Direct and Indirect Effects of Accessibility: Infrastructure and Regional Access

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SUMMARY

Nowadays the topic of accessibility is becoming more and more popular as a national and international research field of study. Regarding its aim, the main question is about the connection between the adequate accessibility and development tendencies (Tóth 2007; Tagai 2007; Dusek and Szalkai 2007; Watanabe 1995).

Accessibility as well as the infrastructure is defined in different ways according to the different approaches in the economic literature. Generally it is declared that the location of a place is inadequate if it is not easily accessible. According to Nemes Nagy (2007) the opposite statement can also occur: e.g., from a military or defence point of view, tough accessibility can be a positive term; in the case of tourism it can be also an attraction, appreciating the "resort value" of a territory.

Tóth (2006) cites Keeble with the definition of accessibility (as the main product of transportation); regarding Keeble, the peripherality is synonymous with the relative accessibility (or lack) of the economic activity. Problems arise in the case of these territories, because the accessibility terms do not increase with the extension of infrastructure, namely the large investments take place where the demand arises, so the benefiting places are mostly the centre or core areas.

*Accessibility and its "tool", infrastructural extension, can be measured in several ways, as I discussed in my earlier research work (Győrffy 2010). During the examination of accessibility, we consider roles and spatial movements, and the targets are usually the capital city, the regional centre, the county capitals and the motorway junctions (Bajmócy and Kiss 1999; Edelényi 2004; Kocziszky 2004; Nemes Nagy 2009). In this paper, I analyse the accessibility of all the Hungarian subregions, taking the time and distance connections in a 174*173 matrix. Further on I analysed the relationship between the development data and accessibility indicators particularly in terms of centre-periphery relations. I tried to find out that improvement of the road infrastructure through the better accessibility what kind of spillover accompanies, how it effects on the social-economical position of a region, or can we talk about direct effect at all?*

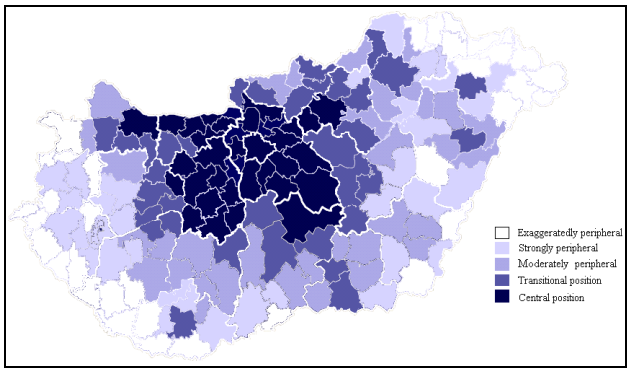
Journal of Economic Literature (JEL) code: R12, R49

ACCESSIBILITY AREA OF THE SUBREGIONS

A modern economy is characterized by a versatile connection system that provides wide network extension. As a result of the road network development in the country the time-space continuously "shrinks". For the local population it is not only the improvement of the connections to the centre that means a key factor of progress; it is also a great opportunity, when an urban centre exists in the peripheral area that has urban functions. Although the density of the cities in the country is adequate, unfortunately many settlements with the rank of "city" cannot play a relevant role in the area due to their growth and organisational tasks. Because of the quality of the roads, the poor accessibility the territories become less attractive. Due to the level of local services and weak job opportunities the working population is forced to commute. If there are just a few settlements that have urban functions in the area, the population has to emigrate. These problems have resulted low retention capacity in small villages.

In defining the accessibility potential I have used centrality indices, and have made a rank from these values to give the relative positions of the subregions. In order to make the centrality indices more comparable, the present subregional positions (from 2009) were used for the year of 2000 as well. The exact methods I used can be found in a previous paper (Győrffy 2010).

Based on the results the central role position of Budapest and its agglomeration is highlighted, but some large cities also have relevant attractive position in their regions as well – e.g. subregions of Szeged and Pécs. Due to the substance of the model, conclusions can be drawn regarding the quality of the network among subregional centres and their neighbouring settlements as well (for example the subregion of Pécs belongs to the transitional group but the surrounding areas are in the exaggeratedly peripheral category).

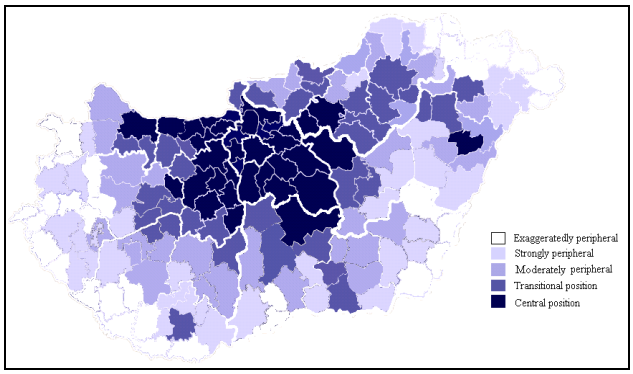


Source: own calculation

Figure 1. Centre and peripheries by population (2000)

The changes in accessibility indices were strongly influenced by the road infrastructure investments – especially the rapid expansion of the road network – through reducing the access time to major cities. In the positions from 2000, most of the subregions in the NorthHungarian region – mostly the eastern border areas – belong to either exaggeratedly or strongly peripheral categories. Although some large urban areas are significant, only the agglomeration of Budapest and the motorways' impact can be identified (Figure 2).

Concerning the case study from the year of 2009, I would assume that in the analysed time period the attraction would have grown in the case of the peripheral areas, but there is no significant change in total volume of the available mass, so the effects of the development occur just locally. In 2009, most peripheral subregions were located in the Northern Great Plain and in Southern Transdanubia, as well as in Szabolcs-Szatmár-Bereg, Vas and Somogy counties – however, taking the average access time into account, Somogy County has stepped one category forward, into the strongly peripheral group (Figure 2).



Source: own calculation

Figure 2. Centre and peripheries by population (2009)

The centrality indicators of the North Hungarian subregions positioned Heves County positively. Dividing the indicator into its parts, it is noticeable that only one county seat of the region has a significant role due to its own potential value. However, the available mass of population in a certain time period is relatively low from Miskolc. Many subregions of the region, including the agglomeration of two county seats, belong to the second group – their own potential is low, while there is no major force in the neighboring area, as exists in the case of Hatvan.

CLUSTERS BASED ON ACCESSIBILITY IN 2000 AND 2009

The classification of the subregions was performed with another cluster method. Due to the outliers of the capital city and its agglomeration, a shift was observed towards peripheral groups, so during the calculation Budapest and Budaörs were eliminated (Table 1).

The first group created by the cluster analysis contains 53 subregions whose internal potential is the smallest and whose available population mass in a certain time period is low. Members of the second cluster have medium internal potential where their own potential is also low – such subregions with small population or low population density, located near catchment areas of major cities (e.g. the subregions of Kazincbarcika or Tiszaújváros). In the case of 12 subregions the internal potential is prominent, to which the second highest own potential (weight of population) values belong. The position of Tatabánya in the third cluster is due to its higher population density and the proximity of the Budapest agglomeration. In the fourth cluster 24 transitional subregions were listed with their own relatively high potential and with inner potential. In case of 7 subregions (cluster 5) their own potential is prominently high (these are, for example, the county seats with large population), but their internal potential is not significant, suggesting that the population weight of the surrounding subregions is low on a national level (Table 1).

The cluster analysis with the data from the year of 2000 and 2009 shows that several subregions changed their position due to their population (own) potential, either as the result of internal[1] potential or their own[2] potential. Compared to the values from 2000, many subregions changed clusters, as indicated in the Table 1. The subregions of Pécs, Nyíregyháza, Szeged, Miskolc and Debrecen had extremely high own potential also in 2009. This group was expanded by the subregion of Győr. Its own potential primarily to favourable demographic trends has became higher, but due to the infrastructural improvements in the country the availability relation has changed, which is why Győr moved from the central availability areas, as also occurred in the case of Veszprém. The situation of Székesfehérvár has improved considerably; both its internal and own potential has grown. Regarding Szolnok, its position in the 4th cluster also represents progress. Its change of position comes from the growth of its own gravity as well as the available population mass.

Overall, it can be stated that in the past 10 years, the potential of low gravity areas decreased further as a result of the infrastructural development, while the largest increase can be observed at the extreme gravity centre.

Table 1. Subregions of the county capitals and other Northern Hungarian subregions by clusters (2009)

1. Low gravity points in periphery	2. Low gravity points in transition areas	3. High gravity points in central areas	4. Medium gravity points in central areas	5. Prominent gravity points in semi-periphery
Békéscsabai ↓ Kaposvári Szombathelyi Zalaegerszegi	Egri Salgótarjáni Szekszárdi Veszprémi ↓	Székesfehérvári Tatabányai	Kecskeméti Szolnoki ↑	Debreceni Győri ↓↑ Miskolci Nyíregyházai Pécsi Szegedi
Northern Hungary				
Abaúj-Hegyközi Bodrogközi Encsi Sárospataki Sátoraljaújhelyi	Balassagyarmati Bélapátfalvai Edelényi **Egri** Kazincbarcikai Mezőcsáti ↑ Ózdi Pétervásárai **Salgótarjáni** Szécsényi Szerencsi Szikszói Tiszaújvárosi Tokaji	Hatvani	Bátonyterenye Füzesabonyi ↑ Gyöngyösi Hevesi ↑ Mezőkövesdi ↑ Pásztói Rétsági	**Miskolci**

Source: own calculation
Legend: ☐ - changing position (compared to 2000)
↑ - positive tendency
↓ - negative tendency

The aggregate data indicate that the values of the subregions in Northern Hungary are lower than the national average. The heterogeneity of the group is also observed here: the Northern Hungarian subregional centres are present in every category from the periphery to the centre based on the available mass of population. Those areas proved to be centre where the proximity of a highway can be felt, such as Miskolc or Budapest.

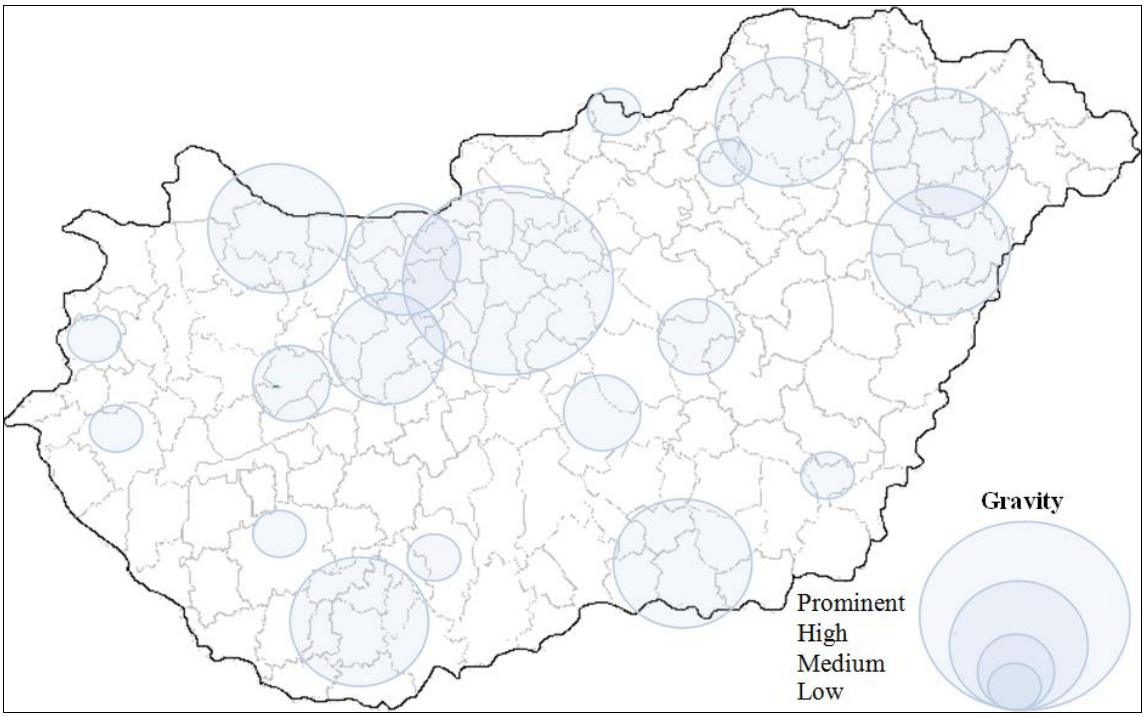
Regarding the region, compared to the year of 2000, several areas changed categories in the region; among the subregions that were exchanged, the reclassification was always positive. Füzesabony, Heves and Mezőkövesd show significant improvement in terms of the factors, their inner and own potential also increased, while the position of Bátonyterenye has decreased due to both potential values – although this change did not resulted in relay among the categories. The connection of Mezőcsát into the economical processes was proved more intensive in 2009, as it moved into a transitional area from the periphery. The internal potential of Miskolc is relatively low. In 2000, the worst positions were held by Szerencs, Sátoraljaújhely and Encs; in their case the availability of the certain population mass is the most difficult issue. Members from the 4th cluster have medium internal potential mostly because of the nearness of Budapest.

Classifying the counties' own potential, the gravity centre of subregions can be outlined. In this case the changing position of the 19 county seats can be explained by the distribution of the population and the radial motorway network. High overlap can be pointed out between the formalized centre that comes as a result of the calculations and the centre as development poles designated by the National Spatial Development Concept (Figure 3).

It is also noticeable that the central and peripheral positions are always relative; we cannot talk about position without reference point (Nemes Nagy 2009). Concerning the development of other territories, a prosperous or inadequate situation is always changing. With the development of the accessibility terms, less and more adequate availability conditions still remain.

[1] *Internal potential of a subregion is represented by the accessible (on the shortest way) population mass of the other 173 subregions in Hungary ina certain time period starting from that subregion.*

[2] *Own potential of a subregion is represented by the accessible (on the shortest way) population mass in a certain time period inside that subregion. The calculations are publihed in my former articles. (Győrffy 2010)*



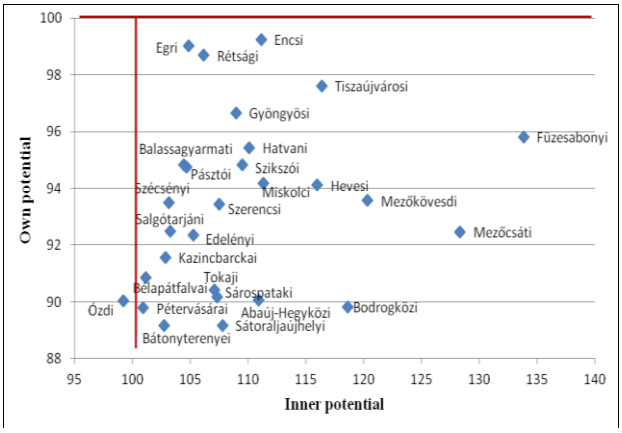
Source: own calculation

Figure 3. Gravity of county capitals based on cluster analysis (2009)

CHANGING SUBREGIONAL POSITIONS

Compared to the data from 2000, the own potential, so the own gravity field of the North-Hungarian subregions does not indicate growth in any case. The smallest decline belongs to the indices of Eger and Encs, the largest decline affects the area of Bátonyterenye, Sátoraljaújhely, Pétervására and Bodrogköz. However, the centrality indices show an average increase in 2009, that was a result of the growth of the internal potential values. Also at regional and national level the subregion of Füzesabony has shown the greatest improvement; its internal potential has grown with more than 30 percent due to the highway investments[3] (Figure 4).

Outside the region, the subregion of Veresegyháza is eminent with its own potential. Mezőkovácsháza is noticeable as a negative example, where its own potential value in 2009 was slightly above 85% of its value in 2000. Due to the negative demographic trends, as was expected, the national average of the own potential values decreased slightly (1%). The higher value of the centrality indices for the year of 2009 comes from the 7% growth of the internal potentials, so the available mass of population from a subregion in a certain time period became higher.



Source: own calculation

Figure 4. Centrality indices of Northern Hungary (2009) compared to 2000 (population weight, %)

The gravity of Northern Hungary's subregions, represented by their population potential and their attracting power (come from the inner and own potential) grew more significantly than the national average between 2000 and 2009; however, the infrastructure effect and the potential growth are lower than expected due to the unfavourable demographical tendencies.

[3] *Between 2000 and 2009 the M3 and M30 enlarged with more than 130 km.*

TESTING THE DIRECT AND INDIRECT EFFECTS OF ACCESSIBILITY POTENTIAL

During my research I proceeded from the basic question: are those areas which can be considered as central or peripheral from a geographical point of view also in the same category from an economic point of view? The economic classification corresponding to the foregoing points was explained by income before tax per capita, as a built-in dependent variable. The variables in the model were chosen based on national references. During the analysis I aspired to reveal the connection between accessibility potential of the subregions, the development and income level, respectively.

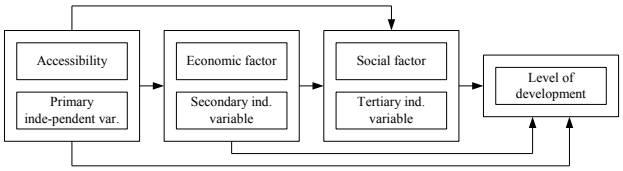
Path analysis is a series of linear multi variable regressive estimations. In the first step we see how the primary variables affect together the indicators belong to the secondary group. In the second step we analyse the common effect of the primary and the secondary variables on the tertiary variables, and finally all the variables are applied together (Németh 2009; Székhelyi and Barna 2002; Tóth 2008). In the regression analysis I use the following indicators as independent variables that explain the dependent variable (income before tax).

1. Accessibility, relative geographical position
   Centrality indices of the subregions (ELER)
2. Economic factors
   Ratio of dwelling construction (LAKASEP; per 1000 dwellings)
   Ratio of dwellings connected to the public sewerage network (KOZCSAT; %)
   Enterprises per 1000 inhabitants (VALL_SU)
   Ratio of joint venture (TARSAS_AR; %)
   Ratio of registered corporations in the sector of industry, constructions and service (VALLALK_R; %)
   Number of passenger cars per 1000 inhabitants (SZGK)
3. Social factors
   Population density (NEPSUR; inhab./km2)
   Change of total population (NEPES_VALT; 2000-2008, %)
   Natural increase or decrease per 1000 inhabitants (TERMSZ; ‰)
   Net migration balance per 1000 inhabitants (VAND_KUL; ‰)
   Ratio of registered jobseekers (NYT_KER; %)
4. Relative level of development
   Income before tax per capita (JOV; thousand HUF)

Regarding the groups of variables, the following hypotheses can be defined:

- accessibility: the higher the availability and population potential of the subregion is, the more favourable value is expected concerning the development indicators (i.e. the income before tax per capita is higher).
- economic factor: the better the economic force (represented by the analysed indicators) of a subregion is, the higher the expected level of income.
- human potential: the more favourable the demographic situation of a subregion is, the more advanced it is.

In the sense of path analysis we assume that the primary independent coefficients (in my case the accessibility and relative geographical position determined by centrality indexes) influence the secondary coefficient, namely the deviations of the economical situations, which have effects on the tertiary coefficients (social factor). We also assume that primary and secondary coefficients have not only an indirect effect on the development, through the tertiary coefficients, but also a direct effect. The arrows in Figures 5 and 6 illustrate this causal connection. In this way the effects are staggered, amplifying or attenuating each other (Tóth 2010; Csite and Németh 2007; Németh 2005; Dabasi Halász 2009; Kecskeméty 2005).

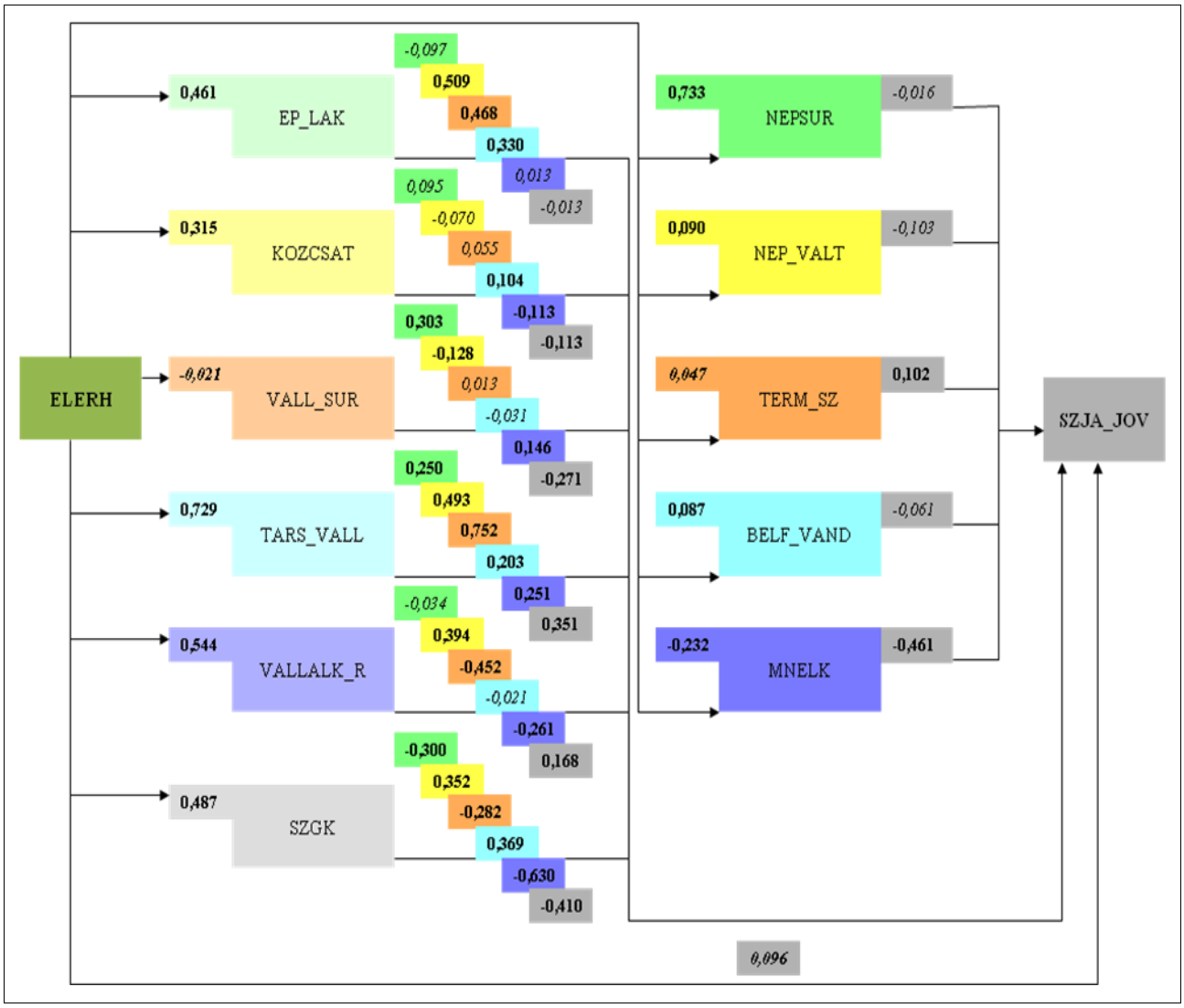


Source: own calculation, HCSO

Figure 5. Causal relations among the group of variables

According to the references that deal with regional models, path analysis reveals the effect of those indicators which does not have an exclusive effect on development relations but through other independent coefficients do have some effect. At the same time that is not even a problem if the coefficients have strong relations with each other (Németh 2009; Székelyi and Barna 2002).

In the regional model presented I attempt to explain the specific incomes with the role of accessibility, namely with the population potential, and its direct and indirect effects through other variables.



Source: own calculation, HCSO

Figure 6. Causal relations of the group of variables in the path model

As the first step of the path analysis I examined the regional distribution of the income per capita that makes the base income before tax, with multi-variable linear regression. The variables contained by the examination together explain the income per person with the value of 81.7% R^2. Among the variables the registered job-seekers (with negative slope) and the proportion of the joint companies have the most significant role in the explanation.

The direct effect of accessibility is non-significant, with the value of 0.096. In addition, the indirect path can be calculated as following: all paths are added together from the primary variables to the dependent variable, and the appropriate path will be multiplied as well as in case of the primary and secondary variables, then the primary and tertiary variables (Table 2).

The effect of the accessibility indicators on the regional development (i.e. in the present study on the income level) indirectly prevails through the economic and social indicators, as the results in Table 2 show. The expansion of the network, the reduction of the accessibility time – depending on favourable demographic trends – so the higher population potential have effects through the economical and social indicators that refer to a better standard of living.

Table 2. Direct and indirect path of the income explanation

Independent variable groups of the model	Accessibility (standardized β)
1-2-3-4.	0.093
1-2-4.	0.362
1-3-4.	0.085
indirect	0.540
direct	0.096
Total	0.636
R^2	0.401

Source: own calculation, KSH

The path-model suggests that the relative geographical situation defined with population potential and accessibility exerts only an indirect impact on the income level of subregions, as indicated by the economic and social indicators involved, and the indirect effect seemed insignificant.

FURTHER RESEARCH PROSPECTS

The literature states that infrastructural development is a key element of the competitiveness of a region, as it increases economic efficiency and promotes integration into the global and international economy. Taking international experiences into consideration, the observation is relevant that inadequate macro regional infrastructural conditions can become a fundamental obstacle to regional development and convergence. This problem is relevant also in Hungary, where despite the progress in accessibility of certain spatial centres, most of the analysed areas are lagging behind. This backwardness unfavourably affects many cities and the centre of the region (Nagy 2007).

In my research I tried to point out the problem that in the case of infrastructural development shortened access time is highlighted in practice as the most important result. However, this is not equivalent with the accessible population mass that characterizes the change of accessibility more accurately. The effect is not the same when an area with lower population comes 10 minutes closer than when this occurs with a high population mass. The population potential – represented by the accessible population mass in a certain time period (namely the centrality index) – has indicated how the gravity of the subregions changed as a result of the shortening access time and demographic tendencies.

Examining the effects of population and infrastructure (based on the data of 2000 and 2009) the population potential would have been bigger in each subregion in Northern Hungary if the number of inhabitants in 2000 had not declined by 2009. In this contexnt the infrastructural development did not have the positive influence in the region that would have been expected.

In the period 2000 to 2009 the spatial differentiation of the population and the income potential declined on national level as a result of the infrastructural investments, but there were certain areas where the results showed areas lagging behind because of their weaker demographic indicators. Mostly the exaggeratedly and strongly peripheral areas are characterized by no or only slow convergence.

During the accessibility examination the differences between the categories indicated that in the exaggeratedly and strongly peripheral areas the results of the indicators are much worse, while towards the central areas they are more favourable. However, based on the results of the path model the direct impact of infrastructural development is not relevant. Although the improvement of the infrastructure is an essential factor in the convergence of peripheral areas, its impact is in itself not able to generate spatial development; with the extension of the infrastructure the growth indicators do not change significantly where the base factors are missing. The results of the path-model pointed out that there is no significant direct effect. Only indirect impacts (through economic-social data) can be expected by the accessibility indices that are affected by the shortening access time and demographic trends.

Many development trends aim to transform the radial form structure into a network scope that exploits economic connections in order to begin a new development path; however, it is unlikely that development processes in the region will be started only as a result of infrastructural improvement. Due to the indirect effects the main issue is to examine which path is capable of creating attractive conditions for investment and private capital. In addition, it needs to be ensured that the impacts of the policies can be measured; the results have to be monitored regularly. For monitoring an indicator calculation should be used that is similar to the potential method in national development plans and could give evidence of a certain development process represented by the higher available mass of population or income.

This paper/research work has been completed as part of the project TÁMOP-4.2.1.B10/2/KONV-2010-0001 – in the framework of the New Hungary Development Plan – with European Union support and co-financing by the European Social Fund.

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