions within EU}} \right)}$$

The interpretation of the formula is the following. SGC = Speed of General Convergence is directly proportional to the convergence speed of the national economy, and for this reason this should be in the numerator of the formula. The denominator on the other hand includes an adjustment factor which attempts to take into consideration the level of regional dispersion within the given country and the change of this dispersion.

The value of denominator is one in case the convergence elasticity is equal to zero, that means if the catching-up of the national economy does not increase at all the dispersion among the regions (in this case the value of the first multiplication factor is one); furthermore, if at the end of the period the dispersion of GDP per capita of NUTS 3 regions of the given national economy is equal to the average dispersion of the NUTS 3 regions within the EU (in this case the value of the second multiplication factor is one). Consequently, in case the value of the denominator is one, thus the dispersion among the regions permanently stabilised at the average level experienced in the EU, the speed of general convergence is effected exclusively by the numerator, by the annual average speed of the national economy's convergence.

However, in case the convergence elasticity exceeds zero, thus if the convergence of the national economy increases the regional dispersion as well, (as it has happened according to the empirical experiences), and/or if at the end of the period the dispersion of the GDP per capita of the regions within the given national economy was higher than that within the EU average, the value of the denominator exceeds one. Consequently, the general convergence is slower than the average rate of the national GDP's convergence.

Consequently, SGC is an adjusted index showing the annual convergence rate of an emerging EU-country (in respect of the GDP per capita calculated on the basis of purchasing power parity), adjusted with the ratio of the national economy's and EU's regional dispersion and adjusted with the rate of change in regional dispersion (convergence elasticity).

Based on the Eurostat data it can be estimated that during the period of 1995-2009 the average dispersion of the EU's NUTS 3 regions was 27.5%.[3] Additionally, I made the calculation of the above defined SGC index referring to the 12 previously analysed member states in respect of the last one and a half decades. The summary of the results are shown in Table 2.

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[3] Eurostat does not keep records of the integrated dispersion index of EU, however its approximate value can be calculated by the average of the dispersion levels of the EU 24 states weighted by their number of population. (Calculation is made not using the weighted average of dispersion levels of all the 27 EU member states, because the sizes of 3 states – Cyprus, Luxemburg and Malta – do not exceed that of a NUTS 3 region, thus the dispersion index cannot be interpreted.)

Table 2

	Annual Average Speed of General Convergence (in percentage points)
Czech Republic	0.14
Portugal	0.19
Bulgaria	0.30
Romania	0.31
Greece	0.42
Latvia	0.57
Poland	0.57
Lithuania	0.72
Estonia	0.80
Slovenia	0.84
Slovakia	1.07
Spain	2.13

Resource: own calculation based on Eurostat data

In my opinion the deficiencies of the SGC index are not or at least only hardly detectable in the discussed data base (in light of the tendencies of the 12 emerging countries in the period of 1995-2009). Consequently, the index can be used quite well referring to the Central-East-European countries of the EU. However, it does not mean that the index could be well applied to any countries and under any conditions. Since the index has several theoretical deficiencies it may not be used more widely, e.g. referring to the developed EU member countries, as well.

1) The value of the convergence-elasticity (and consequently the SGC index) cannot be defined if the average GDP per capita of a national economy is not in the process of catching-up to the EU-27 average.

2) The SGC index cannot be mathematically interpreted if the convergence-elasticity is equal to minus one or if the average dispersion level of the EU or the dispersion level of the given national economy is equal to zero (because in these cases the denominator would be zero). (These mathematical clauses, however, do not have too much practical significance, as these variables are very rarely equal to zero.)

3) The value of the SGC index would show a significant distortion in case the value of the convergence elasticity was lower than minus one (and consequently the denominator showed negative value) furthermore the national economy was in lag, thus the value of the numerator was also negative. Since it would result that while there is a divergence of the given country both in the national and in regional levels, the SGC index would result in a positive value, which – in spite of the real situation – would indicate the success of the country.

4) SGC index unrealistically devaluates quasi to zero the achievements of those countries where there is no national convergence (or it is only minimally above zero), but in the meantime there is an intensive, high speed regional convergence.

Due to these deficiencies this indicator can be regarded only as a general convergence indicator of the emerging economies. (Naturally, the elimination of the above mentioned deficiencies and the further development of the SGC index can be the subject of a further research with the aim of making it applicable not only for the emerging countries.)

Conclusion – How to continue the research?

Table 2 reflects an order of success among the emerging countries of the EU. Consequently, by the creation of a new macroeconomic indicator which is capable of measuring the national convergence, the dispersion of income levels among regions and the speed of regional convergence, as well, the success of economic policies of the countries also become measurable. Namely, the countries generally follow two economic political objectives at the same time: to accelerate the national growth rate and to reduce the regional income differences. In order to achieve these objectives different governments use different instruments for their regional policy (e.g. development of infrastructure, reforms and decentralizations of education policy, technological development, stimulation of labour force mobility, or even redistribution policy supporting poorer regions, etc.), and with the help of the recently created SGC indicator it becomes easier to analyse the successfulness of the economic policies.

Consequently, it would be purposeful to continue the present research with an international comparative analysis which would introduce the economic policies that were followed in the emerging EU-countries during the last one and a half decades. Then these results could be compared and re-evaluated in the light of the SGC-indicators. Contemporarily, the practical applicability of the indicator could be also tested.

Annex

The below figures demonstrate the convergence tendencies of 12 member countries based on the time horizont of the available regional data (source: Eurostat). The continuous line on the diagrams shows how the GDP per capita of the given country varied in the percentage of the average GDP per capita of the 27 member states of the EU when calculated on purchasing power parity. While on each figure the dashed lines show the dispersion of GDP per capita of NUTS 3 regions of the given country.[4] Logically, if this dispersion increases it means that the development differences among the regions increases, thus the economies of the more developed regions grow faster, while that of the less developed ones grow slower.

The diagrams include the complete available time series. Eurostat maintains GDP data of all NUTS regions from 1995 or from 1996 till 2009 referring to most of the countries (the most recent regional GDP data refer to 2009), however in case of Poland (as the diagram shows) we have regional GDP data since 1999 only, while in case of Spain the last regional data are from 2007. Unfortunately, Hungarian tendencies could not be analysed, because in respect of Hungary the GDP data of NUTS 3 regions are available referring only to three years (2007-2009). While Cyprus and Malta are not included in the comparative analysis due to the fact that

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[4] The official methodology of the Eurostat (ESA'95) defines the dispersion of regions within the national economy as the average absolute deviation of the GDP per capita of regions from the national average, expressed in percentage. For the calculation GDP data denominated on purchasing power parity are used and the individual regions are weighed with their population. Source of the regional dispersion data:
http://epp.eurostat.ec.europa.eu/portal/page/portal/national_accounts/data/database , then on the page you have to click on the links in the following sequence: „Regional economic accounts – ESA95", „Gross domestic products indicators – ESA95", „Dispersion of regional GDP by NUTS 3 regions (%)", then at the "Select data" tab you can choose the data to be retrieved.

their territories do not exceed that of a NUTS 3 region and consequently in their case the regional dispersion index cannot be interpreted (territory of Malta is much smaller than an average NUTS3 region, and the territory of Cyprus is equal to the territory of a larger NUTS 3 region).
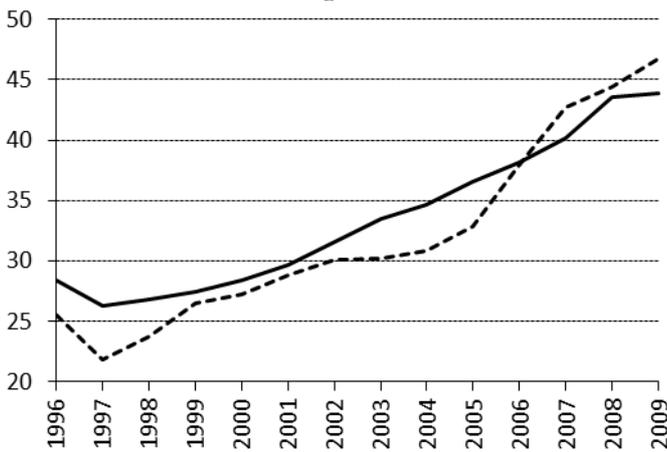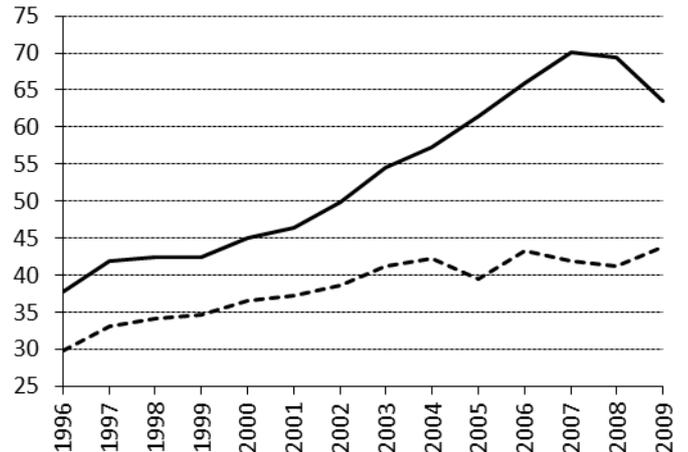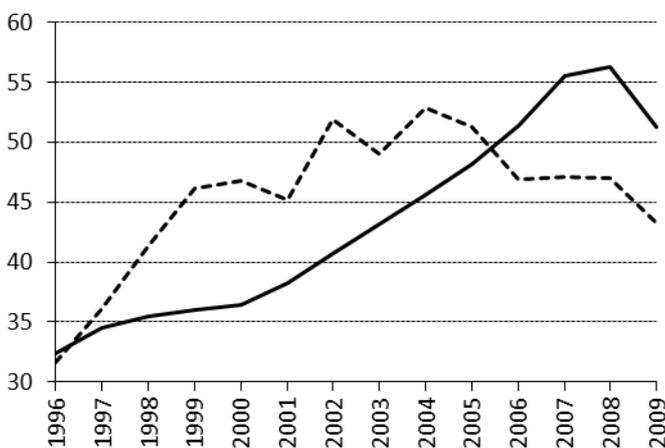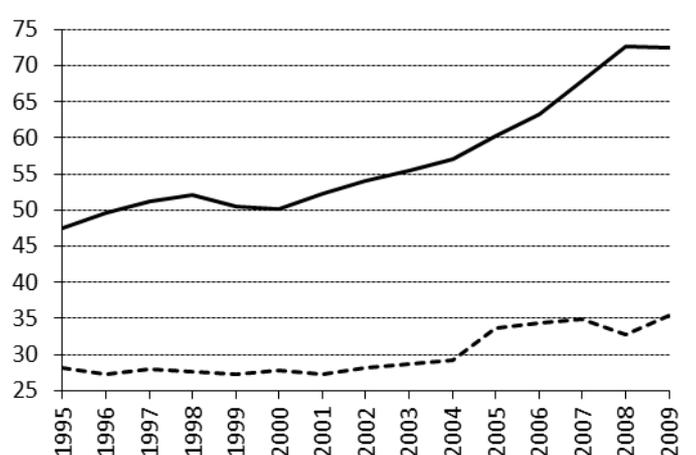
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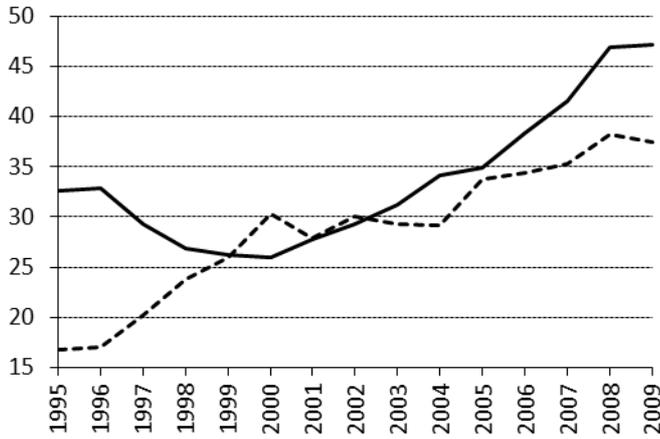
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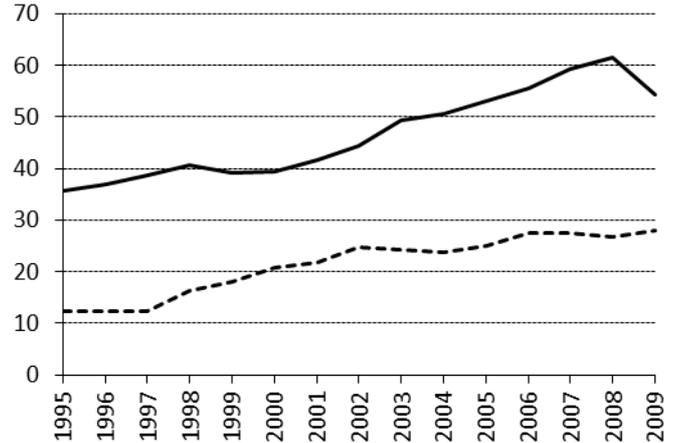
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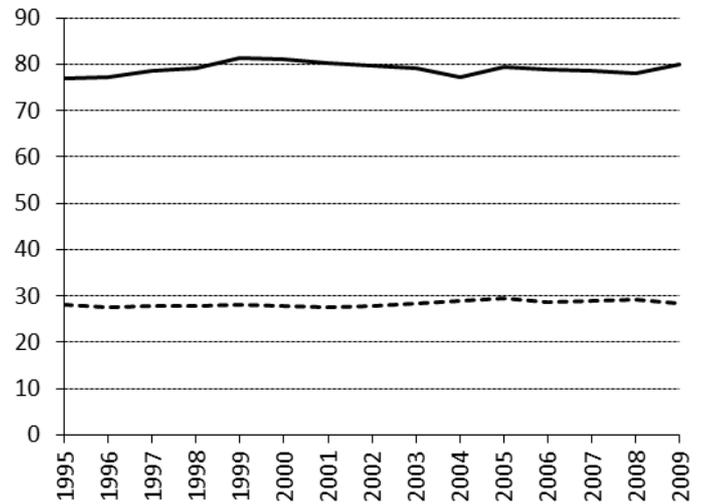
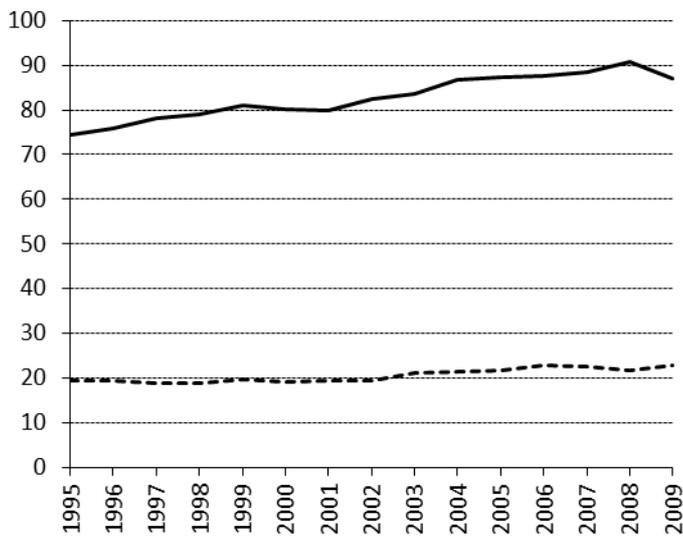**Slovakia**

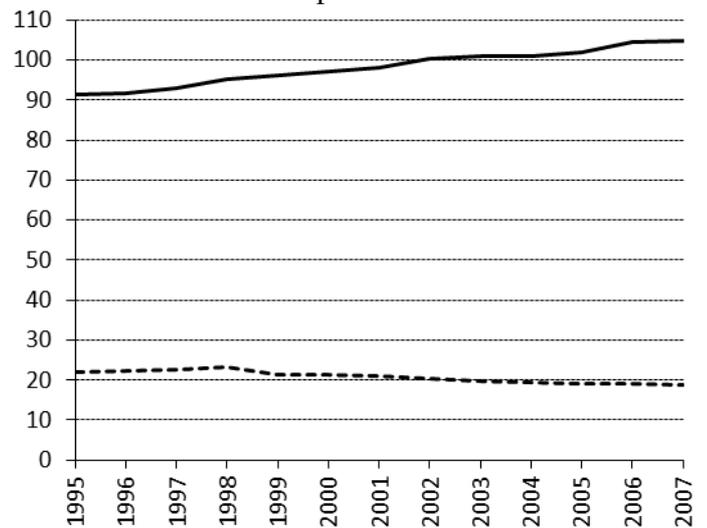### Poland
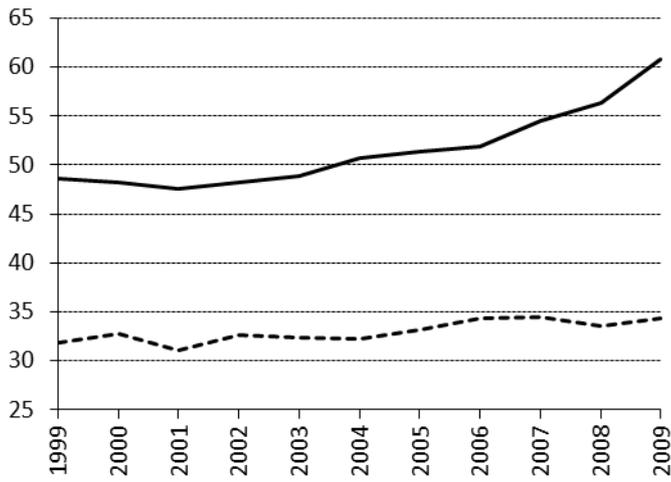
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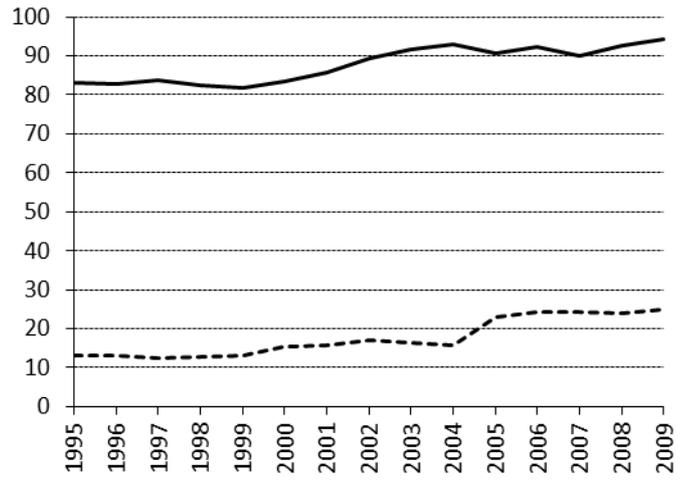
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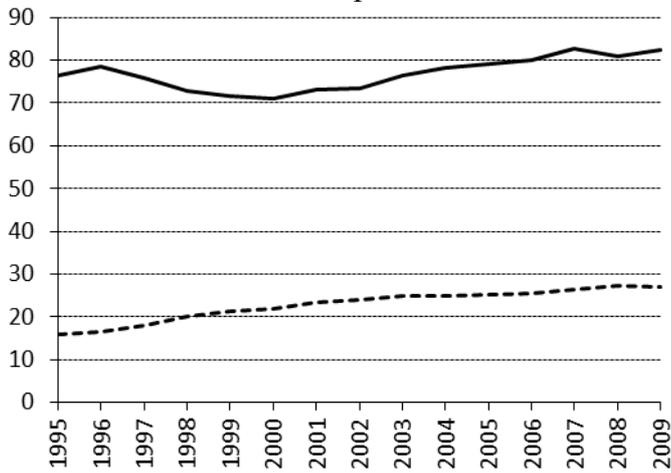
Portugal

Slovenia

Spain

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