

Arkadiusz MROCZEK*

SELECTED BIG CITIES OF POLAND AS REGIONAL GROWTH POLES

WYBRANE DUŻE MIASTA POLSKI JAKO REGIONALNE BIEGUNY WZROSTU

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ABSTRACT: The concept of growth poles is well-established in regional economics. It can be considered in different scales, and big cities are one of them. In Poland, these cities are developing relatively fast. One of the questions that appear in this context is, if this growth can be connected with the growth of their regions, i.e. if they can be regarded as regional growth poles. To address it, the aim of the paper is to test if some selected big metropolitan areas of Poland work as poles of growth for their regions. This is performed using the Granger-causality test, which is one of the methods used to explore, at least in its specific sense, the causal relations between variables. The study shows, that Poznań, Rzeszów and Wrocław (out of fifteen big Polish cities) can be considered the growth poles for their regions. The results are useful to grasp the contemporary understanding of the concept, as well as the specific conditions of Polish regional growth.

KEY WORDS: growth poles, Perroux, metropolises, metropolitan growth poles, Granger-causality test

STRESZCZENIE: Idea biegunów wzrostu jest dobrze zakorzeniona w literaturze regionalistycznej. Bieguny mogą być różnie rozumiane, między innymi jako centralne obszary metropolitalne. Miasta tworzące takie obszary w Polsce rozwijają się szybko i można zadać pytanie, czy są one biegunami wzrostu dla swoich regionów. Aby się do niego odnieść, celem artykułu jest prezentacja rezultatów badania powiązań pomiędzy wzrostem gospodarczym miast i ich regionów. W badaniu wykorzystano test Grangera, który jest uważany za metodę przydatną w rozważaniach nad przyczynowością, przynajmniej w wąskim sensie, do jakiego się odnosi. Rezultaty badania pokazują, że Poznań, Rzeszów i Wrocław (spośród piętnastu dużych polskich miast) mogą być uważane za regionalne bieguny wzrostu. Wyniki mogą być przydatne w pogłębieniu zrozumienia zarówno badanego zjawiska, jak i specyficznych warunków współczesnej polskiej gospodarki regionalnej.

SŁOWA KLUCZOWE: bieguny wzrostu, Perroux, metropolie, metropolitalne bieguny wzrostu, test przyczynowości Grangera

* Cracov University of Economics, Faculty of Economics and International Relations, e-mail: mroczeka@uek.krakow.pl, ORCID: <https://orcid.org/0000-0003-3736-437X>.

Introduction

The concept of growth poles, originally introduced by Francois Perroux in the 1950s, is still popular with regional economics. Understanding of the poles of growth has undergone an evolution over the years to finally include big metropolitan areas as one of their forms. Some relatively recent papers undertake the task of empirical research on the way how the poles influence their surroundings. This study also focuses on this task and the aim of it is to test if big metropolitan areas of Poland work as poles of growth for their regions. First, a review of the relevant literature on the subject is carried out and the evolution of the concept under consideration is shown. Then, the methods used and obtained results are described, with a discussion and conclusions following in the end. The hypothesis tested is as follows: Economically vivid metropolitan areas of Poland with strong connections to their neighbourhoods can be considered to be the growth poles for their regions. In the discussion section, conditions necessary for an area to become a growth pole are suggested.

Literature overview

Many concepts used in social studies, including economics, have their roots in other branches of knowledge, especially in natural sciences. Such was the case with Francois Perroux's idea of growth poles, which was a result of his perception of space. On the one hand, his works did recall the German location school, with such authors as J. von Thunen and W. Christaller. For the representatives of this school, space was a geographical dimension, and the distance between places was one of the main factors determining their thinking. On the other hand, Perroux seemed to be fascinated with the understanding of space that came from modern mathematics and, especially, physics. Space was for him like a force field (*champ de forces*), and this field, in order to exist, needed its poles. The poles generated the field and attracted factors from outside, which was much more than just the closest neighbourhood. This way they could strengthen the process of growth in their surroundings, working as growth poles. An important thing is that for the author space was something more than geographic or administrative area. He referred to his kind of space with a mathematical term "banal", i.e. trivial. To capture all the forces that were important for economic analysis, other "spaces" should be included, such as the space of prices, etc. (Piętak 2014: 185-205).

The main notion deriving from the concept of growth poles is that economic growth does not appear everywhere with the same intensity. For Perroux, the growth poles (or growth points) are the places, where the growth starts (Olejniczak 2003: 55-77). In his original concept, such poles were big individual production companies or industrial complexes formed of groups of firms. In those poles, the "momentum of development" is focused, so it allows to spread influence to surrounding territories. For Perroux, a growth pole is a structure which is capable of promoting growth in other structures (Pysar 2017: 72-85). Growth poles have their impact on other branches and the overall

performance of the national economy. The leading industries dominate and form the poles of growth because they are able to introduce innovations, as they were understood by J. Schumpeter (Piętak 2014: 185-205). They also react to the changes in demand in a fast way (Churski 2011: 9-43). Thus, in other words, the growth poles are innovative and dynamic industries that dominate their surroundings and can be the sources of growth for them.

The concept of growth poles does not describe any state of equilibrium, as by definition it portrays dynamic forces. The leading industries are not dominant forever, and innovations appear in new and constantly changing branches. The growth poles can be then described as the main promising sectors of the regional economy (Stryabkova et al. 2018: 433-442), that have their impact through their expansion. Some other works on this subject matter point to agglomeration effects, as the already existing companies may attract new businesses, which in turn reinforces the pole (Kireeva & Tsoi 2018: 212-224).

Some authors argue, that Perroux was one of the economists to introduce the concept of space (Couzon 2003: 81-102). It is true, that for Perroux this was crucial and he used the term in an explicit way. On the other hand, his analysis is regarded by many authors as aspatial, i.e. actually abstracting from geographical dimension (Churski 2011: 9-43). G. Myrdal, in contrast, is regarded as the first author to have elaborated the theory of growth poles as a fully spatial phenomenon. J. Boudeville and A.O. Hirschman also saw growth poles as spatial phenomena, as they believed that industrial polarization leads to regional polarization. Agglomerations emerge in places, where location conditions are favourable and become well-developed centres, while the rest of the region cannot grow that fast (Dorożyński 2009: 179-199). It is worth noting that this spatial version of the concept is regarded as a theory of polarisation also by other authors. It is in contrast to classical theories, where a tendency towards spatial convergence should prevail. In the latter view, the growth spreads to achieve optimal, i.e. equal distribution of activity. In the conceptual framework of growth poles, they are the points that grow much faster than the rest of the space under consideration (Dyjach 2013: 49-59). Therefore, even the literal meaning of the term “polarisation” can be in this way derived from the concept of growth poles. Yet, polarisation is a side effect, not the primary object of interest in the growth poles theory. First of all, as Perroux indicated, the idea of poles is that they can work as the driving forces for their surroundings.

Contemporary understanding of growth poles also underlines the capability of them to enhance the economic performance of their regions. The basic idea is often connected with other theories of regional growth, which improves or even changes the growth poles theory to a great extent. An example of such an attempt is to consider industrial clusters as potential growth poles (Sengupta, Kannan & Srivastava, 2007: 217-230). As clusters are often seen as innovative and flexible economic entities, this approach may be fruitful.

Economically vivid big metropolitan areas are also regarded as modern growth poles. Due to urban agglomeration effects, they are capable of hosting “propulsive” indus-

tries, i.e. those that can improve the economic performance of a region or a country (Wojnicka-Sycz 2013: 17-33). What is worth noting is the fact that besides the production industry, also service industry, especially business-oriented, can be propulsive and lead to the formation of a growth pole (McKee & McKee 2001: 171-184).

The growth poles theory has been popular with policymakers since the 1960s. It was adopted enthusiastically by them (Sandretto 2009: 57-68) as it was mainly perceived as a way to improve economic conditions in backward regions. It seemed to provide a tool to attain this aim. It was used as a microeconomic effort to improve macroeconomic performance. By artificially creating growth poles, the regional planner could expect the whole region to grow faster. The actual results turned out to be, however, less satisfactory than the assumptions. One of the examples of such a policy is the case of Spain, where it was implemented between 1964-1975. The attempts did not bring expected results, as the artificial poles lost competition with the natural ones (Piętak 2014: 185-205).

Nevertheless, modern concepts of using growth poles as development policy tools are often recommended nowadays, especially for developing economies. Some of such recommendations refer to countries in the Middle East and North Africa (Morad & Panahi 2017: 765-787), Kazakhstan (Kireeva & Tsoi 2018: 212-224), Ukraine (Komarovskiy 2013: 31-42). Except for explicit recommendations, some authors point at the fact that the idea of growth poles is included in regional policies of particular countries. This was the case with the EU supported policy in Romania (Benedek 2016: 285-290) and Hungary (Csete & Szabó 2014: 40-60 and Csomós 2012: 599-618), where major metropolitan areas were supported on these bases.

Besides policy analyses, research studies based on empirical data can also be found in the most recent literature. These papers deal mainly with big metropolitan areas and the effect they have on the surrounding regions. One of them shows, that Beijing and Shanghai can be regarded as growth poles. The results of the study show that those cities can be called “engines of metropolitan regions”. An interesting point is that in the case of those cities both effects ascribed to growth poles were captured. The cities have a positive impact on those of their suburbs that are at a medium level of development. So it can be stated that the growth spreads from the poles. However, those cities have also a backwash effect on the suburbs that are at a low level of development. The effect of polarisation appears in a sense that the central cities just attract and use the development factors remaining in the suburbs (Chiang 2018: 1-14). Also, a study by Lan et al. (2019: 1-20) shows that urban agglomerations have become the growth poles for their surroundings.

The theoretical literature on growth poles is rich and the topic has been described by many authors. The subject has evolved and is still present in the academic discourse, having found many policy implications. The empirical considerations on the topic are relatively rare but are worthy of a mention here. One of such attempts employs a method based on Wikinomics, so the Internet-based activity is the source of data. In this case, an assessment of the websites of municipal administrative authorities was

used to determine, which municipalities can become growth poles for the region under consideration. The main assumption behind this method is that websites provide the first and an important way of promoting the area and attracting investors to it (Jakimowicz & Rzeczkowski 2018: 1362-1370). Although the results may be interesting, this approach does not track either actual economic activity or relations between the centres and other areas. Another approach can be found in Godlewska-Majkowska et al. (2016: 189-212). This study uses structural factors to determine the most dynamic areas of the region under consideration. The data are dynamic and allow pointing to the growth poles understood as highly dynamic areas. Still, it does not indicate any influence of those areas over their surroundings. The same can be said about another study (Strat & Stefan 2017: 456-473) which uses data for Romania. In this research, the growth poles are those areas that are structurally superior to the rest of the country and no transmitting mechanism is determined.

However, papers employing methods which remain closer to the idea of growth poles can also be found. Hughes & Holland (1994: 364-377) used the data for the state of Washington and checked if a negative shock from the core of the state was transmitted to the periphery. They used multiplayer analyses and got results showing that no strong connections between the core and periphery exist, which suggests that the core region is not a growth pole for the rest of the state. Sang-arun (2013: 160-171) used regression analysis and data for Thailand to check whether the structural variables of the centres can explain the growth of their regions. This approach seems to be also close to the idea of growth poles, as it shows how important the centre is for the performance of the whole region. Nevertheless, this procedure does not show any mechanism of spreading development from the centre to the neighbourhood nor does it indicate if the growth of the centre is in any way correlated to the growth of the periphery. Finally, in the above-mentioned work, Chiang (2018: 1-14) uses the ECM model and weak exogeneity test to determine if Beijing and Shanghai can be regarded as growth poles. This approach, based on a kind of causality test, seems to be highly suitable to deal with the growth poles theory.

Methods

Also in this study, an attempt to determine whether the central areas (core) have an impact on their surroundings (periphery) is made. This potential impact is analysed on the GDP growth level, so a test was designed to check it. A simple correlation is not suitable in this case, though. Despite the fact that it may seem that if the dynamics of growth of both core and periphery are positively related, it proves they influence each other, in case of an economic growth, the role of external factors (as the changes in aggregate demand) is so obvious that this would be a textbook example of a pseudo-relation.

In this study, a causality test proposed by C. Granger (1969) is used, which seems to be more appropriate for the purpose. The idea of the test is simple and seems to suit the aim of the paper. In intuitive terms, it can be presented this way: there are two

variables – Y (dependent) and X (independent) that are represented by time series. If a regression that includes the past values of X explains the values of Y better than just an autoregression of Y, then there is a causative relation between X and Y. The key difference between correlation and this approach is that here the past values of the independent variable are taken into account, so the assumption is that they imply changes in the dependent variable. Simply, it would be even possible to say that X “causes” Y, but the very concept of causality is being widely argued about from an epistemological point of view, and some clarification of it must be made here. Leaving aside the broad topic, it is necessary to determine what can be expected from the test. First of all, the results do not show the “total causation”, but indicate, that “some” causative relation may appear. So they usually do not explain the changes in Y to the full extent, but just show if X plays a role in them. Moreover, there are authors pointing to limitations of the Granger test, especially arguing that it cannot be used without prior theoretical knowledge of the phenomena under research (Maziarz 2015: 86-105). Therefore, many scholars often use the term of “Granger causality” or say that X “Granger-causes” Y, if they want to emphasise the character of relations that they present. Nevertheless, in the opinion of the author, this test can be useful to attain the aim of this paper.

Formally, the autoregression for the variable Y can be stated as:

$$Y_t = \sum_{j=1}^m a_j Y_{t-j} + \varepsilon_t \quad (1)$$

The Granger causation function to check whether X causes Y can be stated this way:

$$Y_t = \sum_{j=1}^m a_j Y_{t-j} + \sum_{j=1}^m b_j X_{t-j} + \varepsilon_t \quad (2)$$

There are 15 objects of the study, which are all but one Polish regions. All of those were divided into big metropolitan areas (cores) and their regional surroundings (peripheries). As this division was not possible for the Lubuskie region, this region was not taken into consideration. The GDP growth data for NUTS-3 areas are used, and the time series range from 2000 to 2016, as this kind of data were available from the National Statistical Office (GUS). In each case, the core is either the biggest city (or cities taken together, as in the case of Gdańsk, Sopot and Gdynia – Tricity) or the city with its close surrounding, which depended on the NUTS unit delimitation.

The procedure of determining the Granger causality demands at first to estimate the autoregression model for each object, which was done as in Equation (1). Then, the augmented regression model for each model was estimated, which includes the X variables with time lags, as in Equation (2). In the estimation, two years long lag period was used. It means that the impact of the growth rate in the core area on the surrounding areas a year and two years before were taken into account. Finally, the adjusted R² was calculated for each type of the model and compared for each object. If the adjusted R² for the augmented regression model is better than for the simple autoregression, then it proves the Granger causation between X and Y. The important

detail is that R^2 is in the adjusted form because it allows comparing models with a different number of variables.

Results and discussion

The results of the estimation in terms of adjusted R^2 for autoregression (A) and augmented “Granger-type” regression model (G) are shown in Table 1.

Table 1

R^2 for autoregression and augmented model

Core area	Białystok	Bydgoszcz and Toruń	Katowice	Kielce	Krakow	Lublin	Łódź	Olsztyn
R^2 A	-0.16	-0.08	-0.14	-0.13	-0.01	-0.16	-0.11	-0.12
R^2 G	-0.36	-0.28	-0.19	-0.34	-0.02	-0.03	-0.20	-0.24
Core area	Opole	Poznań	Rzeszów	Szczecin	Trójmiasto	Warsaw	Wrocław	—
R^2 A	-0.14	0.25	-0.14	-0.01	-0.01	-0.12	-0.09	—
R^2 G	-0.35	0.51	0.28	-0.08	-0.20	-0.07	0.21	—

Source: own elaboration.

At first, it is necessary to explain, that in the light of the growth poles theory, only positive values of R^2 for the augmented model can be interpreted. If they are higher than for the autoregression model, then the test result is positive. These values do not need to be close to 1 or even higher than 0.5, as in the case of many classical regression models. The absolute value does not matter, since the aim of the test is not to explain all the variance of the dependent variable, but just to show if there is “any” impact of the independent variable on it. Another thing is that when the R^2 for the augmented model returns a higher negative value, it does not validate the theory. Also when the R^2 for the augmented model is lower than for the basic one, the result is negative. According to this, there are three cases in which the test yielded positive results. These are Poznań, Rzeszów and Wrocław.

On the one hand, the three cases show that the spread of economic growth from the central area to the rest of the region can be grasped using the Granger causality test. On the other hand, in most of the cases, it was not proven. There can be two different kinds of reasons for that. First, the cities under consideration do not actually perform the roles of growth poles for their regions. Second, the problem may be with the data based on the fact that the core regions were not statistically separated enough from the rest of their regions. Some regions, such as Opolskie or Świętokrzyskie, are divided only into two NUTS-3 units, which means that half of the region had to be taken as a core of it. Probably other limitations of the statistical units had their impact on the results.

Besides statistical reasons, the more interesting thing is to consider, even briefly, which cities under consideration have the potential to be urban growth poles. This can be done by checking their growth rates and GDP per capita. The data is shown in Table 2.

Table 2

GDP growth and GDP per capita in the city areas

City area	GDP growth 2000–2016	Average GDP <i>per capita</i> 2000–2016 [PLN]
Białystok	5.57%	28 390
Bydgoszcz i Toruń	5.26%	36 116
Katowice	4.89%	46 216
Kielce	5.32%	27 457
Krakow	6.41%	52 501
Lublin	6.03%	30 013
Łódź	5.48%	40 212
Olsztyn	5.33%	27 404
Opole	5.37%	30 884
Poznań	5.47%	65 701
Rzeszów	6.94%	27 927
Szczecin	4.26%	41 336
Trójmiasto	5.87%	47 446
Warsaw	6.46%	95 897
Wrocław	6.72%	51 019

Source: own elaboration.

The average GDP growth rates for Rzeszów and Wrocław are, respectively, the highest and the second highest amongst all the cities. Only Poznań, the third city verified as a growth pole, is characterized by a relatively moderate growth rate. The two biggest cities in Poland – Warsaw and Krakow – also have a high rate of growth, close to 6.5%, and were not verified as growth poles. But another interesting fact is that the data on the GDP per capita indicates Poznań as the second richest city in the country. Looking for the cities with this indicator above PLN 50 thousand, Warszawa, Kraków and Wrocław should be mentioned. So, all the three growth poles – Poznań, Rzeszów and Wrocław – are either relatively rich or economically dynamic. Most of the rest of the cities do not seem to have the economic potential and this seems to explain the fact that no growth pole effects were proven in their cases.

The question remains in the case of Warsaw and Krakow. Both are economically vivid and form the biggest urban economies in the country. One of the explanations

may be that these cities have become metropolitan to such an extent that their ties to the regional economies have become very loose. Strengthening connections to other international metropolises at the cost of intraregional relations is the very nature of this process. A fact supporting this statement is the high position of Krakow as a destination of business process outsourcing (Tholons 2017). Another are the leading position of Warsaw and Krakow by the number of business outsourcing centers and employment in this sector (PAIIZ 2016) and the role of Warsaw as the natural place for the headquarters of the international companies. Businesses of this kind are indeed more dependent on the international connections than local economies, except for supply of highly skilled human capital. Warsaw and Krakow meet their requirements, as the pools of university graduates are the biggest in these cities. The intensity of airplane connections also distinguishes Warsaw and Krakow from the rest of the cities, and this factor is still often used as an indicator of a metropolitan status. Other structural characteristics of these two cities are: a high number of professional, scientific and technical activities between businesses (section M of the Polish Classification of Activities), a relatively high share of hotels and restaurants and also the “leisure industry” amongst the businesses (accordingly, sections I and R). In particular, the number of R&D units per number of inhabitants is also the highest in Warsaw and Krakow (BDL 2019).

Conclusions

The positive result of the test for three out of fifteen cities still allows stating that the hypothesis put forward in the study has been positively verified. Some metropolitan areas can be considered the growth poles for their regions, yet some conditions need to be met. The central city needs to be economically vivid and, on the other hand, its links with the regional economy should be strong. As it was shown, some cities, in spite of being economically superior, seem to be oriented more onto “the world” than towards their surroundings.

An obvious limitation of the study is data availability. The way that the NUTS-2 regions are statistically divided into NUTS-3 areas is, in the case of this study, sometimes problematic. In future research projects, it could be fruitful both to investigate other objects – other metropolitan areas in other countries with a similar methodology. Also, some more detailed research, including case studies, on city–surrounding areas would bring more understanding to the concept of growth poles.

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References

- Benedek, József. 2016. The Role of Urban Growth Poles in Regional Policy: The Romanian Case. *Procedia – Social and Behavioral Sciences* (223): 285-290.
- Chiang, Shu-hen. 2018. Assessing the Merits of the Urban-Led Policy in China: Spread or Backwash Effect? *Sustainability* 10 (2): 451.
- Churski, Paweł. 2011. Obszary wzrostu i obszary stagnacji gospodarczej – kontekst teoretyczny (Growth areas and economic stagnation areas – a theoretical context). *Biuletyn KPZK PAN* 2011 (248): 9-43.
- Couzon, Isabelle. 2003. Les espaces économiques de François Perroux (1950). Organisation de l'espace et aménagement du territoire dans l'économie et la géographie françaises au milieu du XXème siècle. *Revue d'Histoire des Sciences Humaines* 9: 81-102.
- Csete, Mária, Mariann Szabó. 2014. How the Spatial Distribution of the Hungarian TOP 500 Companies Affects Regional Development: an Examination of Income Generation at Subnational Scale. *Regional Statistics* 4(1): 40-60.
- Csomós, György. 2012. Regions and regional centres in Hungary: The critical interdependence of public administration and regional development. *Society and Economy* 34(4): 599-618.
- Dorożyński, Tomasz. 2009. Przyczyny regionalnych nierówności gospodarczych w świetle wybranych teorii (Reasons for economic inequalities in the light of selected theories). *Studia Prawno-Ekonomiczne* (80): 179-199.
- Dyjach, Katarzyna. 2013. Teorie rozwoju regionalnego wobec zróżnicowań międzyregionalnych (Theories of regional development towards interregional differences). *Annales Universitat Marie Curie-Skłodowska Lublin – Polonia* (47(1)): 49-59.
- Godlewska-Majkowska, Hanna, Agnieszka Komor, Magdalena Typa. 2016. Special Economic Zones as Growth and Anti-growth Poles as Exemplified by Polish Regions. *Entrepreneurial Business and Economics Review* 4(4): 189-212.
- Granger, Clive William John. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods, *Econometrica* 37 (3): 424-438.
- Hughes, David, David Holland. 1994. Core-Periphery Economic Linkage: A Measure of Spread and Possible Backwash Effects for the Washington Economy. *Land Economics* 70 (3): 364-377.
- Jakimowicz, Aleksander, Rzeczkowski Daniel. 2018. Application of the Four Colour Theorem to Identify Spatial Regional Poles and Turnpikes of Economic Growth. *Acta Physica Polonica A* 133(6): 1362-1370.
- Kireeva, Anel'A, Aleksandr Tsoi. 2018. Mechanisms for Forming IT-clusters as "Growth Poles in Regions of Kazakhstan on the Way to Industry 4.0". *Economic and Social. Changes: Facts, Trends, Forecast* 2 (56): 212-224.
- Komarovsky, Viktor. 2013. The Role of the Concept of Growth Poles for Regional Development. *Journal of Public Administration, Finance and Law* 4 (2013): 31-42.
- Lan, Feng, Huili Da, Haizhen Wen, Ying Wang. 2019. Spatial Structure Evolution of Urban Agglomerations and Its Driving Factors in Mainland China: From the Monocentric to the Polycentric Dimension. *Sustainability* 11(3): 610.
- Maziarz, Mariusz. 2015. A review of the Granger-causality fallacy. *The Journal of Philosophical Economics: Reflections on Economic and Social Issues* VIII: 2, 86-105.
- McKee, David., Yosra McKee. 2001. Edge Cities and the Viability of Metropolitan Economies. *American Journal of Economics and Sociology* 60 (1): 171-184.
- Seif Allah, Morad, Hossein Panahi, Davoud Hamidi Razi. 2017. Regional Economic Growth and Spatial Spillover Effects in MENA Area, *Iranian Economic Review* 21(4): 765-787.
- Olejniczak, Karol. 2003. Apetyt na grona? Koncepcja gron oraz koncepcje bliskoznaczne w teorii i praktyce rozwoju regionalnego (Appetite for clusters and synonymous conceptions in the theory and practice of regional development), *Studia Regionalne i Lokalne* 2(12): 55-77.
- 10 lat sektora nowoczesnych usług biznesowych w Polsce (10 years of the sector of modern business services in Poland). 2016. Polska Agencja Informacji i Inwestycji Zagranicznych.PAAIZ. <https://tiny.pl/t42d4>

- Piętak, Łukasz. 2014. Teoria biegunów wzrostu François Perroux i implementacja jej założeń w Hiszpanii w latach 1964–1975 (The theory of growth poles by François Perroux and implementation of its assumptions in Spain in the years 1964-1975). *Ekonomia XXI Wieku* 1(1): 187.
- Pysar, Naia. 2017. Application of the methodology for determining the growth poles of the region's industrial economy in the system of public administration. *Problems and Perspectives in Management* 15 (4): 72-85.
- Sandretto, René. 2009. François Perroux, a precursor of the current analyses of power. *The Journal of World Economic Review* 5(1): 57-68.
- Sang-arun, Nattapon. 2013. Development of regional growth centres and impact on regional growth: A case study of Thailand's Northeastern region. *Urbani Izziv* 24(1): 160-171.
- Sengupta, Arjan, Kannan K.P., Srivastava Ravi. 2007. Growth Pole: A Case for Special Economic Zone for Clusters of Small and Micro Enterprises. *The Indian Journal of Labour Economics* 2007 50(2): 217-230.
- Stryabkova, Elena A., Victor M. Zakharov, Marina V. Vladyka. 2018. Identification of long range growth poles as a key instrument of the federal policy of Russia's regional territories. *Amazonia Investiga*, 7(17): 433-442.
- Disruption by digital. *Digital Nations& Super Cities*. 2017. Tholons Service Globalization IndexTM.
- Wojnicka-Sycz, Elżbieta. 2013. Growth Pole Theory as a Concept Based on Innovation Activity Development and Knowledge Diffusion, *Research on Enterprise in Modern Economy – Theory and Practice*, (3), 17-33.