

## Yearbook of the Institute of East-Central Europe (Rocznik Instytutu Europy Środkowo-Wschodniej)

Publication details, including instructions for authors:  
<http://www.iesw.lublin.pl/rocznik/index.php>

### Your neighbours' growth doesn't always matter – an empirical study of 45 transition economies

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Published online: 01 Oct 2016

To cite this article: Mihalyi, P. and Banasz, Z. (2016) 'Your neighbours' growth doesn't always matter – an empirical study of 45 transition economies', *Yearbook of the Institute of East-Central Europe* (Special Issue: Visvizi, A. (ed.) Re-thinking the OECD's role in global governance: members, policies, influence), 14(4): 101-127.

Yearbook of the Institute of East-Central Europe (Rocznik Instytutu Europy Środkowo-Wschodniej) is a quarterly, published in Polish and in English, listed in the IC Journal Master List (Index Copernicus International). In the most recent Ministry of Science and Higher Education ranking of journals published on the Polish market the Yearbook of the Institute of East-Central Europe received one of the highest scores, i.e. 14 points.



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## Your neighbours' growth doesn't always matter – an empirical study of 45 transition economies

**Abstract:** On the occasion of the 25<sup>th</sup> anniversary of the regime change in the communist world, and the 20<sup>th</sup> anniversary of Poland's membership in OECD, this paper looks at the growth performance of the former post-socialist countries by using a much larger sample than earlier studies. These economies are located geographically very far from each other, and thus, they are imbedded in regions with different growth record. The paper examines whether the growth spillover effect from the neighbourhood is important enough to explain the vastly different catching-up performances of 45 different post-socialist economies (PSEs). The econometric investigations led to divergent findings. For the sample as a whole, the spillover effect does not carry the same significance as compared to the importance of the initial development level in 1989. We also found a small, but statistically significant negative impact of nation-building for those countries which were newly (re)created. Relative to all these factors, the impact of being a landlocked country or having or not having a rich natural resource endowment does not seem to have a significant effect either. The neighbourhood effect for PSEs is statistically significant, but this is not the case for 23 OECD countries which didn't have a communist past in their recent history. But the initial development level (1989) had more impact on growth in the case of OECD countries, than in PSE economies.

**Keywords:** comparative economic systems, growth accounting, neighbourhood effect, regional growth effect, contagion effects

### 1 Introduction

1. In 1987, exactly 70 years after the Bolshevik revolution in Russia, 26 socialist (communist) countries stretched out over 31 percent of the land of four continents. Their combined population amounted to 34 percent of the world's total.<sup>1</sup> Two-years later, in 1989, this system unexpectedly started to collapse. As of end-2014, only two small countries remained truly faithful to the Marxist-Leninist doctrine: Cuba and North Korea. Twenty-five years is a propitious time to reflect and

compare which of these former socialist countries were economically successful or unsuccessful and what the common explanations are, and, if there are such generalizable development characteristics (see Mihalyi, 2014).

Rich literature is available on the determinants of growth in Post Socialist Economies (PSEs). The studies can be divided into two groups according to take/do not take into account the spillover effect from the neighbouring countries. Based on the latter, the growth depending on e.g. the increased productivity of labour and capital (Próchniak and Rapacki, 2006) for example countries' investment rate, the education level of the labour force, financial sector development (Próchniak, 2011).

The starting point of our investigation was the observation that politically and culturally all PSEs converged to their geographic neighbours: East Germany to West Germany, Central Europe to Western Europe, the Baltic countries to the Scandinavian countries, the Caucasian and some Central Asian republics to Turkey and Afghanistan, respectively (Treisman, 2014; Brezis and Verdier, 2014). The same phenomenon may also be observed in the former African socialist countries. The countries which at some point in the 20<sup>th</sup> century had broken away from their geographical neighbourhood as a result of an endogenous revolution, Soviet occupation or Soviet-supported national independence wars and then chose the Marxist-Leninist path of development, after 1989-90 returned to their previous trajectory. In that, they became, once again, similar to their neighbours. In fact, this regression was extremely rapid by any historical measure. In two years, by the end of 1991, the worldwide regime change was essentially a *fait accompli*. Thus, in political and social terms, both path dependency and geographic neighbourhood seem to matter. The follow-up question is whether the economic growth process is also driven, or at least significantly influenced by some kind of spillover effect from the neighbouring countries. This is the rationale of the present paper.

Intuitively, such a hypothesis sounds credible. The former Asian socialist countries all exhibited rapid growth rates and it is conceivable to assume that China's spectacular growth helped her southern (Vietnam, Cambodia and Laos) and northern neighbours (Kazakhstan and Mongolia) as well. One can also argue that the relatively slow-growing Central European countries may simply have had bad luck, as their neighbours in Western Europe, all OECD member countries,

could not display such a magnetic growth impact in the period under investigation.<sup>2</sup>

A relatively large volume of empirical literature pertaining to other parts of the world also supports such a hypothesis. Before the fall of the Berlin Wall, Easterly and Levin (1998) already showed that there was systemic *regional* growth spillover effect across national borders in Sub-Saharan Africa. Favourable or unfavourable growth performance of one's neighbour tended to influence one's own long-run growth rate. For a larger African sample of 44 countries Collier (2007) found that, on average, if neighbours grew at an additional one percentage point, this, in turn, raised the growth of the country itself by 0.4 percent. A more recent IMF study – Arora-Vamvakidis (2010) – convincingly demonstrated that China's economic growth affected her neighbours in a number of ways in both the long and the short-term. Another IMF study – Ding-Masha (2012) – presented similar evidence for India. The results of their panel growth regressions suggest that since 1995, India's growth has ample explanatory power for growth in seven neighbouring South Asian countries. Closer to our region, Obiora (2009) used VAR models to examine the magnitude and sources of growth spillovers to the Baltics from EU countries and Russia, and showed that the former ones were more powerful than the latter one.<sup>3</sup>

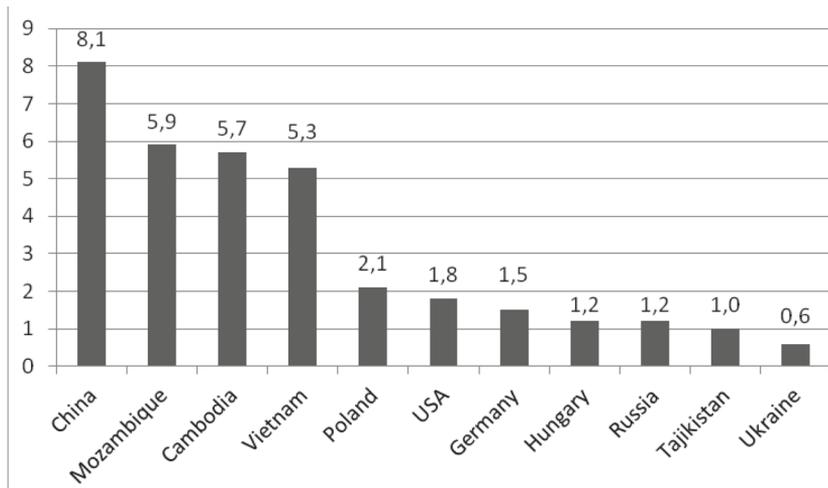
Obiora's, and other studies (see, e.g. Sachs and Warner, 1997; Ades and Chua, 1997; Abreu et. al., 2004; Easterly, 2013). attempted to identify the responsible transmission effects, such as trade, in and outward migration, emulation of economic policies, financial flows, or the exchange rate. We will not go so far. In this paper, we limit our investigations to show whether the growth spillover effect is important enough to explain the vastly different growth and catching-up performances of different PSEs which are located geographically at great distances from each other, and thus, they are imbedded in regions with different growth records.

The rest of the paper is structured as follows. In Section 2, we explain how conducted defining our full set of PSEs and how we selected a control group of developed market economies from OECD countries which were not, at any point, socialist. Sections 3 and 4 present the findings of our econometric analysis, while Section 5 concludes and explains the possible reasons why we did not find robust statistical evidence for the growth spillover effect for the post-communist economies.

## 2. The country sample

Figure 1, below, is a telling illustration of the shocking divergence in terms of the multiplication of the size of the GDP of different PSEs. As one can observe, using this rudimentary measurement, the size of the Chinese economy grew 8 times, which is astonishing in comparison with the growth of the US economy, which did not even double<sup>4</sup>, not to mention Ukraine, the total GDP of which was actually far smaller in 2014 than in 1989. These enormous growth differences are attributable to several factors among which the most important are the growth (or the decline) of population and the (fast or slow) rise in productivity. This needs to be emphasised at the outset, because in such long-term comparisons, there is an inherent *loop of causality* between the dependent and the independent variables. Rising population usually means a growing labour supply and a rising demand, which are conducive to output growth. At the same time, however, insufficient growth usually results in slow or even declining standards of living, which may then induce a population exodus. As will be shown later, this is not merely a theoretical possibility. This is exactly what occurred in some economically unsuccessful PSEs.

Figure 1. The rise of total GDP between 1989 and 2014 in selected countries



GDP ratio (2014/1989)

Note: The underlying time series were in millions of 2014 US\$ at purchasing power parity (PPP) and converted to 2014 price level with updated 2011 EKS PPPs.

Source: Authors' calculations based on The Conference Board Total Economy Database™ (2015).

As a first step of our quantitative analysis, we compiled the set of PSEs, as well as a control group of OECD member countries were not, and are not, socialist. The starting year of our investigation was 1989, while the end-year was 2013 for which we could collect official statistical data.

One of the novelties of the present paper is that we made a careful attempt to increase the sample of Kornai (1992) referred at the very beginning of this paper. In a footnote to the already cited table, Kornai remarked that he could have listed at least seven more countries (Guinea-Bissau, Burma, Cape Verde, Guyana, Madagascar, São Tomé and Seychelles), because these countries were also ruled by Marxist-Leninist, one-party dictatorships and they all benefited from the political, military and financial support of the Soviet Union during an extensive period of time.<sup>5</sup> But for a variety of reasons he did not include them in his analysis at the end. As an additional source we used the 'Marxist Regimes' series, edited by Bogdan Szajkowski, in which three more countries were categorized as socialist oriented: Grenada, Suriname and the United Republic of Tanzania (for a review of the series, see Pryor, 1987). Thus, all in all, the broadest possible coverage as of 1987 was extended from 26 to 36 countries. One of the most momentous consequences of the collapse of the socialist world system was that larger countries fell apart, new countries were created, and international borders changed, too. More specifically, six countries of Central and Eastern Europe, three Baltic nations and 11 further states of the Soviet Union regained *de facto* or *de jure* independence. Two federal states, Czechoslovakia and Yugoslavia disintegrated. The same happened to one African PSE, Ethiopia, when Eritrea re-gained its internationally recognised independence in 1991. At the same time however, two divided nations (Germany and Yemen) were reunited, thus two former socialist countries, East Germany and South Yemen fell out from our initial sample. Taking this into account, as of end-2014 we had 60 PSEs to analyse (see Appendix Table A1). After closer inspection however, 15 PSEs had to be discarded from our sample for one or more of the following reasons: (i) the country was still communist; (ii) GDP time series were not available; (iii) the size of the population was smaller than 1 million; (iv) the country is an island with no terrestrial neighbours; (v) the country did not have international recognition (for a detailed account, see Appendix Table A2, Block A).

These considerations left us with 45 PSEs on which the neighbourhood effect could be tested.

The starting point of setting up the control group was the official list of 34 OECD member states, *minus* those six countries which are PSEs (Czech Republic, Estonia, Hungary, Poland, Slovakia and Slovenia). Then five more countries were discarded either because they were islands or had very small populations (see Appendix Table A2, Block B). Thus, we ended up with a sample of 23 OECDs.

The final step was the inclusion into the database the names of the terrestrial neighbouring countries for our total sample of 68 countries (45+23). Of course, the neighbours of PSEs are not necessarily PSEs themselves and *vice versa*.

## 2.1 Growth and contagion – our main data

As already explained above, this paper estimates an empirical model of the determinants of the growth in post-socialist economies with a focus on contagion effects. The GDP figures were taken from two widely-used and methodological almost identical data bases, from the Conference Board Total Economy Data Base (hereafter: TED) and its predecessor, the Maddison (2009) data base. In the full-sample econometric calculations, our dependent variable, the growth performance was measured at constant prices between 1989 and 2013 expressed in 2013 US\$ at purchasing power parities (PPP) calculated with 2005 EKS weights.<sup>6</sup> In case of missing data, especially for the last 3-4 years in the case of some smaller countries, we used extrapolations based on PPP volume indices estimated by the World Bank. Among the countries which we entered in our data base as ‘neighbouring country’, some are small, therefore the spillover effect cannot be significant either, while others are not only small but also did not have GDP time series. Thus, 11 countries were entirely left out from the calculation of the spillover effect (see Appendix Table A3 for the details and Appendix Table A4 for other data sources).

Our measure of cross-border contagion is growth in the *terrestrial neighbouring* countries. In contrast to similar papers, we do not believe that the length of the common borders is of tantamount importance. High volumes of trade can be easily realized through a short

common border, too. This is particularly true for goods transported by train or by pipelines.

There can be several ways to weigh the spillover effect on one PSE emanating from more than one adjacent neighbour, irrespective of whether the neighbour is a PSE or an OECD member. Accepting the argumentation of Easterly and Levine (1998), we weighted this impact by the size of the neighbour's total GDP observed in the year 2001, the median year between 1989 and 2013. It seems plausible that Russia would be more affected by China than by Latvia, and Poland would be affected more by Germany than by Slovakia,<sup>7</sup> and it seems to be more reasonable for us to use 2001 weights rather than 1989 or 2013 weights.

Table 1 provides a succinct summary of the most important stylized facts of our sample countries of two types. As one would expect, the PSEs displayed much larger variation in growth.<sup>8</sup>

**Table 1. Descriptive statistics**

Variables	N	Min	Max	Mean	Std. dev.
<b>All countries</b>					
X <sub>4</sub> : GDP/capita in 1989	68	245	40 881	12 662	11 357
Y: Growth (GDP ratio: 2013/1989)	68	0.6	8.0	2.12	1.38
X <sub>2</sub> : Neighbours' GDP ratio (weighted 2001)	68	0.5	7.9	2.49	1.91
X <sub>3</sub> : Neighbours' average growth (unweighted)	68	0.5	5.9	2.09	1.06
X <sub>4</sub> : Relative development compared to USA in 1989	68	0.6	108.1	33.49	30.04
<b>OECDs</b>					
X <sub>4</sub> : GDP/capita in 1989	23	7 085	40 881	24 964	9 505
Y: Growth (GDP ratio: 2013/1989)	23	1.2	3.38	1.88	0.66
X <sub>2</sub> : Neighbours' GDP ratio (weighted 2001)	23	0.5	2.9	1.70	.56
X <sub>3</sub> : Neighbours' average growth (unweighted)	23	0.5	3.0	1.72	.53
X <sub>4</sub> : Relative development compared to USA in 1989	23	18.7	108.1	66.03	25.14
<b>PSEs</b>					
X <sub>4</sub> : GDP/capita in 1989	45	245	19 868	6 374	5 629
Y: Growth (GDP ratio: 2013/1989)	45	0.6	8.0	2.25	1.62
X <sub>2</sub> : Neighbours' GDP ratio (weighted 2001)	45	0.9	7.9	2.90	2.21
X <sub>3</sub> : Neighbours' average growth (unweighted)	45	0.9	5.9	2.27	1.21
X <sub>4</sub> : Relative development compared to USA in 1989	45	0.6	52.6	16.86	14.89

### 3. Testing the main hypothesis

As we noted previously, the general objective of this paper is to check whether the economic growth of the terrestrial neighbours affect the growth of a given country. However, before tackling the issue at hand and finding out this, we were curious to know whether growth itself was influenced by our sample countries' political past (communist or non-communist). Thus, we tested the  $Y = f(X_1)$  equation for 68 countries using a dummy variable ( $X_1$  is PSE = 1 or OECD = 0) to see whether the post-socialist past is a sufficient explanation of the GDP ratio ( $Y$ ) – the multiplication of total output between 1989 and 2013. The answer is a straightforward 'no'. The  $\eta^2$  was miniscule and statistically non-significant (see the row 1 of Table 2). Furthermore, we arrived to the same result with a more sophisticated ANOVA model and the Levine-test. These tests confirmed that the expected growth of the two samples (PSE or OECD) is not explained by our dummy variable.

The rows 2-7 of Table 2 shows the strength of the relationship between growth and six other variables, from which two ( $X_2$  and  $X_3$ ) measure the neighbours' average growth (weighted and unweighted), one ( $X_4$ ) serves as a proxy to measure the countries' initial development level. The last three variables ( $X_5$ ,  $X_6$  and  $X_7$ ) are dummies to control for three particularities of the sample countries: being landlocked, resource rich or a newly created nation state. The strongest significant relationship (meaning medium strength  $R^2 = 0.434$ ) was in case of OECDs, between their growth ( $Y$ ) and their initial development ( $X_4$ ). The same value in case of PSEs ( $R^2 = 0.297$ ) is the second largest value of Table 2. It shows medium strength also, but to a lesser degree. According to our hypothesis, among the six variables involved ( $X_2$ - $X_7$ ) the neighbours' growth matters most ( $X_2$  or  $X_3$ ). The weighted version ( $X_2$ ) which was recommended by the literature results only weak relationship with the growth ( $Y$ ). In the case of PSEs the results of the unweighted version ( $X_3$ ) was almost strong as the impact of initial development ( $X_4$ ) to the growth ( $Y$ ).

Table 2. Correlations

No.	Correlation between Y and	Countries		
		PSEs (45)	OECDs (23)	All (68)
1	$X_1$	–	–	0.017**, n.s.
2	$X_2$	0.127*	0.019*, n.s.	0.133*
3	$X_3$	0.281*	0.024*, n.s.	0.262*
4	$X_4$	0.297*	0.434*	0.157*
5	$X_5$	0.033**, n.s.	0.026**, n.s.	0.014**, n.s.
6	$X_6$	0.088**	0.082**, n.s.	0.095**
7	$X_7$	0.252**	0.021**, n.s.	0.123**

where

\*:  $R^2$  \*\*;  $\text{Eta}^2$

The interpretation of  $\text{Eta}^2$  is the same as the  $R^2$ .  $R^2$  was calculated in case of quantitative variables,  $\text{Eta}^2$  was calculated in case of mixed relationship (between qualitative and quantitative variables, more precisely between variables measurable nominal and ratio scale).

Significance level = 0.05, n.s. = not significant

Variables:

Y: Growth (GDP ratio 2013/1989)

$X_1$ : Post-socialist = 1

$X_2$ : Neighbours' average growth ratio (weighted 2001)

$X_3$ : Neighbours' average growth ratio unweighted

$X_4$ : Initial development (GDP/capita1989)

$X_5$ : Landlocked = 1

$X_6$ : Resource rich = 1

$X_7$ : New nation = 1

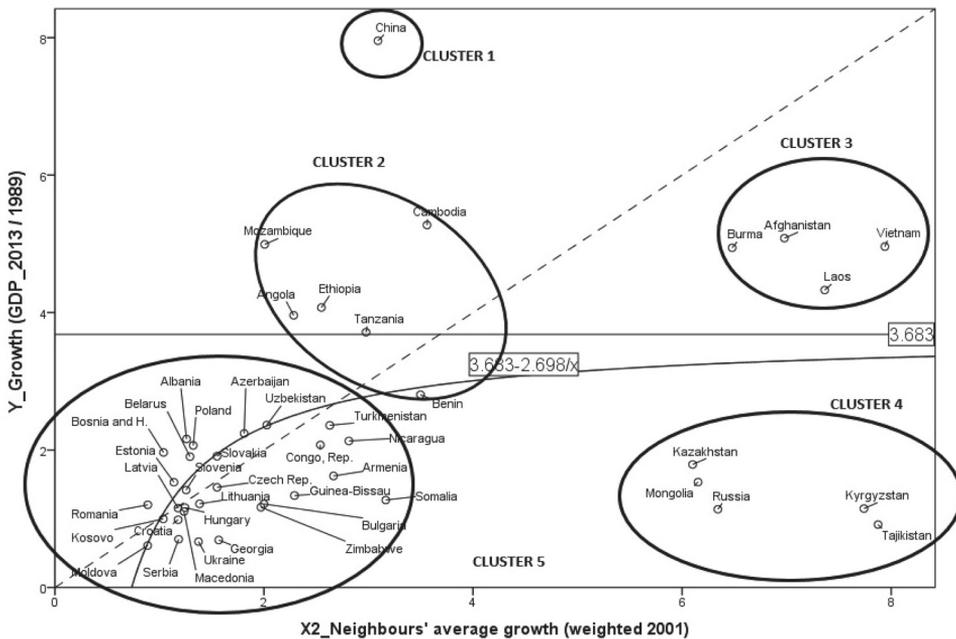
Moving beyond simple correlations, we experimented with linear, logarithmic, hyperbolic, compound, power, growth, exponential and logistic regressions. In Figure 2, we plotted our variables with the best fitting trend. As it can be seen on the diagram our assumed causal relationship for the entire PSE sample is only moderately strong. There are many PSEs far above or below the two trend lines fitted to the data points. (The dashed line corresponds to a 1:1 relationship, the thick line is the hyperbolic trend.) Clearly many countries, like China or Ethiopia, performed a lot better than the neighbours' spillover effect would have justified, while four Central Asian economies, all post-Soviet states in Asia, remained deeply below the trend line.

Our hypothesis suffered another blow, as we tested the same models without any weighting (see row  $X_2$  of Table 2), which should have – according to our original expectation – yielded a smaller  $R^2$ . However, the opposite result can be observed. With both models, the pa-

rameters proved to be significant for our sample of PSEs and the  $R^2$ -s were higher (these regression results are available in Appendix Table A5). (Compare the  $X_2$  and  $X_3$  rows of Table 2.) The one model fits all approach does not work in our case. This is supported by the fact that as we increased our sample of PSEs from 26 to 45, we arrived into an inhomogeneous set, as far as the countries' growth machines are concerned.

A more sophisticated method, the K-means clustering algorithm seemingly offers a possibility to save, nevertheless, the neighbourhood hypothesis. As Figure 2 shows, through this method we can clearly distinguish five well separated clusters with distinctive centres. For the largest group, containing 29 PSEs our initial hypothesis visibly holds and is statistically significant at the 5% level. On the other hand, it is clear that the members of the other clusters are also very important countries – especially China and Russia – therefore it would be foolish to exclude them from further investigations, or making a sweeping generalization on the relevance of the spillover effect for *all* the 45 PSEs.

Figure 2. Bubble plot of post-socialist countries' growth explained by weighted neighbours' growth (hyperbolic trend)



## 4. Controlling for initial development levels and other possible factors

One common-sense explanation of the existence of five clusters can be the convergence effect, meaning that – *ceteris paribus* – countries with lower initial development levels tend to grow at faster rates than richer economies. It is also straightforward to assume that the catching-up process is non-linear: first, rising then falling with per capita GDP levels.

Controlling for initial development is also important for another reason. It explains a large part of the dynamics of population growth, an issue we have already mentioned in the Introduction. In the least developed African countries – both in the PSEs and in other African countries with similar level of development – the population doubled in a quarter of a century (Table 3 Block A). Even in China where, for most of the period under investigation, strict fertility control rules were in force,<sup>9</sup> the population grew by more than 20 per cent, nevertheless. Since our dependent variable (Y) is total GDP (rather than GDP/capita) this is of pronounced relevance in our comparative analysis.

**Table 3. Rising and declining populations in selected post-socialist countries, 1989-2014**  
Population ratios 2014/1989

A		B	
Rising population		Declining population	
Ethiopia	2.09	Bulgaria	0.77
Tanzania	2.06	Estonia	0.80
Angola	2.05	Latvia	0.81
Cambodia	1.71	Moldova	0.83
Tajikistan	1.56	Ukraine	0.86
Turkmenistan	1.45	Armenia	0.88
Uzbekistan	1.44	Belarus	0.94
Vietnam	1.42	Albania	0.95
Azerbaijan	1.31	Romania	0.95
Kyrgyzstan	1.27	Lithuania	0.95
China	1.22	Hungary	0.95
Macedonia	1.12	Russian Federation	0.97

Source: Authors' calculation based on TED (2015).

In order to grasp the income level differences in a visually, easily-recognisable fashion, initial GDP capita levels were expressed as a percentage of the GDP/capita figure of the USA ( $X_i$ ).<sup>10</sup>

**Figure 3. Bubble plot of post-socialist countries' growth as a function of initial development levels**

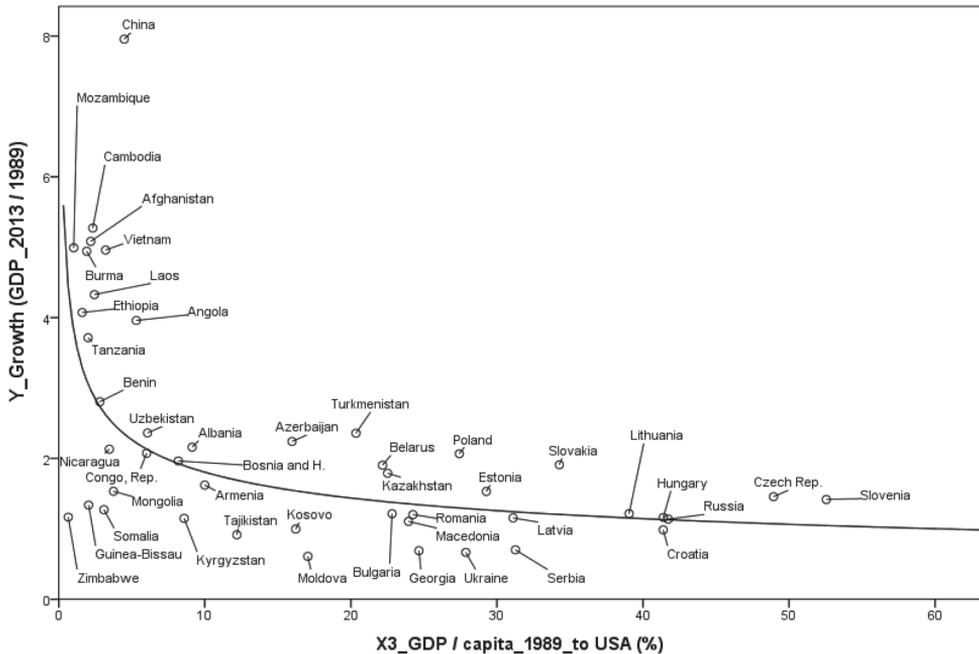


Figure 3 clearly displays a better fit and this is confirmed by the  $R^2$  value (0.390), which in turn poses the next challenge, whether the fit can be improved further by incorporating other frequently used explanatory variables. We tested three of such variables ( $X_4$ ,  $X_5$ , and  $X_6$ ) and thus controlled for whether the country is *landlocked*, *rich in natural resources* and whether the country concerned is a *newly born nation* (Appendix Table A6). The first two (dummy) variables do not require additional explanation. World history, but also economic geography, strongly assert that being a landlocked country is a great handicap and there is no need to argue extensively that most countries, most of the time benefit from a favourable resource endowment.<sup>11</sup>

In the context of the post-socialist economies, it is an intriguing research question to find out whether the challenges of nation-building – the creation of new institutions, setting up new laws and finding nominees to the newly created top positions – are growth enhancing or just the contrary. A priori, one can argue in both ways. In the context of Ukraine, for example, Havrylyshyn (2014) convincingly demonstrated with econometric tools that in the first half of the 1990s the

newly installed politicians were apprehensive to implement the necessary reform measures and preferred those steps which were considered part of the nation-building agenda. On the other extreme, many analysts contended after the shock of the 2008 international financial crisis that the strong reform-determination in Latvia was due to the deep conviction of the local political elite that as a newly independent nation filled with enthusiasm, the ultra-radical reforms would be tolerated by the electorate.<sup>12</sup> The fact is that nation-building proved to be problematic in many other places. The rise of new, ethnically homogenous states led to a brutal outward migration and therefore to a net loss of population in many successor states of the former USSR and – to a smaller extent – in the successor states of former Yugoslavia. In fact, this could have occurred without changes in borders. Among the PSEs of our sample, the largest loss of population occurred in Bulgaria, where during the last five years of the socialist system and also in the years after 1989, ethnic Turks migrated to Turkey in very large numbers.

At this point, however, it is worth noting that in many other PSEs, the decline in population was caused by the decline in fertility<sup>13</sup>, which in turn was to a large extent the mirror image (or the consequence) of the so-called transformation recession (Kornai, 1994), the prolonged and deep annual falls in GDP. This could lead to outward migration, which then, as a vicious circle, negatively affected total output.

As we experimented with multivariate regressions with different combinations of our independent variables, in all but one case we failed to improve our best  $R^2$  (0.297) between growth ( $Y$ ) and the initial development ( $X_4$ ) at the 0.05 significance level. Interestingly, a stronger correlation was achieved ( $R^2 = 0.366$ ) by extending the model  $Y = f(X_4)$  with the unweighted average growth of the neighbouring countries ( $X_3$ ) to  $Y = f(X_4, X_3)$  (detailed results are available in Appendix Table A7).

## 5. Conclusions

We compared the growth performance of 45 post-socialist economies between 1989 and 2013. Our starting hypothesis was that this performance must have been strongly influenced by the *growth spillover effect* of their respective terrestrial neighbours. This assumption was based partly on the characteristics of these countries' cultur-

al and political developments after the collapse of the socialist world system and partly on the findings of earlier econometric studies performed on different samples of countries from other regions of the world economy. To our surprise, the econometric investigations led to opposite findings: the neighbourhood effect itself does not seem to matter much for the entire sample, but it does hold for 29 countries, China, Russia and some other important countries being the important, non-negligible exceptions.

Instead, we obtained reasonably strong evidence that the initial development level in 1989 explains about one third of the variation in growth performance for the entire PSE sample.<sup>14</sup> We also found a small, but statistically significant negative impact of *nation-building*, meaning that the creation of a new nation-state with all the necessary additional institutional building tasks did have a growth-retarding effect in the analysed period. Startlingly, relative to all these factors, the impact of being a *landlocked* country or having or not having a rich natural *resource endowment* has not seemed to have had a significant effect on PSEs.

It is also thought-provoking that those equations, where the growth spillover effect did prove to be statistically significant for the entire PSE sample, we obtained better fit with unweighted data as compared to weighted figures. This might be a relatively new consequence of the worldwide globalisation process generated by continuously falling relative transport and communication costs and improved logistics. As these improvements unfold, immediate terrestrial proximity tends to lose its importance. Consider two examples. In the case of the Hungarian automobile industry, the intra-industry trade links with Germany (which is not a neighbouring country) are clearly more important than the eventual direct impacts from Austria, because two large German manufacturers (Audi and Mercedes) built subsidiaries in Hungary. Another example is the large scale migration outflow of both low and high skill workers from the new EU member states – like Lithuania, Poland or Romania – where the physical distance of the target countries are almost irrelevant as a result of the affordability of discount airline tickets. This may denote, though, that the growth spillover effect remains important for the PSEs at the regional level.

An additional source of our weak correlation results may have arisen from the fact that the worldwide convergence process appears

to have slowed down significantly after its peak in 2008. Since then, growth has fallen sharply in many emerging economies.<sup>15</sup> Despite the rich world's feeble recovery in the wake of the financial crisis, emerging economies, including PSEs are now catching up more slowly with the OECDs, if at all. In technical terms, we have a structural break in our underlying growth time series.

To sum up all these findings, perhaps the best approach can be borrowed from a different discipline. On the first page of his classical novel, *Anna Karenina*, Lev Tolstoy famously said 'happy families are all alike; every unhappy family is unhappy in its own way'. It would be reassuring to state the same about the economic success of PSEs during the economic transition. Unfortunately, even less seems to be true. Both the *catching up* and the *lagging* economies have their own individual stories. At least, so far, we have not found enough common explanation for both groups of post-socialist economies.

#### Endnotes

- 1 See Kornai (1992) encyclopaedic work for his list of 26 countries (reproduced in Appendix Table A1) which were for a considerable period of time controlled by Marxist-Leninist parties, using Soviet-type command economy methods based on state ownership of the means of production.
- 2 Gauged by the same scale used in Figure 1, the ratio of GDP growth in Germany, "the engine of Western Europe" was merely 1.4 times, smaller than the Polish and Czech figure, but larger than the Hungarian one.
- 3 An alternative approach is when the direct neighbours' growth is not used as an explanatory variable, but rather that of the member countries of the institutionalised regional trade agreement to which the analyzed country happens to belong. See Behar (2008).
- 4 In 2014, the absolute size of Chinese economy measured on the scale used in Figure 1, already surpassed that of the USA by a small margin (cca. 1%).
- 5 There are at least two countries, where only this last criterion is not met. As it is well-known, the *Chile* an socialist regime symbolised by the name of President Salvador Allende existed only between 1970 and 1973. On the African continent, the country previously called Upper Volta, embraced the pan-socialist ideology and voluntarily pursued Soviet-type nationalization under a military ruler, named Thomas Sankara as from 1983. The following year, Sankara changed the name of his country to its present one, *Burkina Faso*, meaning "the country of honest people". But in 1987, Sankara along with 12 other officials were killed in a *coup d'état* and then all his policies were reversed.
- 6 For the reason of full-comparability, the time scope of the independent variables was also 1989-2013, even if some data were already available for 2014 at the time of completing the present paper. The definition of EKS method: "A multilateral method developed by O. Élétető, P. Köves and B. Szulc that computes the  $n^{\text{th}}$  root of the product of all possible Fisher indexes between  $n$  countries. It has been used at the detailed heading level to obtain heading parities, and also at the GDP level. EKS has the properties of base-country invariance and transitivity", <http://stats.oecd.org/glossary/detail.asp?ID=5525>.

- 7 In 2001, the total GDP of Germany was 37-times larger than that of Slovakia.
- 8 The detailed results are available from the Authors at request.
- 9 Beginning from 1970, citizens were encouraged to marry at later ages and have only two children. The one-child policy was officially appraised and mandated in 1979. By and large, it is still in force.
- 10 GDP per capita in 2013 US\$, converted to 2013 price level with updated 2005 EKS PPPs.
- 11 While we are aware of the dangers of the so-called Dutch disease, it is generally true that abundance in oil and minerals is usually a great help for both developing and developed economies.
- 12 See Åslund and Dombrovskis (2011). In a way, this is a variant of the Olson-effect, meaning that the collapse of the previous (Soviet-type) state structures is a plus, because this was an easy way to get rid of the inefficient, ossified structures.
- 13 Between 1989 and 1997, the Bulgarian fertility rate fell from 1.90 to 1.09 – the lowest figure ever recorded among all the PSEs, except for East Germany – not included in our analysis, where total fertility between 1989-95 fell well below 1.0.
- 14 In fact, this finding was corroborated in our econometric tests not only for the PSEs, but also for the 23 OECDs, as well.
- 15 See a convincing presentation of this new phenomenon in *The Economist* (2014 a,b) and Åslund (2013).
- 16 Its capital city is Brazzaville. Not to be confused with her 16-times larger neighbor (in terms of population) on the other side of the Congo River, the Democratic Republic of Congo, with the capital city of Kinshasa.

## References

- Abreu, M., de Groot, H.L.F. & Florax, R.J.G.M. (2004) 'Space and Growth: a survey of empirical evidence and methods', *Tinbergen Institute Discussion Paper*, No. TI 04-129/3, [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=631007](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=631007) (accessed 2014-07-20).
- Ades, A. & Chua, H.B. (1997) 'Thy Neighbor's Curse: Regional Instability and Economic Growth', *Journal of Economic Growth*, 2(3): 279-304.
- Arora, V. & Vamvakidis, A. (2010) 'China's Economic Growth: International Spillovers', *IMF Working Paper*, WP/10/165, <https://www.imf.org/external/pubs/ft/wp/2010/wp10165.pdf> (accessed 2014-07-20).
- Åslund, A. (2013) 'Why Growth in Emerging Economies is Likely to Fall', *Peterson Institute for International Economics Working Paper*, WP 13-10, November, <https://piie.com/publications/wp/wp13-10.pdf> (accessed 2014-07-21).
- Åslund, A. & Dombrovskis, V. (2011) *How Latvia Came Through the Financial Crisis*. Washington, DC: Peterson Institute for International Economics.
- Behar, A. (2008) 'Neighbourhood Growth Effects: an Annual Panel Data Approach', *World Development Report*, Reshaping Economic Geography Background Paper, <http://siteresources.worldbank.org/INTWDRS/Resources/477365-1327525347307/8392086-1327527757537/behar.pdf> (accessed 2014-07-25).
- Brezis, E.S. & Verdier, T. (2014) 'Geography, Economics and Political Systems: A Bird's Eye View', *CESifo DICE Report*, 12(1): 29-36.

- Collier, P. (2007) 'Growth Strategies for Africa,' *Country case-studies* – paper prepared for the Spence Commission on Economic Growth, [http://siteresources.worldbank.org/EXTPREMNET/Resources/489960-1338997241035/Growth\\_Commission\\_Workshops\\_Country\\_Case\\_Studies\\_Collier\\_Paper.pdf](http://siteresources.worldbank.org/EXTPREMNET/Resources/489960-1338997241035/Growth_Commission_Workshops_Country_Case_Studies_Collier_Paper.pdf) (accessed 2014-08-04).
- Ding, D. & Masha, I. (2012) 'India's Growth Spillovers to South Asia,' *IMF Working Paper*, WP/12/56, <https://www.imf.org/external/pubs/ft/wp/2012/wp1256.pdf> (accessed 2014-05-14).
- Easterly, W. & Levine, R. (1998) 'Troubles with the Neighbours: Africa's Problem, Africa's Opportunity,' *Journal of African Economies*, 7(1): 120-142.
- Easterly, W. (2013) *The Tyranny of Experts*. New York: Basic Books.
- Havrylyshyn, O. (2014) 'A Quarter Century of Economic Reform in Ukraine: Too Late, Too Little, Too Slow?', *mBank CASE Seminar Proceedings*, No. 135, Warsaw: CASE.
- IMF (2012) 'Macroeconomic policy frameworks for resource-rich developing countries,' *IMF non-paper*, 24/2012: 1-55, <https://www.imf.org/external/np/pp/eng/2012/082412.pdf> (accessed 2014-03-17).
- IMF (2014) 'Legacies, Clouds, Uncertainties,' *IMF World Economic Outlook* October 2014, Washington D.C.: International Monetary Fund, <http://www.imf.org/external/pubs/ft/weo/2014/02/> (accessed 2014-12-12).
- Kornai, J. (1992) *The Socialist System. The Political Economy of Communism*. Oxford: Clarendon Press.
- Kornai, J. (1994) 'Transformation Recession: The Main Causes,' *Journal of Comparative Economics*, 19(1): 39-63.
- Maddison, A. (2009) Historical Statistics of the World Economy: 1-2008 AD, <http://www.ggdc.net/maddison/maddison-project/home.htm> (accessed 2015-08-11).
- Mihalýi, P. (2014) 'Transition in 25 Year Perspective,' *Acta Oeconomica*, Special Issue, 64(S1): 1-24.
- Obiora, K.I. (2009) 'Decoupling from the East toward the West? Analyses of Spillovers to the Baltic Countries,' *IMF Working Paper*, WP/09/125.
- Próchniak, M. (2011) 'Determinants of economic growth in Central and Eastern Europe: the global crisis perspective,' *Post-Communist Economies*, 23(4): 449-468.
- Próchniak, M. & Rapacki, R. (2006) 'Economic Growth in the Post-socialist Countries: 1990-2003,' *Ekonomista* [The Economist: Journal of Economic Sciences Committee, Polish Academy of Sciences and the Polish Economic Society], No. 6: 715-744.
- Pryor, F.L. (1987) 'Marxist regimes series (Review article),' *Journal of Comparative Economics*, 11(1): 124-132.
- Sachs, J.D. & Warner, A.M. (1997) 'Sources of Slow Growth in African Economies,' *Journal of African Economies*, 6(3): 335-376.
- TED (2014) The Conference Board Total Economy Database™, <https://www.conference-board.org/retrievefile.cfm?filename=Output-Labor-and-Labor-Productivity-1950-2013.xls&type=subsite> (accessed 2014-07-20).

- TED (2015) The Conference Board Total Economy Database™, <https://www.conference-board.org/retrievefile.cfm?filename=TED---Output-Labor-and-Labor-Productivity-1950-2015.xlsx&type=subsite> (accessed 2015-06-05).
- The Economist (2014a) 'Hold the catch-up', *Emerging economies*, Sept. 13, 2014, <http://www.economist.com/news/leaders/21616951-incomes-developing-world-are-no-longer-speeding-toward-those-rich-hold-catch-up> (accessed 2014-09-13).
- The Economist (2014b) 'The headwinds return', *Economic convergence*, Sept. 13, 2014, <http://www.economist.com/news/briefing/21616891-ten-years-ago-developing-economies-were-catching-up-developed-ones-remarkably-quickly-it> (accessed 2014-09-13).
- Treisman, D. (2010) "Loans for shares" Revisited', *Post-Soviet Affairs*, 26(3): 207-227.

## Appendix

TABLE A1. The list of socialist and post-socialist countries, 1987 and 2014

No.	Socialist countries in 1987	Year power was attained	No.	Post-socialist countries and territories in 2014
	Continent – Country name			Continent – Country name
<b>EUROPE</b>			<b>EUROPE – ASIA</b>	
1	Union of Soviet Socialist Republics (USSR)	1917	1-15	Russian Federation, Estonia, Latvia, Lithuania, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Ukraine, Tajikistan, Turkmenistan, Uzbekistan
			16 - 19	Abkhazia, Nagorno-Karabakh, South Ossetia, Transnistria
2	Albanian People's Republic	1944	20	Republic of Albania
3	Bulgarian People's Republic	1947	21	Republic of Bulgaria
4	Czechoslovak Socialist Republic	1948	22-23	Czech Republic, Slovak Republic
5	German Democratic Republic (East Germany)	1949		–
6	Hungarian People's Republic	1948	24	Hungary
7	Polish People's Republic	1948	25	Republic of Poland
8	Romanian People's Republic		26	Romania
9	Socialist Federal Republic of Yugoslavia	1945	27-33	Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia, Slovenia, Kosovo
<b>ASIA</b>				
10	People's Republic of China	1949	34	People's Republic of China
11	Democratic Republic of Afghanistan	1978	35	Islamic Republic of Afghanistan
12	Democratic Kampuchea	1975	36	Kingdom of Cambodia
13	Democratic Peoples' Republic of Korea	1948	37	Democratic Peoples' Republic of Korea
14	Lao People's Democratic Republic	1975	38	Lao People's Democratic Republic
15	Mongolian People's Republic	1921	39	Mongolia
16	Socialist Republic of Vietnam	1954	40	Socialist Republic of Vietnam
			41	Republic of the Union Myanmar
<b>AFRICA</b>				
17	People's Republic of Angola	1975	42	Republic of Angola
18	People's Republic of the Congo	1963	43	Republic of the Congo <sup>16</sup>
19	Somali Democratic Republic	1969	44	Federal Republic of Somalia
20	People's Democratic Republic of Yemen (South Yemen)	1969		–
21	People's Republic of Benin	1972	45	Republic of Benin
22	People's Democratic Republic of Ethiopia	1974	46	Federal Democratic Republic of Ethiopia
23	People's Republic of Mozambique	1975	47	Republic of Mozambique

No.	Socialist countries in 1987	Year power was attained	No.	Post-socialist countries and territories in 2014
24	Republic of Zimbabwe	1980	48	Republic of Zimbabwe
			49	Republic of Cape Verde
			50	Republic of Madagascar
			51	Republic of Guinea Bissau
			52	Democratic Republic of São Tomé and Príncipe
			53	Republic of Seychelles
			54	United Republic of Tanzania
			55	State of Eritrea
<b>AMERICAS</b>				
25	Republic of Cuba	1959	56	Republic of Cuba
26	Republic of Nicaragua	1979	57	Republic of Nicaragua
			58	Co-operative Republic of Guyana
			59	Grenada
			60	Republic of Suriname
<b>Addendum (1)</b>				
27	Socialist Republic of the Union of Burma	1962		
28	Cape Verde	1975		
29	Republic of Guinea Bissau	1973		
30	Co-operative Republic of Guyana	1961		
31	Democratic Republic of Madagascar	1975		
32	Democratic Republic of São Tomé and Príncipe	1975		
33	Seychelles	1977		
<b>Addendum (2)</b>				
34	Grenada	1974		
35	Suriname (Socialist Republic)	1980		
36	United Republic of Tanzania	1961		

Categorisation in 1987: 1-26 based on Kornai (1992) Table 1.1, pp. 6-7. 27-33 (Addendum 1): According to a footnote attached to Kornai's table, he considered them as borderline cases and they were not included in his analysis. 34-36 (Addendum 2): In the *"Marxist Regimes"* series, edited by Bogdan Szajkowski two more countries were defined as socialist oriented, namely Grenada, and the United Republic of Tanzania. See Pryor (1987).

TABLE A2. Countries discarded from our data base

A	Country – Territory	Continent	Still socialist	Internation-ally disput-ed territory	Population < 1 mn in 2013	Lack of GDP time series	Island
<b>Post-socialist countries</b>							
1	Abkhazia	Eurasia		x	x	x	
2	Cape Verde	Africa			x		x
3	Cuba	America	x				x
4	Eritrea	Africa				x	
5	Grenada	America			x		
6	Guyana	America				x	
7	Madagascar	Africa					x
8	Montenegro	Europe			x		
9	Nagorno-Karabakh	Eurasia		x	x	x	
10	North Korea	Asia	x			x	
11	Sao Tome & Principe	Africa			x		x
12	Seychelles	Africa			x		x
13	South Ossetia	Europe		x	x	x	
14	Suriname	America			x	x	
15	Transnistria	Europe		x	x	x	
<b>Developed market economies (OECD)</b>							
B	Country – Territory	Continent	Still socialist	Internation-ally disput-ed territory	Population < 1 mn in 2013	Lack of GDP time series	Island
1	Australia	Australia	X	X		X	x
2	Iceland	Europe			x		x
3	Japan	Asia					x
4	New Zealand	Australia					x
5	Luxembourg	Europe			x		

**TABLE A3. Very small land neighbouring countries**

	<b>Country</b>	<b>Relevant for...</b>	<b>Population &lt; 1 million</b>	<b>Discarded due to the lack of GDP time series</b>
1	Gibraltar	Spain	x	x
2	Ceuta and Melilla (Morocco)	Spain	x	x
3	Liechtenstein	Austria, Switzerland	x	x
4	Vatican City	Italy	x	x
5	San Marino		x	x
6	Andorra	France, Spain	x	x
7	Monaco	France	x	x
8	Macau	China	x	x
9	Bhutan		x	x
10	Belize	Mexico	x	x
11	Eritrea	Ethiopia		x

TABLE A4. Data sources and variables

Data	Source
GDP	TED, Maddison, World Bank
Population for GDP/capita	World Bank
Countries' land countries	CIA World Factbook
Countries' landlocked nature	CIA World Factbook
Countries' resource rich nature	IMF (IMF, 2012)
Variables	Measured by
dependent variable: Y growth of examined country	$\frac{GDP_i^{2013}}{GDP_i^{1989}}$
independent variables: X1 countries post-socialist nature or not	dummy variable: 0 (not post-socialist), 1 (post-socialist)
X2 land neighbouring countries' average growth (2001 GDP weights)	$\frac{\sum_{j=1}^n \frac{GDP_j^{2001}}{\sum_{j=1}^n GDP_j^{2001}} \cdot \frac{GDP_j^{2013}}{GDP_j^{1989}}}{\frac{\sum_{j=1}^n \frac{GDP_j^{2013}}{GDP_j^{1989}}}{n}}$
X3 land neighbouring countries' average growth	$\frac{\sum_{j=1}^n \frac{GDP_j^{2013}}{GDP_j^{1989}}}{n}$
X4 1989 GDP/capita	$\frac{\frac{GDP^{1989}}{capita_i}}{\frac{GDP^{1989}}{capita_{USA}}}$
X5 landlocked country	dummy variable: 0 (not landlocked), 1 (landlocked)
X6 resource rich country	dummy variable: 0 (not resource rich), 1 (resource rich)
X7 nation-building country	dummy variable: 0 (not nation-building), 1 (nation-building)

where:

$i = 1, \dots, k$ : examined country (for all country:  $k = 68$ , for post-socialist countries:  $k = 45$ , for non-post-socialist countries:  $k = 23$ )

$j = 1, \dots, n$ : land countries of examined country

TABLE A5. The results of bivariate regressions

		countries	
		PSEs (45)	OECDs (23)
<b>Y=f(X<sub>2</sub>)</b>	linear regression's R <sup>2</sup> =	0.127	0.019
	equation: Y =	1,494+0,261X <sub>2</sub>	1,468+0,263X <sub>2</sub>
	best fit regression's type:	hyperbolic	logarithmic
	R <sup>2</sup> =	0.237	0.167
<b>Y=f(X<sub>3</sub>)</b>	equation: Y =	3,683-(2,698/X <sub>3</sub> )	1,47+0,925 lnX <sub>3</sub>
	linear regression's R <sup>2</sup> =	0.281	0.024
	equation: Y =	0,639+0,710X <sub>3</sub>	0,734+0,667X <sub>3</sub>
	best fit regression's type:	power	linear
<b>Y=f(X<sub>4</sub>)</b>	R <sup>2</sup> =	0.303	0.095
	equation: Y =	1,116·X <sub>4</sub> <sup>0,707</sup>	0,734+0,667X <sub>4</sub>
	linear regression's R <sup>2</sup> =	0.297	0.434
	equation: Y =	3,25-0,059X <sub>4</sub>	3,011-0,17X <sub>4</sub>
<b>Y=f(X<sub>5</sub>)</b>	best fit regression's type:	power	hyperbolic
	R <sup>2</sup> =	0.390	0.504
	equation: Y =	3,841·X <sub>5</sub> <sup>-0,328</sup>	1,139+(38,565/X <sub>5</sub> )

where:

Y: Growth (GDP ratio 2013/1989)

X<sub>2</sub>: Neighbours' average growth (weighted 2001)

X<sub>3</sub>: Neighbours' average growth (unweighted)

X<sub>4</sub>: Initial development (GDP/capita 1989)

not significant

TABLE A6. Codes of dummy variables

Post-socialist countries		Land-locked=1	Resource rich=1	New nation=1	Developed (OECD) countries (excluding		Land-locked=1	Resource rich=1	New nation=1
1	Afghanistan	1	1	0	1	Austria	1	0	0
2	Albania	0	1	0	2	Belgium	0	0	0
3	Angola	0	1	0	3	Canada	0	0	0
4	Armenia	1	0	1	4	Chile	0	1	0
5	Azerbaijan	1	1	1	5	Denmark	0	0	0
6	Belarus	1	0	1	6	Finland	0	0	0
7	Benin	0	0	0	7	France	0	0	0
8	Bosnia and Herzegovina	0	0	1	8	Germany	0	0	1
9	Bulgaria	0	0	0	9	Greece	0	0	0
10	Burma (Myanmar)	0	0	0	10	Ireland	0	0	0
11	Cambodia	0	0	0	11	Israel	0	0	0
12	China	0	0	0	12	Italy	0	0	0
13	Congo, Rep.	0	1	0	13	Korea, South	0	0	0
14	Croatia	0	0	1	14	Mexico	0	1	0
15	Czech Republic	1	0	1	15	Netherlands	0	0	0
16	Estonia	0	0	1	16	Norway	0	1	0
17	Ethiopia	1	0	1	17	Portugal	0	0	0
18	Georgia	0	0	1	18	Spain	0	0	0
19	Guinea-Bissau	0	0	0	19	Sweden	0	0	0
20	Hungary	1	0	0	20	Switzerland	1	0	0
21	Kazakhstan	1	1	1	21	UK	0	0	0
22	Kosovo	1	0	1	22	USA	0	0	0
23	Kyrgyzstan	1	1	1	23	Turkey	0	0	0
24	Laos	1	1	0					
25	Latvia	0	0	1					
26	Lithuania	0	0	1					
27	Macedonia	1	0	1					
28	Moldova	1	0	1					
29	Mongolia	1	1	0					
30	Mozambique	0	1	0					

	<b>Post-socialist countries</b>	<b>Land-locked=1</b>	<b>Resource rich=1</b>	<b>New nation=1</b>	<b>Developed (OECD) countries (excluding</b>	<b>Land-locked=1</b>	<b>Resource rich=1</b>	<b>New nation=1</b>
31	Nicaragua	0	0	0				
32	Poland	0	0	0				
33	Romania	0	0	0				
34	Russian Federation	0	1	1				
35	Serbia	1	0	1				
36	Slovakia	1	0	1				
37	Slovenia	0	0	1				
38	Somalia	0	0	0				
39	Tajikistan	1	0	1				
40	Tanzania	0	1	0				
41	Turkmenistan	1	1	1				
42	Ukraine	0	0	1				
43	Uzbekistan	1	1	1				
44	Vietnam	0	1	0				
45	Zimbabwe	1	0	0				
	<b>Total (45)</b>	<b>20</b>	<b>15</b>	<b>24</b>	<b>Total (23)</b>	<b>2</b>	<b>3</b>	<b>1</b>
	<b>Share</b>	<b>44%</b>	<b>33%</b>	<b>53%</b>	<b>Share</b>	<b>9%</b>	<b>13%</b>	<b>4%</b>

From the total sample of 68 countries 45 (66%) are post-socialist, 22 (32%) are landlocked, 18 (26%) are resource rich and 25 (37%) are new nations.

TABLE A7. The results of multivariate models for PSE countries

Y: Growth (GDP 2013 /1989)

 $X_1$ : Post-socialist = 1 $X_2$ : Neighbours' average growth  
(2001 weights) $X_3$ : Neighbours' average growth  
(unweighted) $X_4$ : Initial development  
(GDP/capita 1989) $X_5$ : Landlocked = 1 $X_6$ : Resource rich = 1 $X_7$ : New nation = 1

n.s.: not significant

Models $Y = f(\dots)$							R <sup>2</sup>
No. models	$X_2$	$X_3$	$X_4$	$X_5$	$X_6$	$X_7$	
<b>Bivariate models (The results of TABLE A5)</b>							
(2)	•						0.127
(3)		•					0.281
(4)			•				<b>0.297</b>
(5)				• n.s.			0.033 n.s.
(6)					•		0.088
(7)						•	0.252
<b>Models involving all potential explanatory variables: only <math>X_4</math> is significant.</b>							
(8)	• n.s.		•	• n.s.	• n.s.	• n.s.	<b>0.395</b>
(9)		• n.s.	0.429				
<b>Based on Model (4) and (8) is there a multivariate model which R<sup>2</sup> &gt; 0.297 and contain any other significant variable in addition to the <math>X_4</math>?</b>							
(10)	• n.s.		•				0.320
(11)			•	• n.s.			0.327
(12)			•		• n.s.		0.312
(13)			•			• n.s.*	0.355
(14)	• n.s.		•	• n.s.			0.363
(15)	• n.s.		•		• n.s.		0.324
(16)	• n.s.		•			• n.s.*	0.378
(17)			•	• n.s.	• n.s.		0.350
(18)			•	• n.s.		• n.s.	0.360
(19)			•		• n.s.	• n.s.*	0.370
<b>Changing <math>X_2</math> to <math>X_3</math>:</b>							
(20)		•	•				<b>0.366</b>
(21)		•	•	• n.s.			0.409
(22)		•	•		• n.s.		0.369
(23)		• n.s.	• n.s.			• n.s.	0.409

\* These parameters would be significant also at the 6% level instead of 5%.