What are the effects of road constructions on the development of the regions in Hungary?

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Abstract

The aim of the paper is to analyze the effect of public road construction on regional economic development through the increased number of traffic. The problem is investigated from two point of view; first from county level and then from individual road level. For analyzing the effects panel data method is used with first difference estimator. The result shows that public road construction and reconstruction influences the flow of traffic positively only on individual road level. Even though no statistical evidence can be found for the correlation between road development and flow of traffic on the county level, it is worth to analyze its indirect effect on regional economic development. By running the regressions it can be concluded that the increase in traffic has positive effect on the Gross Regional Product per capita and therefore on the development of the region.

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Introduction

Public road development is one of the most important strategic elements of the Hungarian economy policy. It coheres with the international standard sufficient network configuration, with the accessibility improvements which promote the development of the underdeveloped regions, with the capacity increase of the existing road network, and with the protection of the environment. According to István Csillag, the former Minister of Economy and Transportation, the coherence between transportation and economy exists: developed transportation infrastructure is the fundamental element of trade and industrial development and of the quality of life. In addition to this, public road developments promote the number of participants acting in the economic life and production. Is this coherence really apparent? Do road constructions or reconstructions deliver regional traffic, economic and environmental advantages?

These questions are worthy of attention since the Hungarian transport policies usually attach lower importance on what happens after the building of a new road or the reconstruction of the existing roads. Therefore within the development of the Hungarian road network it would be essential to analyze whether the construction and reconstruction of roads achieve or hinder to achieve the desired aims. Practically speaking do new roads or reconstructed roads lower traffic and help to achieve other economic and environmental growth, or do they increase traffic and heighten the problems? The taxpayers are rightly curious about the efficiency of the expensive infrastructural investments and their real effects on the environment. The elected representatives should make themselves sure of the rightness of their decision.

Due to the importance of the subject, a rich literature in the field of infrastructure development has emerged, assessing the impact of road construction on regional development. Several papers address the economic evaluation of the road development, for example how the public infrastructure influences the productive performance of Canadian manufacturing industries (Satya, Sahni, and Biswal, 2004), where the empirical results provide strong evidence of the important role played by public infrastructure in the productivity of manufacturing industries. In addition Gabor Bekes and Balazs Murakozy (2005) evaluate the impact of public infrastructure on firm behavior. They found that density of road network positively influenced location choice and productivity as well, while somewhat larger size of administration helps new firms to settle. While analyzing the existing literature there are surprisingly few studies which simply state the change in traffic, economy and environment after the road construction and in those they do not analyze whether these changes were really caused by the road construction or something else. Furthermore they did not run any regressions and without these we economists cannot really rely on the outcomes, since we do not have any statistical proofs in our hand. The regressions are needed to show the correlation and its sign between the examined variables.

In my paper I investigate the effect of public road development on regional economic development through the increased number of traffic. There are no Hungarian examples, as I mentioned before such reports are not common in Hungary, therefore I am going to lean on the international experiments. There is a report (CPRE-Beyond Transport Infrastructure, 2006) about three English case studies which discuss the evaluation of three specific road constructions. In all three they conclude that the traffic increased more than proposed, the number of accidents increased, environmental pollution was higher but the investments along the roads also increased. I use county level data instead of specific roads used by the others. I will analyze whether I can explain the change in traffic, economic investments and environment by the road construction or reconstruction.

The rest of my paper is organized as follows: the first chapter analyses the current situation of the public road network; it gives a brief summary about the transportation policy conceptions, recent developments and the institutional structure and about the road development plan requirements. In chapter two I am going to discuss the effect mechanism of road network development and introduce a model which able to show the outcome of a public road development. In chapter 3, I present the data used for the analysis of the Hungarian public road development. The evaluation of the empirical analysis is presented with the results in order to answer the main question of this paper. Finally my thesis ends with conclusion and some new implications.

1. Transportation policy conception

1.1 Situation analysis

By using Coordination Center for Transport Development data, I can state that the increasing demand for road transportation in the ‘80s and ‘90s did not go along with the infrastructure development. However, the switch over to the market economy, the import of working capital, the investors needs and the workplace creation and prevention have appreciated the importance of accessibility on public roads. According to international and domestic analysis, in the next 15 years the demand for public transportation is expected to increase twice as much, while the demand for road carriage will increase three times more than the railroad transportation. The share of public roads was 60% of the domestic product of carriage services in 2005. This ratio was 62% in favor of public roads in public transportations. The number of vehicles exceeded three million in 2005 (CCTD, 2008).

Now let me give a brief statistical summary about the current road network in order to be able compare the construction data in the result section. According to the Coordination Center for Transport Development, the length of public roads is more than 30,000 km while the length of roads under municipal control is more than 105,000 km. See the length of public road network according to different road types in appendix (picture 2). I deal only with the public road network because it transacts more than 75% of the total road traffic in Hungary. From the public road network 6,700 km (at the end of 2007) is main road, from this 2,130 km is marked as “E” road, in other words they are members of the European road network. The length of clearways (motorways, auto roads and other clearways) at the end of 2009 was 1,117 km. See a comparative table with the European Union averages in the appendix (Table 5). The public roads’ 27% go through settlements; therefore they play an important role in the cities local traffic as well. Overall it can be stated that the traffic on public roads has been increased by 50% from 1985 till 2005, which happened mainly in the last five years. The traffic on clearways shows a distinct increase on average, although the appearance of toll-roads pushed one part of the traffic, mainly heavy transportation, on to parallel roads. The traffic on side roads was essentially unchanged until 1999 and then increased as the average. It can be stated about the public roads' conditions that in the last 20 years it did not succeed to moderate the deterioration of public roads. Apart from the running programs still more than 800 km of road surface should be strengthen (CCTD, 2008).

1.2 Conception of transportation policies

The Uniform Strategy of Transportation Development (EKFS, 2007-2020) is set in the so called "White Book". It is essential to understand why the specific roads were developed.

1. Picture - Helsinki corridors

Source: www.ertms.hu

According to the "Book" the mobility demand and economic carrying capacity increased due to accelerating the economic development. EU accession determines further development needs and financial opportunities. First of all the clearway construction provides proper qualitative and quantitative solution. According to the Hungarian population density characteristics and economic, vehicle allocation and transportation trends Hungary will need similar density networks. Six international corridors of the European Transportation System go through Hungary due to the central location of the country (the Helsinki corridors) and therefore it has the opportunity to take part in the economic circulation, see picture 1. Budapest is the transportation center of the six corridors. According to the report in the long run, clearway will be fulfilled in different measures, in the first one the further development of the radial elements (M3, M5, M6, M35), then the continuously developed combiner elements (M8, M9), see picture 3 in appendix. The public road development program, due to its expected cohesive, regional, economy generative and attractive effect, can induce significant capital inflow which lets all different regions connect to the development. In addition to this the main roads have also an important role in the hierarchy, because they transmit the traffic towards the clearways and on the other hand they allocate the traffic into lower level road networks. Therefore they have to have such structure which allows the better accessibility of the capital city, municipal cities and other big cities. Have a look at the current and the projected expressway accessibility figures in the appendix (picture 4 and 5).

While the density of the Hungarian public road network can be evaluated according to Cordination Center's data as relatively adequate, then the quality – its transmissivity, velocity, condition of road surface and bridges – is poor and it must be developed. This problem mainly comes up on road located in the cities where the stricter traffic security regulation and the lack of overtaking possibilities can cause stress. Then by crossing point the degree of noise and air pollution is always close to threshold value. The solution for the above mentioned problems and threats can be the development of four lined roads and bypasses. The assurance of adequate carrying capacity of road surfaces and bridges is essential due some European Union regulations and principals. The issue of safety, life-, health- and environmental protection come even more to the front. Therefore the priority should be that the increasing mobility demand must be fulfilled by harming the environment as little as possible (CCTD, 2008).

1.3 Main development of clearway network

The hardness of the past years economic development pointed out that both the strengthening of the Hungarian investment magnetism and the achievement of regional development and labor market objectives need foreseeable, safe economic environment, and transparent infrastructure development concepts, the Transport Operative Program. Without these the fulfillment of the integration objectives of the European Union is unimaginable (TOP, 2009). From the program it can be easily seen that contrary to the Hungarian level of development and the appropriate road network density, the county has currently altogether 1,032 km (2007) long clearway network with a density of 7.8 km per 1,000 km2. In order to meet the expectations the length of the clearways should achieve the 2,520 km by 2015 in order to ensure the density of 27 km per 1,000km2, the former EU15 average. Hungary spent less on developing and maintaining road networks in the last ten years compared to its possibilities. Between 2006 and 2013 by ensuring the funds, it would be possible to enlarge the clearways by 700 km to 1,732 km and to prepare (planning, area acquiring, archeological exploration) 800 km new track until 2015 besides the constructed roads.

The total costs of the developing the clearway networks were about 1,100 billion HUF between 2003 and 2006 in the price level of 2002, which are in line with the European plan. The budgeted costs of clearway road development between 2006 and 2007 were around 2,600 billion HUF. Besides the missing development the maintaining and operational deficit must be supplied. There are more funds on realizing the developments. There are direct budget resources like the Pre-Accession Infrastructure Development Program (before the EU enlargement), Transport Operational Program (within the New Hungary Development plan)

(TOP, 2009). Besides this there are also long-term loans (EIB, EBRD, domestic financial institutions), which are expanding the budget income, but also the redeemable part. As non-budget resource the private capital (concession version) and the operative leasing can also arise. The European Union ISPA and supporting the Cohesion Fund can help the realization of the above mentioned facts. Hungary can gain further funds from the Structural Fund by aiming the environment-friendly infrastructure and accessibility. The planned motorway program is supposed to support the goals publicized in May 2006. One of these goals which are laid down in the Transport Operative Program is to continue and finish the M0, M3, M5, M7 and M35 motorway and the related clearway reconstructions, to develop the 4, 6, 8 main roads to clearways, to enlarge the roads between and around the small towns and to ensure the increasing resources in order to operate and maintain the road networks.

1.4 Planning process of road construction

The planning process consists of numerous steps and should be compliant with rigorous and strict rules, mainly due to the complicated institutional systems. According to the Road Planning guideline, the task of people who are managing the public road network development and planning is to prepare network plans that contribute to increase the social living standard both of the country and the different regions. It can be managed by supporting the international goals of the country, the economic development and the upgrade of the catch-up regions, also by taking into consideration the transportation needs and by the decreasing the environmental pressure. The public road development is the series of network status that are changing in location and time. The choice of the road to be developed is decided by the age of the infrastructure, the possible costs of the reconstruction and its probable realization. The process of developing a road should provide the best possible solution.

2. The effect mechanism of road network development

According to the book of Banister and Berechman (2000) the transport infrastructural investments or other actions (interventions) indicate changes in the volume of traffic and in its composition through changing the control variables, like traffic time, costs, conditions, etc. The changes appearing in the route supply, for example the length and cost of lines, are influencing the traffic behavior and through this the transport methods, routes, the volume, composition and the performance of traffic are also changing. In addition to this, interventions to the network also influence the accessibility of the regions, which has an effect on the territory utilization or on the regional or country level economic potential of a country. Among the new circumstances, new economic activities and production facilities can evolve which also amend the socio-economic phenomena such as standard of living, property prices, wealth, economic improvement, cohesion, foreign investments, tax revenues, etc. It is important, which effects and how they are going to be taken into consideration. According to Banister and Berechman (2000) the effect of transport investments on different groups who bears the changes can be categorized as follows:

Direct effect on users: As a consequence of realignment in their traffic flow, they cause changes in the size and circumstances of traffic, for example time spent in traffic including traffic jams as well, in petrol utilization, accidents, etc.

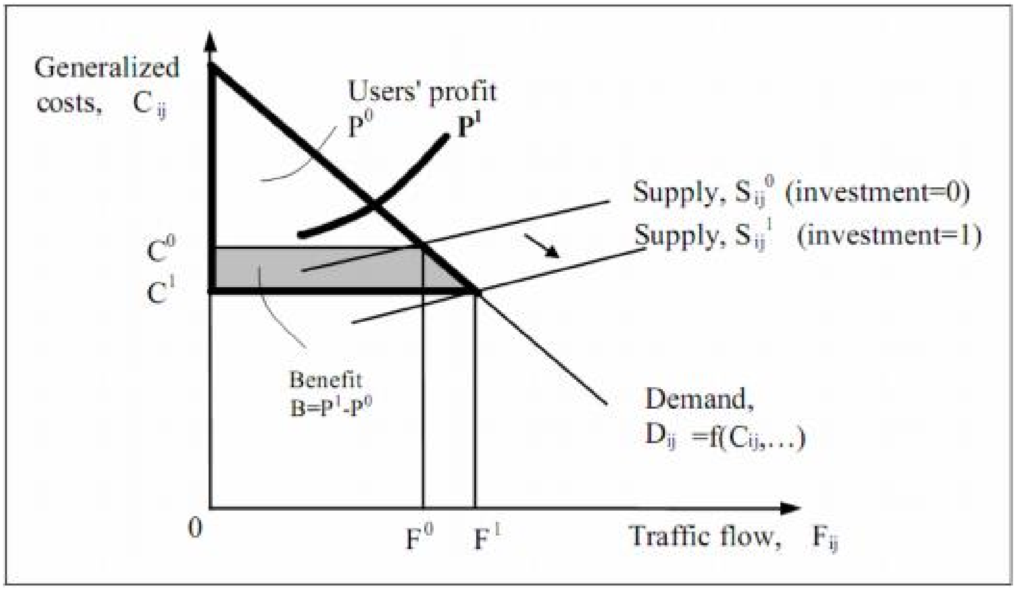
Semi-direct effect on residential groups: these are the additional effects of road network developments on the surrounding, which of course also depend on the size and circumstances of traffic, for example air pollution, noise emission. Accidents happen with non road network users reckon also among this category.

Indirect effect on social-economic players: these are the effects of new opportunities generated by the infrastructure development or new services, which can be contribute to the regional economic improvements.

Retroaction: due to the change in territory utilization and in other actions, the effects originated from the economy towards to the transport generate new transport needs and new traffic flows.

In order to be able to evaluate the effects of transport infrastructure developments it is crucial to find an appropriate model and method which is sensitive enough to deal with transport, environmental and socio-economic questions. In Hungary there is a model and program system, called "Transway", which allows of calculating the effects of change in journey time, maintenance costs, accident losses, air pollution, and territory usage and in accessibility. Moreover it can forecast the traffic demand and loading on the road network (Transman, 2004). It assumes that the direct effects of changes occurred in the transport supply are forming the demand for transport, size of the traffic and other circumstances like time spent in traffic and other costs, which is reflected by the general costs, C_{ij}. They evaluate these changes as the users' benefit (B), which is namely the difference between cases with (1) and without (0) investments. This reflects the change in users' profit (P) between the starting (i) and the ending (j) point of the journey ($B_{ij}=P^1_{ij} – P^0_{ij}$), see the visible illustration on Chart 1:

1. Chart - Illustration of users' profit with and without investment



Source: Transman, 2004

In the model the benefit (B) can be calculated according to the traffic flow (F_{ij}) and the general costs (C_{ij}) by using the "half rule":

$$B_{ij} = \frac{1}{2}(C^0{}_{ij} - C^1{}_{ij}) \cdot (F^0{}_{ij} + F^1{}_{ij})$$

Let us assume that the infrastructure investment does not generate new traffic then it means that $P^1{}_{ij} = P^0{}_{ij}$, and the users' benefit will be equal to the cost differences on the journey between point i and j. On the road network level the users' benefit is the simple sum of different journeys, it looks as follows:

$$B = \sum_{ij}(C^0{}_{ij} - C^1{}_{ij}) \cdot T^0{}_{ij} = \sum_{ij}(P^1{}_{ij} - P^0{}_{ij})$$

In the model they apostrophize the accessibility improvements of different regions as the indirect effects of the change in transport supply, which is responsible for the economic development. Since the change in accessibility is responsible for the choice of premises, productivity improvements, incomes and last but not least for the change in social wealth.

In this paper I am going to start from this model, because first I will focus on the direct effect of road construction and reconstruction in each county in Hungary and then I will analyze its indirect effect on the regional economy and on the development.

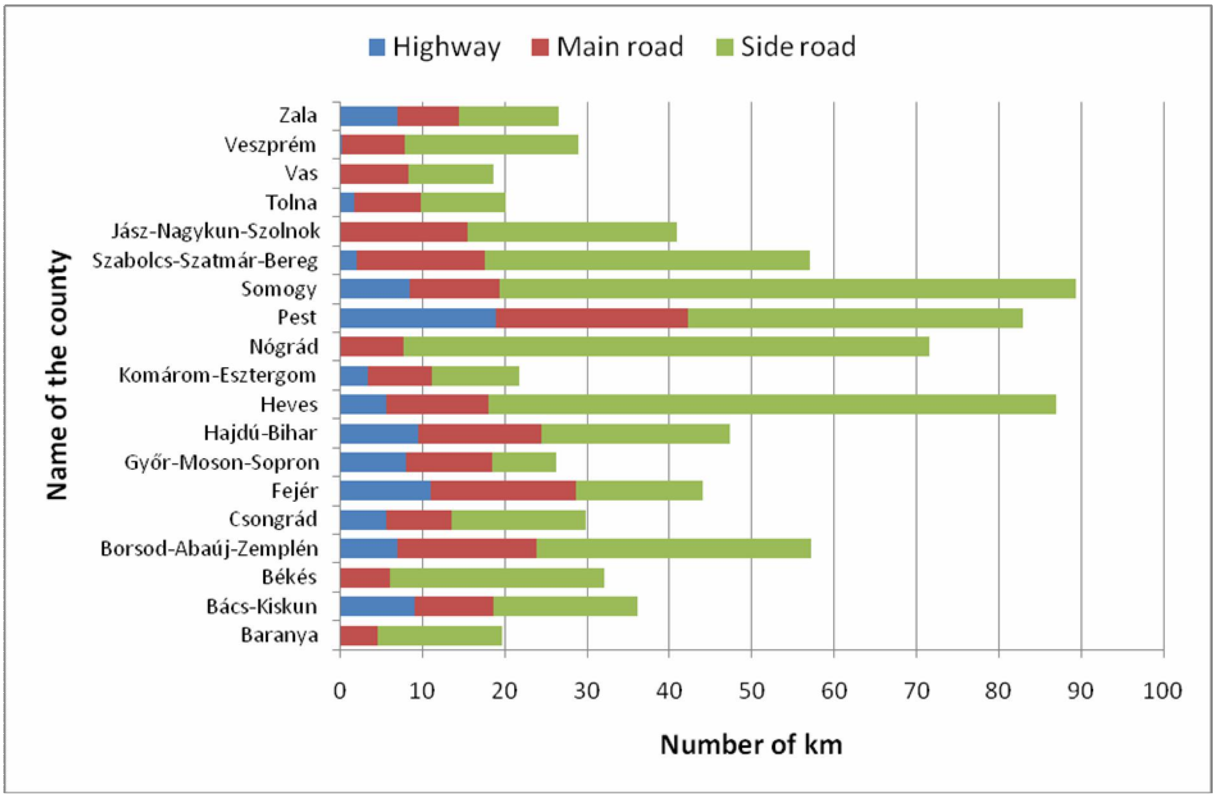
3. Empirical Analysis

3.1 Data

In the study I use partly, publicly available macro data from the Hungarian Central Statistical Office (KSH) database. The data is obtained from the web page of KSH. I use regional statistical data in 9 years period of time from 2000 till 2008, namely the GDP per capita (in thousands) in each county in and the number of unemployment (in thousands). The examined years 2000-2008 were selected as they exhibited the largest increase in the Hungarian road network. There was also much new road deliverance in 2009, but those data are still not available for. The other part of the data comes from the Nationwide Public Road Database (OKA), which is maintained by the Magyar Közút Nonprofit Zrt. This database contains all the necessary information about the roads under public ownership, for example length, status, traffic, etc. of the road network. From this data I focus only a part of it in my thesis, since I examine data which are describing how many km of road were built or repaired and the size of the traffic.

I prepared two samples; one of them shows the correlation between road construction and economic development on county level, and the other one will show this relationship on a road level basis so namely how construction and reconstruction of a specific road influences the economy through the increase in traffic. In the first sample I divided the public roads into three categories: 1. (re)construction on highways; 2. (re)construction on main roads; 3. (re)construction on side roads. I analyze the development of these types in 19 counties, see chart 2.

2. Chart - The average number of km built or repaired in each year between 2000-2008



Source: Magyar Közút Nonprofit Zrt. (OKA) and own calculation

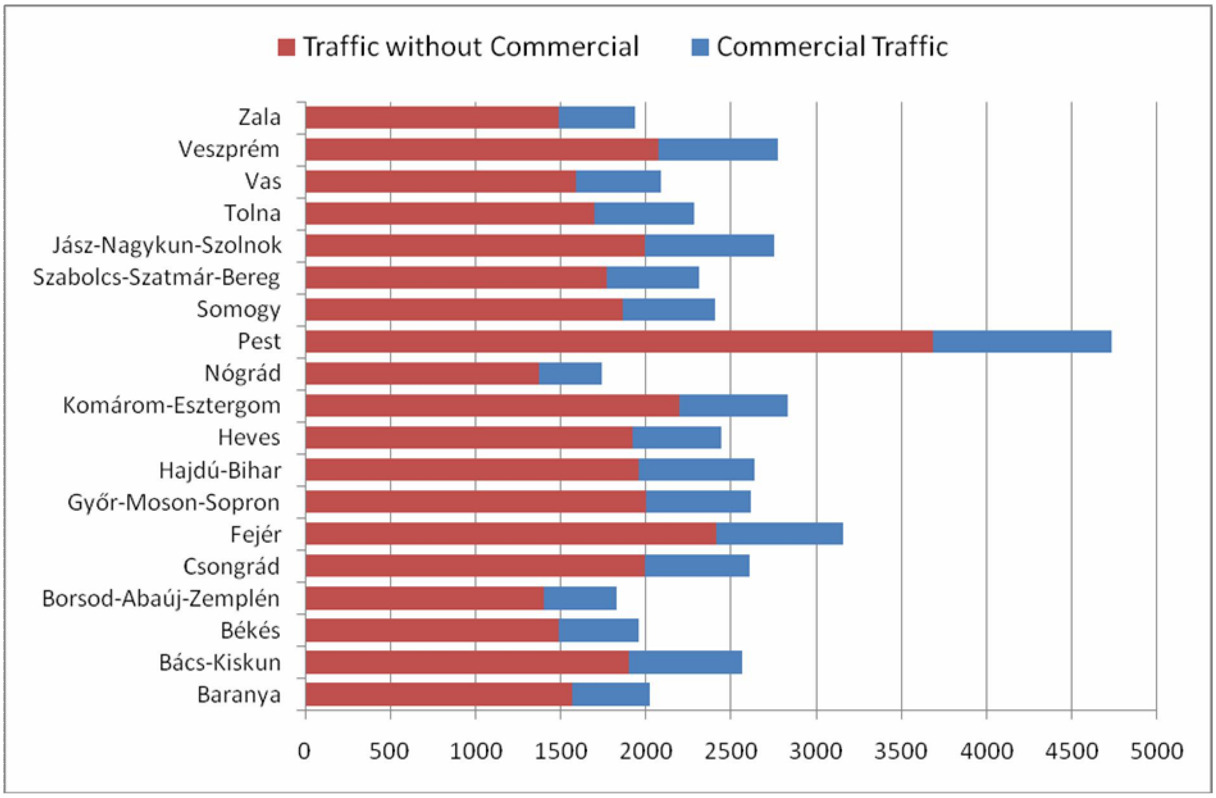
Chart 2 shows the intensity of public road development in each year from 2000 till 2008. We can easily see that the largest average yearly public road (re)construction was in Somogy County, approximately 89 km per year. This was mainly due to the high volume of side road development; especially in 2003 more than 550 km of side road were constructed or repaired. The second largest development in annual average road (re)construction was in Heves County, with an average 86 km per year. This big number is also thanks to the high proportioned development in the side road network. The smallest number of km was (re)constructed in Vas County, since only 18 km public road was renewed. However the economic expansion is mainly due to the commercial traffic which primarily uses the clearway (highway + main road) network. Therefore in that category the largest development was in Pest County with an average 43 km (re)construction of public roads per year. It is not surprising given that the fact that Budapest, the capital city of Hungary, is located in Pest County and its role in the commercial life (which attracts investments into that area).

Now let's turn to the data which describing the traffic on the roads, the numbers show the average annual traffic in a year, in a given county. The traffic count is made by Magyar Közút Nonprofit Zrt. according to the international practice by using sampling method. In order to identify the average daily traffic in a given year, the reasons of daily, weekly, monthly fluctuation of the traffic must be known. These are determined by longer traffic counts. The average daily traffic in a given year (T) can be calculated by the following formula:

$$T_v = t_{x,mo,d,v} * \alpha_{x,mo,d,v} * \beta_{type1,mo,d,v} * \chi_{mo,v}$$

The meaning of the variables in the formula is the following: "t" is the observed traffic in a given "x" time of the day; "α" is the time of the day factor, it shows the relation between the traffic in a given time of the day and the traffic in all day long, with other words it reflect the fluctuation of traffic within a day; "β" is the day factor, it shows the relation between the weekly (monthly) traffic and the daily traffic, so it reflect the fluctuation of daily traffic within a week; "χ" is the month factor, which reflects the fluctuation of the monthly traffic within a given year; "v" is the type of the vehicle (motor, car, truck, etc.); "x" is the time of the day (morning, at noon, afternoon, etc.); "mo" reflects the given month; "d" reflects the type of the days (there are 5 groups: Monday; Tuesday-Wednesday-Thursday; Friday; Saturday; Sunday). Now we know how the average daily traffic is calculated, shows chart 3 the descriptive statistics of the traffic numbers.

3. Chart - Average daily traffic per year



Source: Magyar Közút Nonprofit Zrt. (OKA) and own calculation

What we can see from chart 3 is not surprising, namely that the largest traffic is flowing in Pest County with approximatly 4,700 vehicles per day. In addition to this we can see that the commercial traffic is also the largest in the Pest County, manly due to its central location and Budapest. Moreover Pest County is generating traffic in the neighbouring counties as well for example Fejér County (approx. 3,200 vehicles per day) or Komárom-Esztegom County (approx. 2,800 vehicles per day). From the commercial traffic point of view we can see that the traffic is higher in Komárom-Esztergom County, Veszprém County, Fejér County, Bács-Kiskun County, Heves County, Jász-Nagykun-Szolnok County, Hajdú-Bihar County and of course in Pest County. The reason why the commercial traffic is greater in these counties is that the Helsinki corridors are going through them (see picture 1; and picture 6 in the appendix).

4. Methodology

First of all finding the correct estimation method is crucial. In this case the observations were taken on one hand in the same geographical regions (county level) and on the other and on specific road level over 9 years (2000-2008). It is crucial to investigate the road level data in order to testify whether the road developments in a county induce new traffic or just reallocate the existing one.

These regions and roads are compared primarly to each other and in different years to themselves as well. Therefore the only model that would be able to handle this complex issues is the Panel data method. Pane data set is a combination of two methods, it is namely a "time series for *each* cross-sectional member in the data set" (Wooldridge, 2003 p.10). The time series part of the method is able to capture the outcome of changes in the same region or on road section over time, while the cross-section part of the method can used for comparing the regions or road sections with each other in the same year.

4.1 County level sample

As I mentioned before first I will focus on the direct effect of road construction and reconstruction in each county in Hungary and then I will analyze its indirect effect on the regional economy and on the development. Therefore the direct effect of the road construction can be described with the following general panel regression:

$$Traffic\_All/Com_{ct} = \alpha_c + \delta_t + \beta_1 Const\_HighW_{ct} + \beta_2 Const\_MainR_{ct} + \beta_3 Cons\_SideR_{ct} + u_{ct}$$

The list of all the variables with their meaning, mean value and standard deviation is presented in Table 1. All the variables contain the traffic and the number of km constructed or reconstructed in county *c* and at time *t* (year). The county fixed effect is α_c, which contains all unobserved time constant factors that affect the traffic $Traffic\_All/Com_{ct}$. In addition to this the time fixed effect is δ_t, which can be considered as all time dummies except for the reference year. This simple regression equation likely suffers from omitted variable problems, therefore I tried to control these factors with county fixed effect and year fixed effect which can be, for example, the existence of logistical centers in a given county or the number of commuters in a given county.

1. Table - Variables used in regressions (Country level sample)

Variable	Meaning	Mean Value	Standard Deviation	Maximal value	Minimal Value	Observations
Const_HighW	Number of km of highway constructed or repaired during a year	5,12	9,94	51,12	0	171
Const_MainR	Number of km of main road constructed or repaired during a year	11,19	12,16	87,3	0	171
Const_SideR	Number of km of side road constructed or repaired during a year	27,76	67,41	554,2	0	171
Traffic_All	Number of average daily traffic of all type of vehicle during a year	2510,14	674,73	5003	1535	171
Traffic_Com	Number of average daily traffic of commercial vehicles during a year	595,75	196,16	1202	169	171
GDPperCap	Gross Regional Product per Capita, in thousend Forint	1481,05	453,16	2838	155	152
Unemp	Number of unemployed people in each region, in thousand	12,76	7,13	39	4,4	171

Source of data is Eviews 5.0 statistics, based on the data from Hungarian Central Statistical Office (KSH) and Magyar Közút Nonprofit Zrt. (OKA)

The existence of logistical centers and the commuters could also affect the amount of traffic in a given county. Since they are constant over time, I can eliminate these causes with a simple differentiation like the first difference – it is just a simple cross sectional equation, but each variable is differenced over time – or fixed effect estimations, which can be calculated by subtracting the average effect over time from the original equation. In order to choose between the two methods the Durbin-Watson test statistics must be used. However the test requires really strong assumptions like strict exogeneity, and on top of this the decision rule of this test statistics is complicated. I chose First differenced estimator because I have more than two time periods and it is useful to avoid autocorrelation in the error term (Wooldridge, 2003). My first difference estimation looks as follows:

$$D(Traffic\_All/Com_{ct}) = D(\delta_t) + \beta_1 D(Const\_HighW_{ct}) + \beta_2 D(Const\_MainR_{ct}) + \beta_3 D(Cons\_SideR_{ct}) + D(u_{ct})$$

Thanks to this method the constant term and the fixed effect estimator is eliminated from the pooled OLS equation. In case of independent variables I also use lagged variables, since the effect of road development on traffic is hardly measurable in the same year when the construction was made.

4.2 Road level sample

In the road level sample I analyze the direct effect of construction and reconstruction on a given section of a single road on the amount of traffic which is flowing on these sections. In this sample I focus only on the highways and main roads in Hungary, since according to Magyar Közút's report, the largest part of traffic is accumulated on these roads. I analyze the data of 511 sections on 32 public roads. Therefore the direct effect of construction on these roads can be described with the following simple regression:

$$Traffic\_All/Com_{it} = \alpha_i + \delta_t + \beta_1 Const\_SectionOfRoads_{it} + u_{it}$$

In this case the variables contain the traffic and the number of meter constructed or reconstructed in section *i* and at time *t* (year). The list of variables with their meaning, mean value and standard deviation is presented in Table 2.

2. Table - Variables used in regressions (Road level sample)

Variable	Meaning	Mean Value	Standard Deviation	Maximal value	Minimal Value	Observations
Traffic_All	Number of average daily traffic of all type of vehicle during a year	12088,85	11002,36	134225	0	4345
Traffic_Com	Number of average daily traffic of commercial vehicles during a year	1544,45	1536,44	16768	0	4357
Const_ SectionOfRoads	Number of meter of road constructed or repaired during a year	284,08	1406,03	32476,5	0	4599
Const_Dummy	Indicator of weather the road was developed when the observation is taken; 0=no, 1=yes			1	0	4599

Source of data is Eviews 5.0 statistics, based on the data from Hungarian Central Statistical Office (KSH) and Magyar Közút Nonprofit Zrt. (OKA)

Because of the same reasons I mentioned before I use also the first difference estimation method in this sample as well and therefore my equation looks as follows:

$$D(Traffic\_All/Com_{it}) = D(\delta_t) + \beta_1 D(Const\_SectionOfRoads_{it}) + D(u_{it})$$

With this method I can eliminate the constant term, the fixed effect and the autocorrelation in the error term from my pooled OLS equation. Just as in the previous sample I use lagged variables, since the effect of road development on traffic is hardly measurable in the same year when the construction was made. I analyze the effect of road construction three years after the exact intervention took place.

5. Evaluation of the results

I have ran four different regressions in each sample (county level sample and road level sample); each Panel regression with first difference estimation in order to avoid inconsistency and bias. In order to compare the three cases I collected the coefficients and the standard error of each variable in Table 3. In all regressions the regional or road level fixed effects are captured by first difference estimation and White Period standard errors are taken into consideration to avoid heteroscedasticity and serial correlation. In addition to this period fixed effects are also captured since it is likely to affect the results. I have analyzed these results in each case and finally I have described a proper solution for my “research question”.

In the first two – (1) & (2) – regressions the difference in county level traffic – total and only commercial respectively – are ran on the difference in lagged km of highway, main road and side road were constructed. In this case unfortunately the results do not satisfy my expectations, since none of the coefficients are significant at 5% level, except for the intercept; and in addition to this the sign of the variables are negative which would mean that if one km of road would be built or renewed then the traffic will decrease, which is not realistic. In addition to this I tried to cut the number of explanatory variables and use only the highway and main road construction data in order to get more significant effects (regression (3) & (4)). Unfortunately this attempt does not enter into success, except the effect of main road construction on commercial traffic turned out to be significant at 10% level. This would mean that if 10 km of main road is constructed in one county then the average daily commercial traffic will increase by 19 trucks. In the other cases the explanation can be that the Stable Unit Treatment Value Assumption (SUTVA) – that the “treatment received by one unit do not affect outcomes for other unit” (Imbens and Wooldridge, 2009 p.13) – on county does not hold. Namely the construction or reconstruction of a specific road affects not only that specific road, but the other substituting or neighboring roads as well. Therefore on county level the treatment affects the whole road network, one of them positively and the others negatively. At the end these outcomes extinguish each other and this result in statistically insignificant effect of road construction on the flow of traffic at the county level.

3. Table - Regression coefficients (A)

	Dependant variable							
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	D(Traffic_All)	D(Traffic_Com)	D(Traffic_All)	D(Traffic_Com)	D(Traffic_All)	D(Traffic_Com)	D(LOG(Traffic_All))	D(LOG(Traffic_Com))
			only on HighW and MainR	*only on HighW and MainR*	*on the 511 sections*	*on the 511 sections*	*on the 511 sections*	*on the 511 sections*
Intercept	59.22***	14.88***	399.80***	50.75***	614.95***	76.33***	0.02***	-0.01*
	(6.25)	(2.33)	(76.68)	(10.89)	(66.07)	(13.60)	(0.006)	(0.01)
D(Const_HighW(-1))	-0.24	-0.11	14.90	-1.43				
	(1.11)	(0.29)	(13.00)	(1.54)				
D(Const_MainR(-1))	-0.16	0.42	-11.20	1.89				
	(0.69)	(0.31)	(8.22)	(1.12)				
D(Const_SideR(-1))	-0.14	-0.11*						
	(0.09)	(0.06)						
D(Const_SectionOf Roads(-1))					0.17	0.03**		
					(0.10)	(0.01)		
D(Const_SectionOf Roads(-2))					0.08	0.01		
					(0.05)	(0.01)		
D(Const_SectionOf Roads(-3))					0.11**	0.02*		
					(0.05)	(0.01)		
Const_Dummy(-1)							0.03	0.01
							(0.02)	(0.03)
Const_Dummy(-2)							0.022	0.009
							(0.016)	(0.02)
Const_Dummy(-3)							0.033**	0.05**
							(0.006)	(0.02)
Time Fixed effect	YES	YES	YES	YES	YES	YES	YES	YES
Durbin-Watson stat	1.93	2.53	2.76	2.61	3.16	2.86	1.97	2.37

*Note: White Period standard errors are in parentheses; Source of data is Eviews 5.0 statistics; based on the data from Hungarian Central Statistical Office (KSH) and Magyar Közút Nonprofit Zrt. (OKA); * significant at 10% level ** significant at 5% level, *** significant at 1% level*

In order to see whether the construction or reconstruction of a road has really an effect on the traffic of that specific road I use to the road level sample (regression (5)-(8)). I examine this problem from two aspects. On one hand I analyze how the traffic of one road section will change if 100 meters of road is developed in one section (regression (5) &(6)). On the other hand I analyze the effect of dummy construction variable on the percentage change of traffic in each section (regression (7) & (8)).

In the first case the dependant variable is the difference in the average daily traffic in one road section and the explanatory variables are the lagged construction variables presented in the same form as the left hand side variable. I use three lagged variables in order to see the effect of an intervention one, two and three years later. In case of total traffic (regression (5)) I can see positive and statistically significant effect even two and three years after the construction or reconstruction. The three year later effect of one meter constructed road on traffic is not 0.11, however the sum of all three coefficients, which is in this case 0.363. This means that if 100 meter road was constructed in one section three years before, then now the average daily traffic will increase by 36.30 cars. The same trend can be seen by the commercial traffic regression (number (6)). In this case the amount of constructed road has a positive significant effect on commercial traffic one and three years later. It can be easily seen if 100 meter of road was constructed in one section, then three years later the number of commercial vehicles will increase by 6.5 trucks per day. From this I can conclude that the road constructions provide statistically significant effects only three years after they were made.

I substitute the road construction variable with a dummy in order strengthen the previous results (regression (7) and (8)). Now the difference in the logarithm of traffic – total and commercial respectively – is run on the difference in lagged construction dummies. I use, just as like before, three lagged variables in order to see the long term effect of any intervention happened in each road section. According to the results in table 3, I can conclude that the outcome of any road construction will be effective either on total or commercial traffic only 3 years later. In case of total traffic the meaning of the coefficients is the following: if a road section was developed then the average daily traffic will increase by 8.1%. This is a very strong result, since there should be no serial correlation in the regression because the Durbin-Watson test statistic is really close to two (1.96). On the other hand the result of any intervention on commercial traffic is positive and statistically significant; so the average daily traffic will increase by 7.2% in the following 3 years. I can say that this result is true since the DW statistics are close to two (2.37), therefore the serial correlation is low.

Since the same effect was presented when I made a regression about the flow of traffic on the particular amount constructed road I can draw the conclusion that the road construction and reconstruction significantly affects the average daily traffic, but the magnitude of the effect is slightly lower than I expected before and it does not apply immediately rather several years later. However this is only perceptible on the road level, since on county basis the public road development has multiple effects on the roads which can extinguish each other.

Even though there is no statistical evidence for that the road construction or reconstruction has an effect on the flow of traffic at the county level, it is still interesting to investigate the effect of road construction on the regional economic development. According to chapter 2 this effect is indirect; therefore I use the traffic components as explanatory variables. The results are reported in table 4.

4. Table - Regression coefficients (B)

	Dependant variable (9) D(GDPperCap)	(10) D(GDPperCap)
Intercept	-689.31***	-481.35***
	(98.49)	(56.85)
D(Traffic_All(-1))	0.276	
	(0.625)	
D(Traffic_All(-2))	2.911***	
	(0.619)	
D(Traffic_All(-3))	1.951***	
	(0.605)	
D(Traffic_Com(-1))		1.171
		(1.061)
D(Traffic_Com(-2))		3.537**
		(1.725)
D(Traffic_Com(-3))		1.263***
		(0.469)
Time Fixed effect	YES	YES
Durbin-Watson stat.	1.77	1.87

*Note: White Period standard errors are in parentheses; Source of data is Eviews 5.0 statistics; based on the data from Hungarian Central Statistical Office (KSH) and Magyar Közút Nonprofit Zrt. (OKA); * significant at 10% level ** significant at 5% level, *** significant at 1% level*

In the regressions the difference in GDP per capita are run on the difference in lagged total and commercial traffic. Again period fixed effects are included and heteroskedasticity and autocorrelation consistent (White Period) standard errors are used. I expect larger effect with commercial traffic since the transportation is the motor of the economy. From table 4, I can see that the coefficients of *D(Traffic_Com)* are higher. In both regressions the effect of traffic will be statistically different from zero only two and three years later. This means that the increase in traffic today will have a positive significant effect on the county's economic development only two or three years later. Besides it, the same trend can be seen in the road development sample as well. In case of increase in total traffic, if the average daily traffic in a county increases by 1 vehicle, GDP per capita will increase by HUF 5,139. On the other hand, if the average daily traffic in a county increases by 1 truck, the GDP per capita will increase by HUF 5,971. Surprisingly there is no considerable different between the effects, mainly because the total traffic contains the commercial traffic as well and it involves other movements like tourism or commuter traffic which also influencing the regional GDP.

5.1 Some caveats

Several questions may arise according to the data I used in my study. First of all I used the data from several sources, so the measurement error problem can come up in my dataset. In addition to this as I mentioned before, the road construction numbers contain either reconstructed or the newly constructed roads as well. Probably it would be better to distinguish between them but it was not feasible. Besides these caveats the confidence in the above discussed results remains.

6. Conclusion

In this paper I have investigated the effect of public road development on regional economic development through the increased number of traffic. Before the analysis in accordance with the literature I expected that the higher density and the improving quality of public road network induce the regional economic development.

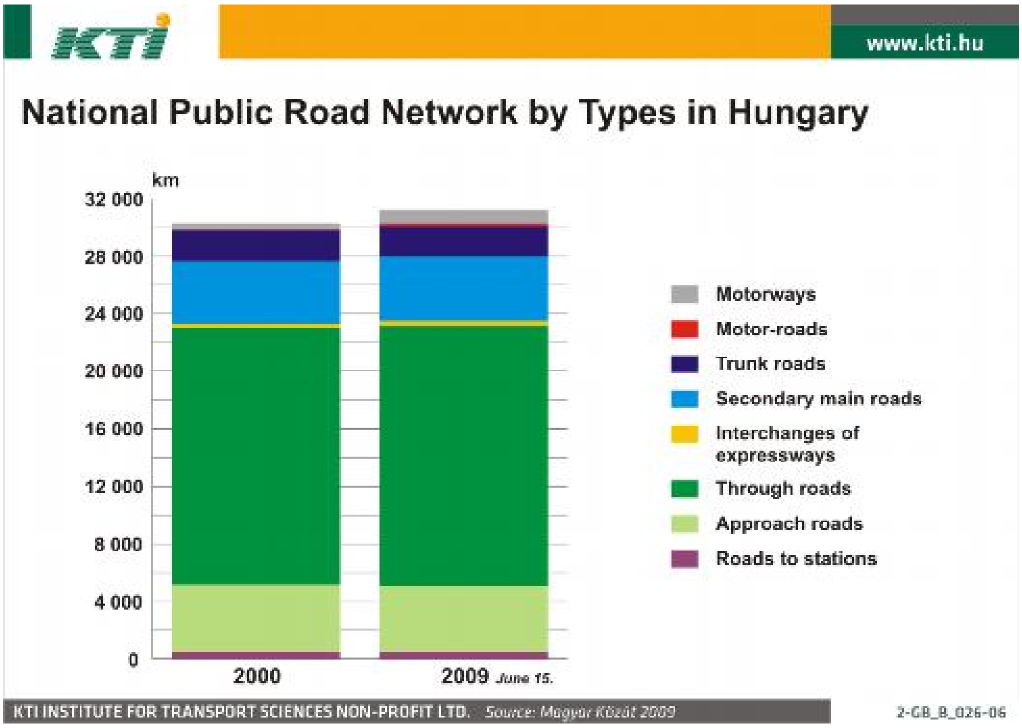
For analyzing the effects I used panel data method with first difference estimator. First I examined the direct effect of road construction and reconstruction in each county in Hungary, namely I analyzed the correlation between public road development and average daily traffic on county level. Unfortunately due to the fact that the Stable Unite Treatment Value Assumption did not hold I could not find any statistical evidence on county level for the positive correlation between traffic and road construction. In order to see whether the construction or reconstruction of a road has really an effect on the traffic of that specific road I turned to the road level sample. From the results I could draw the conclusion that the road construction and reconstruction significantly affected the average daily traffic, but the magnitude of the effect was slightly lower than I expected before and it did not apply immediately rather just several years later. Even though there was no statistical evidence for that the road construction or reconstruction had an effect on the flow of traffic at the county level, I analyzed its indirect effect of public road development on the regional economy and its development. By running the regressions I could conclude that the results supported my expectations and showed positive effect of traffic on Gross Regional Product per capita.

The policy implications are that public road construction and development are essential; moreover beyond the economic effects I examined in this thesis they have different other influences such as on environment protection, since the car consumption would be more optimal and the time spent in traffic could be shorter. On the other hand road development in itself is not enough to induce new traffic in a region. As I can see from the result on county level it only restructures the traffic from one road to another. Therefore other infrastructure developments are also needed to achieve regional economic development.

In the future it would be interesting to separate the data into two: new public road constructions and public road reconstruction; and then run the same regressions. From another aspect it is worth to examine the joint effect of infrastructure development on regional economic development.

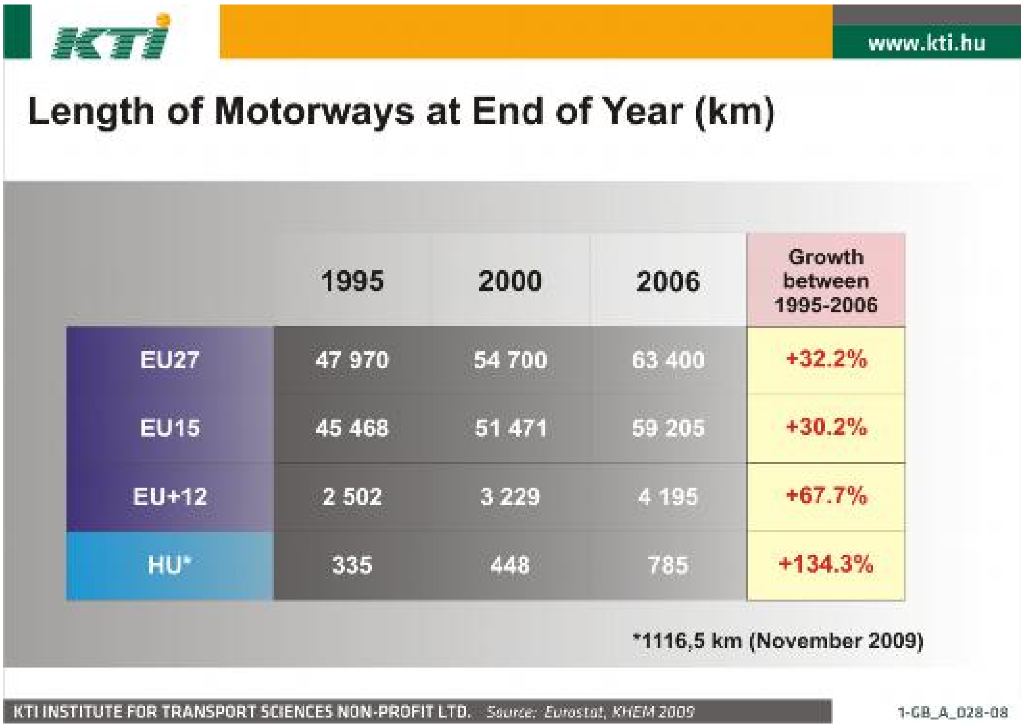
7. Appendix

2. Picture - National Public Road Network by Types in Hungary



Source: Institute for Transport Sciences Non-Profit Ltd. (KTI)

5. Table - Length of motorways at end of year (km)



KTI www.kti.hu

Length of Motorways at End of Year (km)

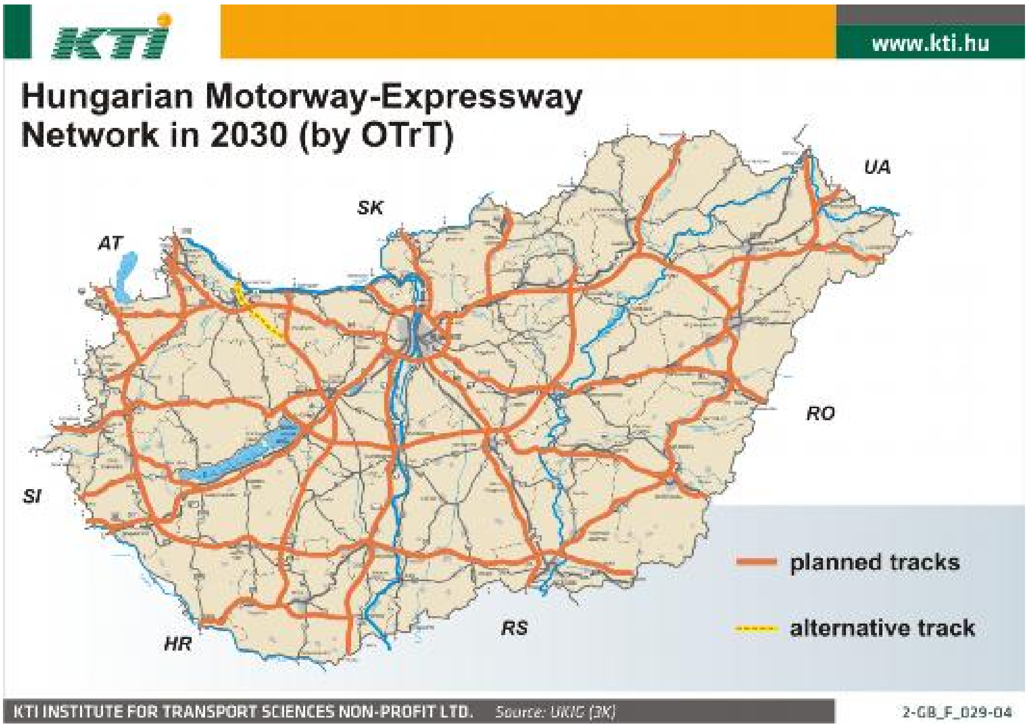
	1995	2000	2006	Growth between 1995-2006
EU27	47 970	54 700	63 400	+32.2%
EU15	45 468	51 471	59 205	+30.2%
EU+12	2 502	3 229	4 195	+67.7%
HU*	335	448	785	+134.3%

*1116,5 km (November 2009)

KTI INSTITUTE FOR TRANSPORT SCIENCES NON-PROFIT LTD. Source: Eurostat, KHEM 2009 1-GB_A_028-08

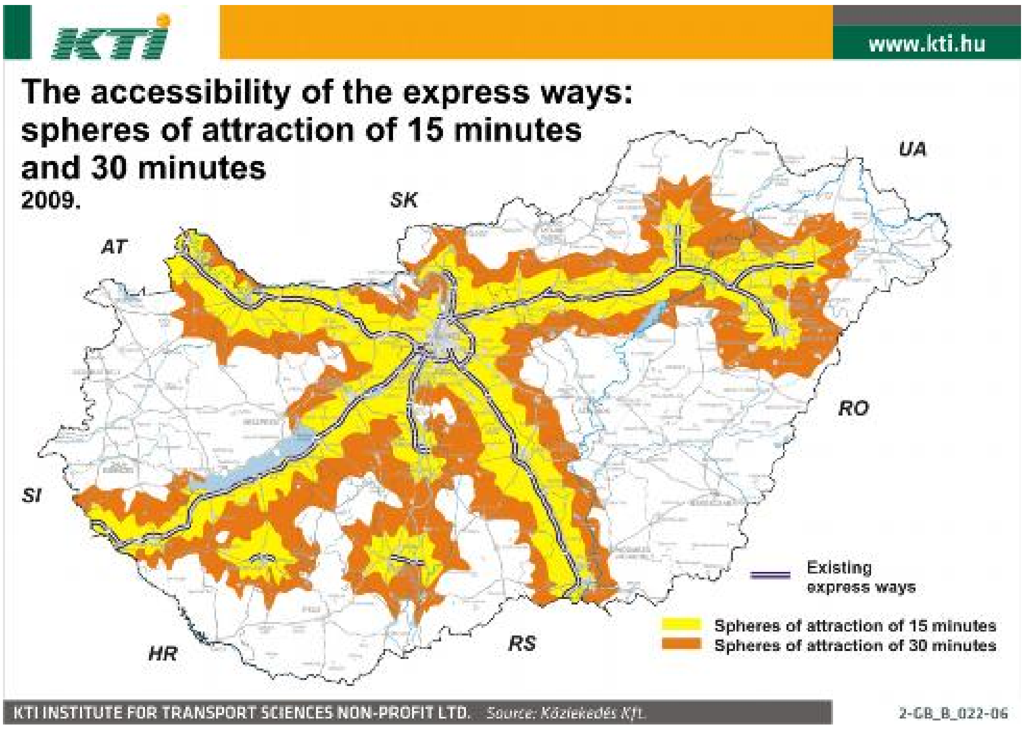
Source: Institute for Transport Sciences Non-Profit Ltd. (KTI)

3. Picture- The Hungarian Clearway Network in 2030



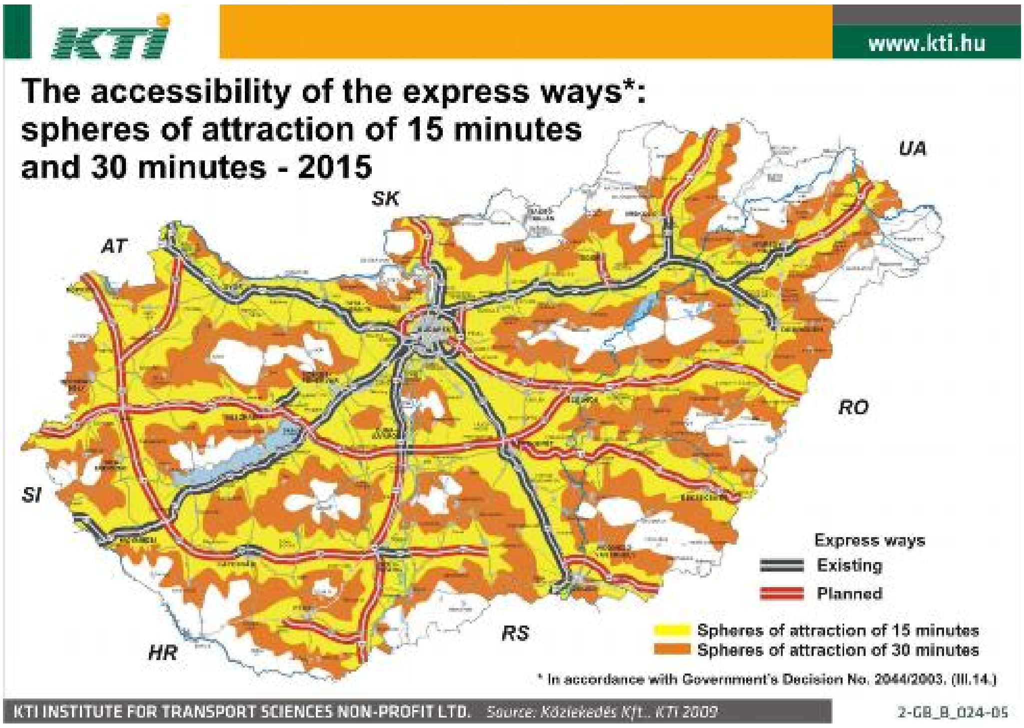
Source: Institute for Transport Sciences Non-Profit Ltd. (KTI)

4. Picture - The accessibility of the express ways in 2009



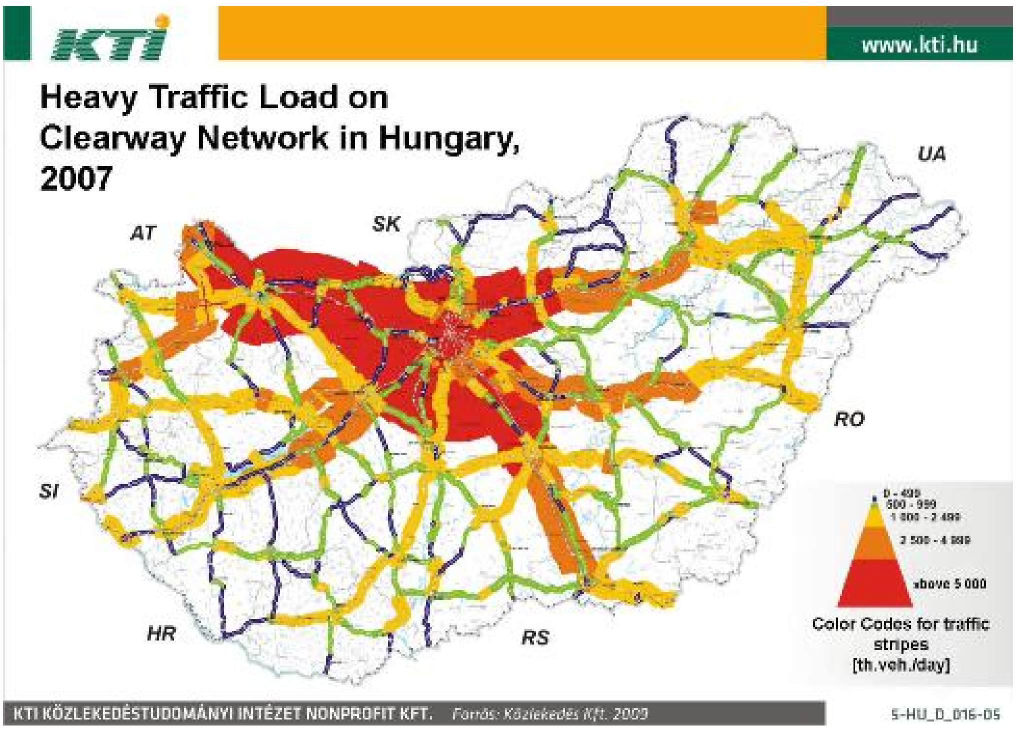
Source: Institute for Transport Sciences Non-Profit Ltd. (KTI)

5. Picture - Projected accessibility of the express ways in 2015



Source: Institute for Transport Sciences Non-Profit Ltd. (KTI)

6. Picture - Heavy Traffic Load on Hungarian Clearway network, 2007



Source: Institute for Transport Sciences Non-Profit Ltd. (KTI)

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