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Determinants and measurement of smart growth: evidence from Poland

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Abstract. The paper deals with smart growth as a new economic category. The first part presents the theoretical aspects of this concept. The second part shows the results of smart economy development measuring for Poland based on the creative economy index (CEI) in the period of 2005–2014. Polish economy in the years 2005-2014 improved the conditions for smart growth – its CEI increased by 47%. This outcome consists of the results in four intermediate composite indicators, i.e.: inventive economy (IE), political institutions (PI), business regulations (BR) and fiscal institutions (FI). At the time, the largest percentage increase was recorded for the political institutions subindex (263%), followed respectively by the business regulations subindex (189%) and then inventive economy subindex (26%). During the same period fiscal institutions subindex decreased by 30%.

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1. INTRODUCTION

Smart growth is a notion mainly identified within the European Union's strategy development paper entitled: Europe 2020. Strategy for smart, sustainable and inclusive growth adopted in 2010 (European Commission, 2010). Smart growth – as developing an economy based on knowledge and innovations – was listed as one of the EU economic priorities in that document. Chronologically, the notional predecessor of smart growth was the concept of knowledge-based economy (KBE). The KBE concept, developed, inter alia, by the OECD in the 1990s, was identified with economies which are directly based on production, distribution and the use of knowledge and information (OECD, 1996; Madrak-Grochowska, 2015). The goal to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion was already presented in the previous strategy paper of the European Union, the so-called Lisbon Strategy, back in 2000.

In order to explain the essence of smart growth it is worth referring to the related theoretical approaches in literature. Searching for the origins of the smart growth theory, one can point out, among

others, works on urban development economics. In this view, it is a deepened concept of sustainable approach to urban areas development. Smart growth is a comprehensive strategy covering various aspects of urban development, it makes urban development blend in the regional ecosystem with the goal of harmonious development of the human and the society (Huang et al., 2010). In this context, the main emphasis is placed on sustainable environment management (including space) in order to facilitate the development of local communities. Mixed land use, protection of open space, compact building design, variety of transportation choices, attractive communities – these are only some of the principles of urban smart growth (Huang et al., 2010). Smart growth serves the development of economy, community and environment at the same time. It defines the framework enabling society make better informed decisions on how and where to allocate resources. It supports economic development and employment, creates strong neighbourhoods with a wide range of housing, commercial and transportation options which allow healthy society functioning in a clean environment (Smart Growth Network and ICMA, 2002).

Smart growth issues are also inherent at the mesoeconomic, regional level. The knowledge–innovation trajectory is particularly visible in Ph. Aydalot's (1986) concept of innovative milieu, according to which it is a particular milieu i.e. various forms of interdependencies arising in a particular area and combining different elements that are the sources of economic growth. The significance of regional knowledge management conditions was reflected in the concept of regional innovation systems (Okoń-Horodyńska, 1998). The mezoeconomic perspective of knowledge-based economy has also been developed in literature (Nowakowska et al., 2011; Kondratiuk-Nierodzińska, 2016). Currently, the practical expression of considerations on smart growth at the regional level is the so-called smart specialization (Foray et al., 2009; Kogut-Jaworska, 2015; Miłek & Nowak, 2015). It is based on the synergy of research and innovation with market needs in the identified areas of the greatest potential by focusing resources and avoiding duplication and fragmentation of activities. The process of identifying and developing regional smart specialization is called the entrepreneurial discovery process.

In turn, the importance of knowledge and innovation for the economy in micro- and macroeconomic approaches has been the subject of interest for theorists from the beginning of economics as a science (Żelazny, 2006). It is assumed that in the macroeconomic approach, as far as terminology is concerned, knowledge economy was introduced into economic research by F. Machlup (1962). As he stressed: '(…) promotion of knowledge from the rank of an exogenous independent variable to that of an endogenous variable dependent on input, on the allocation of resources, is an important step' (Machlup, 1962, p. 5). Not overstating the innovative nature of this change, he drew attention to the size of analyses of economic growth and development in the context of the effectiveness of investment in knowledge (Popov et al., 2016).

Smart economy combines the successful elements of enterprise economy and the innovation or 'ideas' economy while promoting a high-quality environment, improving energy security and maintaining social cohesion. Building the innovativeness component is possible through utilization of human capital – knowledge, skills and creativity of people and their abilities and effectiveness in translating ideas into valuable processes, products and services (Government of Ireland, 2008). At the core of smart economy lies an exemplary research, innovation and commercialisation of ecosystem. The smart growth concept stresses the importance of the increasing role of education, knowledge and innovation in creating added value in the economy. It is assumed that growth based on innovation is potentially more universal and sustainable (Balcerowicz & Rzońca, 2015, p. 37).

Moreover, it is stressed that smart economy same as 'green economy', is focused on renewable energy resources, improving energy efficiency in order to limit the demand and reduce natural environment

pollution (Government of Ireland, 2008). Its materialisation requires the implementation of solutions based on knowledge and innovations.

2. KNOWLEDGE, TECHNICAL PROGRESS AND INNOVATION IN ECONOMIC THEORY

The significance of the so-called fourth factor of production (technical progress, innovation, organization, entrepreneurship) for the economic growth is the subject of a broad research interest of economists and economics as a scientific discipline. The conceptual relationships: knowledge – technical progress – innovations were defined in the following way for the purpose of this paper. An increase of the set of possible production techniques resulting from the growth in the body of knowledge (e.g. inventions, discoveries) is technical progress. Technical progress which is a derivative of the growing body of knowledge provides feedback to the development of this resource. Implementation of new technologies to solve a specific problem in practice is an innovation. It also becomes a source of new knowledge (Panikarova & Vlasov, 2016). Thus, the relationship between the categories of knowledge, technical progress and innovation has a nature of feedback.

Economists in their works tackled issues connected with inventions and technical progress, although they rarely sought the answer to the question of their origin and their quantitative influence on the economic growth rate. Such considerations can already be identified in the works of the proponents of classical economics (e.g. A. Smith, D. Ricardo, & J.B. Say). Smith (1904) pointed out the division of labour and the consequent saving of time as a factor facilitating inventions. Ricardo (1821) analysed the impact of new machinery and equipment on economic results, though these were not clear views. Say (1855) wrote about the benefits of innovation resulting from the introduction of machinery to the production, also in the context of the creation of new jobs. Among the economists taking up the issue of technical progress, inventions and innovation the following are worth mentioning K. Marx (capital-saving and labour-saving innovations), A. Marshall (organisation as a factor of production), J.R. Hicks (the concept of neutral technical progress), R.F. Harrod (distinguishing technical progress as a decisive factor of labour productivity growth), M. Kalecki (the non-investment improvement coefficient), J.A. Schumpeter (an entrepreneur-innovator), T. Veblen (the instinct of workmanship and idle curiosity as determinants of technological change), W.C. Mitchell (technological progress as a source of business cycles), D.C. North (feedback between the institutional framework and knowledge), R. Solow (egzogenous technical progress, total factor productivity - TFP), P. Romer (endogenization of technical progress and externalities), R. Lucas (human capital and externalities).

A qualitative change in the analysis of the so-called fourth factor of production was introduced by Schumpeter (1934, 1939), considered as a precursor of the theory of innovation. According to him, the driving force of economic growth is the implementation of innovations in practice by entrepreneurs-innovators. He defined an innovation as the introduction of a new product or service, new method of production, opening new markets, acquiring new sources of raw materials or semi-finished products, carrying out a new organisation of any industry (Schumpeter, 1934, pp. 65-66). The category of innovation in this paper will be defined following Schumpeter's view, as the use of new ideas-innovative proposals introduced into economic activity (Balcerowicz & Rzońca, 2015, p. 38). So broadly understood innovation is related to all the resources enabling to limit the decreasing marginal productivity of inputs. Among these sources there may be mentioned (Żelazny & Pietrucha, 2017):

– increasing human capital stock and/or productivity of human capital, in particular, engaged in R&D activities,

– increasing the number and/or quality of intermediate goods, which are innovations applied to final goods manufacturing,

– improving the resource of final goods of higher utility level for households,

– occurrence of positive externalities connected with no possibility to entirely appropriate benefits from innovation by the entity bearing the risk and cost of implementing the solution.

According to Balcerowicz and Rzońca (2015, p. 38): 'sustained economic growth is possible only as long as innovations increase the productivity of the factors of production'. Launching and/or maintaining such a growth mechanism requires functioning of appropriate institutions. Institutions, according to representatives of the so-called new institutionalism, are limitations created by human beings that define and limit the system the choices made. Their main aim is to reduce uncertainty by creating a stable order (North, 1990). Institutions co-determine the direction of the search for knowledge and skills – this direction is the determining factor in long-term development of society (North, 1990). Institutional environment with specific characteristics creates, therefore, the conditions for enlarging the body of knowledge and its effective use in the form of innovation (Chernov et al., 2016). On the other hand, it is a larger set of possible production techniques resulting from the increase in the body of knowledge that is a determinant of institutional change. The mutual interaction between the body of knowledge and institutional framework will gradually shape the transformation of the latter (North, 1990, pp.75-79). Institutions do not always keep up with changes in the technology of production, and thus can inhibit the development (Veblen, 1998). Hence feedback relationships can also be identified between categories of knowledge and institutions. Among the key institutions determining smart growth the following should be mentioned (Balcerowicz & Rzońca, 2015, pp. 21-23; Żelazny & Pietrucha, 2017; Balcerzak & Pietrzak, 2015):

– economic institutions (i.e. structure and level of property rights protection, market structure, intensity of competition, business regulations aimed at supporting entrepreneurship, effectiveness of juridical system in keeping low level of transaction costs and supporting effectiveness of market mechanism)

– political institutions (e.g. political stability, political regime)

– financial institutions (e.g. monetary system, financial supervision authority, autonomy of central bank)

– fiscal institutions (e.g. size of the government, the fiscal position of the state in the economy).

Smart growth will be possible under the conditions created on the basis of feedback between institutions, human capital and technology. Such an environment is conducive to the development of creativity which is an accelerator of innovativeness on the micro, meso and macro level, and consequently the creation of creative economy (Żelazny & Pietrucha, 2017).

3. MEASURING OF SMART GROWTH

The first attempts to measure the impact of technological progress and innovation on the rate of economic growth were made by Solow (1957). He estimated that the increase in the productivity of factors in the United States in the period of 1909-1949 accounted for 87.5% growth in the gross national product per hour worked, and the remaining 12.5% was due to the increased use of capital (Solow, 1957, pp. 316, 320). Total factor productivity was calculated as the difference between the rate of output growth and the sum of weighted share of the revenue from a given factor in the national income growth of capital and labour. On the basis of Solow's model, the size of TFP for both economies as well as individual industries was estimated. In parallel, the methods of measuring the share of TFP in relation to the share of other

inputs, which resulted in a reduction of Solow's original estimates of TFP share in the growth, were modified and refined (Jorgenson & Griliches, 1967; Islam, 1999; Shestalova, 2001). And so, for example, in the period of 1960-95, close to 50% Japanese output growth and more then 40% German and Italian output growth were determined by TFP growth (Helpman, 2004, p. 24). Currently, research is conducted using different methodologies to estimate TFP in output growth, and the results are made available in the form of databases (for example: The Conference Board, 2015). In summary, Solow's approach did not explain the sources of technological progress, therefore, it was insufficient, what drew attention, among others, of Barro & Sala-i-Martin (2004, p. 18) who wrote: 'Thus we end up with a model of growth that explains everything but long-run growth, an obviously unsatisfactory situation'.

Chronologically, another attempt to measure the share of knowledge in the growth of GNP was a proposal of Machlup (1962), based on the use of System of National Accounts. He identified the so-called knowledge industry, and estimated its share in the US GNP. In total, the knowledge industry (knowledge production and knowledge distribution) accounted for 29% of the US GNP in 1958 (Machlup, 1962, p. 361). He included in the knowledge industry the following: education, R&D, the media of communication, information machines and information services.

The criticism of exogenous approach to the analysis of the role of technological progress has resulted in an increase in the development of endogenous models, still within the growth accounting framework (Romer, 1990; Aghion & Howitt, 1992; Lucas, 1988). The variables explaining the economic growth were: innovations in the means of production, innovations in the field of final goods, the accumulation of human capital or externalities.

A potential explanatory variable in such a model can also be a composite index (CI) diagnosing the level of innovation in the economy based on a set of quantitative and/or qualitative variables. Among the most popular CI in this field one can indicate the Summary Innovation Index - SII (Hollanders et al., 2015) or the Global Innovation Index - GII (Dutta et al., 2015). Further this paper assesses the level of the Polish economy development in the period of 2005-2014, based on an original proposal of a composite index, i.e. Creative Economy Index - CEI (Żelazny & Pietrucha, 2017).

4. EMPIRICAL RESULTS

Creative economy index is a composite index designed on the basis of 71 variables characterising innovativeness and institutional environment in 34 European countries in the period of 2005-2014 (Żelazny & Pietrucha, 2017). Based on the factor analysis applying the principal component method, four factors explaining of at least 60% of initial database variance in total were found. Taking into account the matrix of factor loadings, 43 variables were assigned to four principal components (marked with bold in Table 1). After analysing the constituent variables the following names were proposed: factor 1 – inventive economy (IE), factor 2 – political institutions (PI), factor 3 – business regulations (BR) and factor 4 – fiscal institutions (FI). The institutional variables come from different databases, in some cases they have similar or the same names. Further in the discussion, their detailed characteristics is provided. The relevant data is shown in Table 1.

Table 1

Factor loadings – varimax rotation

Variable	Factor			
	f1 (IE)	f2 (PI)	f3 (BR)	f4 (FI)
International scientific co-publications per million population	**0.74**	0.07	0.27	0.25
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	**0.78**	0.19	0.11	0.39
Non-EU doctorate students as a % of all doctorate students	**0.63**	0.04	0.21	0.25
Business R&D expenditures as % of GDP	**0.63**	0.21	0.17	0.53
SMEs innovating in-house as % of SMEs	**0.68**	0.20	-0.27	0.27
PCT patents applications per billion GDP (in PPS€)	**0.67**	0.12	0.23	0.50
PCT patent applications in societal challenges per billion GDP (in PPS€)	**0.64**	0.06	0.28	0.39
SMEs introducing product or process innovations as % of SMEs	**0.72**	0.07	-0.31	0.16
Employment in knowledge-intensive activities (manufacturing and services) as % of total employment	**0.69**	0.43	-0.04	0.11
Voice and accountability	**0.67**	0.59	0.16	0.30
Political stability and absence of violence/terrorism	0.45	**0.62**	0.20	0.13
Government effectiveness	**0.80**	0.42	0.17	0.27
Regulatory quality	**0.69**	**0.60**	0.29	0.11
Rule of law	**0.79**	0.47	0.18	0.25
Control of corruption	**0.88**	0.30	0.16	0.28
Property rights	**0.80**	0.42	0.13	0.19
Freedom from corruption	**0.86**	0.29	0.21	0.31
Fiscal freedom	-0.44	-0.28	0.15	**-0.71**
Government spending	-0.17	-0.29	0.09	**-0.75**
Business freedom	**0.60**	0.21	0.37	0.34
Size of government	-0.15	-0.31	0.12	**-0.68**
Protection of property rights	**0.86**	0.36	0.04	0.14
Legal system & property rights	**0.86**	0.34	0.18	0.18
Sound money	0.09	**0.68**	0.20	0.21
Freedom to trade internationally	0.17	**0.61**	0.04	0.01
Regulation	0.25	0.18	**0.61**	-0.13
Property rights	**0.85**	0.37	0.05	0.15
Intellectual property protection	**0.83**	0.38	0.10	0.30
Diversion of public funds	**0.91**	0.21	0.06	0.20
Public trust in politicians	**0.91**	0.12	0.11	0.14
Judicial independence	**0.87**	0.31	0.14	0.21
Favoritism in decisions of government officials	**0.89**	0.14	0.16	0.25
Wastefulness of government spending	**0.89**	0.07	0.11	0.00
Burden of government regulation	**0.77**	0.02	0.28	-0.28

Efficiency of legal framework in settling disputes	**0.90**	0.18	0.17	0.13
Efficiency of legal framework in challenging regulations	**0.92**	0.18	0.10	0.13
Transparency of government policymaking	**0.89**	0.13	0.17	0.06
Registering property	0.23	-0.12	**0.64**	-0.04
Getting credit	0.02	-0.02	**0.72**	0.02
Paying taxes	**0.69**	0.08	0.27	-0.09
Political rights (PR)	-0.26	**-0.77**	-0.10	-0.23
Civil liberties (CL)	-0.32	**-0.73**	-0.16	-0.22
Freedom of the press	**-0.60**	-0.58	-0.18	-0.21
Explained variation	**0.36**	**0.12**	**0.07**	**0.08**

Source: own evaluation.

These four principal components are CEI constituents as intermediate composite indicators (ICI). The intermediate composites are aggregated by assigning a weight to each one of them equal to the proportion of the explained variance in the data set. The final composite indicator is expressed by the formula (Żelazny & Pietrucha, 2017):

$$CEI = 0.57IE + 0.19PI + 0.11BR + 0.13FI \quad (1)$$

It is worth noting the specifics of the selected institutional variables included in the various subindices. And so, creative economy subindex consists of 32 variables, including 9 characterising innovativeness, and 23 of an institutional nature. Among the latter are (Kaufmann and Kraay, 2015; Fraser Institute, 2015, The Heritage Foundation, 2015; World Economic Forum, 2015; World Bank, 2015; Freedom House, 2015):

– voice and accountability (captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media)

– government effectiveness (captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies)

– regulatory quality (captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development)

– rule of law (captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence)

– control of corruption (captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests)

– property rights (measures the degree to which a country's laws protect private property rights, the extent to which those laws are respected, the existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts)

– freedom from corruption (measures the level of perceived corruption)

– business freedom (measures the extent to which the regulatory and infrastructure environments constrain the efficient operation of businesses)

– legal system & property rights (measure how effectively the protective functions of government are performed)

– property rights (measure the extent to which property rights including financial assets are protected)

– intellectual property protection (measures the extent to which the intellectual property is protected)

– diversion of public funds (measures the prevalence of illegal diversion of public funds to companies, individuals, or groups)

– public trust in politicians (measures the level of the ethical standards of politicians)

– judicial independence (measures the level of independence of the judicial system from influences of the government, individuals, or companies)

– favoritism in decisions of government officials (measures the extent to which government officials show favoritism to well-connected firms and individuals when deciding upon policies and contracts)

– wastefulness of government spending (measures the effectiveness of spending public revenues by the government)

– burden of government regulation (measures burdensome for companies to comply with public administration's requirements, e.g.: permits, regulations, reporting)

– efficiency of legal framework in settling disputes (measures the effectiveness of the legal and judicial systems for companies in settling disputes)

– efficiency of legal framework in challenging regulations (measures the possibilities of obtaining justice through the judicial system against arbitrary government decisions by individuals, institutions, civil society, and businesses)

– transparency of government policymaking (measures the possibilities of obtaining information about changes in government policies and regulations affecting their activities by businesses)

– paying taxes (measures the taxes and mandatory contributions that a medium-size company must pay in a given year as well as the administrative burden of paying taxes and contributions)

– freedom of the press (measures the level of press freedom, the ability to provide and access news and information).

The political institutions subindex consists of the following variables (Kaufmann & Kraay, 2015; Fraser Institute, 2015; Freedom House, 2015):

– political stability and absence of violence/terrorism (measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism)

– regulatory quality (captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development)

– sound money (measures the consistency of monetary policy or institutions with long-term price stability and the ease with which other currencies can be used via domestic and foreign bank accounts)

– freedom to trade internationally (measures a wide variety of restraints that affect international exchange: tariffs, quotas, hidden administrative restraints, and controls on exchange rates and the movement of capital)

– political rights (captures the manner of conducting election, the possibility of the functioning of the democratic opposition and competitive parties)

– civil liberties (focuses on the level of freedoms of expression, assembly, association, education, and religion).

The business regulations subindex is composed of three variables, i.e. (Fraser Institute, 2015; World Bank, 2015):

– regulation (focuses on regulatory restraints that limit the freedom of exchange in credit, labour, and product markets)

– registering property (captures procedures, time and cost to transfer a property and the quality of the land administration system)

– getting credit (captures movable collateral laws and credit information systems).

The fiscal institutions subindex constitutes of three variables, i.e. (The Heritage Foundation, 2015; Fraser Institute, 2015):

– fiscal freedom (composite measure of the burden of taxes that reflects both marginal tax rates and the overall level of taxation, including direct and indirect taxes imposed by all levels of government, as a percentage of GDP)

– government spending (captures the burden imposed by government expenditures, which includes consumption by the state and all transfer payments related to various entitlement programs)

– size of government (measure the degree to which a country relies on personal choice and markets rather than government budgets and political decision-making).

The values of CEI and individual intermediate composite indicators for Poland in the period of 2005-2014 presents Figure 1.

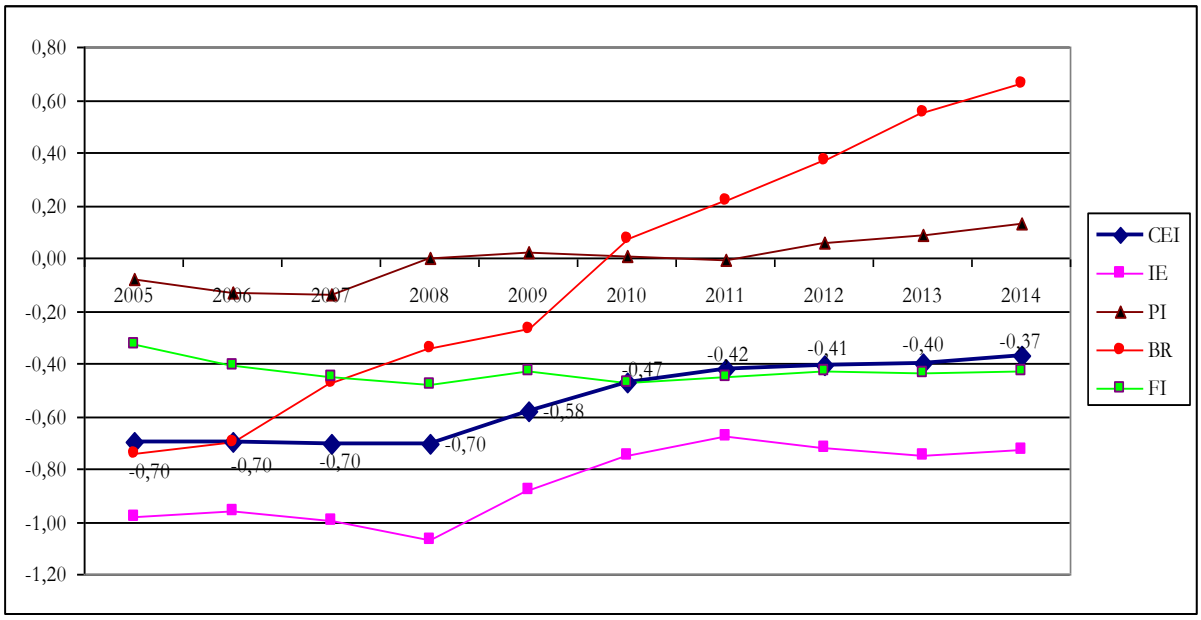

Figure 1. CEI and its components in Poland in the period of 2005-2014

Source: own evaluation.

The database is available on the website http://rzelazny.pl/category/cei and will be updated systematically

In the period of 2005-2014 the value of the creative economy index for Poland increased by 47% (from -0.7 to -0.37). At the time, the largest percentage increase was recorded for the political institutions subindex (263%), followed respectively by the business regulations subindex (189%) and the inventive economy subindex (26%). For the fiscal institutions subindex showed a decrease by 30% (from -0.33 to -0.43) in the period 2005-2014. Details of the annual percentage changes in the value of CEI and intermediate composite indicators presents Figure 2.

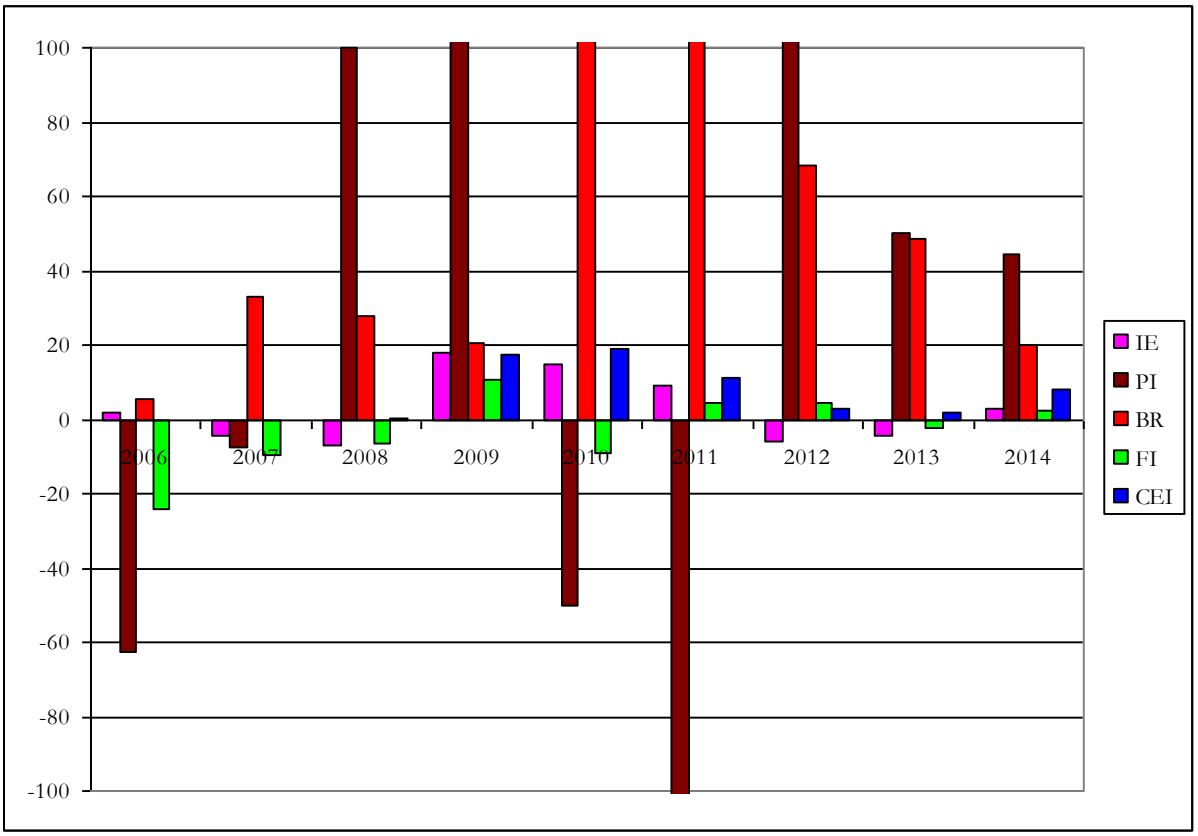

Figure 2. Percentage changes in the value of CEI and its components for Poland (previous year = 100)

Source: own evaluation.

CEI values in 2005-2008 oscillated around the same level, which is reflected in Graphs 1 and 2. In some years, changes exceeding 100% were reported for PI and BR, which in case of PI is mainly due to the low values of this subindex and a result of its high volatility.

To compare, in the period of 2007-2014, the SII value for Poland increased from 0.29 to 0.31 (7%) and in the same period the CEI increased by 48%. The Pearson correlation coefficient between the CEI and the SII is 0.53. There was also confirmed a strong correlation w between CEI and lg GDP per capita at r = 0.92. An attempt to perform a regression analysis for Poland between lg GDP per capita and a set of explanatory variables including CEI failed because of too short a time series.

CONCLUSIONS

Smart growth is growth based on innovation and institution. For smart growth mechanism to occur a proper institutional environment is required, in which the appropriate human capital using the appropriate body of knowledge will trigger creativity which is an accelerator of innovativeness on the micro, meso and macro level. The interdependence of innovation and institutions was reflected in the studies which resulted in the creative economy index. The components of this index are both variables diagnosing innovativeness of the economy, as well as variables characterising institutional environment.

The Polish economy in the years 2005-2014 improved the conditions for smart growth – CEI increased by 47%. This result consists of results in four intermediate composite indicators. The inventive economy subindex representing innovation variables and these institutional variables that describe the rules of conducting economic activity, in particular its freedom and property rights turned out to be the most important CEI component. In the analysed period, the IE had the highest weight and dynamics of growth of 26%. The greatest progress was achieved in the political institutions and business regulations. A contraction was recorded in fiscal institutions.

In the next step, after supplementing a time series, a regression analysis will be conducted where the dependent variable will be GDP growth, and CEI for the Polish economy will be included in the set of explanatory variables.

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