Discussion Papers 2007.
Regionality and/or Locality 178-186. p.

THE IMPACT OF TECHNICAL INFRASTRUCTURE ON ENTREPRENEURSHIP ACTIVITY – EXAMPLE OF RURAL AREAS IN POLAND

DARIUSZ ŚWIĄTEK

The question of whether infrastructure stock affects private sector growth remains unanswered, although the notion that the provision of public capital has an impact on the economic activity of private sector was explored in literature for many years (*Mead,* 1952; *Hansen,* 1965). The large discussion about the impact of infrastructure equipment or investment on economic growth was initiated by David Aschauer at the end of the 1980's and the beginning of the 1990's (1989a, 1989b, 1989c, 1990), when he proved that the decrease of productivity that took place in the US in 1970's was preceded by a slow down of infrastructure investment. Much of the studies that followed Aschauer's papers have focused on the influence of a rise of infrastructure stocks or aggregate public capital[1] on private sector output and productivity. Douglas Holtz-Eakin (1988, 1992) confirmed that aggregate public capital has significant impact on private sector productivity and similar conclusions were reached by Alicia Munnell's (1990, 1992).

Further studies showed that growth of infrastructure stock enhance output and productivity of the companies, by decreasing their costs, stimulating technological innovation and increasing productivity of other factors of production (Lee and Anas 1992, Suarez-Villa and Hasnath 1993). Alternative explanation for the influence of infrastructure on firms' activity was given by Rafael Flores de Frutos and Pedro Pereira (1993). They assumed that public capital is an endogenous variable in the macro growth system, proving that it is driven positively by output of private companies and negatively by their employment changes. Similarly to Aschauer (1989a), they found high return rates of the public capital (Flores de Frutos and Pereira 1993). Although other studies state the positive dependency between infrastructure stock and firms founding (Eberts 1991), differences among cases has been demonstrated. The variation depends on size of firm, type of infrastructure stock and the development stage of the country. Eberts' evidence shows much stronger relation in case of small companies then larger firms. David Canning and Marianne Fay (1993) found in their study of 96 countries that rate of return of transport networks in developed and industrializing countries is high to normal and moderate in underdeveloped countries.

[1]Aggregate public capital – sum of public capitals.

Dariusz Swiatek :
The Impact of Technical Infrastructure on Entrepreneurship Activity - Example of Rural Areas in Poland.
In: Regionality and/or Locality. Pécs: Centre for Regional Studies, 2007. 178-186. p. Discussion Papers, Special

Also agricultural production is affected by infrastructure stocks prove numerous studies (*Ahmed–Hossain,* 1990; *Antle,* 1983, 1984; *Binswanger–Khandker–Rozenzweig,* 1993; *Pradhan–Ratha–Sarma,* 1990). However, the connection between existing infrastructure and enterprises (or wider speaking productivity) is also criticized. This critical approach, nonetheless, will be here limited to few authors (e.g. Henry Aaron (1990), Charles Schultze (1990), Dale Jorgenson (1991), John Tatom (1991, 1993) or Edward Gramlich (1994)) as, literature analysis is not main goal of this paper.

This paper aims at checking if entrepreneurship is driven by infrastructure stock in rural areas[2] in Poland by calculating correlation between those two variables. The dependent variable is the number of enterprises (per 1000 inhabitants) and the independent the infrastructure stock (in various units according to the kind of infrastructure). Such choice was made on basis of review of several documents of local policy in Poland, where presence of infrastructural stock is expected to change entrepreneurship activity.

The character of available data makes difficult to measure long run dependency between those two variables, mainly due to the lack of data before 1990 and to the various spatial approaches in collecting data employed during transformation period. Therefore, this paper focuses on one particular year (2002) and aggregates data on the communes' level. The infrastructural as well as entrepreneurship data cover whole area of rural Poland (2171 communes) and were collected by the Polish National Statistical Office.

The infrastructure data gives measures of technical stocks (e.g.: water pipelines, sewage systems, gas, electric and telephone networks and sewage plants) and were collected during National Census in 2002. The data on firm formation is from the Statistical Office Database REGON (the National Official Business Register), which is the most representative database for entrepreneurial activity in Poland. The basic unit of data contains information on company name and location, number of employees, character of activity, date of establishment, and branches. The REGON database collects information for whole Poland however, it contains information solely of companies with more than nine employees. Though the abovementioned restriction it can be consider as the most valuable polish enterprises database.

To proceed with the assessment of spatial differentiation of infrastructure stock in rural areas in Poland, the first step is the calculation of the synthetic index suggested by Parysek and Wojtasiewicz (1979) for evaluating spatial differentiation of socio-economic issues. For index construction purposes, seven features were selected from various characteristics of communal infrastructure stock in rural areas

[2]Rural areas, according to the Polish Statistical Office, are all areas located outside of the city or town borders.

Dariusz Swiatek :
The Impact of Technical Infrastructure on Entrepreneurship Activity - Example of Rural Areas in Poland.
In: Regionality and/or Locality. Pécs: Centre for Regional Studies, 2007. 178-186. p. Discussion Papers, Special

in Poland: rate of flats with water pipeline connection (1), rate of flats with sewage system connection (2), rate of flats connected to gas network (3), rate of flats with electricity of medium voltage 380 V (4), rate of household with fixed phone line (5), density of hard roads (6), and rate of households served by sewage plants (7).

Linear dependency test (Pearson) between those characteristics revealed strong correlation level (r = 0.8) between two of them: rate of flats with sewage system connection (2) and rate of households served by sewage plants (7). The latter was higher correlated also with other infrastructural characteristics and thus skipped in further analysis. The remaining features were processed according to equation:

$$y'_{ij} = \frac{y_{ij} - \bar{y}_j}{S_j}$$

where:

y'_{ij} – value of j feature for i unit

y_{ij} – standardized value of j feature for i unit

$\bar{y}_j$ – average value of j feature

S_j – standard deviation of j feature

Following, the average value of normalized features for each rural commune was counted according to equation:

$$W_s = \frac{1}{p} \sum_{j=1}^{p} y'_{ij}$$

where j =1,2,3,…,p

W_s - synthetic index of infrastructure equipment

y'_{ij} - standardised value of j feature for i unit

p - number of features

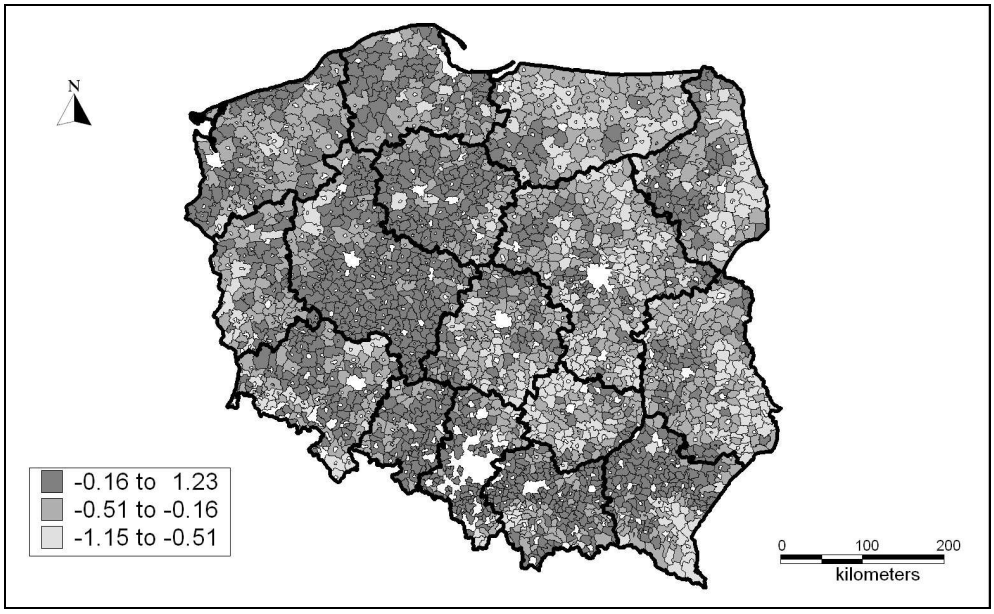
The above calculations generate values for synthetic index that form series of data, which are divided into three groups according to the suggestion of Paryskek and Wojtasiewicz (1979):

Class I: $W < (x - ½ S_x)$
Class II: $(x - ½ S_x) \leq W \leq (x + ½ S_x)$
Class III: $W > (x + ½ S_x)$

Dariusz Swiatek :
The Impact of Technical Infrastructure on Entrepreneurship Activity - Example of Rural Areas in Poland.
In: Regionality and/or Locality. Pécs: Centre for Regional Studies, 2007. 178-186. p. Discussion Papers, Special

Figure 1

Technical Infrastructure Index in rural communes in Poland 2002



Source: Author's own elaboration based on the Polish National Census 2002.

The synthetic index of infrastructure equipment shows a distinct division of polish communes into two groups: units located in eastern part of the country which are poorer equipped with technical infrastructure on the one hand and communes located in western part of Poland which are strongly differentiate but generally better equipped with infrastructure stocks on the other hand. This phenomenon can be partly explained by historical determinants: like inheriting German infrastructure stock after the WWII in west part of Poland (*Siemiński*, 1992; *Pięcek*, 2001; *Świątek*, 2003, 2004). There are few groups of rural communes with higher number of infrastructure stock index can be observed: a) communes located in vicinity of large cities like Poznań, Kraków, Bielsko Biała, and Sielsian agglomeration, and; b) communes that are under strong influence of middle size towns and c) communes where former state farms were located (*Dzun*, 2005).

Rural communes with high and average infrastructure index create spatial shape similar to spatial layout of areas with high values of the synthetic index of national economy created in 60's by the polish geographer Stanisław Leszczyki. The index was created based on three groups of indicators: value of fixed capital assets, national income generated and national income *per capita* (*Leszczycki*, 1964). Leszczycki's index revealed areas with high living standard, characterised by in-

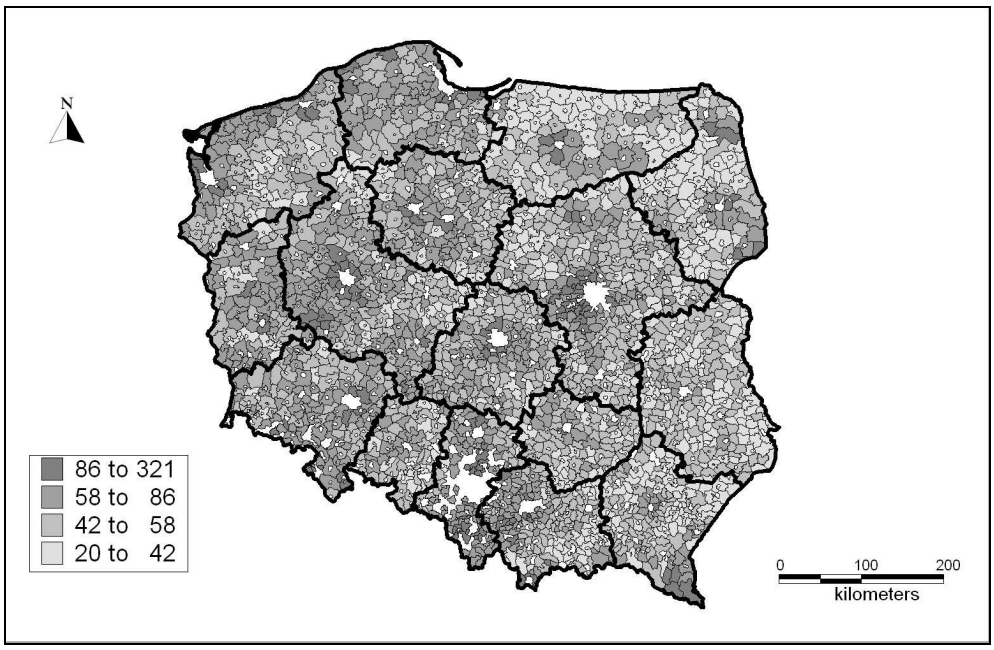
Dariusz Swiatek :
The Impact of Technical Infrastructure on Entrepreneurship Activity - Example of Rural Areas in Poland.
In: Regionality and/or Locality. Pécs: Centre for Regional Studies, 2007. 178-186. p. Discussion Papers, Special

dustrial development above the national average, rich in mineral deposits and complemented by intensive agriculture (former *voievodships Wrocławskie* and *Opolskie*). These communes together create an area shaped as a 'L' letter, which correspond with the shape created by the communes with higher infrastructure index calculated with data of 40 years later. Therefore, it shows us that spatial divisions present in Poland's space after the WWII still exist.

The Figure 1 illustrates a classification of infrastructure of polish communes, that can be divided in three groups: Congested (with index higher then -0.16), Intermediate (index between -0.16 and -0.51) and Lagging (index lower then -0.51), following the division proposed by Hansen (1965), who theorized that the impact of new investments on regional development would vary according to the level of socio-economic activity in the region. As Hansen explained Congested regions can be characterised with high level of economic activity in comparison to infrastructure provision, Intermediate regions have high potential but deficit of infrastructure and finally Lagging regions can be characterised as areas with scarcity of human and physical potential and lack of attractions for infrastructural investments (*Hansen*, 1965).

Figure 2

Number of companies per 1000 inhabitants of rural communes in Poland 2002



Source: Author's own elaboration based on the REGON's database.

Dariusz Swiatek :
The Impact of Technical Infrastructure on Entrepreneurship Activity - Example of Rural Areas in Poland.
In: Regionality and/or Locality. Pécs: Centre for Regional Studies, 2007. 178-186. p. Discussion Papers, Special

During the period of transformation from central planning to market driven economy started in 1989, entrepreneurship in Poland rose significantly. Changes in law regulations reduced to minimum the administrative requirements for opening new companies, and thus resulting in quick increase of enterprises' number. Poland had 624,4 thus registered firms in 1989, while in 2002 this number rose to 2 261,9 thus. The most significant increase of entrepreneurial activity was noticed at the beginning of transformation period (years 1989–1992), when quantity of registered companies rose 227,2% (*Kamińska,* 2006).

Increase of private activity in rural areas was observed especially in communes located in the neighbourhood or within the borders of the Special Economic Zones;[3] as well as in communes that beneficiated by international aid programs (like PHARE); areas with potential for tourism and spa; and communes located in the fringe of large cities. The latter group gathered 13% of all private companies in rural areas in 2002. It is worth noting that all above mentioned communes had extra source of founds that allowed them not only to support entrepreneurship in direct and indirect ways but also to promote general development in their area.

The highest concentration of private firms in rural Poland was in the north-western part of the country (*voievodships: Wielkopolskie, Kujawsko-Pomorskie, Pomorskie* and *Zachodniopomorskie*), which had on average over than 58 companies per 1000 inhabitants. The leading position was reached by communes with potential for tourism (like seashore, Mazury lake district or mountain communes) as well as those located in vicinity of large cities (like *Poznań, Budgoszcz, Gdańsk*). On the other hand, the smallest number of companies per 1000 inhabitants was registered in the eastern part of Poland (*Lubelskie, Podkarpackie, Podlaskie voievodship*), where even large cities do not seem to generate high entrepreneurial activity (e.g. *Lublin, Rzeszów*).

Hence, to check how technical infrastructure stock (measured by the infrastructure index) influence non-agricultural economic activity (measured by the number of companies registered per 1000 people) in rural areas in Poland, we must analyse the result of the correlation analysis, which can be seen in *Figure 3*.

The correlation indicates moderate association between entrepreneurship and infrastructure index with a correlation coefficient of 0.270 and sinusoidal fit where y=68.739+19.725*cos (1.483x–2.387). The moderate association between analysed variables means that the influence of technical infrastructure can not be considered as a crucial for 'new firm birth'. This level of dependency was confirmed also by analysis of Canning and Fay (1993) for developing countries.

One of the reasons of the discovered lack of strong dependency can be found in generally short history of technical infrastructure investments in rural areas. During

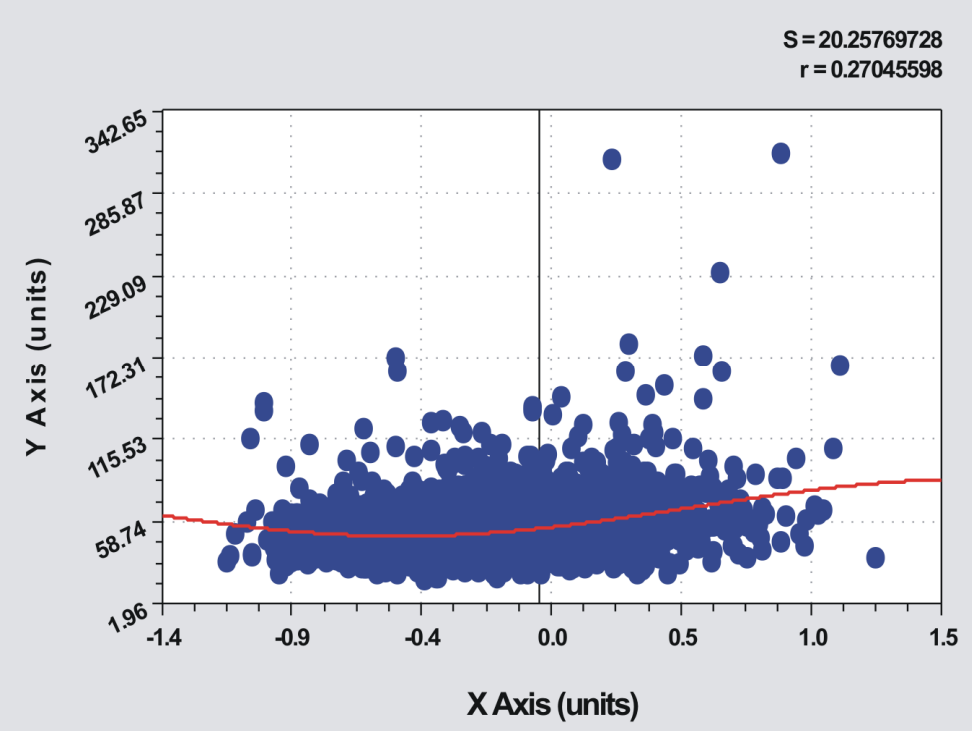
[3]Special Economic Zone are areas created to stimulate the economic activity in underprivileged regions (e.g. diverse kinds of tax exemption).

Dariusz Swiatek :
The Impact of Technical Infrastructure on Entrepreneurship Activity - Example of Rural Areas in Poland.
In: Regionality and/or Locality. Pécs: Centre for Regional Studies, 2007. 178-186. p. Discussion Papers, Special

the communism, technical infrastructure in the country was developed only to short extend. Therefore infrastructure as a factor that stimulates entrepreneurship is a relatively new phenomenon and associations between infrastructure and firms birth are still not very widespread. Additionally, only a medium level of association between analysed variables is obtained due to the fact that infrastructure in rural Poland is build mainly to satisfy needs of residents of the region and not to provide services or to attract entrepreneurial activity. However one can expect that this aspect of infrastructure investments will be more significant in the future.

Figure 3

The correlation between technical infrastructure index (X Axis) and number of registered companies per 1000 people (Y Axis) in 2002



Y Axis – Enterprises per 1000 inhabitants
X Axis – Index of technical infrastructure
Sinusoidal fit: y = 68.739+19.725*cos (1.483x–2.387).
Source: Own elaboration.

Dariusz Swiatek :
The Impact of Technical Infrastructure on Entrepreneurship Activity - Example of Rural Areas in Poland.
In: Regionality and/or Locality. Pécs: Centre for Regional Studies, 2007. 178-186. p. Discussion Papers, Special

A separate problem requiring further analysis is the direction of causation between infrastructure and entrepreneurship in rural areas. However, the goal of the present study is to analyse only if 'firm birth is driven by infrastructure stock', a statement frequently taken for granted in local policy making in Poland. Thus, the causation problem between the above mentioned variables was omitted in this paper, which is based on the assumption that infrastructure is independent variable that may influence or not entrepreneurial behaviour. Considering the results of the undertaken analysis is recommended that the line of reasoning of dependency between infrastructure and entrepreneurship should be more cautiously applied, especially concerning the low level of infrastructure development experienced in Poland. Nonetheless, bearing in mind the theory of circular causation (*Myrdal*, 1957) the more developed commune is, the bigger its development will be and therefore the possibility of infrastructure driving entrepreneurial behaviour should be strongly considered.

References

Aaron, H. J. 1990: Why is infrastructure important?, Discussion. In: A. Munnell (Ed.), Is there a shortfall in public capital investment? Proceedings of a conference sponsored by the Federal Reserve Bank of Boston, Federal Reserve Bank of Boston, Boston.

Ahmed, R.–Hossain, M. 1990: Development impact of rural infrastructure in Bangladesh, International Food Policy Research Institute, Washington DC.

Antle, J. M. 1983: Infrastructure and aggregate agricultural productivity: International evidence. Economic Development and Cultural Change, 31(3), pp. 609–619.

Antle, J. M. 1984: Human capital, infrastructure and the productivity of Indian rice farmers, Journal of Development Economics, 14, 163–181.

Aschauer, D. A. 1989a: Is Public Expenditure Productive?, Journal of Monetary Economics, 23 (2), pp. 177–200.

Aschauer, D. A. 1989b: Public Investment and Productivity Growth, Economic Perspectives, 13(5), pp. 17–25.

Aschauer, D. A. 1989c: Does Public Capital Crowd Out Private Capital? Journal of Monetary Economics, 24(2). pp. 171–188.

Aschauer, D.A., 1990, Why Is Infrastructure Important? In Is There a Shortfall in Public Capital Investment? Proceedings of a Conference (A Munnell, Ed.). Boston: Federal Reserve Bank.

Binswanger, H.P., Khandker, S.R., and Rosenzweig, M.R., 1993, How infrastructure and financial institutions affect agricultural output and investment in India, Journal of Development Economics, 41, pp.331–366.

Burek, R., 1984, Infrastruktura gospodarcza a towarowość rolnictwa (na przykładzie województwa kieleckiego), Dokumentacja Geograficzna, 6, IGiPZ PAN, Warszawa.

Canning, D., and Fay, M., 1993, The Effect of Transportation Networks on Economic Growth, Columbia University Press.

Dzun W., 2005, Państwowe gospodarstwa rolne w procesie przemian systemowych w Polsce, IRWiR PAN, Warszawa.

Eberts, R.W., 1991, Some empirical evidence on the linkage between public infrastructure and local economic development. In: H. W. Herzog and A.M. Schlottmann (Eds.), Industry location and public policy, University of Tennessee Press, Knoxville, pp. 83–96.

Dariusz Swiatek :
The Impact of Technical Infrastructure on Entrepreneurship Activity - Example of Rural Areas in Poland.
In: Regionality and/or Locality. Pécs: Centre for Regional Studies, 2007. 178-186. p. Discussion Papers, Special

Flores de Frutos, R., and Pereira, A., 1993, Public Capital and Aggregate Growth in the United States: Is Public Capital Productive?, University of California at San Diego Discussion Paper, 93 (131).

Gramlich, E.M., 1994, Infrastructure Investment: A Review Essay, Journal of Economic Literature, 32 (3), pp. 1176–1196.

Hansen, N.M., 1965, The structure and determinants of local public investment expenditures. Review of Economics and Statistics, 45, pp. 150–162.

Holtz-Eatkin, D., 1988, Private Output, Government Capital, and the Infrastructure Crisis, Discussion Paper No. 394, Columbia University.

Holtz-Eatkin, D., 1992, Public Sector Capital and the Productivity Puzzle, National Bureau of Economic Research Working Paper No. 4144.

Jorgenson, D., 1991, Fragile Statistical Foundations: The Macroeconomics of Public Infrastructure Investment, American Enterprise Institute Discussion Paper.

Kamińska, W., 2006, Pozarolnicza indywidualna działalność gospodarcza w Polsce w latach 1988–2003, Prace Geograficzne 203, IGiPZ PAN, Warszawa.

Lee, K.S. and Anas, A., 1992, Impact of infrastructure deficiencies on Nigerian manufacturing: Private alternatives and policy options, Staff Discussion Paper, Report INU 98, Washington DC, World Bank.

Leszczyki S., 1964, Syntetyczne wskaźniki dla określenia przestrzennej gospodarki narodowej Polski, in: Z badań nad problematyką przestrzenną przemysłu Polski, Biuletyn KPZK, z. 32, s.7–24.

Mead, J.E., 1952, External Economies and Diseconomies in a Competitive Situation, Economic Journal, 62, pp. 54–67.

Munnell, A.H., 1990, Why Has Productivity Declined? Productivity and Public Investment, New England Economic Review, Federal Reserve Bank of Boston, pp. 3–22.

Munnell, A.H., 1992, Policy Watch: Infrastructure Investment and Economic Growth, Journal of Economic Perspectives, vol. 6, no. 4, pp. 189–198.

Myrdall, G., 1957, Economic Theory and Under-Developed Regions, University Paperbacks, Methuen, London.

Parysek J.J., Wojtasiewicz L., 1979, Metody analizy regionalne i metody planowania regionalnego, Studia KPZK PAN, Tom LXIX.

Pięcek, B., 2001, Wpływ infrastruktury na warunki życia ludności wiejskiej i procesy demograficzne, Wieś i rolnictwo na przełomie wieków (ed. Bukraby-Rylska I. and Rosner A.), IRWiR PAN, Warszawa.

Pradhan, B.K., Ratha, D.K., and Sarma, A., 1990, Complementarity between public and private investment in India, Journal of Development Economics, 33, pp. 101–116.

Schulze, Ch.L., 1990, The Federal Budget and the Nation's Economic Health, In: Setting national priorities: Policies for the nineties. H.J. Aaron (Ed.), Brookings Institution, Washington, pp. 19–64.

Siemiński, J. L. 1992: Zróżnicowania infrastruktury obszarów wiejskich, IRWiR PAN, Warszawa.

Suarez-Villa, L. – Hasnath, S. A. 1993: The effect of infrastructure on investment: Innovative capacity and the dynamics of public construction investment. Technological Forecast and Social Change, 44, pp. 333–358.

Świątek, D., 2003, Zróżnicowanie sieci infrastruktury technicznej na obszarach wiejskich woj. mazowieckiego, Problemy zagospodarowania terenów wiejskich w Polsce (ed. A. Stasiak) Biuletyn KPZK PAN, 207, pp. 111–120.

Świątek, D., 2004, Developement of technical infrastructure in Poland, Problems of Geography, 3–4, pp. 56–74.

Tatom, J. A., 1991, Public Capital and Private Sector Performance, Federal Reserve Bank of St. Louis Review, Federal Reserve Bank of St. Louis, St. Louis, pp. 3–15.

Tatom, J.A., 1993, Paved With Good Intentions: The Mythical National Infrastructure Crisis, Policy Analysis, Cato Institute.