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FIRM BEHAVIOUR AND PUBLIC INFRASTRUCTURE:

THE CASE OF HUNGARY

GABOR BEKES

BALAZS MURAKOZY

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Firm behaviour and public infrastructure:
The Case of Hungary

Authors: Gabor BEKES, CEU Department of Economics: Budapest, 1051 Nádor utca 7., Email: bekes.gabor@chello.hu
Balazs MURAKOZY, CEU Department of Economics: Budapest, 1051 Nádor utca 7., E-mail: cphmub01@phd.ceu.hu

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MAGYAR TUDOMÁNYOS AKADÉMIA
KÖZGAZDASÁGTUDOMÁNYI INTÉZET

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FIRM BEHAVIOUR AND PUBLIC INFRASTRUCTURE: THE CASE OF HUNGARY

BY

GABOR BEKES - BALAZS MURAKOZY

Abstract

In the paper, we test the effect of local development, regional and local policies on the location decisions and productivity of firms. Development indicators include local research and development activity or education while policy decisions used in this study encompass for example tax rates, investment incentives or road construction. The study builds upon a large national panel of firms. Importantly, such a rich dataset has rarely been employed for productivity and location choice exercises. The paper is composed of two sections dealing with location choice and productivity, respectively and we compare the effect of variables used in both sections. Among others, we find that density of road network positively influenced location choice and productivity as well, while a somewhat larger size of administration helps new firms to settle but later on, it has no effect on productivity.

Keywords: industrial location, FDI, productivity, discrete choice models, GMM

Journal of Economic Literature (JEL) code: R3, R12, D24, H7, C30, C35

MAGYAR TUDOMÁNYOS AKADÉMIA
KÖZGAZDASÁGTUDOMÁNYI INTÉZET

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BÉKÉS GÁBOR – MURAKÖZY BALÁZS

A VÁLLALATI MAGATARTÁS ÉS A KÖZÖSSÉGI INFRASTRUKTÚRA KAPCSOLATA MAGYARORSZÁGON

Összefoglaló

Ebben a tanulmányban azt vizsgáljuk, hogy mi egy térség fejlettségének valamint az ott alkalmazott regionális és a helyi polikák hatása a vállalatok telephelyválasztására és termelékenységére. Fejlettségi mérőszámként a helyben folyó kutatás-fejlesztés mértékét és az adott területen tanulók arányát használjuk. Helyi politikán pedig többek között az adókulcsokat, beruházás-ösztönző eszközöket és a helyi infrastruktúra fejlettségét értjük. A tanulmány empirikus elemzését egy nagyméretű, országos vállalati panel-mintán végezzük el. Ilyen gazdag adatbázist a korábbiakban ritkán alkalmaztak a vállalati telephelyválasztás és termelékenység vizsgálatára. A tanulmány két részből áll: az első a telephelyválasztást, a második a termelékenységet vizsgálja. Az utolsó fejezetben pedig összehasonlítjuk az olyan változók hatásait, amelyek mindkét részben szerepelnek. Többek között arra jutottunk, hogy az úthálózat sűrűsége pozitív hatással van a telephelyválasztásra és a termelékenységre is, az adminisztratív dolgozók nagyobb száma viszont csupán a vállalatok betelepülését segíti, de nincs hatással a termelékenységükre.

1 INTRODUCTION

Various economic policy decisions influence corporate behaviour. Measures may be taken at municipal regional or national level. From a policy perspective, corporate reaction to economic policy measures and development incentives has a great significance. First, European Union development policies will either target firms directly or influance them as a by-product of cohesion efforts. Second, while several empirical papers discuss the linkages between firms and policy in the US or Western Europe, the topic has rarely been discussed in the context of a less developed country. In particular, we are interested in the effect of local development as well as regional and local policies on the location decisions and productivity of firms. We argue that policies should - inter alia - be evaluated on the basis of their impact on improving the economic environment and business conditions for firms in manufacturing. For state involvement in the economy is related to the provision of public goods (such as the road network) and to encouragement of activities, the effects of which would spill over to other actors of the economy such as firms in the industry. Development indicators, which would capture these externalities as well as cost factors for firms, include local research and development activity, telephone network or education. Policy decisions used in this study encompass for example tax rates, municipal and national investment expenditures, investment incentives and road construction.

The study builds upon a large national panel of firms. Rather than following sectoral patterns, this dataset allows to analyse firm behaviour directly. Such a rich dataset has rarely been employed for productivity and location choice exercises. We use several sources for policy and development variables. In addition to county-level data that has been available by the Central Statistics Office, we use a recent survey on about a hundred municipalities.

The paper is composed of two sections dealing with location choice and productivity, respectively. Results from separate sections will be compared and evaluated in the Conclusions followed by some ideas for future research.

2 LOCATION CHOICE

In the first section, we look at location choices of foreign firms in manufacturing. Such companies have chosen relatively small number of locations for their production between 1991 and 2003. A key stylized fact is the presence of concentration at the national level: a few counties attracted the majority of investment.

Location decisions will be based on three types of factors. Choices will be influenced by some geographic properties of counties including size or proximity to borders - this is called the first nature geography and these features would change very slowly. Location choices as well as behaviour (output) of other firms determine second nature geography with sales between various firms becoming a key pulling factor. The second nature properties of a county may change rather quickly - as the experience of transition in Central Europe would suggest. In addition, location choices are influenced by the "one and a half" nature: roads, universities or administration capacities that change more slowly than firms but nevertheless, adapt to corporate needs as well as shape firms' behaviour.[1]

The section is organised as follows. First, we give a brief summary of the key theoretical underpinnings of the research as well as surveys of the empirical findings of previous papers. This is followed by a presentation of the econometric model along with a description of the datasets and variables in section three. Subsection three present the results.

2.1 RELATED LITERATURE

2.1.1 AGGLOMERATION AND MARKET ACCESS

Underlying the exercise in this section is a new economic geography approach using input-output linkages among firms. Note that most models of new economic geography (or NEG) aim at uncovering the essential reasons behind both agglomeration and dispersion of economic activity by taking into account "second nature" geography features.2

[1] 1For more on this, see Baldwin (2004)

[2] 2A detailed description Krugman and Venables (1995) type model may be found in

As for the access to markets, the key idea that firm location depends on the proximity of demand was introduced a long ago, and already in 1954, Harris devised the simplest aggregate market-potential function. Market potential has been first investigated in an international context; proximity to key markets and suppliers has been explicitly featured in empirical works explaining overall economic activity or per capita income. Redding and Venables (2004) argue that a country's wage level (proxied by per capita income) is dependent on its capacity to reach export markets and to manage to get hold of the necessary intermediate goods cheaply. Head and Mayer (2005) look at Japanese investments carried out in the European Union.

Results show that apart from a very important market potential measure, a number of traditional explanatory variables (e.g. taxes) and agglomeration variables turn to be significant as well. Agglomeration externalities were first emphasised by Marshall, and formalisation of most such externalities may be found in Fujita et al. (1999, Ch. 16.). One such agglomeration force is labour migration: an increased population generated greater demand inviting more firms to settle in a larger city, and this allowed for a lower import bill and hence, lower living costs in general. Another driver of co-location of firms comes from the potential of supplier-buyer link between firms, i.e. one firm's output is the intermediate good of another as in Krugman and Venables (1995). Thus, firms try to locate close to other firms, hence lowering transaction costs. An other reason for agglomeration is the presence of knowledge spillover: proximity allows to exchange inventions while technology spillovers help increase productivity using other firms' knowledge. Further, labour pooling may be important as firms would enjoy the presence of a larger set of labour pool where the specific knowledge required by the firm can be fished out easily (Amiti and Pissarides (2001)).

There have been several papers dealing with location decisions of foreign investors and clustering of these firms. Crozet et al. (2004) study location of FDI in France and find that firms of the same nationality like to group together, locations close to home country are chosen more frequently, and some industries (like car plants) have a strong tendency to agglomerate.

Békés (2005). An excellent survey of key hypotheses emerging from models of new economic

geography and their mixed empirical support can be found in Head and Mayer (2004).

Similarly, a study by Head and Ries (2001) looks at Japanese investments in the US and finds that firms belonging to the same keiritsu tend to settle close to each other. Some studies considered countries of similar size and population to Hungary. Barrios et al. (2003) look at multinationals' location choice in Ireland to find that agglomeration forces contributed substantially to location choices but proximity to major ports and airports was also helpful.

Urbanization, i.e. denisty of the actual location may foster agglomeration by helping face-to-face communication or the spillover knowledge. Of course, high land prices and congestion may be a deterrent factor. Coughlin and Segev (2000) found a positive effect of urbanisation on location of manufacturing plants. Proximity to businesses that provide services for manufacturing firms such as banks or accountancies has been proved to attract investments.

2.1.2 Development, accessibility and transportation network

In a broader sense, regional development has often been investigated. For example, Basile (2004) showed that public infrastructure and education are attracting forces while crime rate is negatively related to new investments in Italy. Several studies considered the role of transportation per se in a regional setting. Cieslik (2003) looked at 50 Polish regions to find that both proximity of main export targets and road network have been the key magnets for foreign investment.

In the lack of appropriate data, only a few studies investigated the role of settlement level determinants of location choice. Holl (2004) analysed explicitly the impact of road infrastructure on new manufacturing establishments in Spanish municipalities. The paper suggests that infrastructure development affects municipalities differently even within one region and agglomeration forces operate within a relatively small geographic scope. Holl posits that a new motorway will positively affect productivity of firms in the very proximity of the motorway but adds that a negative spillover to more distant areas is likely as they loose out on investments. Results suggest that apart from the size of the settlement, share of educated workforce and proximity to major cities attract new investments, while competition presents a deterrent force. In contrast with other studies showing positive spill-over effects from co-location within a region or country, at a lower level of aggregation, competition overweighs these externalities. Most interestingly, it is shown that there is an average 14% increase in firm entry for municipalities located within 10km from the new motorway. Outside this 10km corridor, distance from motorways plays a small role only. Woodward (1992) took local transportation linkages as a separate variable to measure accessibility of regional and national markets. Here, interstate highway connection was taken as proxy to good access, and the positive and significant coefficients confirmed hypotheses.

Another way to look at transportation infrastructure is to estimate the impact of road density. A more developed network should help firms trade with other companies in the neighbourhood as well as transport final goods to cities. Hence, good transportation within regions allows for agglomeration externalities to yield greater profits form specialisation and economies of scale or technological spill-overs. In Indonesia for example, Deichmann et al. (2005) found that road density positively influences location choice for most of the industries. For China, Amity found strong evidence of the importance of railway network.

Note that theoretically, the impact of access to key transportation channels may not serve as an attraction force. Recent models of new economic geography[3] suggest that providing a new transportation link between a rich and a poor region may excercebate agglomeration tendencies, leading to new investment in the agglomerated (richer) area and hence, a greater divergence. This important theoretical aspect that is quoted in some recent studies (e.g. Basile (2004)) has been generally left out of policy analyses. For example, Puga (2002) quotes a report of European Union's Committee of the Regions that emphasises positive impacts of a better infrastructure but disregards agglomeration forces that may lead to a loss of industry in the poorer region that was originally to be developed.

[3] See Baldwin et al. (2003), Head and Mayer (2004) or Martin (1999).

2.1.3 LABOUR MARKET

In previous studies, various labour market variables have been investigated including gross wages, income tax rates, unemployment or the composition and skills of the labour force. Theoretically, lower wages reduce production costs and higher unemployment provides the necessary labour supply for new investments, thus, both should attract FDI. Studies of international location choice certainly support this position, while results are quite mixed when considering intra-national choice. For example, in Figueiredo et al. (2002) local wage has the expected sign, but in other studies like Holl (2004), the wage coefficient is insignificant.

There may be various explanations for ambigous results. Labour migration within one country may be strong thus alleviating differences. Different industries would use different types of labour in terms of skills and profession. The share of blue-collar workers may vary a great deal among sectors and furthermore, their wage may differ greatly depending on how skilled they are. Hence, the industry profile of a region may well influence the average wages. An insignificant or a positive coefficient may just imply that investors are bringing in superior technology and hence, require more skilled and educated (i.e. more expensive) sort of labour reflected in higher wages.

2.1.4 LOCAL TAXES AND REGIONAL POLICIES

There have been a few studies looking at local and regional taxes as well as regional policy initiatives. Woodward (1992) analyses a period of booming Japanese FDI activities in the US focusing on greenfield start-ups that, unlike foreign acquisitions, require an explicit location decision. Location of 540 plants are analysed with firms assumed to have freely chosen a US state and a county. Interesting explanatory variables include various tax rates, the presence of industrial policy (at the state level) and manufacturing agglomeration, racial and educational mix of population or labour market features (at the county level). High taxes did serve as a deterrent at the state level but the local property tax seemed to have no direct effect. As for the county level regressions, labour market variables proved to be important determinants of location choice.

Measuring state policy towards FDI was not easy. Woodward (1992) used an index developed by Luger (1987) and it includes land and building subsidies, debt and equity capital support, job training, infrastructure improvement and site preparation. Another instrument is the presence of state-level investment and export promotion offices operating in Japan. In the early eighties only 15 US states had such office, but by the end of the decade most states had established such institution. Interestingly state effort had no significant impact while, an office in Japan proved an efficient tool to attract investments. For the late eighties and early nineties, Kim et al. (2003) considers new manufacturing FDI plants in the US to analyze the effect of industry promotion programs[4] by states. The impact of expenditures on FDI attraction programs was estimated and found to have a positive and significant effect. Moreover, Kim et al. (2003) suggested that promotion expenditures may be used to offset the lack of agglomeration. For example, 100 thousand dollars worth of promotion should have the same effect on FDI attraction as increasing the number of manufacturing plants by 3300.

Another way of looking at regional policy is to consider national initiatives to attract FDI into certain areas of the country. Barrios et al. (2003) find evidence that higher public incentives in Irish designated areas have increased the probability of multinational investment. In the United Kingdom, Devereux et al. (2003) examine whether discretionary government grants influence firm location. It is found that policy instruments in the form of regional grants do have some effect in attracting new firms to supported location, but this effect is rather small.

In several Central and Eastern European countries, special industrial zones were created to attract foreign investors. Several studies argued that zones would have a favourable impact. However. for Poland, Cieslik (2003) found that when controlling for access and agglomeration variables, the existence of such zones had no considerable impact on the number of investments. Spending on incentives and infrastructure should have a favourable impact, but bureacracy as a potentially important impediment to investment must be

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[4] 4 In the US, there exists a central database, the "State Export Program Database"

that collects state programs prepared by the National Association of State Development Agencies.

taken into account as well. Deichmann () investigated the impact of local bureaucratic costs of doing business in Indonesia and found that the occurance of local interventions has a small negative effect, especially for regulation sensitive industries, such as tobacco.

Although local taxes have been found to be a deterrent force for firms (Bartik (1985), Papke (1989)), sensitivity was often found to be rather low and highly variable among industries and firm size (Freidman et al. (1992)). Looking at growth of establishments in Maine (USA), Gabe (2003) found that the local (personal) property tax rate has a negative effect on establishment growth but local government expenditure variables show little or no correlation with firm development. Local taxes in particular have an adverse effect, but the coefficients are almost negligable in size.

2.1.5 HUNGARIAN RESULTS

Agglomeration of investments and a spatial polarization have also been visible phenomena in many sectors. For example, manufacturing of electronic devices by firms such as Flextronics in Central and Eastern Europe can be found in a fairly narrow band from north Poland through the Czech Republic, West Slovakia, West and Central Hungary down to North Slovenia and Croatia.[5] To our knowledge, the impact of such variables on firm location in Hungary has not been investigated in detail. However, various agglomeration forces have been described and shown to be in work in Hungary and several policy and infrastructure variables were used to explain development patterns.

Barta (2003) described regional differentiation in post-transition Hungary giving a good example of agglomeration forces in work in the automotive industry. In Hungary, suppliers to the car plant of Suzuki are shown to be settled in neighbouring counties of Komarom-Esztergom megye, where the Suzuki plant is located. Further, second wave of suppliers that settled directly to service the plant are on average much closer to the factory than the suppliers during the first half of the nineties. There have been several studies discussing the role of accessibility in influencing municipal and regional development in Hungary. Németh (2004) examined which variables could explain income per levels and unemployment rates in NUTS4 "kistérség"

[5] For details see Barta (2003)

regions. Unemployment rates were substantially lower in regions close to the Western borders as early as 1990 and the East- West division remained an important explanatory variable throughout the nineties. Apart from the usual measures of income (education or age), proximity to the capital city as well as the Western border have been key in explaining higher wages. Proximity to other borders proved to be insignificant.

Fazekas (2003) is closer to this research as it considers FDI and not development in general. In the focus of the paper lays the impact of FDI from a labour market perspective to study the impact capital inflow had on the regional structure of the country. The paper finds that concentration pattern of foreign-owned enterprises is just marginally higher than that of the domestically owned ones. However, FEs are concentrated in a different pattern, being located closely to the Western border. The approach of this paper is somewhat different to Fazekas (2003) in that it investigates the agglomeration patterns of foreign firms only.

2.2 ECONOMETRIC MODEL

Firms choose a location by maximising the (expected) profit function that depends on several explanatory variables. For parsimonious notation, let us introduce $INC_{r(t-1)}$ as the measure of county level income, the vector of variables $ACC^{j}_{r(t-1)}$ that includes all industry specific access variables $wage^{j}_{r(t-1)}$ for county level wages. Further, all county level aggregate measures (such as the size of road network or university students) are included in the $County_{r(t-1)}$ vector. Survey based averages of municipal level policy variables are captured in the $local\_avg_{r(t-1)}$ vector. (see detailes below). As a result, our expected profit function for a firm i is:

$$\pi^{j}_{r(t)}(i) = \alpha_1 wage^{j}_{r(t-1)} + \alpha_2 INC_{r(t-1)} + \beta'_1 \mathbf{ACC}^{j}_{r(t-1)} + \gamma County_{r(t-1)} + \gamma local\_avg_{r(t-1)} + \zeta^{j}_{r(t)}(i) \quad (1)$$

where the error term, $\zeta^{j}_{r(t)}(i)$ includes all the non-observed variables.

Note that explanatory variables that have a time dimension are lagged one year for two reasons. The economic rationale (see "time-to-build" models) is that firms may be assumed to spend a year between investment decision and actual functioning (that is picked up by the data). The econometric support stems from a requirement to try to avoid endogeneity, and lagging will free the model of simultaneity bias. We also need to assume that firms at time t considering values of explanatory variables at time $t-1$, pick a county independently of each other. Agglomeration works as firms locate close to other firms that had settled previously, but there is no strategic interaction between firms settling at time t. This is a necessary assumption for using the logit model.

In this econometric structure, one may assume that firms base their location decision on expected profits conditional on choosing a particular location. However, they make errors due to unobserved features of the various regions/settlements as well as inability to make perfect decisions. However, the likelihood of choosing a particular location does indeed depend on the expected profit there. This gives the basis of the Random Utility Maximisation (RUM) models such as ours. The econometric model that follows from RUM models is the McFadden (1974) type conditional logit. However, for several setups, it may be shown to be equivalent to the Poisson model and Figueiredo et al. (2004, p. 203.) shows that the Poisson concentrated log likelihood is "identical to the conditional logit likelihood with some constraints."

The advantage of count data models is their applicability for large choice sets. The conditional logit model may well be applied for studying regional decisions, but is inappropriate for the analysis of settlement level choices. In this paper, we use count data models to get results that may later be comparable with results on settlement level decisions.

2.3 COUNT DATA MODELS

In our count data models, the dependent variable represents the number or frequency of a particular event, in our case, the number of investments in a particular county for a given year and industry. In these models, coefficients explain why $x\%$ more projects took place in county A relative to county B.

2.3.1 POISSON

Define $n^j_{r(t)}$ as the number of investments in industry j, region i and time t. The expected value of the number of projects is:

$$E(n^j_{r(t)}) = \lambda^j_{r(t)} = \exp(\beta \prime X^j_{r(t-1)}) \quad (2)$$

The probability of the actual number of investments being $n^j_{r(t)}$ is:

$$Pr(n^j_{r(t)}) = \frac{e^{(-\lambda^j_{r(t)})}(\lambda^j_{r(t)})^{n^j_{r(t)}}}{n^j_{r(t)}!} \quad (3)$$

where the X s are the explanatory variables. For every year, firm entry data were aggregated by industry and county, and Poisson regressions were run with the same set of explanatory variables used at logistic regressions.

2.3.2 NEGATIVE BINOMIAL

The Poisson model has the advantage of being closely related to the conditional logit, but it assumes that the conditional variance of the dependent variable, λ equals the conditional mean of λ. However, equidispersion is a rare property of firm level data, and for most cases, the variance is larger than the mean. Overdispersion may be treated, but in a more general, negative binomial model that allows to test the null hypothesis of equidispersion.[6] Given their easy applicability, no wonder that both the Poisson and the negative binomial model have been used in location research.[7] The negative binomial distribution may be considered as a generalized Poisson, where the mean does not equal the variance. This deviation is represented with a

[6] 6Importantly, the negative binomial model yields more efficient test statistics and prevents
us from drawing overly optimistic conclusions (see Cameron and Trivedi (1998)).
[7] For example, see Basile (2004), Holl (2004)

dispersion parameter, α. The case with $\alpha = 0$ corresponds to equidispersion, and in that case the model collapses into a Poisson model.

2.4 Data and variables

To study location choices, we distinguish four types of forces. First, classic variables include gravity type variables (size, income par capita) and labour market measures as well as economic geography variables that are centered around two key determinants of location: agglomeration externalities and market access. Second, we use several municipal and regional infrastructure and development variables. Third, policy variables from the municipality survey (such as local tax rates) are included. Due to data availibility, empirical results in this paper are based on county level data. Table 1 summarizes variables for this county level exercise.

2.4.1 Basic determinants and access variables

Classic determinants include the measure of income per capita as well as labour market features such as the average regional wage. To measure consumer demand, two variables were created as the total income is taken as income per capita multiplied by size of population. In addition to this, foreign demand is estimated with a proxy of access to foreign markets. Wage is measured by the average county level wage. Economic geography variables are based on the concept of market access that posits that firm location depends on the proximity of demand. Building on Békés (2005), input-output linkages between firms are taken into account and two corporate access variables are estimated, one for the county and one for the rest of country. These variables include both access to suppliers and corporate customers. Note that agglomeration externalities such as technology spill-over are not measured directly, but the local own-industry output variable picks up such effects.

Other economic geography models incorporated input and/or output competition among firms (Baldwin et al. (2003)). In our case, input competition, which is expected to be important locally, is picked by the non-own industry access variables. Output competition shall be more important nationally and hence, the national own-industry access may indicate such force.

2.4.2 MUNICIPAL AND REGIONAL INFRASTRUCTURE AND DEVELOPMENT

We know that municipal infrastructure in general positively affects the productivity of firms operating at or in the proximity of the actual settlement. As a result higher expected profits should attract more firms in the areas. Below, variables of the vector $County_{r(t-1)}$ are discussed.

First, we take KSH data on county aggregates to measure human infrastructure such as the presence of research activity and administration capacities - all relative to the population of the county. R&D is measured by the number of research centers (at universities or elsewhere), the number of employees at such centers, and the annual expenditures at these centers. The role of universities is also captured by the number of students enrolled at high education institutions in the given county.

Second, administration capacities are measured by the size of personell as well as expenditures on IT and the number of PC computers. In addition to this, investment in physical capital at government and local institutions are both measured directly, in forints.

Third, the transporation infrastructure within counties is captured by the number of telephone lines and the density (i.e. km/area) of various types of road networks (total, motorways, other roads).

2.4.3 POLICY VARIABLES FROM THE MUNICIPALITY SURVEY

The MTA-KTI/Median municipality database is composed of two surveys. The first one includes answers to questions on drivers of municipal activities with responses from the Mayor’s office. The second survey is filled in by the municipal adminsitration and questions are related to financial features. Below, variables of the vector $local\_avg_{r(t-1)}$ are discussed.

For the basis of this analysis is the county, we simply averaged responses from various settlements within each counties. (The survey included districts of

Budapest but unfortunately, excluded Zala county.) This is of course imperfect for several firms are not located in surveyed settlements, and for example, actual local taxes may be quite different from one area to another. Accordingly, insignificant parameters would either signal the lack of explanatory power in economic sense or suggest that settlement level heterogeneity is substantial even within counties that prevents inference. Note that most questions in the first survey are related to a period in time.

As for the first part, the surv_infr_projects variable measures the importance of large-scale infrastructure related investments between 1995 and 2004. This includes projects defined as "road construction/improvement", "infrastructure development", "transportation development" or "industry parks/areas". The variable ranges between 0 (if there was no infrastructure related investment carried out) and 4 (if four out of five major projects were such investments).

Costs of fixed investment is captured by land prices that are given for 1995, 2000 and 2004, so missing years had to be estimated based on these three points using a simple linear method. Prices are related to areas for industrial activity, with utilities and a road connecting the settlement and the area. Not all municipalities gave figures but there were enough to estimate county level averages.

Tax policy is captured both by the nominal tax rates and presence of concessions. The variable of the local tax rate payable for enterprises is based on their output (and not the profit). The rate is given by the municipalities ranging between 0% and 2%. The survey included figures for 1992, 1995, 2000 and 2004, so missing years had to be estimated based on these four points using a simple linear method.

In addition we have special variables to take into account various concessions offered by municipalities to investors. The first such variable refers to occasions when an area for manufacturing purposes were provided free or with a deep discount for new firms. For every settlement, another dummy takes on 1 where a special tax allowance was promised for new firms (for "recent years") and so it refers to a general approach toward new manufacturing plants. A further concession dummy takes unity when the municipality offers training for new firms.

2.5 RESULTS

As for the classic decision variables are concerned, Poisson results (equations [1], [3]) suggest that high per capita income implies more new firms. Of course, when various explanatory variables of development are included in the regression, size and significance of the per capita variable decline. Lower labor costs persistently lead to more new investments as well. Access variables are important determinants of firm decisions. The presence of own industry is the most stable determinant, but national access to suppliers and customers is also important. The negative sign of the presence of local firms, excluding those operating the same industry, may reflect a strong input competition, while the negative sign of the national presence of firms in the same sector points toward output competition that is not offset by positive externalities. Distance from foreign markets is always one of the strongest determinants of location choice. Importantly, the entry of various county feature variables hardly affects the access variables save the access to business services that is highly correlated with other measures of development.

Looking at the development variables, road network is reassuringly positively related to location choice.[8] Similarly, a positive effect is generated by the development of the telephone network, while a positive but weaker effect is generated by the number of students at local universities. Employment in research and developments centers is also an important factor, while the introduction of other R&Ð variables provides no significant information any further.

Although the Poisson specification comes from the Random Utility Maximisation framework, the likelihood ratio test of equidispersion fails for all specifications we have tried, and the overdispersion parameter ranges mostly between 0.3-0.4. Thus, we turned to the negative binomial specification that allows for overdispersion. Importantly, qualitative results are mostly unchanged (see equations [3] versus [4] or [11] versus [12]) although the significance level would sometimes differ a great deal between the two

[8] When estimated separately, motorways alone enter with a strongly significant coefficient. However, the best explanatory variable is generated by including all types of roads.Results are available on request.

methods[9]. Note further, that when we include many variables that are correlated with the average wage variable, its the significance would disappear (as in equation [5]). To remedy this, we included an industry specific county wage available for 91% of all industry-year-county combinations. Indeed, the wage variable becomes negative and significant once again ([6], [7]).

Apparently, administration capacities (available for 1995-2002 only) matter as the total employment of public administration offices enters strongly suggesting that firms appreciate cities that offer decent administrative services (see equations [6] or [10]). Interestingly, other features such as employment or investment in information technology, seem to have no impact. [10]

Higher local taxes are shown to be a deterrent of new firms. In addition to altering taxes, cities can improve business conditions by providing concessions for new firms. The provision of explicit tax allowance has a very strong positive impact and offering education subsidies looks like a decent signal of business friendly environment, too. In contrast, the number of infrastructure related projects seems to be incapable of picking up the pace of development in an area.

The effect of higher land prices in most cases is slightly negative but insignificant - this may be taken as proof that municipalities may give various concessions but leave land prices to market forces. The dummy for special industrial area is very unstable and mostly insignificant. We suspect that a favourable property deal may be offset by signals of a poor area. Remember that these results (equations [4], [8] or [10]-[12]) being based on the municipal survey should be taken with care due to the scarcity of data for several counties.

Finally, we looked at the impact of public investment variables (available for 1996-2002 only) that pick up investment carried out first by the central government and second by the local one. It was found that local expenditure is strongly negative while the central government effort is mostly positive but

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[9] This robustness is not unusual in the literature, for example Smith and Florida (1994) finds a similar pattern for Poisson, negative binomial and even for the Tobit model. In this paper, we mostly presented results with the negative binomial regression – results with the Poisson are available on request.

[10] 10As expected, IT expenditure and number of PCs are closely correlated, and individually both enter with the same sign.

insignificant.[11] This suggests that firms perceive the costs that local investments incur while disregard those in case of central efforts (equation [13]).

Eventually, location choice features may have changed through time. For several cases, we included time effects to treat some of these problems that may have been masking important effects. Due to the lack of data for several years, a few variables may have lost explanatory power when data is analysed for a sub-period only. For example, the standard deviation of local tax rates between 1993 and 1998 is half than what it is for 1999-2003. When time fixed effects are introduced in equation [14], the negative sign for this variable returns even if being significant at 10% only.

Overall, these results confirm that all types of variables do indeed influence location choices.

3 THE PRODUCTIVITY OF PUBLIC INFRASTRUCTURE

The main question of this section is the effect of specific policies on the productivity on firms. Using data on municipality investment expenditure, research and development spending, and different aspects of public infrastructure, we study if firms become more productive because of higher public inputs.

3.1 THEORETICAL FRAMEWORK AND EMPIRICAL RESULTS

The recent stream of literature on the productivity of public infrastructure began with the study of Aschauer (1989). Similar studies were published by Munnel (1992) and Holz-Eatkin (1988). These studies used time series data for the United States, to estimate an aggregate production function. These production functions used three inputs: labor, private capital and public capital. Accordingly, the typical equation estimated would look like this:

[11] Investment at a regional level is a relatively poor measure and it is biased towards human capital. Thus, it may have little correlation with actual investment in physical capital.

$$\ln Y_t = \alpha \ln K_{Pt} + \beta \ln K_{Gt} + \gamma \ln L_t + \delta X_t + u_t \quad (4)$$

where K_{Pt}. refers to aggregate private capital in year t, K_{Gt} is aggregate public capital, L_t. is the aggregate labor employed, X_t. refers to other variables, for example utilization rate, and u_t is the error term. These studies found that the impact of public capital was very large. In Aschauer's study for example, the elasticity of the public capital on output was even higher than that of private capital. Furthermore, in Munnell's study the estimated marginal productivity of public capital was 60%, thus a $1 increase in public capital would lead to $0.60 increase in the output.

These first results led to several debates about the role of public infrastructure in the United States. If the coefficient of public infrastructure is so high, then a very high level of public spending is adequate. These results show that reduction in the expenditures on public capital may very well explain the slowdown of the productivity growth in the United States. The policy implication of these results is clear and strong. Several researchers found the estimated parameters unreasonably high and the method used unconvincing. Some critique was based on the argument, that time-series modelling is inadequate when studying the effect of public infrastructure on private output. These problems can be corrected with the application of new statistical methods for time series data. The other possibility is to use panel data (for example state data in the United States), which corrects for some of the weaknesses of this approach.

A more fundamental critique came from Berndt and Hansson (1991). They argue that the production function approach is inadequate because of three reasons. First they argue, that the Cobb-Douglas production function used in previous studies, is too restrictive, consequently scholars should use and advise more flexible functional forms. The second problem is that some right-hand variables are endogenous. The authors refer to the labor input and utilization rate. The third problem is that with the production function approach one cannot determine how much public investment is useful, thus the production function approach is inadequate for normative policy analysis.

Berndt and Hansson suggest usingthe application of the duality theory, and estimating the cost function instead of the production function. Duality theory provides enough restrictions to estimate the relevant parameters of the model. In effect, researchers, applying this methodology, estimate the conditional factor demand functions, and by using their coefficients structural parameters can be calculated. Having structural parameters, it is possible to estimate the shadow value of the different factors. This value shows the value of another unit of the given input for the firm. This has fundamental importance in normative policy analysis, since from the shadow value of public capital one can determine the optimal quantity of public capital.

Using this methodology Berndt and Hansson (1991) find positive coefficients for public capital for Sweden from 1960 to 1980. Their estimates are significantly smaller than the ones they get with the production function approach. Indeed, the coefficients estimated by the cost function approach are much more reasonable than those estimated by the production function methodology.

Finding small positive or insignificant coefficients is common in later literature as well. Holz-Eatkin (1994) applies a more sophisticated production function estimation for state data, using instrumental variables to handle endogeneity and simultaneity bias. This study finds that public capital has essentially no role in private productivity. Garcia-Mila et al. (1996) estimates a Cobb-Douglas production function for state-level data for the United States from 1970 to 1983 using first differencing. They differentiate three kinds of public capital: highways, water and sewers and other public capital and find none of them significant in their favoured specification. Morrison and Schwartz (1996) using the cost function framework find positive coefficients of public capital on private productivity, thus the shadow price of it exceeds zero.

These kind of questions are not only important in the US and other rich countries, but they are of fundamental relevance for less developed nations. For these countries it is a very important question, what kind of infrastructure to build in order to promote economic growth. There is an important public debate about the sign and the magnitude of spillovers from public infrastructure. Some argue that roads and highways can have negative effects on the economy of a region as transport costs decline. Consequently, firms should not locate in those regions, given that firms from other regions would compete more successfully with local ones. Moreno and López-Bazo (2003) argue that public infrastructure can produce benefits for the region where it is built, and at the same time it can produce spillovers to other regions. The authors argue that this spillover can be both positive and negative. With it's connectivity it enhances interrelationship between regions (positive productivity spillover), but it can increase factor migration, thus harming the region, which competes with the given region for labor and mobile capital. The study, using Spanish provinces as units of observation, finds positive effect of public capital for the given region, but negative spillovers from neighbouring provinces. Boarnet (1998), using county-level data for the United States, also examines the possibility of negative spillovers from public infrastructure. He finds positive effects of the public capital in the given county but negative spillovers to other areas.

3.2 METHODOLOGY

The above mentioned literature concentrates on estimating regional aggregate production (or cost) functions and study the effect of public infrastructure on this production function. We decided to study firm-level production function. With this methodology we measure something else that the mentioned literature. We measure how the public infrastructure effects the productivity of individual firms. In our opinion this viewpoint is very important: we can see how the different policies effect the productivity of existing firms. This question is important both from normative and positive viewpoint. From the normative viewpoint we can see this way what the effect of the policy in on the actual taxpayers. On the positive side the legitimacy of the policies is mainly determined by it's effect on the actual actors of the economy.

We admit, that our method has some disadvantages compared to the method customary used in the literature. The firm-level production function approach do not take into consideration how the number of firms changed in the given period, which we studied separately in the previous section. Another weakness of this procedure is that we do not study the economy as a whole, as a significant section of the economy is not included in our estimation, as not all firms are included in our sample. We think however that this method has more statistical advantages than disadvantages. First using a firm-level sample we have much more observations than using regional data. This makes it possible to control for several kinds of structural brakes.

Because of the rapid change in the Hungarian economy and the regional inequalities in this country makes controlling for regional and time structural brakes inevitable. Second, the parameters of the production function of different industries may differ from each other. As in the different regions there are great difficulties in the structure of industry, the estimated coefficients can be biased because of this composition effect. Third, we expect that measurement error is less a problem with firm-level data then with regional data. The main reason for this is the much richer sample for firm-level data, but the regional data has several other problems: the presence of the shadow economy and aggregation problems can be very serious limitations.

We use the production function approach. Although, some of the criticisms of this approach are valid in our opinion, but the use of dynamic panel data models makes it possible to estimate production functions even with endogenous inputs. On the other hand our possibilities are restricted by data sources. With the data at hand this appears to be the more efficient choice.

For the estimation we use a Cobb-Douglas production function, with unrestricted returns to scale. The estimation procedure is similar to Halpern and Muraközy (2005). Because of the large sample size we do not constrain the elasticity of labor and capital to be equal in the different industries. The form of the production function is the following:

$$\ln y_{it} = \alpha_1 \ln l_{it} + \alpha_2 \ln k_{it} + \alpha_3 Zt + \alpha_4 X + D_i + u_i + v_{it}, \qquad (5)$$

where y_{it} is the value added of firm i in year t, deflated by the industry specific price index, l_{it} is the labor employed by firm i in year t, K_{it} is the capital employed by firm i in year t (deflated by the industry-specific price index); α_1 and α_2 are the elasticities of labor and capital, respectively. Z denotes the control variables. From the equation one can see that they are multiplied by t, thus we assume that they have an effect not just on the level of productivity but on productivity growth as well. When differentiating, these variables do not disappear. X denotes the variables of interest, mainly public infrastructure and industry policy variables. D_i denotes the industry and regional dummies and their interactions. The regional dummies mean the six great planning-economic regions (NUTS-2). With this specification we allow different growth rates in different regions for different industries.

Without such an extended dummy set we were not able to get robust results. u_i is the firm-specific fixed-effect, and v_{it} denotes the disturbance in the given year.

There are several econometric problems in connection with the estimation of production functions. The most important problem is that the inputs of the firms are endogenous, as when firms make their input decisions they take into consideration their likely future productivity, which is not observed. This means that input choices can be correlated with the unobserved characteristics of the firms, including past productivity. This phenomenon was emphasized by for example Blundell and Bond (1998). This problem can be handled by using dynamic panel model estimators. Our preferred model is the estimator proposed by Arellano and Bond (1991). Although some other (and more complex) methods were proposed since that time, we prefer this estimator because of it's robustness and simplicity. This estimator works in two steps. First we differentiate the data to eliminate the firm-level fixed effects. Second, the lags of the variables are used as instruments for the differences. This method produces consistent estimates even for endogenous inputs.

3.3 DATASET

Our main dataset is a subsample of the Hungarian tax dataset. This is a similar, but somehow different dataset then the one used in the previous section. The number of observations per year is reported in the following table:

Year	**Number of observations**
1992	3,696
1993	4,020
1994	4,100
1995	4,175
1996	4,619
1997	5,131
1998	6,151
1999	5,501
2000	5,919
2001	5,784
Total	49,096

As we can see the dataset involves more than 49,000 observations. In the estimation the actual number of observation is significantly less, because of missing data, lagged dependent variables, and because we do not have data for consequent years.

This dataset contains balance sheet and other accounting data of the firms, which makes it possible to calculate the important variables for the estimation of the production function. From the viewpoint of this work the most important problem was to find the location of firm, which is not included in the original tax dataset. To find it out, we employed the wage survey, which involves the location of work for the given worker. This dataset consists firms, which employ at least 10 employees, but not all such firms are included. The sampling technique is such that the sample is strongly biased towards large firms. Some firms operate more than one plant. Theoretically this makes possible to estimate on a plant-level basis, but unfortunately we cannot separate the assets and the output in any meaningful way. Because of this we decided to aggregate the number of employees in different plants of the given firm in all years, and the location of the plant with the most employees was taken as the location of the firm. This method do not take into account the spatial structure within the firms (like the division of headquarters and the other parts of the firm), and does not allow firms to change their location. Despite these problems we think that this is the most adequate method that we can employ.

3.4 RESULTS

We present the results in table 4. The coefficients of the industry and region dummy variables are not reported. In the first column we report the basic specification. To control for some of the characteristics of settlements, we use general development variables, $crime\_rate$, (the number of criminal affairs per capita), $averag\_wage\_in\_settlement$, $no\_tel\_lines\_per\_capita$, $unemployment\_rate$, and $personal\_tax\_base\_per\_capita$. All these variables are calculated from the T-Star database. In our opinion we are able to control for the level of economic development of the given municipality with these variables. To avoid complications, we used the last available value of these variables to control. We assumed that the level of these variables has effect on the growth rate of productivity. From the table it is clear, that none of these variables is significant, although their signs are the expected ones. The only variable with a 'wrong' sign is the tax base per capita variable, which is negative, although one would expect higher productivity in regions with more income.

The insignificance of these variables suggest that our dummy variable set controls for most of the economic-demographic characteristics of the different municipalities. As the variables are jointly significant, we use them as control in the following.

In the second specification we check if the investment allowances has any effect on the productivity of firms. The source of these variables is the same survey as the source of ones in the previous section. As in this exercise the unit of observation is the firm, it is possible to employ settlement-level variables. This has the advantage of more precise estimates, but the sample size is smaller, as only limited number of settlements is included in the MTAKTI/Median survey. Otherwise the variables are the same and calculated in the same way as those in section 1.

We expect that investment allowance variables have effect only on the location choice of firms and not on their productivity. On the other hand it is possible that more mobile firms are more responsive for investment incentives, and these firms have different characteristics in terms of productivity than others. This selection effect can lead to significant coefficients. Thus the second specification is an indirect check for the presence of this selection bias. As these variables are only given for one time period, we assume that they effect the growth rate rather than the level of TFP.

In the second column we report the results of this specification. We found that none of the investment incentives has a significant effect on the productivity of firms. This confirms our hypothesis, that investment incentives have no effect on the productivity of firms. This also suggests indirectly that there is no selection effect, thus more mobile firms have no different characteristics in terms of productivity.

In the third specification we investigate the effects of public capital, which is the main question of this section. As we do not have reliable data about the stock of capital, we use investment data. This means no problem, as in the estimation we use differences anyway. The only problem is that in this way we can not take depreciation into consideration. Although it is a very disturbing problem, we could not find reliable source of data for this.

To see this we use two variables. $\ln(inv\_central\_govt)$ denotes the logarithm of government investment per capita in the given county in the previous year. $\ln(inv\_local\_govt)$ denotes the logarithm of municipal investment per capita in the given county in the previous year. Both variables are reported by the Central Statistical Office of Hungary, in it’s statistical yearbook for every year. This separation of government and municipal investment makes it possible to see which of them is spent more productively.

On the other hand we have to admit that government investment is very volatile, as for example highway investments and other projects has a long lifetime. It would be possible to use TÁKISZ settlement-level data, but we have chosen county level variables rather then settlement-level variables because of two reasons. First county-level variables seems to have better statistical properties than municipality level investment data, as there are lot of zeroes in that kind of data. Second, most of large investment project has effects which spill over from a given municipality, and with county-level variables we can get rid off these complications.

Both variables are significant at 5% level. The government investment has a positive effect on the productivity change. This suggests that public capital is productive. It is obvious however that the coefficient of the public capital is smaller than the coefficient of private capital. Thus our estimate seems to be reasonable: the elasticity of public capital is about 1/8 of the elasticity of private capital. This fact suggests that our methodology is capable for studying the effect of public infrastructure. Using firm-level data and controlling for the endogeneity of inputs by using dynamic panel data modelling, it is possible to obtain reasonable estimates. In our opinion this method is a useful alternative of cost-function modelling, which can be obtained from firm-level panel datasets.

Municipality investment has a negative effect on the productivity of firms. The sign of this coefficient contradicts our expectations. It is possible that local investment is productivity-enhancing, but it is possible as well that this result is driven by some statistical problems.

In specification (4) and (5) we investigate if different infrastructure variables has effect on productivity or not. Thus we follow Garcia-Mila et al. (1996), by distinguishing different kind of public capital. In specification (4) we investigate if these variables effect the growth rate of productivity, in specification (5) we investigate if they have an effect on the level of productivity. The estimated equation in (4) is the following:

$$d\ln y_{it} = \alpha_1 d\ln l_{it} + \alpha_2 d\ln k_{it} + \alpha_3 Z + \alpha_4 \ln X_{t-1} + D_i + u_i + v_{it}, \qquad (6)$$

in specification (5), the estimated equation is:

$$d \ln y_{it} = \alpha_1 d \ln l_{it} + \alpha_2 d \ln k_{it} + \alpha_3 Z + \alpha_4 d \ln X_{t-1} + D_i + u_i + v_{it}, \quad (7)$$

where are the variables of interest: $\ln(road\_network\_density)$ is the logarithm of the lagged length of the most important roads in the county per capita. $\ln(R\&D\_emploxment\_per\_capita)$ is the logarithm of the lagged value of the people working on R&D in the county, $\ln(no\_computers\_in\_adm/adm\_employment)$ denotes the logarithm of the lagged ratio of number of computers and state employees in the county, $\ln(adm\_emp\_p.c.)$ denotes the logarithm of the lagged number of state employees per capita. These variables are all calculated from the T-Star database.

We have to admit that the variation of these variables is not too large, which can make the estimates of (5) less precise than the estimates of (4), although more correct from the econometric point of view.

Theoretically the effect of the road density is ambiguous. On the one hand, the road density improves the connectivity between firms, which makes knowledge spillovers more likely. On the other hand by reducing transport cost the competition can be greater, which can lead to lower productivity (Moreno and López-Bazo (2003)). The R&D employment captures how knowledge-based the production is. The higher this variable, the higher the potential for knowledge spillovers. Thus we expect a positive sign of this variable. The other two variables capture the inputs used in the administration. The better quality of administration should enhance the productivity of firms, although the greater bureaucracy is not necessarily good for efficient production. Thus we expect nonnegative sign for these variables.

The $\ln(road\_network\_density)$ variable is significantly positive in both specifications. This suggests that road - as part of public capital – increases productivity. This shows, that the positive effect of main roads is stronger than it’s negative effects. The benefit of easier transfer and higher spillovers is higher than the cost, which comes from the increased competition. These results suggest that it is effective to build such roads.

The next result is that $\ln(R\&D\_employment\_per\_capita)$ has a small but at 10% significant effect on productivity growth, and insignificant effect on the productivity level. In other, unreported specifications we similarly observed a small, but significant negative effect of other measures of R&D, namely the people employed in R&D activities and the R&D costs. This result contradicts the hypothesis of strong positive spillovers coming from R&D of other firms in the county.

The $\ln(adm\_emp\_p.c.)$ has an insignificant positive effect on productivity. We could not show any positive effects of state employees on productivity. On the other hand, we found a strong positive effect of. $\ln(no\_computers\_in\_adm / adm\_employment)$ This shows, that the more computers the state employees use, the more effective they are in enhancing productivity. From these we can conclude that state employees can only affect productivity if they use up to date technology.

4 CONCLUSIONS

In the first section of the paper, we estimated count data models to detect the impact of various factors on location choice of firms. We considered manufacturing companies with foreign ownership setting up a new company between 1993 and 2002. Using a set of industry specific access variables with intercompany sales, we found that the proximity to sellers and buyers of potentially important intermediate goods influence location choices. In addition to the location of other firms and wages, it was shown that regional development and some public policy measures will influence decisions. The key variables found here include industry specific wages, output of the actual firm's industry, distance from export markets, density of road network, employment in R&D units. Further, local taxes as well as tax allowance policy of municipalities seem to matter.

In the second section of the paper we estimated the effects of different kinds of public infrastructure on the productivity of the firms. For this we used a great panel of Hungarian firms from 1992 to 2001. We estimated Arellano-Bond panel data model to control for the endogeneity of inputs. This methodology is different from the one used in the literature, which uses aggregate data to estimate aggregate productivity. We found that the effect of state investment is positive on productivity. The estimated coefficient is reasonable, showing that the estimation method used can produce useful estimates. The benefits of main roads are higher than their costs of greater competition. All R&D variables have small negative effect, which contradicts the hypothesis of high positive spillovers. The number of state employees is not significant, but the it technology they use has a strong positive effect on both the level and the growth rate of productivity.

It is interesting to compare the effect of variables used in both sections. Several measures of development proved to be significant in both cases. Most importantly, the density of road network (including motorways) positively influenced location choice and productivity as well. Regarding policy, local investment in public infrastructure has a negative effect in both cases, as firms take investment costs into account, while actions of the central government may have a positive impact especially for the productivity of existing firms. A somewhat larger size of administration helps new firms to settle but later on, it has no effect on productivity. However, the intensity of information technology used in offices contributes positively to corporate TFP. As expected municipal concessions offered for new firms would influence location decisions only.

5 FUTURE RESEARCH

Our main goal in future research is to analyse the effect of spatial structure in more detail. First, location choice should be considered at the settlement level as well. Second, we are interested to find out if there is a spillover from infrastructure development onto "nearby" regions. Indeed, econometric issues like spatial autocorrelation of development measures should be taken greater care of, too. Third, we plan to look explicitly on the influence of exact proximity to transportation infrastructure (such as motorways) as well as key public institutions (e.g. universities, administration offices).

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Table 1. Summary statistics

Variable	Source	Area	Mean	Std. Dev.
Income per capita	KSH	County	87.234	27.646
Population size	KSH	County	505.85	339.57
ACCESS: local own industry	APEH, AKM	County	649437	2637335
ACCESS: national own industry	APEH, AKM	County	231341	501525
ACCESS: local suppliers	APEH, AKM	County	1050664	2810798
ACCESS: local markets	APEH, AKM	County	1879780	5910528
ACCESS: national suppliers	APEH, AKM	County	354441	574277
ACCESS: national markets	APEH, AKM	County	621667	1041976
ACCESS: business services	APEH, AKM	County	72692050	30586220
LABOUR: average wage	LMS	County	31204.02	14371.81
LABOUR: industry wage	LMS	County	30362.51	16232.25
no. telephone lines	KSH	County /settlement	123244	158637
no. students in university	KSH	County	9803	7332.54
road network density -total	KSH	County	1526.8	563.77
ACCESS: foreign market distance	HAS-IE	County	254	117.478
Road distance between cities	HAS-Institute of Economics	Settlement	190.54	103.01
investment central govt2	KSH	County	18472.36	35035.55
investment local govts2	KSH	County	8964.692	9951.13
R&D employment	KSH	County	2067.28	4706.384
administration employment p.c.	KSH	County	6713.894	14331.58
adminsitration employment in IT p.c.	KSH	County	3281.344	8370.92
administration IT investment p.c.	KSH	County	1362516	6671039
survey local tax rate	KTI Survey	Settlement average	1.202325	.5751337
survey land price	KTI Survey	Settlement average	38.59442	60.09663
survey infrastructure projects	KTI Survey	Settlement average	.8397756	.461991
D(municip. gives special area for investment)	KTI Survey	Settlement average	.7671508	.2032564
D(municip. tax invallowance)	KTI Survey	Settlement average	.6357029	.2238097
D(municip. offers training subsidies)	KTI Survey	Settlement average	.6916895	.2894948

KSH: Hungarian Central Statistics Office, „AKM”: Input-output tables, „LMS”: Annual Labour Market Survey by Ministry of Labour, APEH: Hungarian Tax Authority’s corporate database. NB All variables in estimations are taken in logs.

Table 2. Poisson and negative binomial regressions of location choice

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Estimation method	*poisson*	*neg.bin.*	*poisson*	*neg.bin.*	*neg.bin.*	*neg.bin.*	*neg.bin.*
ln(income p.c.)	0.69***	0.80***	0.76***	0.86***	0.30	0.23	0.32
	(0.15)	(0.19)	(0.15)	(0.19)	(0.24)	(0.24)	(0.27)
ln(county size km2)	0.32	0.02	0.36	-0.00	0.56	0.38	0.37
	(0.25)	(0.31)	(0.27)	(0.35)	(0.44)	(0.43)	(0.46)
ln(LABOUR: average wage)	-0.42***	-0.65***	-0.15	-0.45***	-0.29		
	(0.10)	(0.14)	(0.11)	(0.16)	(0.20)		
ln(LABOUR: industry wage)						-0.78***	-0.85***
						(0.10)	(0.11)
ln(ACCESS: local own industry)	0.24***	0.27***	0.24***	0.27***	0.27***	0.27***	0.26***
	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
ln(ACCESS: national own industry)	-0.03*	-0.14***	-0.02	-0.13***	-0.12***	-0.11***	-0.11***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
ln(ACCESS: local suppliers)	-0.08***	-0.15***	-0.12***	-0.19***	-0.20***	-0.21***	-0.21***
	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
ln(ACCESS: local markets)	-0.09***	-0.09***	-0.06***	-0.05	-0.08**	-0.04	-0.05
	(0.02)	(0.03)	(0.02)	(0.03)	(0.04)	(0.04)	(0.04)
ln(ACCESS: national suppliers)	0.00	0.21***	0.04	0.25***	0.25***	0.29***	0.29***
	(0.03)	(0.04)	(0.03)	(0.04)	(0.05)	(0.05)	(0.05)
ln(ACCESS: national markets)	0.16***	0.13***	0.17***	0.14***	0.16***	0.08*	0.09**
	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
ACCESS: business services	-0.26***	-0.19**	-0.32***	-0.25***	-0.32***	-0.13	-0.15
	(0.06)	(0.08)	(0.07)	(0.08)	(0.11)	(0.08)	(0.11)
ln(no. telephone lines)	0.15**	0.20**	0.33***	0.38***	0.40**	0.34**	0.24
	(0.06)	(0.09)	(0.07)	(0.10)	(0.16)	(0.16)	(0.17)
ln(no. students in university)	0.68***	0.78**	0.55**	0.71**	0.20	0.15	0.28
	(0.25)	(0.31)	(0.27)	(0.34)	(0.40)	(0.40)	(0.41)
ln(road network density -total)	0.28***	0.24***	0.32***	0.27***	0.21***	0.12**	0.13*
	(0.04)	(0.05)	(0.04)	(0.05)	(0.06)	(0.06)	(0.07)
ln(R&D employment)	0.06**	0.06**	0.09***	0.08***	0.15***	0.13***	0.14***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)

Standard errors in parentheses , * significant at 10%; ** significant at 5%; *** significant at 1%
N.B. „D" stands for a dummy variable, p.c. - in per capita terms

(Table continued overleaf)

Table 2. Poisson and negative binomial regressions of location choice *(cont'd)*

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Estimation method	*poisson*	*neg.bin.*	*poisson*	*neg.bin.*	*neg.bin.*	*neg.bin.*	*neg.bin.*
ln(survey local tax rate)			-0.25***	-0.22***	-0.08	-0.08	-0.03
			(0.05)	(0.07)	(0.11)	(0.11)	(0.12)
ln(survey land price)			-0.09**	-0.07	-0.07	-0.02	-0.03
			(0.04)	(0.05)	(0.06)	(0.06)	(0.06)
ln(investment central govt2)							
ln(investment local govts2)							
ln (administration employment p.c.)					0.48***	0.43***	0.35**
					(0.12)	(0.12)	(0.14)
ln(adminsitration employment in IT p.c.)					-0.03	-0.03	-0.09
					(0.04)	(0.04)	(0.12)
ln(administration IT investment p.c.)					-0.03	-0.05	0.04
					(0.08)	(0.07)	(0.08)
survey infrastructure projects							
D(municip. gives special area for investment)							
D(municip. tax invallowance)							
D(municip. offers training subsidies)							
ln(ACCESS: foreign market distance)	-0.43***	-0.41***	-0.40***	-0.38***	-0.58***	-0.57***	-0.57***
	(0.05)	(0.07)	(0.05)	(0.07)	(0.10)	(0.10)	(0.10)
FE (time)							*yes*
years included	*1993/2002*	*1993/2002*	*1993/2002*	*1993/2002*	*1995/2002*	*1995/2002*	*1995/2002*
Observations	3000	3000	2850	2850	2280	2091	2091
Model chi-square	7081.70	1874.92	nov.17	1834.67	1409.24	1324.53	1373.82
df	15.00	15.00	17.00	17.00	20.00	20.00	27.00
Log likelihood	-4839.71	-4365.87	-4611.64	-4158.88	-3192.60	-3054.15	-3029.51
Pseudo R2	0.42	0.18	0.43	0.18	0.18	0.18	0.18
overdispersion alpha		0.42		0.41	0.38	0.33	0.30
log likelihood test of alpha=0		947.69		905.52	565.37	493.05	438.14

Standard errors in parentheses , * significant at 10%; ** significant at 5%; *** significant at 1%
N.B. „D" stands for a dummy variable, p.c. - in per capita terms

Table 3. Poisson and negative binomial regressions of location choice

	[8]	[9]	[10]	[11]	[12]	[13]	[14]
	neg.bin.	*neg.bin.*	*neg.bin.*	*poisson*	*neg.bin.*	*neg.bin.*	*neg.bin.*
ln(income p.c.)	0.03	-0.10	-0.12	-0.31	-0.25	-0.49	-0.40
	(0.24)	(0.25)	(0.28)	(0.25)	(0.30)	(0.31)	(0.32)
ln(county size km2)	-0.33	-0.66*	0.05	-0.04	-0.27	-0.87*	-0.89*
	(0.37)	(0.38)	(0.47)	(0.41)	(0.49)	(0.49)	(0.50)
ln(LABOUR: average wage)			-0.28				
			(0.21)				
ln(LABOUR: industry wage)	-0.72***	-0.84***		-0.81***	-0.86***	-0.72***	-0.80***
	(0.09)	(0.10)		(0.08)	(0.11)	(0.11)	(0.11)
ln(ACCESS: local own industry)	0.26***	0.26***	0.27***	0.27***	0.26***	0.27***	0.26***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln(ACCESS: national own industry)	-0.12***	-0.11***	-0.12***	-0.03	-0.10***	-0.13***	-0.12***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)
ln(ACCESS: local suppliers)	-0.20***	-0.20***	-0.19***	-0.15***	-0.21***	-0.18***	-0.19***
	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)
ln(ACCESS: local markets)	0.04	0.04	-0.04	-0.04	0.01	0.05	0.04
	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)
ln(ACCESS: national suppliers)	0.29***	0.30***	0.25***	0.10***	0.29***	0.28***	0.29***
	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)
ln(ACCESS: national markets)	0.04	0.05	0.14***	0.10***	0.07	0.00	0.02
	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)
ln(ACCESS: business services)	-0.07	0.10	-0.24**	0.02	0.00	0.06	0.08
	(0.07)	(0.09)	(0.11)	(0.10)	(0.12)	(0.09)	(0.12)
ln(no. telephone lines)	0.27***	0.41***	0.31**	-0.04	0.13	0.33*	-0.00
	(0.10)	(0.12)	(0.16)	(0.13)	(0.18)	(0.18)	(0.23)
ln(no. students in university)	1.06***	0.93**	0.84*	0.89**	0.92**	1.28***	1.58***
	(0.36)	(0.36)	(0.44)	(0.38)	(0.45)	(0.46)	(0.47)
ln(road network density -total)	0.22***	0.09	0.25***	0.16**	0.14*	0.19***	0.22**
	(0.05)	(0.06)	(0.07)	(0.07)	(0.08)	(0.07)	(0.09)
ln(R&D employment)	0.11***	0.10***	0.19***	0.18***	0.19***	0.09*	0.13***
	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)
ln(survey local tax rate)	-0.25***	-0.05	-0.20	-0.18	-0.13	-0.06	-0.34*
	(0.07)	(0.09)	(0.13)	(0.12)	(0.15)	(0.17)	(0.22)
ln(survey land price)	-0.09*	0.02	-0.02	0.06	0.07	0.01	0.01
	(0.05)	(0.06)	(0.07)	(0.07)	(0.08)	(0.08)	(0.09)

Standard errors in parentheses , * significant at 10%; ** significant at 5%; *** significant at 1%
N.B. „D" stands for a dummy variable, p.c. - in per capita terms

(Table continued overleaf)

Table 3. Poisson and negative binomial regressions of location choice *(cont'd)*

	[8]	**[9]**	**[10]**	**[11]**	**[12]**	**[13]**	**[14]**
	neg.bin.	*neg.bin.*	*neg.bin.*	*poisson*	*neg.bin.*	*neg.bin.*	*neg.bin.*
ln(investment central govt2)						0.20	0.26
						(0.19)	(0.19)
ln(investment local govts2)						-0.61***	-0.45**
						(0.20)	(0.21)
ln (administration employment p.c.)			0.50***	0.22*	0.31**		
			(0.12)	(0.12)	(0.15)		
ln(adminsitration employment in IT p.c.)			-0.01	-0.02	-0.03		
			(0.04)	(0.09)	(0.12)		
ln(administration IT investment p.c.)			-0.09	0.04	-0.00		
			(0.08)	(0.06)	(0.08)		
survey infrastructure projects	0.08	-0.00	0.07	0.13*	0.10	0.10	0.19*
	(0.08)	(0.08)	(0.09)	(0.08)	(0.09)	(0.10)	(0.11)
D(municip. gives special area for investment)	-0.69***	-0.12	0.16	0.13	0.37	-0.02	-0.14
	(0.25)	(0.29)	(0.33)	(0.30)	(0.35)	(0.32)	(0.37)
D(municip. tax invallowance)	0.57***	0.53***	0.51***	0.54***	0.52***	0.56***	0.62***
	(0.14)	(0.14)	(0.16)	(0.13)	(0.16)	(0.17)	(0.17)
D(municip. offers training subsidies)	1.16***	0.83***	0.59**	0.77***	0.63**	0.71***	0.95***
	(0.22)	(0.23)	(0.27)	(0.23)	(0.27)	(0.26)	(0.28)
ln(ACCESS: foreign market distance)	-0.88***	-0.77***	-0.87***	-0.92***	-0.87***	-0.92***	-0.97***
	(0.11)	(0.11)	(0.13)	(0.11)	(0.13)	(0.14)	(0.15)
fixed effects (time)		*yes*		*yes*	*yes*		yes
years included	*1993/2002*		*1995/2002*	*1995/2002*	*1995/2002*	*1996/2002*	*1996/2002*
Observations	2613	2613	2280	2091	2091	1837	1837
Model chi-square	1757.64	1864.66	1427.20	4638.24	1398.54		
Df	21.00	30.00	24.00	31.00	31.00	1135.52	1179.62
Log likelihood	-3959.81	-3906.30	-3183.63	-3231.50	-3017.15	-2647.77	-2625.72
Pseudo R^2	0.18	0.19	0.18	0.42	0.19	0.18	0.18
overdispersion alpha	0.35	0.30	0.37		0.29	0.35	0.32
log likelihood test of alpha=0	778.51	670.54	552.05		428.70	445.73	378.05

Standard errors in parentheses , * significant at 10%; ** significant at 5%; *** significant at 1%
N.B. „D" stands for a dummy variable, p.c. - in per capita terms

Table 4. Productivity, spillover infrastructure and policy

	(1)	(2)	(3)	(4)	(5)
	production function	investment incentives	effect of investment	infrastructure: TFP growth	infrastructure TFP level
LD.ln(real output)	0.18156***	0.17377***	0.23594***	0.18800***	0.11632***
	[0.02022]	[0.02402]	[0.03236]	[0.02753]	[0.03522]
D.ln(real capital)	0.15663***	0.14032***	0.11761***	0.08069***	0.07523**
	[0.02205]	[0.02731]	[0.02365]	[0.02347]	[0.03038]
D.ln(labor)	0.38492***	0.45339***	0.41434***	0.46723***	0.34535***
	[0.06762]	[0.07603]	[0.07605]	[0.07257]	[0.09566]
ln(inhabitants in the given settlement)	-0.00000	-0.00000**	-0.00000**	0.00000	-0.00000***
	[0.00000]	[0.00000]	[0.00000]	[0.00000]	[0.00000]
ln(crime rate)	-0.06701	-0.19242	-0.20276	-0.00050	-0.08262
	[0.15860]	[0.28797]	[0.19284]	[0.18949]	[0.17442]
ln(no. telephone lines per capita)	0.07512	0.17318	0.10539	0.10864	0.08641
	[0.09282]	[0.14262]	[0.10297]	[0.10407]	[0.08253]
ln(unemployment rate)	-0.33087	-0.28300	-0.45545	-0.33608	0.01785
	[0.29128]	[0.49617]	[0.34002]	[0.31133]	[0.38726]
ln(average wage in settlement)	-0.00000	-0.00002	-0.00001	-0.00001	-0.00001**
	[0.00001]	[0.00006]	[0.00001]	[0.00001]	[0.00000]
ln(average personal income tax base)	-0.00005	-0.00004	-0.00012***	-0.00009**	-0.00002
	[0.00004]	[0.00006]	[0.00004]	[0.00004]	[0.00004]
survey infrastructure projects		-0.00511			
		[0.00338]			
D(municip. gives special area for investment)		-0.01819			
		[0.01536]			
D(municip. tax invallowance)		0.00406			
		[0.01268]			
D(municip. offers training subsidies)		0.00133			
		[0.01103]			
ln(investment central govt)			0.01765**		
			[0.00741]		
ln(investment local govts)			-0.05122**		
			[0.02121]		
D.ln(road network density)					0.05749*
					[0.03208]
D.ln(R&D employment per capita)					0.00284
					[0.00965]
D.ln(computers in administration, p.c.)					0.06984*
					[0.03736]
D.ln (administration employment in IT)					0.05137
					[0.03684]
ln(road network density -total)				0.00972**	
				[0.00413]	
ln(R&D employment per capita)				-0.00621*	
				[0.00344]	
ln(computers in administration, p.c.)				0.10773***	
				[0.01283]	
ln (administration employment in IT)				0.00212	
				[0.00486]	
Observations	20068	12983	13990	16281	10905
Number of id	5603	3663	4815	5082	3738

Robust standard errors in brackets, * significant at 10%; ** significant at 5%; *** significant at 1%

N.B. „D." stands for difference, p.c. - in per capita terms