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# Effects of the EU-Enlargement on Income Convergence in the Eastern Border Regions

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No. 383/2009

Warsaw Bishkek Kyiv Tbilisi Chisinau Minsk

The paper was prepared under the ENEPO project (EU Eastern Neighbourhood: Economic Potential and Future Development) coordinated by CASE, financed within the Sixth Framework Programme of the European Commission. The study includes some of the results of the Workpackage 2 coordinated by Norwegian Institute of International Affairs. The content of this publication is the sole responsibility of the authors and can in no way be taken to reflect the views of the European Union, CASE, or other institutions the authors may be affiliated to.



Keywords: **Income convergence; European integration; Border effects**
JEL codes: **R11, O18**


Graphic Design: Agnieszka Natalia Bury

EAN 9788371784866
Publisher:
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# Contents

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## Abstract

This paper analyses the effect of the EU enlargement process on income convergence among regions in the EU and in the Eastern neighbourhood of the EU. The data used is NUTS II regions in the EU and Oblasts' of Russia over the period 1996-2004. The estimation techniques used take into account both regional and spatial heterogeneity. The main findings are that the regional income differences are reduced within EU15. The income convergence within the EU is mainly driven by reductions in the differences across countries rather than by a reduction in regional differences within countries. When differences in initial conditions in the regions are controlled for by fixed regional effects there are strong evidences of convergence among regions in all studied country groups.

# 1. Introduction

The ongoing integration of countries within the EU reduces barriers to trade; hence improves competition in previously segmented markets. This should have contributed to higher growth and improved efficiency in the production of the EU. This may, however, also have resulted in concentration of production in areas with good market access causing income differences across regions to increase. The enlargement of the EU further increases the differences across regions within the EU, as some regions in the new member countries are relatively poor compared to the poorest regions within the pre-enlargement EU. EU regional policies have been aimed at reducing these regional differences but may also have reduced the gains from integration if they reduced the factor mobility. Moreover, improvements in infrastructure, for example, will have the same effect on production patterns as other reductions in trade costs and might therefore re-enforce a core-periphery pattern of production. The financial integration among the Euro countries should have increased the possibility for income and growth convergence as capital can move more easily from capital-rich to capital-poor countries.

Empirical findings, suggest that there is a strong correlation between the income levels and growth in one region and its neighbourhood; hence the localisation of a region is an important factor in determining its development prospects. The enlargements of 2004 and 2007 have altered the pattern of income distribution in the EU from a North-South dimension to a North-West-East dimension (Ertur & Koch 2006). The issue of income and growth convergence in the EU has been studied in the context of the old EU members (EU15) by Maurseth (2001) who found that the European integration has contributed to convergence in incomes and growth rates. This convergence has reduced the core-periphery pattern in distribution of per capita income in the EU but the same is not true for regions within countries (Combes & Overman 2004). Paas and Schlitte (2006) include the 10 EU new member states (as of 2004) into their analysis. They show that there are significant differences across regions within the EU-25 and that the convergence of the new member states towards other EU countries seems to be driven by a few concentrated growth areas.

The enlargements of the EU have widened the income differences within the EU and the spatial distribution of economic activity within countries seems to differ between the old and new members states, with a more concentrated production in the latter (Brulhart & Koenig 2006). Further, as a result of spatial dependencies among regions it is likely that the enlargement of the EU may have quite different effects in a Polish region close to the German border than in a region on the border to Russia (Kaliningrad). There are some facts

indicating that border regions towards non-EU members in the new member states (NMS) may be less attractive for foreign investors than other regions (see for example (Cieslik 2005)).

Regions in countries outside the EU could gain from economic growth in the NMS but they could also be affected negatively if the new EU border reduces the economic contacts with the NMS. The present paper analyses the effects of the EU enlargement process on income and convergence in the EU and its Eastern neighbourhood. Firstly, the pattern of income distribution across regions in Europe is described to highlight differences across countries. Secondly, conditional convergence and unconditional convergence of income across countries and within countries are analysed. Thirdly, the impact of borders on the geographical distribution of income and growth in the EU and the CIS countries is studied. The results are corrected for both spatial dependencies across regions and heterogeneity among countries using the panel dimension of the data set.

The paper uses a sample of regions within the EU (NUTS2), Russia (Oblast') and other CIS countries over the period 1996-2004.[1] This implies that we cannot directly analyse the effect of the enlargements. However, the new member countries were gradually integrated with the EU in the studied period. The Europe Agreements signed in the first half of the 90s stipulated that tariffs and other similar trade barriers should be removed before 2004 and that the new member states should gradually adjust to EU institutions, regulations and standards. These measures reduced trade costs between the EU and the new member states before they became members and the anticipated membership in the EU also contributed to a reduction in the investment risk. It is therefore valid to study the effects of the integration process as they are a result of the enlargement of the EU. The actual membership induced additional changes, for example, the implementation of the common external tariff which may have reduced trade with non-EU countries in the case of countries with initial liberal trade policy but for other countries the tariff towards non-EU countries were reduced. The membership deepens the integration with the old EU member states as firms in the new member states do not need to comply with rules of origin when exporting to other EU countries and competition may increase as all rules of the internal market is implemented. In addition, it has become easier to move within the EU which may contribute to convergence of incomes if workers move to regions with high wages. That is, we should expect the membership in the EU to affect income growth and convergence in the enlarged EU but regional data for the years after 2004 was not available.

[1] The CIS countries are: Armenia, Azerbaijan, Belarus, Georgia, Kirgizia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Turkmenistan, Ukraine and Uzbekistan.

## 2. Theoretical considerations

Theoretical models both within the new economic geography and the macroeconomic literature give inconclusive predictions on the effect of economic integration on income distribution and growth. In the traditional neo-classical growth model, (Solow 1956), where technological change is exogenous and the same technology is available to all countries, capital inflows to capital-poor countries would result in a faster growth due to diminishing returns to capital. The model predicts unconditional (absolute) convergence of both growth rates and income levels given that countries/regions have identical production functions. This convergence process should be even faster in the context of monetary integration e.g. EMU as it would reduce the transaction cost and uncertainty and should thus have increased the capital flows to capital-poor countries with relatively high marginal return to capital. The traditional interpretation of the new growth theory is that it predicts divergence of income and growth as growth is determined by investments in knowledge and the knowledge sector shows increasing returns to scale. However, as a result of the development of the neo-classical growth theory and the new growth theory it is now possible to explain both convergence and non-convergence by both these models (Islam 2003). Turning to new economic geography models (Krugman 1991), the effect of economic integration on income distribution depends on the initial trade costs and the trade costs after integration. All high trade costs industries are localized in countries/regions in proportion to their size. As trade costs are reduced firms tend to reallocate to locations with good market access; hence a core-periphery pattern of production will appear. The real wages of workers in the core will be higher than in the periphery as demand for production factors increases in the core and drives up the factor prices. If trade costs are further reduced some firms will reallocate from the core to the periphery to be able to reduce their costs. In this case the integration would result in a reduction of the differences in income across regions. The foundation of the new economic geography models explaining these effects are increasing returns to scale and a market with monopolistic competition. In a new economic geography model explicitly considering the effect of the regional allocation of the domestic production Brulhart et al. (2004) find that trade liberalisation will increase the attractiveness of the periphery and that this effect will be stronger the bigger the foreign country. This implies that the integration of the NMS into the EU should have increased the attractiveness of border regions towards the EU in the NMS relatively more than it would for border regions in the pre-2004 member states. Even though the attractiveness of border regions increases, the production will concentrate in the core only if a sufficient share of the production is located in the core prior

to the trade liberalisation; hence the actual outcome of integration on the location of production is an empirical question.

Convergence could be either strong (absolute) or weak (conditional).[2] Absolute convergence would imply that countries converge to the same income levels and growth rates. As initial conditions vary across regions absolute convergence will not be feasible in short term (as the one studied in this paper). Conditional convergence implies that countries approach their own steady-state growth trajectory given by the initial conditions. In the long run these conditions and the steady-state income levels and growth rates can be affected by economic policy and reallocation of resources. These two convergence hypotheses can be put against two similar hypotheses on non-convergence. According to the hypothesis of strong non-convergence the agglomeration effects (increasing returns to scale and externalities) are strong and reduction in barriers to trade are likely to result in concentration of production in the core. The weak non-convergence assumes that externalities and increasing returns to scale will give regions with strategic resources an advantage over other regions that cannot exploit the gains from these externalities. This hypothesis implies that regions with similar initial conditions will converge but regions with different initial conditions will not converge (club-convergence).

## 3. Methodology and Data

The most commonly used measures of convergence in the literature are the so called beta- and sigma-convergence. The former measures to what extent relatively poor regions grow faster, that is, catching-up while the latter measures the dispersion of income levels or growth rates. Both measures can be used to examine absolute or conditional convergence. Although convergence is a statement about the dispersion of income or growth as noted by, among others, Quah (1993) beta-convergence is interesting as it reveals information on the relative growth of initially poor regions. Moreover, beta-convergence is a necessary but not sufficient condition for sigma-convergence. Several studies use cross-section data to investigate convergence but it has been argued that cross-section studies of unconditional convergence may be affected by Galton's fallacy and cross-section estimates are therefore not reliable (Quah 1993).[3] Moreover unobservable heterogeneity will bias the cross-section

[2] For a discussion on different concepts of convergence see Islam (2003).

[3] Galton's fallacy states that a poor performance would be more likely to be followed by a better performance. In our case this may imply that initially poor regions (performed poor in the past) would have a larger probability to grow relatively fast.

estimates.[4] To reduce this problem the present study uses panel data techniques to test for convergence. Including fixed- or random-region effects will allow us to control for time-invariant factors specific to each region and thereby reduce the problem of omitted variables.

Both the new economic geography and the new growth theory indicate that spatial interactions between regions have an important role in determining the outcome of economic integration in terms of income levels and growth. This is also strongly supported by recent empirical findings of Carrington (2003) and Ertur and Koch (2006). Failing to control for spatial dependencies would result in OLS producing biased and inconsistent estimates (see Florax and de Graaff (2004) for a discussion).

The database used in this study covers a relatively short time-period (1996-2004) while convergence is a long-run phenomenon. However, limitations in data quality and availability do imply that a longer time-period cannot be used to study EU and the Central- and Eastern European countries. The database covers regions (NUTS-2) in all current EU-member countries and Russia (Oblast')[5]. In addition, CIS countries (excl. Russia) and EFTA countries (Iceland, Norway and Switzerland) are included but each country is treated as a single region. The data is compiled from Eurostat's (2007) Regio-database, the World Bank's (2007) World Development Indicators and Goskomstat's "Regions of Russia" (various issues).

The data from Eurostat is not comparable to the data reported by the World Bank and Goskomstat. For example, GDP is recorded in different currencies and the conversion from nominal to real terms differs. To overcome this difficulty the regional data have been used to calculate regional shares of national data and then country level data from the World Bank (2007) has been allocated to each region in proportion to its relative size. As a result of lack of observations for a sufficient number of regions a large number of relevant variables had to be discarded from the data set, for example indicators of R&D. The main aim of the analysis is to identify the effect of the European integration on the regional level, so as many regions as possible should be included. To control for differences in initial conditions across countries a set of dummy variables has been constructed.

The data shows that there are large differences across regions and countries. Table 1 illustrates the large differences in income per capita across regions within country groups. In the full sample the difference between the poorest region and richest one in 1996 is approximately 358 times but it decreases to 299 times in 2004. The differences are rather constant within country groups with a slight reduction within the entire EU25. Russia, on the contrary, displays increasing differences between the richest and the poorest region. This is

[4] For a more extensive discussion of the benefits and limitations of using panel data see Arbia et al. (2005).
[5] Note that Moscow and St. Petersburg have been included in Moscow oblast and Leningradskaya oblast, respectively.

not so surprising since the relatively high oil prices tend to increase incomes in the oil rich regions and Moscow. The difference between the richest and poorest regions indicates that regional differences in Russia are rather large when compared to the EU15 and EU25 (at the end of the sample period). Comparing the richest and the poorest region does not provide any conclusive evidence on regional differences but rather an indication of their magnitude.

To enable a discussion on the regional distribution of the economic activity within Russia and EU27 Figures 1 and 2 illustrate the initial real GDP per capita and its growth. The maps in Figure 1 clearly demonstrate the importance of resources such as oil and gas in explaining regional distribution of income in Russia. The richest regions are all resource rich except for Moscow and all they are located to the East of Moscow.[6] Most of the poorer regions are situated in the South-West of Russia. The growth in GDP per capita does not show any clear relationship with the initial income levels. Some rich regions grow relatively fast, most notably Tyumen', but also some poor regions grow relatively fast, for example, Dagestan. The most resource rich regions, however, grow faster than the average and it is worth noting that this is also the case for most districts in the Western Russia.

In the EU/EFTA the initial income (GDP per capita) distribution shows a clear pattern. The richest regions are in the North-West (Germany, UK, France, and Norway) and the poorest regions are in the East and South. The growth pattern is reversed since the highest growth is in the East in Ireland and in parts of Spain and Greece. Growth in Germany, on the other hand, has been rather slow. UK has a relatively high growth rates but within the UK and Italy the regional inequality is increasing during the period 1996 to 2004. The richer regions in England are growing faster than poorer regions in England and Wales and this pattern is even stronger in Italy despite efforts of the EU regional policies to reduce differences across regions. The border regions towards non-EU countries all grow relatively fast but they were also relatively poor in 1996. Based on the descriptive statistics illustrated by the maps we cannot, thus, draw any conclusions about the relative development in border regions. In the next section we will test whether regions converge and whether the external border of the EU affected growth in the border regions.

[6] The GDP per capita in Moscow is higher than in the Moscow district, thus if Moscow would be reported separately the difference in GDP per capita between Moscow city and the rest of Russia, except Tyumen', would have been larger.

# 4. Empirical Results

In order to analyse the evolution of regional incomes per capita the following regression is estimated:

$$\Delta Y_j = \beta \ln Y_{jt} + \sum_i \alpha_i d_i + \varepsilon_j \quad (1)$$

$$\Delta Y_j = \ln Y_{jt+8} - \ln Y_{jt}$$

where $Y_j$ is real gdp per capita in region *j*, d is a set of country dummy variables included in the estimations of the conditional convergence. Other explanatory variables which could capture region-specific factors have not been included as a result of the lack of consistent data for a sufficiently large sample. We have tried, however, to include population and population density to capture the market potential of each region but these variables where mostly insignificant and did not affect our key variables and have therefore not been included in the baseline model presented. If convergence is evident we would expect the estimated beta to be negative since that would imply that relatively poorer regions growth faster than relatively rich regions. It is not plausible to expect absolute convergence in the full sample of regions and countries as the initial conditions vary a lot and the economies are not fully integrated. Within countries or well integrated groups of countries convergence is more likely since economic and political conditions may be more similar.

The regression results are presented in Table 2 where the first four columns test for absolute convergence. Indeed, they indicate that there are no significant changes in income differences across all countries and regions. In addition, the r-squared indicates that the regression including all countries and regions does not provide much information at all. In the EU, however, there is evidence of significant convergence both within the EU15 and the EU25 and the explanatory power of these regressions is in line with previous studies (see for example Paas and Schlitte (2006)). Turning to Russia there is no evidence of absolute convergence as the estimated coefficient is positive and not significant. These estimates do not take into account that regions are heterogeneous and this would make convergence less likely. In an attempt to control for some of the heterogeneity country dummy variables have been included in the regression. As argued above regions within one country are believed to have more similar conditions than regions in different countries. This is also indicated by the fact that the difference between the richest and poorest region across groups of countries (presented in Table 1) is much larger than the same difference within individual countries (see Table A1).

After including country dummy variables into regression the estimates in columns five to eight in Table 2 show less evidence of convergence. This might imply that the reduction in income differences is a result of a reduction in differences across countries but within individual countries the differences across regions are not decreasing at the same speed even though the results still indicate convergence across regions within the EU15 (which is the most integrated group of countries). The presence of beta-convergence shows that initially poorer regions grow faster than initially richer regions but it does not necessary imply that the differences across regions have been reduced. Therefore it is useful to look at the variation in income per capita across regions over time, the so-called sigma convergence, which is measured by the standard deviation of income per capita across regions.

Figure 3 shows the evolution of the standard deviation of the log of income per capita for four groups of countries (all, EU25, EU15 and Russia). The figure shows that the differences in income across regions have been reduced except for Russia. This confirms our previous results on absolute convergence. These results may be biased if regions are affected by the economic growth in neighbouring region. Spatial dependencies will cause the OLS results to be biased. Test for spatial dependencies presented in Table 3 indicates that there is a strong correlation between both the income and growth of income in a region and its neighbours. This means that richer regions tend to be clustered together.

The spatial dependencies can be handled by using either a spatial error model (SEM) or a spatial lag model (SLM). The spatial weight matrix (w) used to estimate the spatial models is based on the great circle distances between regional centres. The rows in the weight matrix are standardized so that each row sum to one. That is, the further away two regional centres are from each other the less the regions are assumed to affect each other. Formally the SLM estimated is

$$\Delta Y_j = \beta \ln Y_{jT} + \sum_i \alpha_i d_i + \rho \sum_{j=1}^{n} w_{i,j} \ln \left[ \frac{Y_{jT+8}}{Y_{jt}} \right] + \varepsilon_j, \qquad (2)$$

$$\Delta Y_j = \ln Y_{jT+8} - \ln Y_{jt}$$

where $\rho$ is the coefficient of the spatial lagged growth rate, included to capture the effect of growth in the neighbouring regions. The size of the estimated spatial coefficient rho will indicate the importance of spillover effects across regions. The included spatial effects are assumed to capture all spatial dependence; hence the error term should be normally distributed and independent of the growth rate. The SEM leaves the model unchanged but handles the spatial dependencies by allowing for them in the error term

$$\Delta Y_j = \beta \ln Y_{jT} + \sum_i \alpha_i d_i + \varepsilon_i$$

(3) $$\Delta Y = \ln Y_{jT+8} - \ln Y_{jT}$$

$$\varepsilon_i = \lambda \sum_j w_{i,j} * \varepsilon_{ij} + u_i$$

where $u_i$ is assumed to be independent and normally distributed. The estimated lambda from the SEM does not have a straightforward interpretation like rho in the spatial lag model.

In Table 4 results for both these models are shown.[7] The estimated beta-coefficients for the EU (EU15 and EU25) and Russia are similar in size and significance to the OLS results. That is they indicate significant absolute convergence across regions in the EU and no convergence in Russia. In the full sample, however, the SEM estimates seems to indicate significant convergence, this result is not confirmed by the SLM estimates. These estimates reduce the problem with spatial dependencies but they do not solve possible omitted variable bias resulting from regional heterogeneity not controlled for. Moreover the spatial effects indicated may also capture part of the regional heterogeneity rather than the true spatial dependence. In order to reduce these problems once again the model is re-estimated with the inclusion of country dummy variables. The results shown in Table 5 are interesting in several ways. First, they show that the estimated spatial dependence is reduced when country specific factors are controlled for as rho in the SLM model is insignificant in most cases (the exception is the full sample). Secondly, the beta coefficients are insignificant except for the EU15. The studied period (1996-2004) is characterized by the integration of the Central- and Eastern European countries into the EU and the deepening of the integration within EU15. This deeper integration may explain the reduction in the income differences across regions. Also by comparing these results to the absolute convergence results in Table 4 it is possible to conclude that the reduction in the absolute differences across regions in EU25 is mainly a result of a reduction in the differences across countries rather than across regions within countries. These findings are similar to the findings of Paas and Schlitte (2006). In addition several studies have found that convergence of CEECs with the EU is driven by a reduction in differences at the national level but that regional differences within the CEECs have increased.[8]

Country dummy variables seem to capture some differences across countries but they do not fully account for differences in the initial conditions across regions. One way to capture these differences is to estimate the convergence regression (1.1) using panel data estimators. We use the fixed effect estimator since the random effect model is rejected when

[7] The estimation is carried out in Stata using Pisati's ado-files for spatial econometrics.
[8] see Mechior (2008) for a detailed discussion.

tested.[9] The fixed regional effects capture differences in conditions across regions that are more or less constant over time. Since the studied period is quite short it is also likely to capture some of the differences in human capital and industrial structure. In addition, time fixed effects are included to control for changes common to all regions such as for example global business cycles. Fixed effects with short periods (one year) between the observations will not fully capture the long run effects. For this reason the model is also estimated with growth over three year periods. The panel estimates, presented in Table 6, shows strong evidence of convergence after regional heterogeneity has been controlled for by means of including spatial lags of other countries GDP per capita weighted by distances. The results for one year and three year intervals are similar. This indicates that given similar conditions the poorer regions are growing faster than the richer regions. The panel estimates do not take possible spatial heterogeneity into account but given that the country dummy variables used in the above regressions tended to reduce the estimated spatial dependencies it is likely that the region fixed effects will reduce the problems with spatial dependencies even more. This is confirmed by our panel estimates where the coefficient on neighbouring countries GDP per capita is insignificant (see appendix table A2) and the estimated coefficients are virtually the same as without the spatial lag of GDP per capita. A serious drawback of the fixed effect estimator constructed for the purpose of this paper is that the border effects can not be estimated with the fixed effect model.

To see the effects of the European integration on border regions of the EU and border regions of countries outside the EU the SEM-model is estimated with added dummy variables for border regions. The border regions outside the EU could be affected in a negative way if the trade costs between them and the new EU-members are increased.[10] On the other hand, if border regions in the new member states grow faster this could also have a positive effect on growth in the border regions in neighbouring countries. To analyse how border regions have developed compared to other regions a set of dummy variables is included in the regression. The four dummy variables are EU-out for regions outside the EU with a land border to the EU25, EU-in for regions in the EU25 on the border towards a non-member/non-EFTA country, EU15-out is one for regions in the EU25 with a land border to an EU15 country and EU15-in is a region in the EU15 with a land border to a non-member/non-EFTA country (regions in Greece, Italy and Germany). A positive coefficient will be interpreted as indicating that the relevant group of regions has grown faster than the average region given its initial income. The SEM is used to handle possible spatial dependencies.

[9] The random effect model is tested and rejected by a Hausman test.
[10] Strictly speaking our estimates covers the period before the 2004 enlargement of the EU. Trade costs between border regions outside the new member states and the new member states may still have increased in the accession period as regulations and in some cases tariffs were adjusted towards the EU-level.

The estimation results in Table 7 indicate that the border regions in the new member states and in non-member countries have grown relatively fast, that is, they do not seem to have disadvantaged by the integration process but the results should be interpreted with caution since many other factors, not controlled for, can affect economic growth. Within the EU15 we have seen that regions tend to converge but border regions of EU15 seems to grow slower than other regions. But after allowing for differences across countries the border regions are not significantly different from other regions in their countries; hence it seems that it might be countries rather than individual regions growing faster in Eastern and Central Europe explaining the convergence within EU25

## 5. Summary and Conclusions

This paper uses regional data from the EU and Russia and country data from EFTA and CIS countries covering 1996-2004 to analyse how the European integration process has affected income differences across regions and whether border regions in the EU and outside EU are affected in a different way from regions in the core of the EU and further away from the EU. Border regions outside the EU may have been adversely affected if the trade costs across the new EU borders were higher than they were across the national borders but they could also have been affected positively as higher growth in neighbouring regions tend to have a positive impact on the region.

The estimation techniques implemented in this paper allow for differences across countries and deal with both regional heterogeneity and spatial dependencies. It is important to control for spatial dependencies across regions since the estimates will be biased if spatial dependencies are not controlled for. The results in this paper indicate that it is sufficient to control for differences in initial conditions across regions to overcome the problems with spatial dependencies. Once regional heterogeneity is controlled for by introducing fixed regional effects we found no evidence of spatial dependencies. However, it is possible that other spatial dependencies than those modelled in this paper are present.

The results show that the income inequality across regions is relatively large in the full sample and in Russia but smaller in the EU15. Furthermore, the differences across regions in the EU15 are becoming smaller. In Russia there is no evidence of absolute convergence even though from a theoretical point of view absolute convergence is more likely within countries than across countries. The income convergence in the EU seems to be driven by a reduction in differences across countries since the significance of the convergence vanishes once differences across countries are controlled for by including country dummy variables. It

is also worth noting that, by large, the convergence results for the EU countries are consistent across the different estimation techniques (OLS and the spatial econometrics). When differences across regions are captured by fixed regional effects the results give strong support to the hypothesis of income convergence in both the EU and Russia. However, these panel data results on conditional convergence does not indicate that the regions are becoming more similar but rather that if two regions have the same initial conditions they will become more similar. In reality there are vast differences in initial conditions across regions.

Analysing absolute convergence, we conclude that border regions outside the EU and in the new member countries (as of 2004) grow faster than other regions, while border regions in the EU15 towards non-member/EFTA countries grow slower. However, after controlling for differences across countries it is shown that the border regions are not developing significantly different from other regions in their country.

# 6. Tables and Figures

**Table 1.Differences in income per capita richest/poorest region**

| Year | All | EU25 | EU15 | RU |
|---|---|---|---|---|
| 1996 | 358.47 | 19.98 | 7.50 | 20.35 |
| 1997 | 370.68 | 19.65 | 7.03 | 18.45 |
| 1998 | 371.18 | 19.41 | 7.02 | 18.23 |
| 1999 | 375.80 | 20.30 | 7.15 | 16.93 |
| 2000 | 366.03 | 20.65 | 8.09 | 19.28 |
| 2001 | 348.09 | 20.17 | 8.12 | 23.55 |
| 2002 | 334.02 | 20.18 | 8.35 | 36.93 |
| 2003 | 314.76 | 20.20 | 8.24 | 35.81 |
| 2004 | 294.98 | 19.62 | 8.27 | 45.60 |

Own calculations using Eurostat (2007) and Goskomstat (various issues)

**Table 2. Convergence in real income (OLS)**

| Sample | ALL | EU15 | EU25 | RU | ALL | EU15 | EU25 |
|---|---|---|---|---|---|---|---|
| Real gdp per capita 1996 | -0.049*** | -0.045* | -0.079*** | 0.088 | 0.049 | -0.054* | -0.014 |
| | [0.007] | [0.024] | [0.011] | [0.065] | [0.044] | [0.029] | [0.029] |
| Constant | 0.638*** | 0.593** | 0.933*** | -0.354 | 0.229 | 0.678** | 0.706*** |
| | [0.064] | [0.238] | [0.104] | [0.460] | [0.217] | [0.292] | [0.225] |
| Country dummy variable | No | No | No | No | Yes | Yes | Yes |
| Observations | 340 | 203 | 244 | 77 | 340 | 203 | 244 |
| Moran-I | 4.609*** | 9.618*** | 10.84*** | 0.474 | 0.598 | 1.546 | 1.489 |
| R_LM-error | 20.00*** | 6.802*** | 36.35*** | 2.250 | 2.000 | 0.402 | 0.0140 |
| R_LM-lag | 7.155*** | 0.0859 | 0.506 | 2.497 | 4.895** | 1.666 | 1.172 |
| BIC | -407.0 | -411.8 | -457.9 | -29.22 | -435.9 | -458.6 | -532.5 |
| AIC | -414.667 | -418.475 | -464.929 | -33.907 | -512.514 | -504.973 | -595.466 |
| Adjusted R-squared | 0.185 | 0.025 | 0.237 | 0.035 | 0.379 | 0.392 | 0.565 |

Robust standard errors in brackets: *** p<0.01, ** p<0.05, * p<0.1

**Table 3. Test for spatial heterogeneity**

| Variables | Morans-I | E(I) | sd(I) | z | p-value* |
|---|---|---|---|---|---|
| Real gdp per capita 1996 | 0.611 | -0.003 | 0.013 | 47.846 | 0.000 |
| Change in real gdp per capita | 0.116 | -0.003 | 0.013 | 9.275 | 0.000 |
| Real gdp | 0.167 | -0.003 | 0.013 | 13.221 | 0.000 |

*1-tail test

**Table 4. Absolute convergence in real income correcting for spatial dependencies**

| | All | | EU25 | | EU15 | | RU | |
|---|---|---|---|---|---|---|---|---|
| Variable | SEM | SLM | SEM | SLM | SEM | SLM | SEM | SLM |
| GDP per capita 1996 | -0.023** | -0.004 | -0.085*** | -0.065*** | -0.051* | -0.037 | 0.084 | 0.091 |
| | [0.010] | [0.005] | [0.013] | [0.011] | [0.029] | [0.024] | [0.058] | [0.062] |
| Constant | 0.500*** | 0.108** | 1.011*** | 0.655*** | 0.671** | 0.392 | -0.912 | -0.918 |
| | [0.137] | [0.050] | [0.142] | [0.109] | [0.280] | [0.245] | [0.810] | [0.871] |
| Lambda | 0.836*** | | 0.886*** | | 0.858*** | | -0.320* | |
| | [0.100] | | [0.111] | | [0.138] | | [0.181] | |
| Sigma | 0.134*** | 0.137*** | 0.088*** | 0.089*** | 0.081*** | 0.081*** | 0.186*** | 0.187*** |
| | [0.008] | [0.008] | [0.006] | [0.006] | [0.007] | [0.007] | [0.015] | [0.015] |
| Rho | | 0.714*** | | 0.854*** | | 0.858*** | | -0.320 |
| | | [0.135] | | [0.129] | | [0.135] | | [0.196] |
| Observations | 340 | 340 | 244 | 244 | 203 | 203 | 77 | 77 |
| Wald | 69.70 | 28.04 | 64.10 | 43.85 | 38.68 | 40.18 | 3.131 | 1.202 |
| LM | 58.71 | 65.53 | 45.52 | 18.88 | 36.58 | 31.76 | 1.457 | 2.670 |

Robust standard errors in brackets ** p<0.01, ** p<0.05, * p<0.1

**Table 5. Conditional convergence in real income correcting for spatial dependencies**

| | All | | EU25 | | EU15 | |
|---|---|---|---|---|---|---|
| Variable | SEM | SLM | SEM | SLM | SEM | SLM |
| GDP per capita 1996 | 0.051 | 0.046 | -0.014 | -0.016 | -0.053** | -0.054** |
| | [0.038] | [0.040] | [0.026] | [0.028] | [0.026] | [0.027] |
| Constant | 0.376 | 0.543** | 0.311 | 0.377 | 0.694*** | 0.762** |
| | [0.231] | [0.237] | [0.259] | [0.307] | [0.261] | [0.299] |
| Lambda | -0.586** | | -1.030 | | -0.729 | |
| | [0.263] | | [1.029] | | [0.925] | |
| Sigma | 0.105*** | 0.106*** | 0.066*** | 0.066*** | 0.065*** | 0.065*** |
| | [0.007] | [0.007] | [0.005] | [0.006] | [0.006] | [0.006] |
| Rho | | -0.486** | | -0.307 | | -0.422 |
| | | [0.215] | | [0.479] | | [0.597] |
| Observations | 340 | 340 | 244 | 244 | 203 | 203 |
| LM | 11.73 | 9.075 | 0.975 | 0.372 | 0.759 | 0.551 |
| Wald | 4.951 | 5.111 | 1.002 | 0.411 | 0.620 | 0.500 |

Robust standard errors in brackets ** p<0.01, ** p<0.05, * p<0.1 All regressions include country dummy variables not reported.

**Table 6. Panel data estimation of convergence**

| Sample | All | All | EU25 | EU25 | EU15 | EU15 | RU | RU |
|---|---|---|---|---|---|---|---|---|
| Time between obs. | 1 year | 3 years | 1 year | 3 years | 1 year | 3 years | 1 year | 3 years |
| GDP/capita | -0.333 | -0.580 | -0.230 | -0.383 | -0.271 | -0.436 | -0.456 | -0.660 |
| | [0.033] | [0.072] | [0.026] | [0.046] | [0.030] | [0.054] | [0.041] | [0.122] |
| Constant | 2.949 | 5.264 | 2.250 | 3.720 | 2.703 | 4.333 | 3.385 | 4.909 |
| | [0.295] | [0.644] | [0.247] | [0.445] | [0.293] | [0.528] | [0.300] | [0.876] |
| Observations | 2768 | 1036 | 1952 | 732 | 1624 | 609 | 616 | 231 |
| Groups | 348 | 348 | 244 | 244 | 203 | 203 | 77 | 77 |

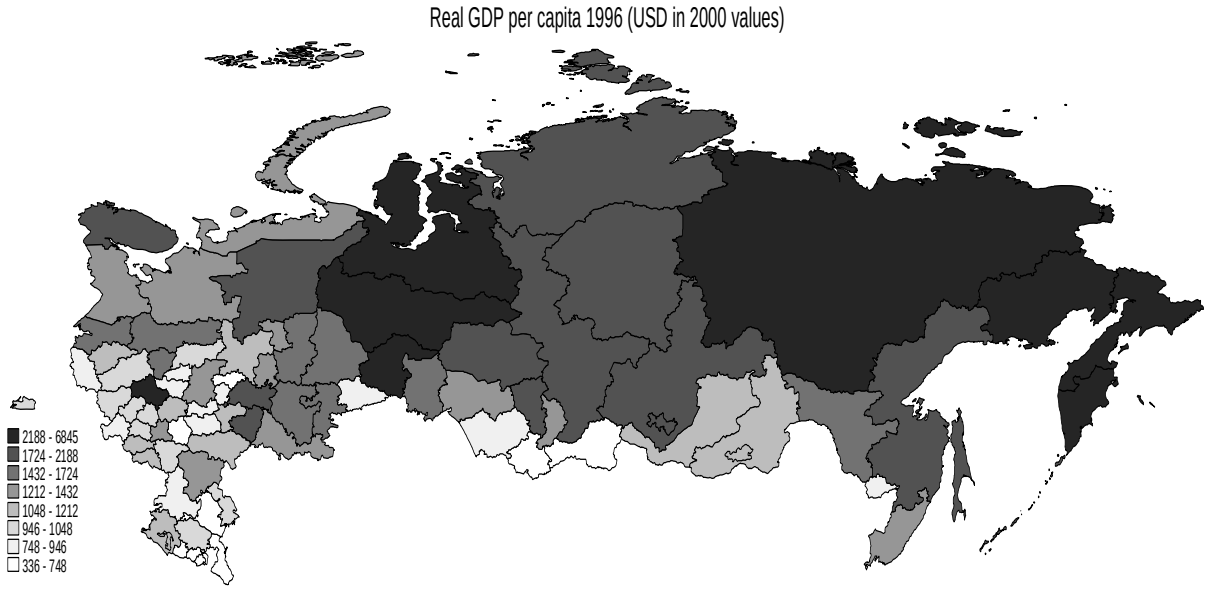
All coefficients are significant at 1 %. Time dummy variables are included in the regression but not reported.

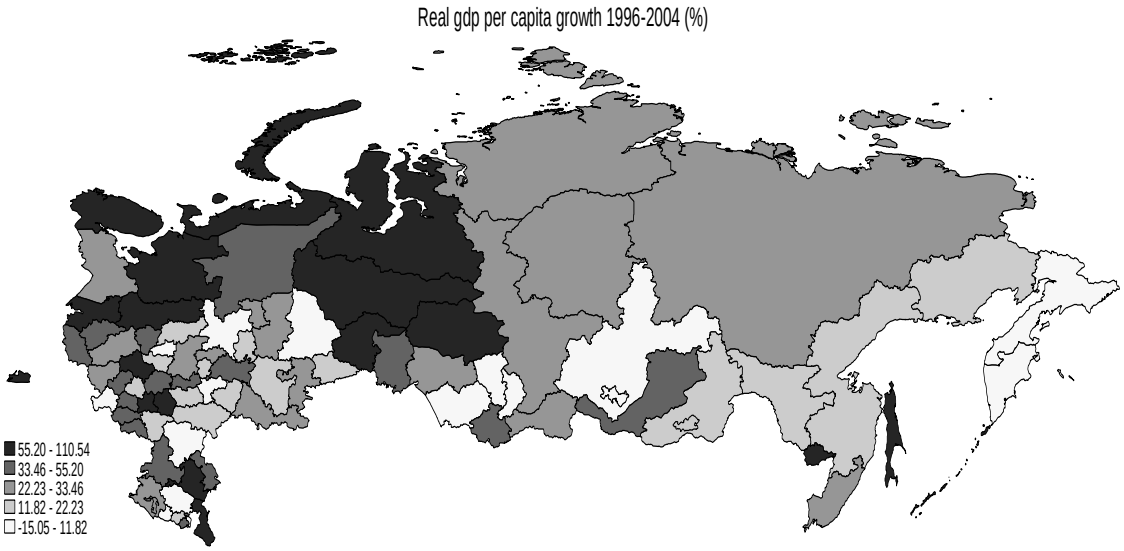
**Table 7.Border effects on income convergence**

| Sample | All | All | EU25 | EU25 |
|---|---|---|---|---|
| Real GDP per capita 1996 | -0.043*** | 0.047 | -0.082*** | -0.014 |
| | [0.008] | [0.040] | [0.014] | [0.026] |
| EU_out | 0.124** | 0.097 | | |
| | [0.052] | [0.075] | | |
| EU_in | 0.055* | -0.044 | | |
| | [0.029] | [0.029] | | |
| EU_out15 | 0.053* | -0.002 | 0.030 | 0.002 |
| | [0.030] | [0.026] | [0.035] | [0.024] |
| EU_in15 | -0.054** | 0.016 | -0.028 | 0.001 |
| | [0.023] | [0.023] | [0.020] | [0.024] |
| Constant | 0.582*** | 0.401 | 0.980*** | 0.311 |
| | [0.077] | [0.245] | [0.150] | [0.265] |
| Lambda | 0.135 | -0.447 | 0.878*** | -1.034 |
| | [0.206] | [0.323] | [0.119] | [1.041] |
| Sigma | 0.128*** | 0.105*** | 0.088*** | 0.066*** |
| | [0.008] | [0.007] | [0.006] | [0.005] |
| Country Dummy variables | No | Yes | No | Yes |
| Observations | 340 | 340 | 244 | 244 |
| LM | 0.731 | 5.608 | 36.99 | 0.966 |
| Wald | 0.432 | 1.917 | 54.11 | 0.987 |

*** p<0.01, ** p<0.05, * p<0.1 Robust standard errors in brackets

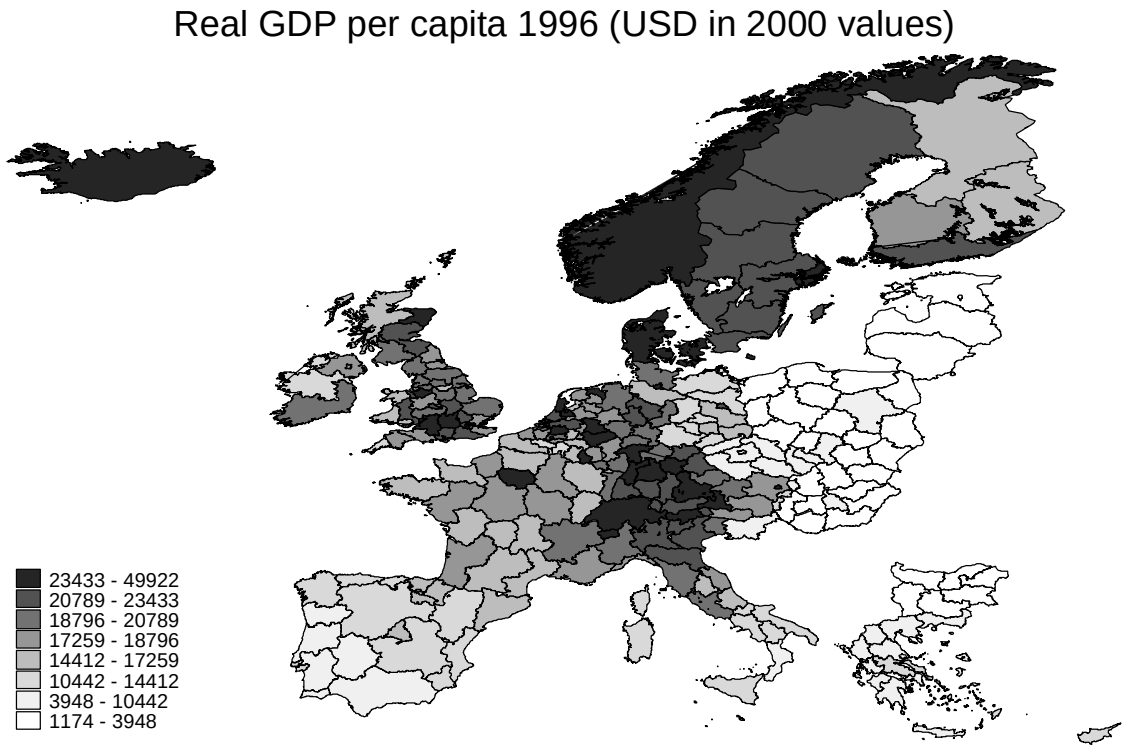
**Figure 1. Regional real GDP per capita and growth in real GDP per capita in Russia**






Note The regional division is more detailed on the map than in the database. The database does usually not cover autonomous districts. The data for the relevant region in the database is allocated to all regions on the map which it covers. Chukotka has been excluded to improve the readability of the map. The cities of Moscow and St. Petersburg are included in the Moscow and Leningrad district, respectively.

**Figure 2. Regional real GDP per capita and growth in real GDP per capita in EU**



Real gdp per capita growth 1996-2004 (%)

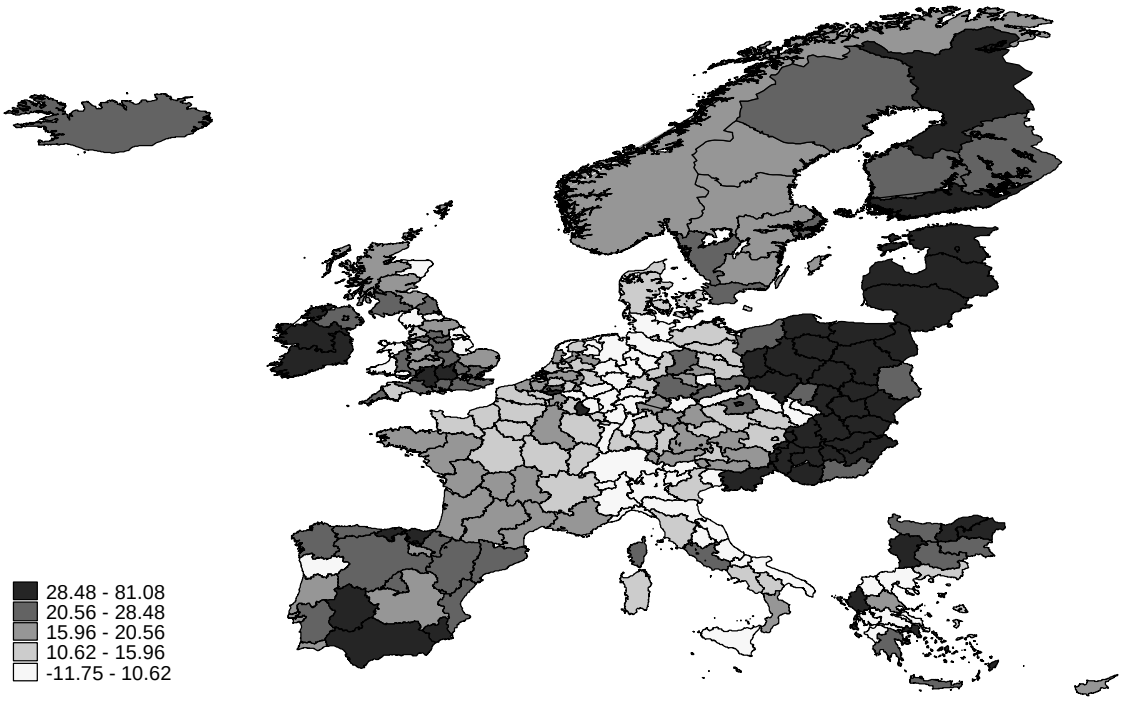


**Figure 3. Sigma convergence**

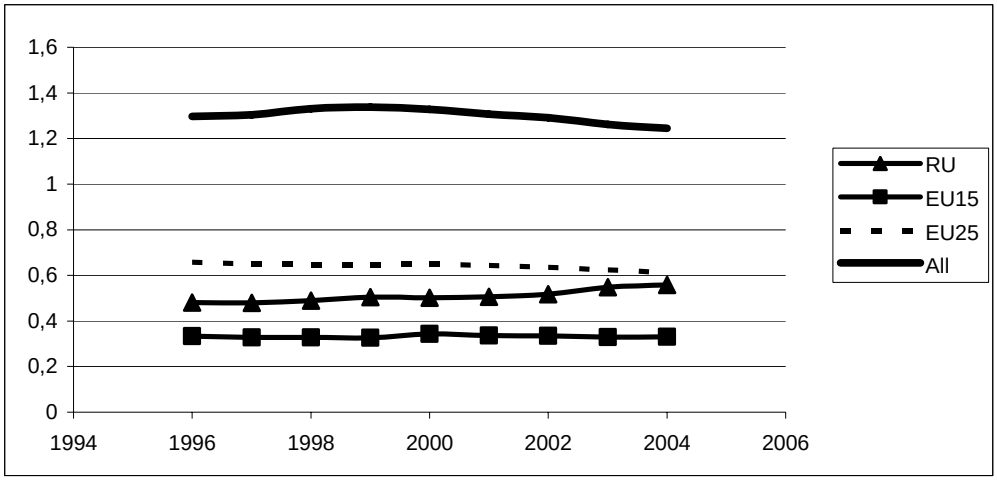



**Table A1. Descriptive statistics by country**

| | | *GDP per capita* | | | | | |
|---|---|---|---|---|---|---|---|
| | Number of regions | Minimum | | Maximum | | Ratio richest/poorest region | |
| | | 1996 | 2004 | 1996 | 2004 | 1996 | 2004 |
| Armenia | 1 | 496 | 987 | 496 | 987 | 1.00 | 1.00 |
| Austria | 9 | 13613 | 17550 | 31422 | 35325 | 2.31 | 2.01 |
| Azerbaijan | 1 | 489 | 945 | 489 | 945 | 1.00 | 1.00 |
| Belgium | 11 | 13853 | 15515 | 41541 | 47306 | 3.00 | 3.05 |
| Bulgaria | 6 | 1175 | 1506 | 1921 | 2892 | 1.64 | 1.92 |
| Belarus | 1 | 949 | 1701 | 949 | 1701 | 1.00 | 1.00 |
| Switzerland | 1 | 31631 | 34349 | 31631 | 34349 | 1.00 | 1.00 |
| Cyprus | 1 | 11802 | 14066 | 11802 | 14066 | 1.00 | 1.00 |
| Czech republic | 8 | 4564 | 4971 | 9039 | 13104 | 1.98 | 2.64 |
| Germany | 41 | 12840 | 15371 | 35909 | 39892 | 2.80 | 2.60 |
| Denmark | 1 | 27233 | 30779 | 27233 | 30779 | 1.00 | 1.00 |
| Estonia | 1 | 3059 | 5320 | 3059 | 5320 | 1.00 | 1.00 |
| Spain | 15 | 8474 | 10991 | 17259 | 21852 | 2.04 | 1.99 |
| Finland | 5 | 14745 | 18628 | 25379 | 32131 | 1.72 | 1.72 |
| France | 22 | 13965 | 17649 | 30485 | 35300 | 2.18 | 2.00 |
| Georgia | 1 | 517 | 880 | 517 | 880 | 1.00 | 1.00 |
| Greece | 13 | 6657 | 7970 | 14239 | 16531 | 2.14 | 2.07 |
| Hungary | 7 | 2587 | 3583 | 5579 | 8724 | 2.16 | 2.43 |
| Ireland | 2 | 12796 | 20794 | 20017 | 32467 | 1.56 | 1.56 |
| Iceland | 1 | 26529 | 33824 | 26529 | 33824 | 1.00 | 1.00 |
| Italy | 21 | 10443 | 12223 | 25511 | 25866 | 2.44 | 2.12 |
| Kirgizstan | 1 | 240 | 324 | 240 | 324 | 1.00 | 1.00 |
| Kazakhstan | 1 | 1044 | 1819 | 1044 | 1819 | 1.00 | 1.00 |
| Lithuania | 1 | 2704 | 4468 | 2704 | 4468 | 1.00 | 1.00 |

| | | *GDP per capita* | | | | | |
|---|---|---|---|---|---|---|---|
| | Number of regions | Minimum | | Maximum | | Ratio richest/poorest region | |
| | | 1996 | 2004 | 1996 | 2004 | 1996 | 2004 |
| Luxembourg | 1 | 37128 | 50727 | 37128 | 50727 | 1.00 | 1.00 |
| Latvia | 1 | 2499 | 4525 | 2499 | 4525 | 1.00 | 1.00 |
| Moldova | 1 | 318 | 400 | 318 | 400 | 1.00 | 1.00 |
| Malta | 1 | 8502 | 9436 | 8502 | 9436 | 1.00 | 1.00 |
| Netherlands | 12 | 15760 | 18312 | 27258 | 29812 | 1.73 | 1.63 |
| Norway | 1 | 33600 | 39353 | 33600 | 39353 | 1.00 | 1.00 |
| Poland | 16 | 2735 | 3486 | 5021 | 7629 | 1.84 | 2.19 |
| Portugal | 5 | 7996 | 8692 | 13377 | 15656 | 1.67 | 1.80 |
| Romania | 8 | | 1502 | | 4111 | n.a. | 2.74 |
| Russia | 77 | 336 | 286 | 6845 | 13034 | 20.35 | 45.60 |
| Sweden | 8 | 20830 | 24775 | 31877 | 40433 | 1.53 | 1.63 |
| Slovenia | 1 | 8119 | 11012 | 8119 | 11012 | 1.00 | 1.00 |
| Slovakia | 4 | 2552 | 3358 | 6993 | 10258 | 2.74 | 3.05 |
| Tajikistan | 1 | 139 | 223 | 139 | 223 | 1.00 | 1.00 |
| Ukraine | 1 | 609 | 928 | 609 | 928 | 1.00 | 1.00 |
| UK | 37 | 13769 | 17147 | 49923 | 65879 | 3.63 | 3.84 |
| Uzbekistan | 1 | 499 | 647 | 499 | 647 | 1.00 | 1.00 |

**Table A2 Panel data estimation of convergence with spatial lag**

| Sample | EU25 | EU15 | RU |
|---|---|---|---|
| Time between obs. | 1 year | 1 year | 1 year |
| GDP/capita | -0.214*** | -0.270*** | -0.456*** |
| | [0.032] | [0.036] | [0.041] |
| Spatial lag | -0.051 | -0.142 | 0.347 |
| | [0.065] | [0.100] | [1.032] |
| Constant | 2.090*** | 2.693*** | 6.527*** |
| | [0.308] | [0.353] | [0.585] |
| Observations | 1451 | 1458 | 616 |
| Groups | 189 | 203 | 77 |

Time dummy variables are included in the regression but not reported. *** p<0.01, ** p<0.05, * p<0.1 Robust standard errors in brackets

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