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Introduction

The Department of Regional Economy at the Faculty of Economics, Management and Tourism of Wrocław University of Economics organized yet another scientific conference entitled: “Local and regional economy in theory and practice”. It was already the 23rd conference held on 23-25th September 2015 in “Chata za wsią” hotel in Mysłakowice near Jelenia Góra.

The conference was attended by the representatives of national and international scientific circles, regional and local government structures, and also other entities representing business practice and interested in the problems of local and regional economy, as well as PhD students. Over 80 participants of the conference arrived from over 30 national and foreign scientific centres and institutions to present papers and posters.

The subject matter of the conference covered the following areas: local and regional development, local and regional governance, application of quantitative methods in regional studies, partnership in local and regional development, directions of research in local and regional development, cooperation between academic centres and local government units.

The conference contributed to establishing more extensive and stronger relationships, created within the framework of the constructed platform for the exchange of scientific and practical experiences (the conference has been held cyclically since 1992) at the local, regional, national and international forum. The discussions were focused on the dissemination of research results, the exchange of experiences and the establishment of a discussion forum covering both theoretical and practical aspects of local and regional development. They also resulted in more extensive cooperation between academic centres, local government units as well as research and development centres, including the cross-border ones.

The conference is cyclically attended by the representatives of science from Poland and abroad. So far we have hosted e.g. the research workers representing academic centres from Ukraine, the Czech Republic, Italy, Sweden, Germany, Austria, Denmark, Slovakia and also the representatives of business practice, e.g. city presidents and mayors, village heads, county governors, presidents of regional development agencies or of local enterprises, etc.

As a result of the organized conference, the hereby publication presents the collection of thematically selected articles in English covering the broadly understood problems of local and regional economy. Its authors represent the following scientific centres: Warsaw School of Economics, University of Łódź, Gdańsk University of Technology, Koszalin University of Technology, University of Warmia and Mazury in Olsztyn and Wrocław University of Economics.

We are most grateful to the conference participants for the joint meeting and we do hope for further cooperation.

Elżbieta Sobczak, Andrzej Raszkowski, Andrzej Sztańdo

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REVERSION TOWARD THE MEAN OF REGIONAL ECONOMIC GROWTH – A POLISH EXPERIENCE

REWERSJA DO ŚREDNIEJ REGIONALNEGO WZROSTU GOSPODARCZEGO – DOŚWIADCZENIA POLSKIE

DOI: 10.15611/pn.2016.431.04

Summary: Individual regions of a single country may show significant differences in the pace of their economic growth. This phenomenon is well documented in abundant research studies based on data from developed economies, according to which the regional business cycles are featured by considerable inter-regional dispersion. However, the empirical studies have also found that many economic variables show strong tendency to revert toward the mean in the long run. In the case of regional economic growth it would mean that regions which in a given period experience above-average (below-average) growth, in the following years tend to show significantly slower (faster) relative growth (as compared to the country as a whole). Although mean-reversion is well documented for many economic variables in developed economies, it is much less explored in the case of emerging markets. This paper explores the phenomenon of reversion toward the mean in the case of real GDP-per-capita (GDP) growth of sixteen administrative voivodeships of Poland in 2001-2013 years. The research has confirmed that the relative pace of economic growth of individual regions of Poland shows discernible tendencies of mean-reversion.

Keywords: regional economic growth, mean-reversion.

Summary: Liczne badania wskazują, że charakterystyczną cechą wielu zmiennych mikro- i makroekonomicznych jest ich długookresowa rewersja w kierunku poziomów przeciętnych dla całej gospodarki. W przypadku regionalnego wzrostu gospodarczego oznacza to, że regiony kraju, które w danym okresie notują ponadprzeciętnie wysoki (niski) wzrost gospodarczy, w kolejnych okresach wykazują tendencję do wolniejszego (szybszego) relatywnego tempa wzrostu. W artykule zbadano zjawisko rewersji do średniej wzrostu gospodarczego szesnastu polskich województw w trzynastoletnim okresie obejmującym lata 2001-2013. Badanie potwierdziło, że relatywne tempo wzrostu gospodarczego poszczególnych regionów Polski wykazuje dostrzegalne tendencje rewersji do średniej.

Keywords: regionalny wzrost gospodarczy, rewersja do średniej.

1. Introduction

Individual regions of a single country may show significant differences in a pace of their economic growth. This phenomenon is well documented in abundant research studies based on data from developed economies, according to which the regional business cycles are featured by considerable inter-regional dispersion [Parker 1997; Mitchell, Carlson 2003; Wakerly et al. 2004; Wall, Zoega 2004; Gerlach-Kristen 2009; Crone 2006; Wall 2007].

However, the empirical studies also found that many economic variables show strong tendency to revert toward the mean in the long run. In the case of regional economic growth it would mean that regions which in a given period experience above-average (below-average) growth, in the following years tend to show significantly slower (faster) relative growth (as compared to the country as a whole).

Although mean-reversion is well documented for many economic variables in developed economies, it is much less explored in the case of emerging markets. The previous research confirmed the presence of mean-reversion in the case of stability of regional economic growth of the EU regions [Welc 2011]. However, the authors of this paper are not aware of any empirical study related to mean-reversion of economic growth among Polish regions. This paper explores the phenomenon of reversion toward the mean in the case of real GDP-per-capita (GDP) growth of sixteen administrative voivodeships of Poland in 2001-2013 years. Thus, the purpose of this research is to evaluate the pace with which the intra-regional differences in the economic growth of Polish regions tend to disappear (or at least to narrow).

The remainder of the paper is organized as follows. In the next section we describe the data and research method used in the study. Then the section that presents the empirical results follows. The paper closes with concluding comments.

2. Data and research method

In this research the annual data regarding the growth of GDP-per-capita (GDP) of sixteen Polish voivodeships between 2001 and 2013 have been used. The underlying statistical data were extracted from Eurostat database (for regions identified at the NUTS 2 level).

The only analyzed variable was the regional annual growth of real GDP-per-capita defined as follows:

$$GDPG_t = \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}}, \quad (1)$$

where: $GDPG_t$ – growth of GDP-per-capita in a given voivodeship in year t ,
 GDP_t – GDP-per-capita of a given voivodeship in year t .

The summary statistics of the data used are presented in the table below.

Table 1. Summary statistics computer for real GDP-per-capita growth of sixteen Polish voivodeships in 2001-2013

Year	Arithmetic mean	Median	Standard deviation	Coefficient of variation	Max. in a sample	Min. in a sample
2001	1.6%	2.1%	1.8%	112.0%	5.88%	-1.30%
2002	5.5%	5.4%	1.3%	24.0%	7.37%	3.00%
2003	2.5%	2.7%	1.5%	59.8%	4.44%	-1.05%
2004	8.2%	7.2%	2.8%	34.9%	16.05%	5.26%
2005	4.9%	5.4%	1.9%	38.3%	7.23%	1.63%
2006	6.4%	5.9%	1.7%	26.3%	10.92%	4.65%
2007	11.4%	10.7%	1.4%	12.5%	13.86%	9.78%
2008	2.9%	3.1%	1.9%	65.1%	6.42%	-0.81%
2009	1.4%	1.3%	2.0%	141.1%	4.65%	-1.72%
2010	8.0%	7.8%	1.6%	19.9%	12.10%	6.14%
2011	6.2%	6.1%	1.2%	19.7%	8.03%	4.48%
2012	4.1%	4.2%	1.2%	28.6%	6.25%	2.36%
2013	3.1%	3.3%	1.1%	37.3%	4.96%	0.77%

Source: Eurostat; author's calculations.

As may be seen, the investigated sample is characterized by significant diversity of GDP growth, both in cross-sectional dimension (between individual regions within the individual years) as well as in time-series dimension (between individual years). There were as many as four years when some regions enjoyed relatively fast economic growth (above 5% y/y) while others fell into recession (negative GDP growth). The coefficients of variation computed for all the years are double-digit or three-digit, which confirms that there exists significant inter-regional diversity in terms of GDP-per-capita growth.

The whole sample under investigation was divided into nine moving sub-samples. Each sub-sample comprised five years. The first sub-sample embraced the period between 2001 and 2005, the second one embraced 2002-2006 period, etc. The last sub-sample embraced the period between 2009 and 2013. For each of the sub-samples the visual inspection of the reversion toward the mean of economic growth was conducted.

In the case of the first sub-sample all sixteen voivodeships were sorted in order of decreasing GDP-per-capita growth in the first year, which is 2001 (from the region with the fastest growth to the one with the slowest growth in 2001). The GDP growth data computed for the individual voivodeships were then normalized with the following formula:

$$NGDPG_t^i = GDPG_t^i - MedianGDPG_t^n, \quad (2)$$

where: $NGDPG_t^i$ – normalized growth of GDP-per-capita of i -th region in year t , $GDPG_t^i$ – growth of GDP-per-capita of i -th region in year t (as defined by formula 1), $Median\ GDPG_t^n$ – median growth of GDP-per-capita of all sixteen voivodeships in year t , $n = 16$ – number of voivodeships.

Then the sorted regions were divided into four quartiles so that the first quartile embraced four voivodeships with the fastest normalized GDP-per-capita growth in 2001 and the last quartile embraced four regions with the slowest normalized economic growth in 2001. For each of four quartiles constructed in this way the median normalized GDP-per-capita growth in 2001 was computed. The median normalized GDP growth rates for individual quartiles were calculated as the medians of all four observations of individual normalized GDP growth rates of regions included within the given quartile.

Then, for the same quartiles, the median normalized GDP-per-capita growth in the following four years (i.e. 2002-2005) was computed. Analogous computations were made for the remaining eight sub-samples (comprising 2002-2006, 2003-2007, 2004-2008, 2005-2009, 2006-2010, 2007-2011, 2008-2012 and 2009-2013 periods). The results obtained from all nine rolling sub-samples were averaged in order to obtain the findings which are more representative for long-term processes. The results from individual sub-samples may be distorted by some factors specific for a given period. For example, the sub-sample for years 2003-2007 covers the period of fast economic growth, while the sub-sample for years 2007-2011 covers the period of world economic crisis. Although individual sub-samples may be biased by these specific factors, these biases tend to smooth out when the results are averaged. Thanks to this, the final results capture only the long-term patterns.

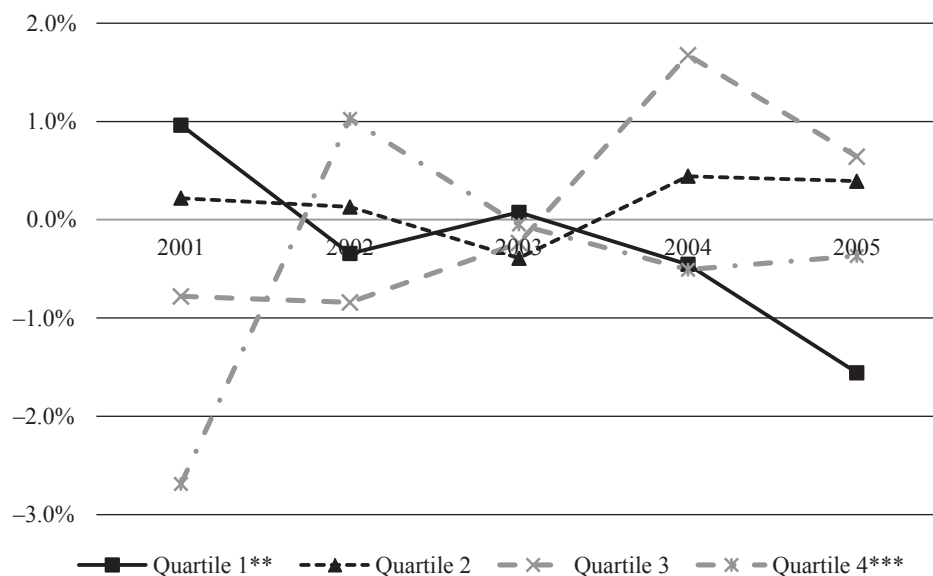
The research method described above enables visual inspection of the behaviour of regional economic growth in five-year windows. It enables observation of the paths of the decrease / increase of the relative GDP-per-capita growth in the quartiles with the fastest / slowest GDP growth in a given year (period t) in four years following the t -th year.

3. Results

Figure 1 presents the phenomenon of reversion toward the mean in the case of regional GDP-per-capita growth in the first sub-sample (comprising 2001-2005 period). The figure shows the medians of normalized economic growth in four quartiles formed on the basis of the data for 2001 year.

As can be seen, there was quite a strong tendency of reversion toward the mean of GDP-per-capita growth in the period under investigation in the case of two extreme quartiles. Particularly, voivodeships with the fastest GDP growth in 2001 (Quartile 1) were those with negative (or close to zero) normalized growth rates in the following four years (2002-2005). In contrast, regions with the slowest

economic growth in 2001 (Quartile 4) were those with the above-average growth in the following four years.



* normalized GDP-per-capita growth as computed in accordance to formulas (1) and (2), ** four voivodeships (25%) with the fastest GDP-per-capita growth in 2001, *** four voivodeships (25%) with the slowest GDP-per-capita growth in 2001.

2001 is the year for which the initial sort of all the regions is made.

Figure 1. Medians of normalized GDP-per-capita growth rates* in four quartiles of regions in 2001-2005 sub-sample

Source: Eurostat; author's calculations.

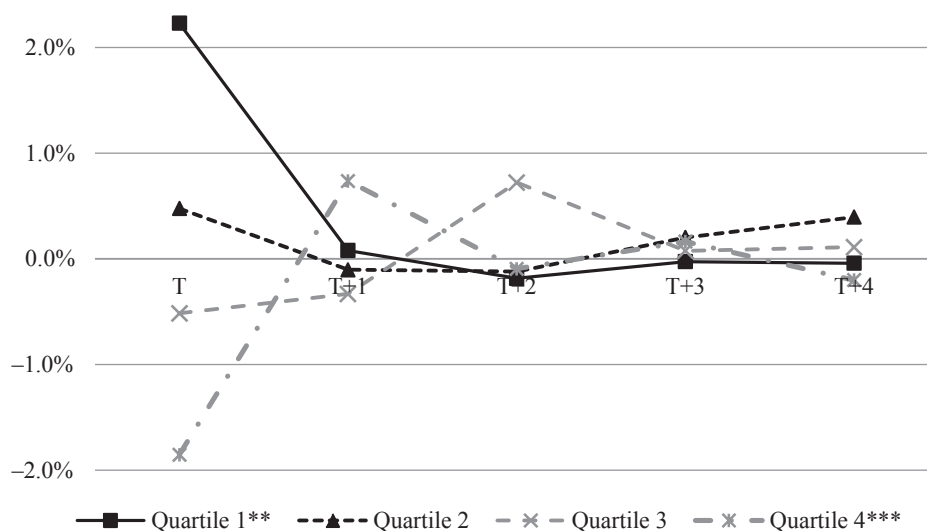
Analogous computations were conducted for the remaining eight rolling sub-samples. However, due to the space limitations the detailed results for the individual sub-samples are not presented here. Instead, in Table 2 as well as in Figure 2 the averages obtained for all nine sub-samples are presented.

The data shown in Table 2 and in Figure 2 present the averaged numbers for all nine sub-samples. For example, the value for the first quartile in year T (equalling 2.23%), where T is the year for which the sort of all the companies is made, constitutes the arithmetic mean of the nine medians of normalized GDP-per-capita growth rates obtained for the first quartile in the first year of all nine sub-samples. This number (equalling 2.23%) means that the median GDP-per-capita growth in the group of four voivodeships with the fastest growth in any given year is on average about 2.23 percentage points higher than the median GDP-per-capita growth for all sixteen voivodeships in the same year. Analogously, the value for the first quartile in period

Table 2. Averaged* medians of normalized GDP-per-capita growth rates in four quartiles of regions in all nine rolling sub-samples

Quartiles of regions	Period				
	T**	T+1	T+2	T+3	T+4
Quartile 1***	2.23%	0.08%	-0.18%	-0.03%	-0.04%
Quartile 2	0.48%	-0.10%	-0.12%	0.20%	0.40%
Quartile 3	-0.52%	-0.33%	0.72%	0.08%	0.11%
Quartile 4****	-1.85%	0.74%	-0.09%	0.16%	-0.20%

* each number in the table is the arithmetic mean from the nine values taken from the nine rolling sub-samples for a given quartile and for a given period, ** T means the sorting period (the year in which the voivodeships are sorted and grouped into four quartiles); periods from T+1 to T+4 are the following years, *** four voivodeships with the fastest GDP-per-capita growth in the sorting period (i.e. in year T), **** four voivodeships with the slowest GDP-per-capita growth in the sorting period (i.e. in year T).



* each number on the chart is the arithmetic mean from the nine values taken from the nine rolling sub-samples for a given quartile and for a given period, *** four voivodeships with the fastest GDP-per-capita growth in the sorting period (i.e. in year T), **** four voivodeships with the slowest GDP-per-capita growth in the sorting period (i.e. in year T).

Figure 2. Averaged medians of normalized GDP-per-capita growth rates* in four quartiles of regions in all nine rolling sub-samples

Source: Eurostat; author's calculations.

T+1 (equalling 0.08%), where T+1 is the year following the year for which the sort of all the regions is made, constitutes the arithmetic mean of the nine medians of normalized GDP-per-capita growth rates obtained for the first quartile in the second

year of all nine sub-samples. This number (equalling 0.08%) means that the median GDP-per-capita growth in the group of four regions with the fastest growth in period T, which in period T is on average about 2.23 percentage points higher than the median growth for all the voivodeships, in the following year (i.e. T+1) is on average 0.8 percentage points higher than the median growth in the group of all the regions.

As can be seen, the 2001-2013 period was characterized by a significant reversion toward the mean of GDP-per-capita growth rates of sixteen Polish voivodeships. In the years under investigation the median normalized GDP-per-capita growth in the first quartile in period T averaged 2.23%. That means that the median growth in the first quartile exceeded the median growth among all the regions by about 2.23 percentage points, on average. However, in the following year (T+1) such regions tended to report growth only slightly faster than average (by 0.08 percentage points) and in the further years (T+2 to T+5) they suffered from below-average growth of GDP-per-capita.

The strong mean-reversion is evident also in the case of the last quartile. In the years under investigation the median normalized GDP-per-capita growth in the fourth quartile in period T averaged -1.85%. That means that the median growth among slowest-growing voivodeships lagged behind the median growth among all the regions by about 1.85 percentage points, on average. However, in the following year (T+1) such regions tended to catch up with their economic growth and to report growth rates which exceed the country-wide median by 0.74 percentage points, on average.

4. Conclusions

The research presented in this paper was based on the data concerning GDP-per-capita growth rates of sixteen Polish voivodeships in 2001-2013 years. The findings corroborated that relative regional economic growth tends to revert toward the mean. This mean-reversion is evident in the case of extremely fast-growing and extremely slow-growing regions. It means that voivodeships characterized by relatively fast / slow economic growth in any year, usually experience below-average/above-average relative growth in the following years.

The obtained findings are of relevance for both corporate management as well as regional economic policy (including public finance management). This is so because the fast pace of mean-reversion of regional economic growth, if not adequately factored into decision making models and processes, may entail poor economic decisions. For example, if relatively fast/slow past growth of a particular region of a given country is over-extrapolated (by corporate managers) too far into the future, then their business decisions may be biased by, for instance, over-investing in the regions with above-average past growth while under-investing in the areas which are seemingly and temporarily lagging behind. Similarly, if mean-reversion of economic

growth is not fully understood by policymakers, it may result in overly optimistic/essimistic forecasts of local tax revenues in those regions or municipalities, which at the moment grow relatively fast/slowly.

However, this study has some relevant limitations. First of all, the period covered by the research is pretty short and embraces only few incomplete business cycles. During the years under investigation Polish economy did not experience any single year of recession (i.e. decline of gross domestic product). This means that the results can be somewhat biased. In particular, it is likely that the obtained estimates overstate the true pace of the mean-reversion, particularly in the case of regions with below-average economic growth. It is important qualification because in the case of recession (especially the deep, prolonged and unforeseen one) the higher share of Polish regions could fall into more structural and “stubborn” economic problems and that could significantly change the empirical estimates of their reversion toward the mean.

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