

# Bulgarian NUTS2 Regions' Beta- and Sigma- Convergence Towards the Eurozone

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## Abstract

In this scientific article Bulgarian regional economic convergence has been investigated in the 2000 – 2018 period. Beta- and sigma-convergence tests have been performed on Bulgarian regional data using level 2 Nomenclature of Territorial Units for Statistics (NUTS 2). By using panel econometric modelling Gross domestic product (GDP) per capita and structural Gross value added (GVA) are subject to the economic convergence investigation. Bulgarian NUTS 2 regions seem to converge with the average value for the Eurozone, however the upward development is quite uneven. The results suggest that unconditional beta-convergence can be justified for both types of variables and it can be concluded that Bulgarian regions narrow the gap with the Eurozone averages. Perhaps the sigma-convergence hypothesis cannot be justified since differences among regions grow with time. The most economically and socially developed NUTS 2 region in Bulgaria, Yugozapaden region, widens the gap with the rest five regions in respect to GDP per capita and differs considerably in terms of the structure of GVA. At the beginning of the period GVA generated by less productive

economic activities in Agriculture, forestry and fishing took a larger share in GVA in comparison to the Eurozone but managed to converge at the end of the period.

**Keywords:** beta-convergence, sigma-convergence, NUTS 2 regions, regional convergence, panel regression

**JEL:** O47, R11, R15

## 1. Introduction

It is widely accepted that poorer economies and regions generally tend to catch-up economically and socially with richer ones, however for some large groups of countries and regions this seems to be an exception (most of the African countries for example) rather, not a rule. Economic and social convergence is not guaranteed, since a set of pre-conditions need to be fulfilled in order for regions to be able to catch up with highly developed ones. A number of authors defend the hypothesis that different requirements for a faster economic growth of regions need to be matched for a beta-convergence process to evolve (see Barro and Sala-i-Martin, 1991; Sachs and Warner, 1995; Cuadrado-Roura, 2001; Caselli and Coleman, 2001; Cappelen et al., 2003; Dall'Erba and Gallo, 2008; Enflo & Rosés, 2015; Coppola and Destefanis, 2015; Ganong and Shoag, 2017; Minns and Rosés, 2018).

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Even after confirming the presence of beta-convergence of regions it is not quite unusual to find that regions follow a heterogeneous path of development, namely due to the stronger presence of factors facilitating economic convergence in some of the regions (see Caselli and Coleman, 2001; Dokov, 2008; Enflo and Rosés, 2015; Coppola and Destefanis, 2015; Ganong and Shoag, 2017; Stefanova, 2020).

Over the period from the beginning of 2000 until the end of 2018, the six regions, applying level 2 Nomenclature of Territorial Units for Statistics (NUTS 2), in Bulgaria experience faster Gross domestic product (GDP) per capita growth in comparison to the Eurozone averages. GDP per capita in Purchasing power standard (PPS) represents between 21 and 38% of the Eurozone average and managed to grow to 31-77% of the Eurozone average at the end of the period. The fastest growing NUTS 2 region in Bulgaria, Yugozapaden, becomes more productive and prosperous than the rest five regions, leaving a bigger gap in economic and social development and leading to the assumption that a heterogeneous development in Bulgarian NUTS 2 regions is underway.

In respect to the sectoral structure, measured through Gross value added (GVA) of selected economic activities of NUTS 2 regions, an even more interesting dynamics is observed. At the beginning of the period around 5% of GVA was generated by activities in Agriculture, forestry and fishing in Yugozapaden NUTS 2 region, while at the other five NUTS 2 regions respective economic activities generate between 14 and 18% of GVA. While at the same time these activities generate around 2% GVA in the Eurozone on average. Discrepancies between the share of selected economic activities in

the six NUTS 2 regions and the average for the Eurozone tend to diminish over the course of time under investigation.

Regional convergence in the EU creates opportunities but also challenges. The analysis of regional convergence is increasingly relevant in assessing the effectiveness of regional, national and EU cohesion policies. Less developed regions in the EU tend to catch up with richer regions until a specific mid-level of development is reached, after which other conditions are needed to be fulfilled for the purpose of continuation of the convergence process (see Cuadrado-Roura, 2001). The convergence rate of less developed areas in the US and the EU is around 2% per year on average according to Barro and Sala-i-Martin (1991) and Sachs and Warner (1995), while convergence is within 1.8% per year according to Ganong and Shoag (2017).

The analysis of regional convergence is of great importance since the NUTS 2 regions in Bulgaria have a GDP per capita below 75% of the EU average and are subject to the EU cohesion policy. Barely at the end of the period the Yugozapaden NUTS 2 region exceeds this threshold. It is the responsibility of Bulgarian national and regional authorities to direct EU funds for regional cohesion effectively, so as to reduce the dispersion in the socio-economic development between the individual regions in Bulgaria, and to narrow the gap with EU and eurozone average levels.

This scientific paper analyses regional (NUTS 2 level) convergence of the structure of GVA and of GDP per capita in Purchasing parity standard (PPS) terms, with Eurozone average values used for reference (Eurozone=100). Two working hypotheses need to be verified: the first hypothesis is that an unconditional beta-convergence of GDP and GVA by different economic activities can

be justified; the second hypothesis is that a sigma-convergence exists. After a brief literature review an econometric investigation of convergence has been carried out, with the aim to justify or reject working hypotheses.

### 2. Brief literature review

Not only in the last couple of decades has it been of great interest to analysts, researchers and decision makers what needs to be done for poorer countries and regions to be able to catch up economically and socially with rich ones. In a 109-year time span of analysis Baumol (1986) supports the hypothesis of economic and social convergence due to know-how introduction, copying successful practices of institutional set-up, investments in physical and human capital. Copying working practices and technologies and not spending on research and development activities would rather help regions and countries to converge to abundant counterparties according Barro and Sala-i-Martin (1995). Sachs and Warner (1995) draw the conclusion that economic convergence is possible only when a preset of conditions are met, like openness of the economy, quality of democracy and institutions, private ownership rights protection.

Regional convergence is conditional and depends on a number of factors according to the research of selected EU regions done by Cuadrado-Roura (2001). A number of less developed regions, after a period of convergence of GDP per capita and labour productivity, cease or vastly diminish the cohesion, mostly due to national peculiarities (see *ibid.*). Another possible reason for the lack of convergence is the fact that the free movement of goods, capital and people is not what neoclassical growth patterns suggest. A positive causality between labour productivity and regional convergence is supported by

the analyses of Enflo & Rosés (2015) and Coppola and Destefanis (2015). The starting point of economic and social development before EU accession, incl. the quantity of capital, technology and the competitiveness of the human capital in the respective region are of key importance for the process of economic convergence (see Coppola and Destefanis, 2015).

According to Cuadrado-Roura (2001), large enterprises, usually with inherited problems and operating in sectors that have passed the zenith of their development (e.g. the mining industry and producers of electricity from coal energy sources) are a factor for a slow or absent process of convergence. Stimulating economic activity, the creation and development of SMEs is crucial for regional convergence. Perhaps, the lack of socio-economic tensions between employees, trade unions, employers and regional authorities contributes to outpacing economic development (see *ibid.*). Cuadrado-Roura (2001) argues that regional infrastructure (roads, telecommunications, etc.) and the presence of cities with a population of at least 40,000 -150,000 are a factor for economic convergence. In addition, the presence of companies with advanced technology and high value-added production supports outpacing economic development (see also *ibid.*).

Barro & Sala-i-Martin (1990, 1992) examine the convergence in the economic development in the individual states in the US and for a group of countries, supporting the hypothesis that less developed regions / states and economies tend to grow faster, respectively,  $\beta$ -convergence is justifiable. The slower return on capital can only fit into the neoclassical models of economic growth (see also *ibid.*). The presence of the phenomena of

economic convergence of poor states in the United States and selected regions in seven EU countries is undeniable, but the rate of convergence (rate of reduction of the gap) is on average of 2% per year (see Barro & Sala-i-Martin, 1991). The rate of convergence according to the study of Ganong and Shoag (2017) for the period of 1880-1990 is around 1.8% but declines by half in the post 1990s period.

Increasing labour productivity, the transfer of employment from the agriculture, forestry and fisheries sectors to high value-added sectors and activities, and the right mix of government and regional policies allow Sweden's less developed regions to reduce their economic and social discrepancies with the richest region (Stockholm), in the period 1940-1980 (see Enflo & Rosés, 2015). Caselli and Coleman (2001) have established similar findings, i.e. the decline in agricultural employment is a factor of higher GDP growth per capita and lower dispersion in regional development in the United States, for the period 1880-1980.

Dall'Erba & Gallo (2008) find that the construction of transport infrastructure, which is most often financed through the EU structural funds, leads to relocation of enterprises and entire sectors close to the newly built transport infrastructure, while the spillover effects in the peripheral areas are very insignificant, such as especially valid for the regions of Greece and Portugal. It can even be argued that the EU's structural funds and cohesion policy do not actually reduce regional disparities, even deepen them. On the other hand, according to Coppola and Destefanis (2015), cohesion policy and the Structural Funds have a small but positive

impact on regional convergence but have no or limited impact on employment dynamics and fixed capital accumulation (see *ibid.*). According to Cappelen et al. (2003), EU funds stimulate regional beta-convergence, but the latter is conditional on regional institutions' effectiveness, which are usually more effective in larger regions, saturated with a higher quality of human capital and administrative capacity, thus smaller and poorer regions that are with limited supply of physical and human capital will lag behind larger and richer regions, i.e. sigma-convergence is unachievable without proper regional outcome-oriented policies.

The main factor for regional convergence in Canada has been resource booms and not the change in the structure of regional economy (that usually is caused by resource booms) according to Minns and Rosés (2018).

Ganong and Shoag (2017) blame house prices and net migration of uneducated labour force to states with lower house prices for the absence of beta-convergence of incomes. Perhaps net migration of educated labour force is causing the convergence of income between poorer and richer states.

When it comes to smaller dispersion among regions over time, sigma-convergence is justified for selected states in the USA in the work of Barro & Sala-i-Martin (1990), however in the same study the sigma-convergence hypothesis remains unsupported for a large set of countries. The hypothesis of unconditional beta-convergence and the presence of sigma-convergence in the NUTS 2 region of 11 CEE EU member-states is supported in the post- 2000 period in the work of Peshev and Pirimova (2019), justified by a smaller coefficient of variance values.

### 3. Methodology and results of $\beta$ - and $\sigma$ - convergence of Bulgarian NUTS 2 regions

In this paper Eurostat and the National statistics institute (NSI) regional data has been analysed. The data is according to the COMMISSION DELEGATED REGULATION 2019/1755 of 8 August 2019 amending the Annexes to Regulation (EC) No 1059/2003 of the European Parliament and of the Council on the establishment of a common classification of territorial units for statistics (NUTS). Bulgaria is comprised of six NUTS 2 regions, as shown in Table 1. Regional data on a NUTS 2 level for GDP per capita in PPS and GVA generated in selected economic activities have been considered in the empirical analysis.

**Table 1.** *NUTS 2 regions in Bulgaria*

NUTS 2 region	Code
Severozapaden (Northwestern)	BG31
Severen tsentralen (Northern Central)	BG32
Severoiytochen (Northeastern)	BG33
Yugoiztochen (Southeastern)	BG34
Yugozapaden (Southwestern)	BG41
Yuzhen tsentralen (Southern Central)	BG42

**Source:** <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019R1755&from=EN>; NSI; Eurostat.

In the current section of the article a panel econometric investigation of beta-convergence has been carried out together

with a sigma-convergence econometric and descriptive investigation, for the period between 2000 and 2018. The analysis starts first with the variable of GDP per capita in PPS (Eurozone=100) and continues with the analysis of the GVA generated in nine more broadly and narrowly defined economic activities following a Statistical classification of economic activities in the European Community (NACE Rev. 2), respectively GVA generated by: Agriculture, forestry and fishing; Industry (except construction) which aggregates the economic activities (B-E NACE Rev. 2 codes) of: Mining and quarrying; manufacturing; electricity, gas and air conditioning supply; water supply, sewerage, waste management and remediation activities; Manufacturing; Construction; Wholesale and retail trade, transport, accommodation and food service activities, information and communication; Financial and insurance activities, real estate activities, professional, scientific and technical activities, administrative and support service activities; Financial and insurance activities; real estate activities<sup>1</sup>. Manufacturing activities are included in the Industry activities, but they are one of the pillars of advanced economics and worth a separate investigation. The same logic applies when analysing the aggregate non-financial service activities as presented by Eurostat (Wholesale and retail trade; transport; accommodation and food service activities; information and communication) and stressing the importance of information

<sup>1</sup> NACE Rev. 2 - Statistical classification of economic activities [code-activity]: A-agriculture, forestry and fishing; B-mining and quarrying; C-manufacturing; D-electricity, gas, steam and air conditioning supply; E-water supply; sewerage, waste management and remediation activities; F-construction; G-wholesale and retail trade; repair of motor vehicles and motorcycles; H-transportation and storage; I-accommodation and food service activities; J-information and communication; K-financial and insurance activities; L-real estate activities; M-professional, scientific and technical activities; N-administrative and support service activities; O-public administration and defence; compulsory social security; P-education; Q-human health and social work activities; R-arts, entertainment and recreation; S-other service activities; T-activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; U-activities of extraterritorial organisations and bodies;



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and communication activities by individually focusing on IT activities. The same logic applies when aggregating the Financial and insurance activities; real estate activities; professional, scientific and technical activities; administrative and support service activities and focusing on Financial and insurance activities, real estate separately.

As of the end of 2018, 5.8% of regional GVA is generated by the Agriculture, forestry and fishing activity, compared to 14.8% in 2000. The average for the Eurozone for the whole period hovered around 2%, confirming the convergence of Bulgarian regions toward the Eurozone, from one point of view and the tremendous transformation of Bulgarian economy, from another.

At the beginning of the period GVA generated by industry activities (which aggregates economic activities of: mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; water supply; sewerage, waste management and remediation activities) is equal to 22% on average for Bulgarian regions and 23.2% for the Eurozone, advancing to 28% for Bulgarian regions at the end of the period and declining to 19.8% for the Eurozone. As of 2018, industry activities are generating above 34% of regional GVA in Yugoiztochen, Severozapaden and above 30% of Yuzhen tsentralen GVA and have an upward trend. The share of Industry activities in GVA in Yugoiztochen region is declining in significance for the region, generating just 12% of regions GVA.

Manufacturing increases in importance for Bulgarian regions, with GVA generated by manufacturing activities growing from 14% to 19% over the period. A diverging dynamic is revealed in the Eurozone, where GVA generated by manufacturing activities

declines from 20.3 to 16.8%. As of the end of the period GVA by manufacturing activities has a share of 27% in Severen tsentralen region and 25% in Yuzhen tsentralen, while in the richest, Yugoiztochen region, these activities generate around 10% of GVA.

The aggregated activities of: Wholesale and retail trade; transport; accommodation and food service activities; information and communication; generate around 24.1% of GVA as of 2018 in comparison to 22.8% at the beginning of the period. Values for Bulgarian regions are very close to Eurozone averages; however, Bulgarian NUTS 2 regions experience an ascending tendency, with a descending trend for the Eurozone.

GVA in Information and communication activities (IT) comprised between 2.9 and 3.1 of GVA, generating between 4.4 and 4.8% of GVA in the Eurozone. There is no need to mention how important the IT sectors are for modern economic and social development and for innovations-driven economic growth. In this respect, Yugoiztochen region's development is very impressive, with GVA generated by IT activities creating 12.5% of GVA and being in a clear-cut uptrend. IT activities in the rest NUTS 2 regions in Bulgaria even become less important for GVA creation, judging by declining values. Policies of stimulating education, job creation and business in the IT sector would help regions to ensure a faster economic convergence.

Over the course of the period Financial and insurance activities; real estate activities; professional, scientific and technical activities; administrative and support service activities create between 17.5 and 21% of regional GVA in Bulgaria, and 24 to 28% in the Eurozone, increasing its contribution to GVA for Bulgarian regions and for the Eurozone.

During the investigated period GVA created in Financial and insurance activities grow from 1.7 of GVA to 3.7% and decline from 5.1 to 4.6% for the Eurozone. In the richest and most productive Bulgarian NUTS 2 region, Yugozapaden, Financial and insurance activities are responsible for 11.4% of GVA creation in 2018, maintaining a strong uptrend, growing from 4.1% in 2000. The Yugozapaden region is distinct also with the large share of GVA generated by IT activities assuming those play a key role in the faster economic convergence of the region.

Real estate activities create 12.6% of GVA at the end of the period, growing from 12.1% in 2000, while in the Eurozone, the respective activities contribute between 9.5 and 1.2% in GVA. On the other hand, construction becomes less important to Bulgarian regions and GVA by this activity is also diminishing in the Eurozone. Construction activities are generating 4.6% of GVA on average in the Bulgarian NUTS 2 region at the beginning of the period, advancing to 9.1% in 2009 and shrinking to 4% at the end of the period. In the Eurozone more stable dynamics can be observed, with GVA from the respective sector declining from 6 to 5.1% over the period.

### 3.1. $\beta$ -convergence

The following formal panel equation has been employed for the purpose of the current analysis:

$$Y_{it-n} = \beta_0 + \beta_1 X_{it-n} + \beta_2 Z_i + u_{it} \quad (1)$$

Where:

$Y_{it}$  – dependent variable for  $i_{th}$  NUTS 2 region in  $t_{th}$  period;

$\beta_0$  – constant;

$\beta_1$  –  $k \times 1$  a matrix of parameters representing the association between the independent variable  $X_{it}$  and dependent variable  $Y_{it}$ ;

$\beta_2$  – a matrix of parameters representing the association between the independent variable  $Z_i$  (representing individual effects for a specific  $i_{th}$  NUTS 2 region) and the dependent variable  $Y_{it}$ ;

$Z_i$  – a variable for individual (fixed) effects for the  $i_{th}$  NUTS 2 region, irrespective of time;

$X_{it}$  – an independent variable  $X_{it}$  for  $i_{th}$  NUTS 2 region in  $t_{th}$  period;

$n$  – the time period index notation, accepting values between 0 and T;

$t$  – the time period variable;

$u_{it}$  – an error term.

The results of the performed Hausmann test and Redundant Fixed Effects tests suggest that the null hypothesis should be rejected at 1 % level of significance, thus a fixed effects panel model should be employed. Investigating for  $\beta$ -convergence in the current panel investigation has been done using the Sala-i-Martin (1996) model, transformed and rewritten as follows:

$$[\text{Ln}(Y_t/Y_{t-n})]/T = \alpha_i + \beta \text{Ln}Y_{it-n} + u_{it} \quad (2)$$

where:

$\text{Ln}(Y_t/Y_{t-n})$  – a natural logarithm between the quotient of one of the indicators of economic activity [GDP per capita in PPS (Eurozone=100) or the index of the relative share in GVA for the selected sector of activity] in the NUTS 2 regions in period “t” and the corresponding indicator in period “t-n”. This indicator (dependent variable) performs the role of compound annual growth rate (CAGR), i.e. a geometric mean. Information on the construction of the index of the relative share in GVA can be found in eq.3.

$T$  – number of years variable;

$n$  – number of years variable, taking values from 0 to T;

$\alpha_i$  – time invariant variable for  $i_{th}$  NUTS 2 region (individual factors variable) comprised

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by constant and fixed for the individual region effects;

$\beta$  – a  $k \times 1$  matrix of parameters representing the association between the independent variable  $\text{Ln}Y_{it-n}$  and the dependent variable  $[\text{Ln}(Y_t/Y_{it-n})]/T$ ;

$\text{Ln}Y_{it-n}$  – a natural logarithm of one of the two indicators of economic activity [GDP per capita in PPS (Eurozone=100) or the index of the GVA for the selected sector of activity] in the NUTS 2 regions in period “t-n”.

$u_{it}$  – an error term.

In eq.1 and eq.2 the  $\beta$ -coefficient needs to accept negative values for justifying the presence of  $\beta$ -convergence, hence revealing the negative relationship between the earlier values of the dependent variable and the growth rate of the dependent variable. Larger initial values for the dependent variable for the respective NUTS 2 region result in slower convergence, i.e. lower CAGR.

**3.1.1. GDP per capita in PPS, Eurozone=100;**

The results of the panel regression shown in eq. 3 reveal that the CAGR of GDP per capita in PPS (Eurozone=100) in the Bulgarian NUTS 2 regions is inversely related to the values of GDP per capita in PPS (Eurozone=100) at the beginning of the period. On average, the

growth rate decreases by 7.7% caused by a 1% change in the initial value, resp. the higher the GDP at the beginning of the period, the lower the growth rate during the period.

$$[\text{Ln}(Y_t/Y_{it-n})]/T = -0.07^{***} - 0.077 \text{Ln}Y_{t-n}^{***} + [\text{FE}] \quad (3)$$

Where: \* – 10% level of significance; \*\* – 5% level of significance; \*\*\* – 1% level of significance; FE – fixed effects, individual for each country;  $\text{Ln}Y$  – a natural logarithm of GDP per capita in the PPS compared to the average levels for the Eurozone, at values for the 19 members of the Eurozone = 100; i-index for the individual region; t-index for the current (last) period; n-number period, can take values from 1 to T; T-the total number of periods in the regression.

The coefficients in equation 3 are significant, at a significance level of 1%, as well as the high value of the Adjusted R-squared variable, together with the F-stat value and its level of significance point to a good fitness of the model. Summarized results can be found in Table 2. Jarque-Berra stat from the normality of distribution test has a value of 1.69 and the probability of 43% for accepting the null hypothesis of normality of distribution, hence failing to reject the null hypothesis and assuming normality of the distribution.

**Table 2:** Summarized statistics of the panel regression

Adjusted R-squared	0.89	Mean dependent var	0.02
S.E. of regression	0.00	S.D. dependent var	0.01
Sum squared resid	0.00	Akaike info criterion	-8.14
Log likelihood	226.79	Schwarz criterion	-7.88
F-statistic	74.64	Hannan-Quinn criter.	-8.04
Prob(F-statistic)	0.00		

Source: Own calculations

At the beginning of the period GDP per capita in PPS terms was 38% of the Eurozone

average at the beginning of the period for Yugozapaden region reaching to 76.1% at



the end of the period, while the next best performing NUTS 2 region, Yugoiztochen region, started at 29% of the Eurozone average and climbed to 38.5% at the end of the period. Both regions are outperforming the rest four, but the outperformance of the Yugozapaden NUTS 2 region is much stronger and remarkable, justifying higher fixed effects value, of 0.055 respectively. Fixed effects analysis results presented in Table 3 for each of the six NUTS 2 regions suggest that Yugozapaden region (accounting for the capital city) and Yugoiztochen region grow faster than the rest four peers, assuming that region-specific factors other than the initial values of the independent variable are causing the faster CAGR (e.g. education, population, workforce quality, infrastructure, i.e. physical and human capital abundance).

**Table 3.** Fixed effects for eq.3

NUTS2 region	Fixed effect
BG31	-0.025
BG32	-0.016
BG33	-0.002
BG34	0.001
BG41	0.055
BG42	-0.013

Source: Own calculations

### 3.1.2. GVA $\beta$ - convergence

In the current section, the convergence of the index of the relative share of GVA by economic activity for each of the six NUTS2 regions and towards the Eurozone average, has been analysed through a panel econometric regression. Structural convergence has been investigated through the constructed by the author Index of the relative share in GVA, applying the following formula:

$$Isgva_i = (SGVAnuts2_i / SGVAez_i) * 100 \quad (4)$$

where:

**Isgva<sub>i</sub>** – an index of the relative share of the i-th economic activity, comparing the relative share of GVA created in the respective NUTS2 economic activity for “i” with the corresponding share of GVA created in the Eurozone for the relevant economic activity.

**SGVAnuts2<sub>i</sub>** – the relative share of GVA created in the respective NUTS2 region for the i-th economic activity;

**SGVAez<sub>i</sub>** – the relative share of GVA created in the euro area by the i-th economic activity;

**Isgva<sub>i</sub>** can accept positive values only. Values between 0 and 100 mean that the share of the total GVA of the respective economic activity for the NUTS 2 region is smaller than the relative share of the economic activity in the Eurozone GVA. Similarly, values above 100 mean a larger share of the economic activity in the NUTS 2 region than in the euro area. A narrowing trend towards 100 during the period under review signals convergence in the GVA share of the investigated economic activity, regardless of whether it is ascending, with initial values below 100 or descending, with initial values above 100.

Replacing  $Y_{it}$  in eq.2 with the Index of relative share in GVA notation “ $I\_GVA_{it}$ ” and rewriting eq.2 in the following form is done, as shown in the eq.:

$$[\ln(I\_GVA_{it}/I\_GVA_{it-n})]/T = \alpha_i + \beta \ln I\_GVA_{it-n} + u_{it} \quad (5)$$

where:

all notations have been kept the same as in eq.2 apart from  $Y_{it}$  being replaced by the Index of relative share in GVA notation “ $I\_GVA_{it}$ ”

Nine panel regressions accounting for the selected nine economic activities and sub-activities generating GVA have been

constructed, respectively GVA generated by the following economic activities: Agriculture, forestry and fishing; Industry (except construction); Manufacturing; Construction; The broad category of Wholesale and retail trade, transport, accommodation and food service activities, information and communication; Information and communication (only); The broad category of Financial and insurance activities, real estate activities, professional, scientific and technical activities, administrative and support service activities; Financial and insurance activities only; real estate activities only. The results of all nine equations reveal an inverse relationship between the earlier values of the index of the relative share of GVA of the respective economic activity for the respective NUTS 2, on one hand and the CAGR (the dependent variable) on the other. In the next nine panel regressions the hypothesis of the presence of  $\beta$ -convergence can be supported, since there is an inverse relation between the CAGR rate of the index of the relative share of GVA and initial values of the index. The presented nine panel regression equations are significant, with high explanatory power, with high F-statistics of the model and low probability of accepting the null hypothesis.

The nine panel regression results, revealed in eq.6.1 to eq.6.9, suggest that a 1% increase in the independent variable (initial value of the natural logarithm of the index of the relative share of GVA) is causing between 0.05 and 0.16% decrease in the dependent variable (CAGR of the index of the relative share of GVA for the respective economic activity), which confirms the hypothesis of  $\beta$ -convergence in the case of the structure of GVA.

$$\text{LN}(I\_AGRI/I\_AGRI(-10))/10 = 0.49^{***} - 0.08^{*} \text{LN}(I\_AGRI(-10))^{***} + [\text{FE}] \quad (6.1)$$

Where: \* - 10% level of significance; \*\* - 5% level of significance; \*\*\* - 1% level of significance; FE- fixed effects, individual for each NUTS 2 region; Ln (I\_AGRI) – a natural logarithm of the index of the relative share of GVA in the sector of agriculture, forestry and fishing in period-t ; Ln (I\_AGRI (-10)) – a natural logarithm of the index of the relative share of GVA in the sector of agriculture, forestry and fishing in the period-t-10;

$$\text{LN}(I\_CNSTRCT/I\_CNSTRCT(-10))/10 = 0.70^{***} - 0.16^{*} \text{LN}(I\_CNSTRCT(-10))^{***} + [\text{FE}] \quad (6.2)$$

Where: \* - 10% level of significance; \*\* - 5% level of significance; \*\*\* - 1% level of significance; FE- fixed effects, individual for each NUTS 2 region; Ln (I\_CNSTRCT) – a natural logarithm of the index of the relative share of GVA in the sector of Construction in period-t ; Ln (I\_CNSTRCT (-10)) – a natural logarithm of the index of the relative share of GVA in the sector of Construction in the period-t-10;

$$\text{LN}(I\_FNINSR/I\_FNINSR(-10))/10 = 0.56^{***} - 0.14^{*} \text{LN}(I\_FNINSR(-10))^{***} + [\text{FE}] \quad (6.3)$$

Where: \* - 10% level of significance; \*\* - 5% level of significance; \*\*\* - 1% level of significance; FE- fixed effects, individual for each NUTS 2 region; Ln (I\_FNINSR) – a natural logarithm of the index of the relative share of GVA in the sector of Financial and insurance activities in period-t ; Ln (I\_FNINSR (-10)) – a natural logarithm of the index of the relative share of GVA in the sector of Financial and insurance activities in the period-t-10;

$$\text{LN}(I\_FRPA/I\_FRPA(-10))/10 = 0.61^{***} - 0.14^{*} \text{LN}(I\_FRPA(-10))^{***} + [\text{FE}] \quad (6.4)$$

Where: \* - 10% level of significance; \*\* - 5% level of significance; \*\*\* - 1% level of

significance; FE- fixed effects, individual for each NUTS 2 region; Ln (I\_ FRPA) – a natural logarithm of the index of the relative share of GVA in the sector of Financial and insurance activities, real estate activities, professional, scientific and technical activities, administrative and support service activities in period-t ; Ln (I\_ FRPA (-10)) – a natural logarithm of the index of the relative share of GVA in the sector of Financial and insurance activities, real estate activities, professional, scientific and technical activities, administrative and support service activities in the period-t-10;

$$\text{LN}(I\_INDU/I\_INDU(-10))/10 = 0.25^{***} - 0.05 * \text{LN}(I\_INDU(-10))^{***} + [\text{FE}] \quad (6.5)$$

Where: \* - 10% level of significance; \*\* - 5% level of significance; \*\*\* - 1% level of significance; FE- fixed effects, individual for each NUTS 2 region; Ln (I\_ INDU) – a natural logarithm of the index of the relative share of GVA in the sector of Industry (except construction) in period-t ; Ln (I\_ INDU (-10)) – a natural logarithm of the index of the relative share of GVA in the sector of Industry (except construction) in the period-t-10;

$$\text{LN}(I\_IT/I\_IT(-10))/10 = 0.44^{***} - 0.12 * \text{LN}(I\_IT(-10))^{***} + [\text{FE}] \quad (6.6)$$

Where: \* - 10% level of significance; \*\* - 5% level of significance; \*\*\* - 1% level of significance; FE- fixed effects, individual for each NUTS 2 region; Ln (I\_ IT) – a natural logarithm of the index of the relative share of GVA in the sector of Information and communication in period-t ; Ln (I\_ IT (-10)) – a natural logarithm of the index of the relative share of GVA in the sector of Information and communication in the period-t-10;

$$\text{LN}(I\_MNFCT/I\_MNFCT(-10))/10 = 0.28^{***} - 0.06 * \text{LN}(I\_MNFCT(-10))^{***} + [\text{FE}] \quad (6.7)$$

Where: \* - 10% level of significance; \*\* - 5% level of significance; \*\*\* - 1% level of significance; FE- fixed effects, individual for each NUTS 2 region; Ln (I\_ MNFCT) – a natural logarithm of the index of the relative share of GVA in the sector of Manufacturing in period-t ; Ln (I\_ MNFCT (-10)) – a natural logarithm of the index of the relative share of GVA in the sector of Manufacturing in the period-t-10;

$$\text{LN}(I\_REAL/I\_REAL(-10))/10 = 0.21^{**} - 0.05 * \text{LN}(I\_REAL(-10))^{**} + [\text{FE}] \quad (6.8)$$

Where: \* - 10% level of significance; \*\* - 5% level of significance; \*\*\* - 1% level of significance; FE- fixed effects, individual for each NUTS 2 region; Ln (I\_ REAL) – a natural logarithm of the index of the relative share of GVA in the sector of real estate activities in period-t ; Ln (I\_ REAL (-10)) – a natural logarithm of the index of the relative share of GVA in the sector of real estate activities in the period-t-10;

$$\text{LN}(I\_WTAI/I\_WTAI(-10))/10 = 0.46^{***} - 0.10 * \text{LN}(I\_WTAI(-10))^{***} + [\text{FE}] \quad (6.9)$$

Where: \* - 10% level of significance; \*\* - 5% level of significance; \*\*\* - 1% level of significance; FE- fixed effects, individual for each NUTS 2 region; Ln (I\_ WTAI) – a natural logarithm of the index of the relative share of GVA in the sector of Wholesale and retail trade, transport, accommodation and food service activities, information and communication in period-t ; Ln (I\_ WTAI (-10)) – a natural logarithm of the index of the relative share of GVA in the sector of Wholesale and retail trade, transport, accommodation and food service activities, information and communication in the period-t-10;

In eq. 6.1-6.9 the lower the beta coefficient (the higher value following the

minus sign of the beta coefficient), the higher the convergence of the Index of the relative share of GVA, hence Construction; Financial and insurance activities; real estate activities; professional, scientific and technical activities; administrative and support service activities; Information and communication services converge faster to Eurozone averages.

### 3.2. $\sigma$ -convergence

In the current section a sigma-convergence analysis has been performed for the purpose of verification of the hypothesis of narrowing divergence between NUTS 2 regions' analysed variables, for the 2000-2018 period. Declining values of dispersion, either the standard deviation, or the coefficient of variable, over time would signal the presence of sigma-convergence. A standard deviation for the six regions for each year and the coefficient of variation based on it and the arithmetic mean are used for the analysis of sigma-convergence. The coefficient of variation is calculated as the quotient between the standard deviation and the arithmetic mean for each of the five variables, using the following formula:

$$CV = \text{STD} / \text{MEAN} \tag{2}$$

Where:

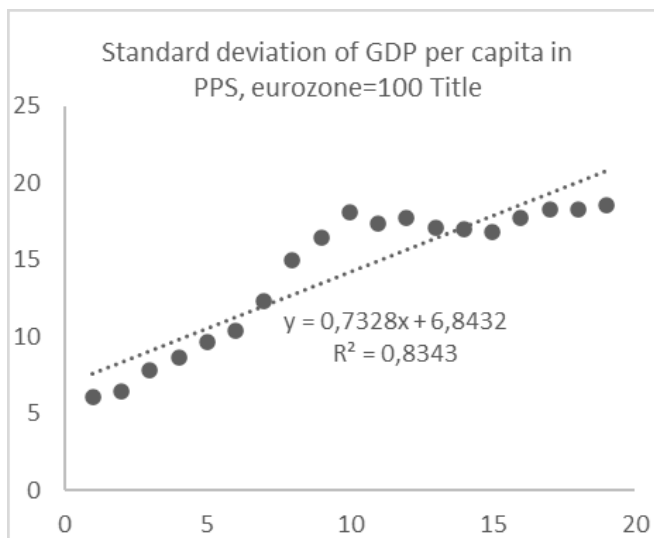
**CV-** The coefficient of variation is calculated as the quotient between the standard deviation and the arithmetic mean;

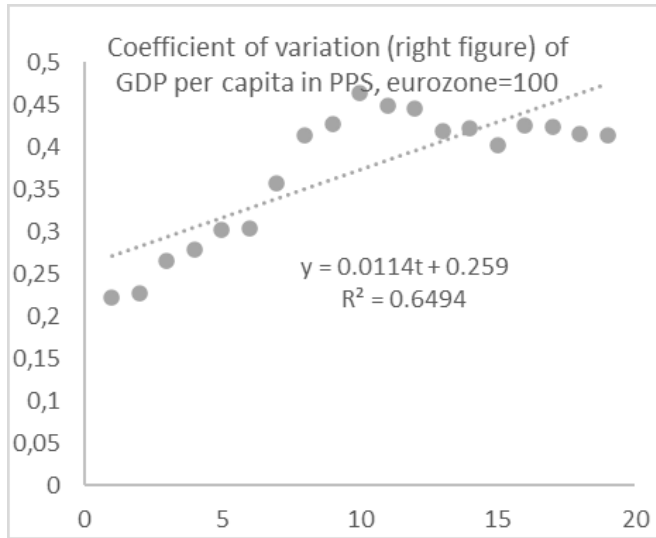
**STD-** the standard deviation calculated using the formula as follows:  $\sigma = [\sum (xi - \mu)^2 / N]^{0.5}$ , where  $xi$ -each observation from the population (six separate observations, one for each NUTS 2 area);  $\mu$ -arithmetic mean of observations;  $N$ -number of observations in the population (six for each year);

**MEAN-** the arithmetic mean of one of the two type variables (GDP per capita or the index of relative GVA share for the six NUTS 2 regions for each year).

$$CV_t = \alpha + \sigma t + u_t \tag{7}$$

On the left graph on Figure 1 the standard deviation of GDP per capita in PPS (Eurozone=100) is presented, while on the right graph the Coefficient of variation of GDP per capita in PPS (Eurozone=100) has been introduced.





Source: Own calculations, NSI, Eurostat.

**Figure 1:** Standard deviation (left figure) and Coefficient of variation (right figure) of GDP per capita in PPS, Eurozone=100

As can be seen on the left and right graphs in Fig.1, accounting for the standard deviation and the coefficient of variance of GDP per capita in PPS (euro area=100) for the six NUTS 2 region, sigma-convergence is rather rejected, since the two indicators increase the function of time.

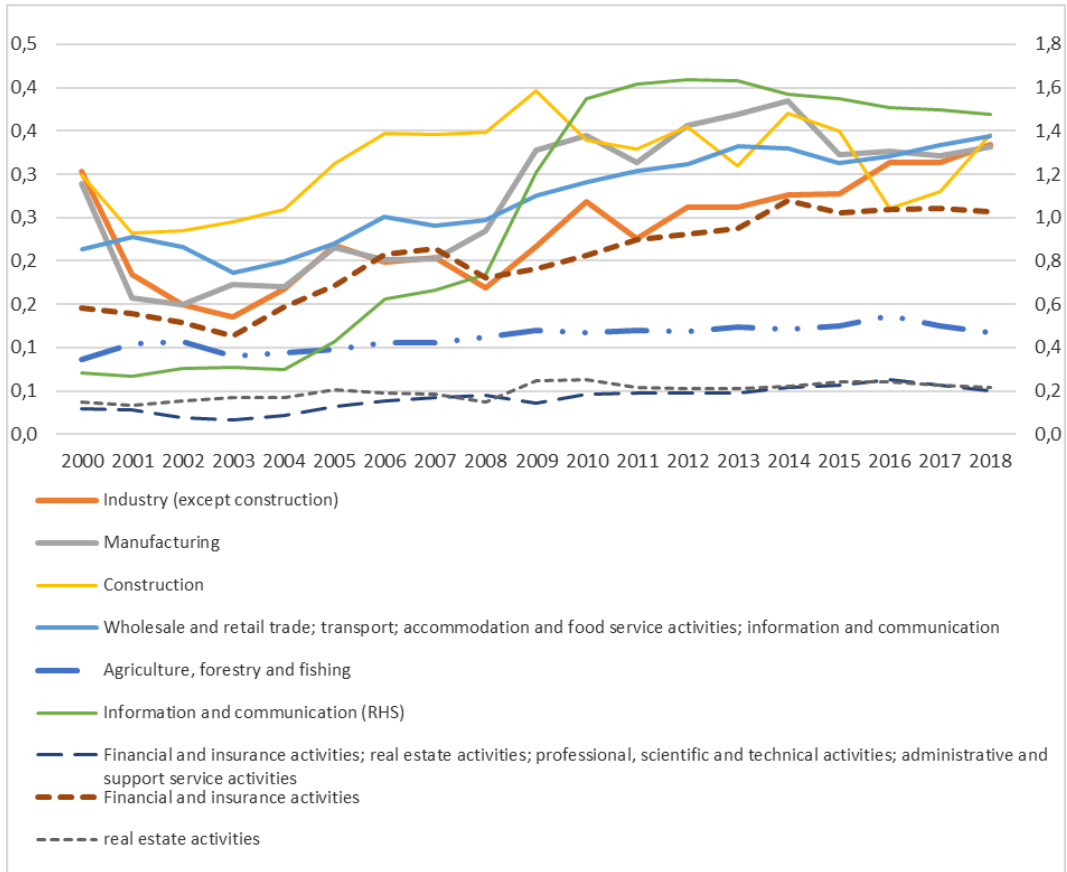
At the beginning of the period GDP per capita in PPS terms (Eurozone =100) accepts values between 21 and 29% of the Eurozone average for the five NUTS regions, while 38% of GDP per capita of the Eurozone is generated in Yugozapaden region. At the end of the period five Bulgarian NUTS 2 regions generate between 30 and 39% of the Eurozone average, while GDP per capita created in Yugozapaden region rose to 76.1% of the of the Eurozone average. The economic development in the six NUTS 2 regions is very uneven. The Bulgarian regional GDP per capita grows faster than the one for the Eurozone but the growth rate is distinct at Yugozapaden region, being 3 to 6 times higher in comparison to

the rest NUTS 2 regions in Bulgaria, hence the differences between NUTS 2 regions grow over time. Rejecting the sigma-convergence hypothesis contradicts the results of Peshev and Pirimova's (2019) research, in which EU member-countries convergence from the region of CEE has been analysed.

In Figure 2 and Figure 3 the Coefficient of variation and Standard deviation of the index of the relative share of GVA by selected economic activities in the NUTS2 regions of Bulgaria have been plotted respectively (GVA generated by the following economic activities: Agriculture, forestry and fishing; Industry (except construction); Manufacturing; Construction; Wholesale and retail trade, transport, accommodation and food service activities, Information and communication; Financial and insurance activities, real estate activities, professional, scientific and technical activities, administrative and support service activities; Financial and insurance activities; real estate activities). The ascending lines

signal that CV and STD are a positive function of time, hence the dispersion, i.e., differences among NUTS 2 regional variables rise with

time. The second working hypothesis of sigma-convergence presence is unjustifiable; hence it is rejected.

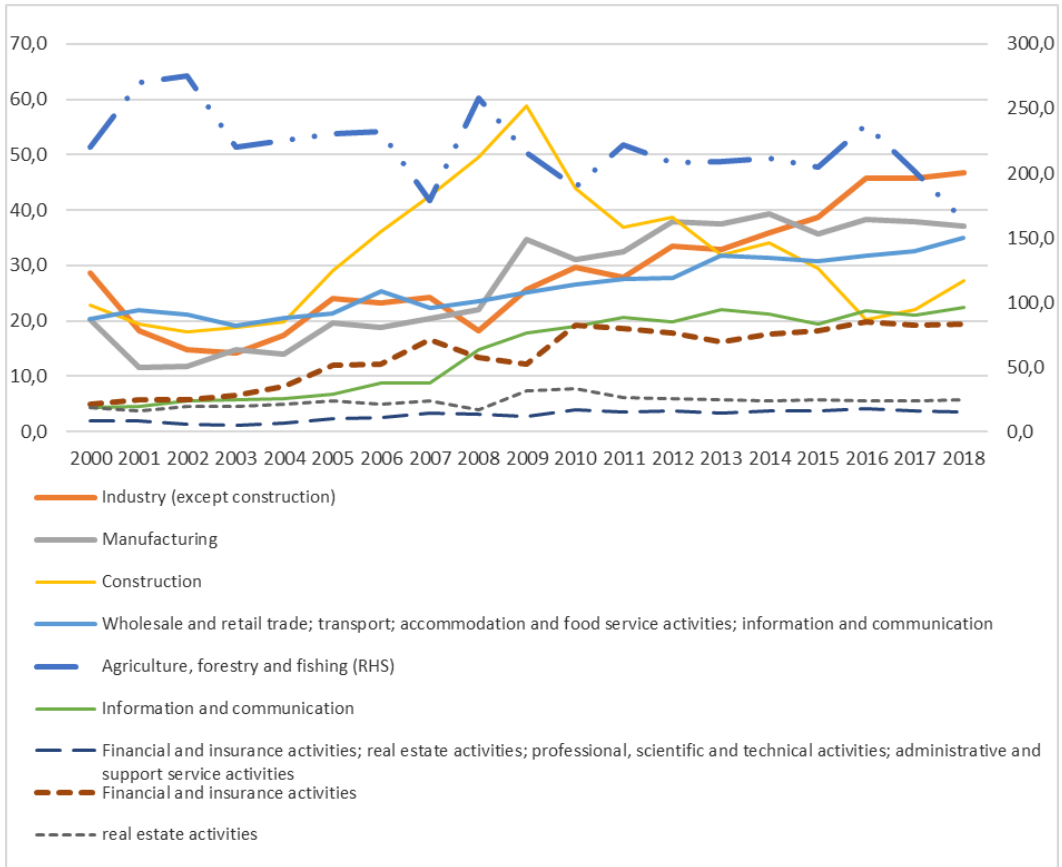


Source: Own calculations, NSI, Eurostat.

Where:  
RHS-right-hand side

**Figure 2. Coefficient of variation of the index of the relative share of GVA created by selected economic activities in the NUTS2 regions of Bulgaria**





Source: Own calculations, NSI, Eurostat.

Where:  
RHS-right-hand side

**Figure 3:** Standard deviation of the index of relative share of GVA created in the NUTS2 regions of Bulgaria

At the beginning of the period the Bulgarian regional GVA generated by Agriculture, forestry and fishing activities is six times higher than the Eurozone average, however the differences diminished at the end of period. In the most prosperous region, Yugozapaden region, the GVA of the Agriculture, forestry and fishing activities always had the lowest share in Bulgarian regions, but also managed to generate a lower share in GVA at the end of the period in comparison to Eurozone levels, confirming the results of Enflo & Rosés

(2015) and Caselli and Coleman (2001) that convergence is possible through transferring labour and capital from less productive activities to more productive ones.

The share of GVA created in manufacturing and GVA generated by Financial and insurance activities was considerably lower in relation to the Eurozone values at the beginning of the period and seem to converge with Eurozone averages at the end of the period.

The share of Information and communication activities in the GVA is the

highest in the Yugozapaden NUTS 2 region. Sofia is responsible for turning the region into a regional digital technologies' hub. GVA in Information and communication activities in the rest of the Bulgarian regions is even in a distinct downward trend, justifying their lagging economic development.

GVA structure is in position to explain why some of the Bulgarian regions are not converging faster with the Eurozone averages and why regional divergence widens throughout the period under review.

#### 4. Conclusions and recommendations

The results from the analysis of beta-convergence of GDP per capita in PPS and structural convergence of GVA in selected economic activities suggest that the hypothesis of unconditional beta-convergence can be confirmed. NUTS 2 regions converge with richer ones considering GDP per capita. On the other hand, the structural divergence between Bulgarian NUTS 2 regions' GVA and the Eurozone's average GVA seems to narrow over time, suggesting that the beta-convergence hypothesis in terms of GVA structure can also be justified. Even though only unconditional beta-convergence has been tested and confirmed, it appears that the richest NUTS 2 region in Bulgaria, Yugozapaden is leading the economic convergence process with the Eurozone in terms of GDP per capita in PPS. When it comes to structural convergence of GVA it could be said that again Yugozapaden region represents more closely the share of GVA by selected economic activities.

The results perhaps suggest that the sigma-convergence hypothesis can hardly be supported for both type of variables, GDP per capita and GVA generated by different economic activities, respectively. The

standard deviation of the six NUTS 2 regions and the Coefficient of variation tend to rise in value in the investigated period, hence rejecting the second hypothesis laid out in the Introduction of this article regarding the sigma-convergence for Bulgarian NUTS 2 regions in terms of both types of variables. The divergence between Bulgarian NUTS 2 regions grows over time regarding GDP per capita and in terms of the GVA structure.

The widening gap in development between Bulgarian NUTS2 regions requires effective and focused regional policy, aiming to narrow the differences between the least developed regions and the most developed one, on one hand and to narrow the gap of Bulgarian NUTS 2 region with averages for the Eurozone, on the other. Properly addressing the problems with the quality of human and physical capital, administrative capacity, labour resources, cohesion and other EU funds' investments, have the chance to stimulate a faster and more even growth of Bulgarian regions.

The regional development of poorer regions is very challenging due to the fact that EU freedoms, namely the freedom of movement of workers and capital, support emigration from poorer regions, hence richer and faster developing regions benefit, *ceteris paribus*. A focused discretionary regional economic and social policy are the only options for a more homogenous regional development.

It is recommended that the analysis should be augmented in the future with conditional beta-convergence analysis, in order to outline the most important factors of convergence and their impact on the speed of convergence. Nevertheless, it is easy to conclude that the GVA structure by economic activities of Yugozapaden NUTS 2 region and factors behind it lead to a faster convergence

to the Eurozone in comparison with the rest five NUTS 2 regions in Bulgaria.

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