Demographic change and the efficiency of primary schools in Hungary

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The paper analyses the effect of demographic change on the provision of primary education in Hungary. Stochastic cost frontier functions are used to estimate technical efficiency of schools, with cost measured as the number of teachers relative to students. The results reveal considerable flaws in technical efficiency, related to the decrease of student population at the local level. However, demographic change seems to be far from the major determinant of the level of technical efficiency. As opposed to efficiency, no sign of demographic change influencing school quality has been detected.

The persistent decline in the number of school aged children emerged in the last decade as a serious problem both for local and central education policy in Hungary. In the 1990s demographic change hit hardest primary schools (providing primary and lower-secondary education in the ISCED terminology; 1-8th grades). Between 1990 and 2001 the number of students in primary schools has decreased by around 20%, almost entirely due to demographic change[2] (Halász – Lannert, 2003). The pace of this decline was higher than in the previous decade and reached secondary education, as well, by the end of the 1990s. Moreover, middle-term demographic forecasts predict the continuation of this declining trend (Halász – Lannert, 2003). In the next decade secondary education as well has to face the problems of declining enrolment.

At the same time, the size of the teaching staff has not followed closely the demographic trend. As opposed to the 20% decrease in the number of students in the 1990s, the number of full-time teachers in primary schools has been reduced by only about 7% (Halász – Lannert, 2003). Consequently, the student per teacher ratio has decreased substantially; within the group of OECD countries in 2000 this was among the lowest values (Education at a Glance, 2002).

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[2] A fraction of the decrease is related to changes in school structure: some secondary schools extended the education and now include the last two or four years of primary schools.

Several experts argue that these trends endanger the fiscal sustainability of public education unless the number of teaching staff will be accommodated to the shrinking cohorts of children. Average teacher salaries relative to the GDP per capita in Hungary lag behind most of the OECD countries, and any increase in salaries puts an extra burden on the government budget if the number of teachers remains unchanged. The effects of demographic change are usually interpreted in the context of the efficiency of education in the policy discourse (e.g. Halász – Lannert, 2003, see also Berryman, 1996 about transition countries). The argument is that the low and declining student per teacher ratio, since it is not followed by any obvious improvement in student achievement is a clear signal of increasing inefficiency. Student performance on standardised academic tests has decayed in time and fairly poor in an international comparison, as well (Halász – Lannert, 2003). The argument is solely based on macro-level data. The aim of this paper is to analyse this hypothesis at the micro level. We use cost frontier functions to test whether settlement level demographic change has an effect on the efficiency of primary schools. We also compare the size of the effect to the overall level of estimated inefficiency (given the school size) and inefficiency related to economies of scale not realised. Thus, beyond testing the presence of the effect of demographic change at the micro level, we can also investigate whether this can be considered as the main source of inefficiency in primary education .

Demographic change and the provision of education

In contrast to educational policy debates, academic interest in the effects of demographic change has mainly focused on the impact on the demand for education. Cutler et al. (1993) analysed three possible mechanisms by which the demographic composition of the local community may affect the demand for public services. First, if communities compete for residents offering different tax-public service bundles, citizens with similar preferences will tend to sort in the same communities (known as the Tiebout model). Second, if voters seek to maximise their welfare, in the median voter model of the local political process, communities with more families with children will tend to demand more education, as the median voter position is shifted towards the preferences of parents. Third, if individuals take into account the welfare of their fellow citizens, as well, and seek to maximise a community welfare function, the greater share of families with children will increase the demand for education. The latter two arguments can clearly be applied to demographic change. Hence, an increase (decrease) in the share of children can be expected to raise (lessen) the demand for public education services. A similar conclusion can be drawn from the voter group model of Craig and Inman (1986), where the community decisions are assumed to be made as a weighted mean of the preferences of voter groups. Poterba (1997) and Harris et al. (2001) present empirical evidence for the demand effect of generational conflict in the US, showing that the increasing share of elderly has a negative effect on local education spending. Moreover, mobility may also interplay with demographic change. Ladd et al. (2001) found that changes in the share of elderly in US counties do not has a direct effect on the demand for education, but affect education expenditures by the migration of elderly.

However, as Borge and Rattso (1995, 1999) argue, the shift of the median voter or changes in the relative size of voter groups is not the only mechanisms by which demographic change may affect the demand for or the provision of education. First, the increasing relative share of children has a negative income effect at the community level, since the public budget has to be spent for more public service consumers. Second, the larges relative share of children in the population has a negative price effect: increasing the quality of other public services becomes relatively cheaper than increasing the quality of education, since the latter implies additional expenditures for more clients. Beyond the demand effects, the provision of education may adjust to changes in demand with a substantial delay (Borge et al., 1995). Since neither the school infrastructure nor the size of the employed teaching staff can not be adjusted immediately, the adjustment to changes in enrolment takes time, even if the demand for school quality has not changed. Altogether, contrary to the expected greater political influence of parents, larger cohorts of students may experience lower per student spending. This conclusion is also supported by empirical evidence from the US (Poterba, 1997), Norway (Borge – Rattso, 1995) and Denmark (Borge – Rattso, 1999).

Are these demand effects contradict to the hypothesis of decreasing efficiency due to declining enrolment? The decreasing efficiency argument has most common with the sluggish adjustment mechanism, but it goes one step further. Proponents argue that teaching staff relative to enrolment became more abundant *and* this led to decreasing efficiency. In principle, the reduction in the student per teacher ratio could have resulted in increasing school quality, as well, without any effect on efficiency. This can be thought as an unintended side-effect of the inelastic adjustment process. At the same time, the effects of demographic change on the demand (political influence, income and price effects) or the adjustment of the provision of education says nothing about efficiency. Changing demand or the slow adjustment to changes in enrolment implies changes in the amount of per student resources spent in schools. This may either result in changes of quality or changes in the efficiency of schools (or both to some extent). Thus, explaining the mechanisms of the effect of demographic change or detecting its actual consequences for effectiveness and efficiency are two different tasks. This paper aims at the latter.

Interestingly, previous studies directly analysing the efficiency of schools have not devoted much attention to the demographic composition of community change. Apart from the analysis of economies of scale (in relation to technical efficiency see e.g. Deller – Rudnicki, 1992 and Merkies, 2000), studies estimating efficiency of the production of education mainly focused on school or community level institutions as the determinants of efficiency (see the review of Worthington, 2001). For example, Ruggeiro and Duncombe (1995) examined the pressure for competition and the operation of school districts, Grosskopf and Moutray (2001) analysed expanded decentralisation in school management on efficiency, Grosskopf et al. (2000) studied the impact of input regulations as opposed to greater school autonomy in the choice of the input mix given the budget constraint, as determinants of school efficiency.

The following analysis examines whether demographic change is related to the efficiency of schools by estimating cost frontier functions.

Methodology

The effect of demographic change on the quality and efficiency of education is analysed by estimating simple production functions of school quality and cost frontier functions for teacher employment relative to the number of students, respectively.

Education production functions relate the output of schooling to school inputs, family inputs, individual ability and peer effects (Hanushek, 1986). In this case a two-step procedure is applied; first school quality is estimated in an individual level model,

TE_i

controlling for the effects of family background, then the estimated quality measures are related to school inputs and proxies for student composition. The estimation of school quality is described in the next section.

Input oriented technical efficiency is estimated by a stochastic cost frontier function. For frontier function estimation see Kumbhakar – Lovell (2000). Though linear programming efficiency models are more often applied for education (see the review of Worthington, 2001), stochastic frontier estimation is preferred here because of its better performance in the presence of 'noisy' data. While linear programming models ascribe all deviation from the best practice frontier to inefficiency, stochastic frontier models allow for random error (e.g. measurement error) and generally less sensitive to extreme data points.

In this paper a linear form cost frontier is estimated:

$$c_i = \beta_0 + \beta_q q_i + \beta_s s_i + \beta_z z_i + v_i + u_i$$

where c denotes average cost, q school quality, s measures of student composition and z for other control variables affecting costs. The model has two error terms, v is assumed to independently normally distributed with zero mean, while u, the inefficiency term is assumed to have a half-normal distribution. The inefficiency term can be modelled as a function of covariates in the form:

$$\sigma_{ui}^2 = \exp(\delta w_i)$$

where σ_u^2 stands for the variance of the inefficiency term and w for the exogenous covariates. The cost frontier function and the inefficiency model is estimated simultaneously.

Technical efficiency is defined as the ratio of minimum cost (the predicted value) to the minimum cost plus inefficiency:

$$TE_i = \frac{\widehat{c}_i}{\widehat{c}_i + u_i}$$

Thus, the maximum value of technical efficiency is one, identifying efficient cases on the cost frontier.

Data and the definition of variables

Educational production or cost function analysis in general requires data on a measure of school output, individual ability or prior achievement, family background and school resources (and in the case of cost functions, the prices of school inputs).

School inputs are measured by the inverse of student per teacher ratio (both cost and production function estimation) and class size (cost function estimation). Reliable data on school expenditures are available only for smaller sample of schools in Hungary. Nevertheless, teaching staff is evidently the most important input, and the room for substitution of other inputs for it is rather limited. Note that, since substitution between inputs is ignored, we can analyse only technical efficiency in the usage of the basic input. Neither allocative efficiency of production nor overall cost efficiency can be considered in this framework.

School inputs are measured at the school level, we do not know the size of the particular class a student has attended, just the school mean. The production function estimates are based on historical data for the eight years the observed cohort of students spent in primary schools. School input variables are averaged for the first and second four year periods, corresponding to the lower- and upper cycle of primary schools.

Most of the empirical studies on the production of education uses standardised test results as the measure of output (e.g. see the review of Hanushek, 2003). When test results are available for at least two points in time, the value added specification of the education output can be applied, which, under certain assumptions, make the estimation of a production or school function possible without measuring innate ability[3]. In Hungary no standardised student achievement data are available. We measure the output of primary schools in terms of providing better or worse opportunities for secondary schooling. In Hungary after the primary school students

[3] The value added specification is generally regarded as the best available method in empirical research, given the usual data limitations. However, as Todd and Wolpin (2003) show, from a theoretical point of view it is far from ideal, underlying assumptions are not very plausible.

continue their studies either general secondary schools (usually chosen by the most able students who later continue their studies at universities) or vocational secondary schools (with smaller chance of further university studies) or technical schools (not qualifying for university studies). School continuation is clearly not the best possible output measure, as it muddles individual choice and school quality. Additionally, it may measure quality only on a limited range, since above a threshold almost every student will choose the most prestigious general secondary schools. Nevertheless, it can be argued, that making the better secondary schools achievable for more students is indeed an extremely important part of the output of primary schools. Dustmann et al. (2003) for the UK shows that school continuation decisions play a decisive role in mediating the effect of school inputs on wages. This way school continuation decisions are crucial steps in the human capital accumulation process.

We assume that the choice of secondary school depends on family background, individual ability and achievement in primary school, and the latter itself is a function of family background, ability and school quality. Ability is unobservable, but we have individual level data on some measures of family background and secondary school choice. Thus, we can estimate school effects for each primary school by fixed effects logit regressions of secondary school type[4]. The two choices considered are general or vocational secondary school versus technical school and general versus vocational secondary school. Individual and family characteristics are the education of parents, one or both of the parents being unemployed in the previous year, gender and a dummy for attending private foreign language classes (as an indicator of aspirations). The results are shown in Table 1. As it is expected, parents' education has a major impact of secondary school choice, but the other three variables also prove to be significant.

The school fixed effects are estimated as the difference between the actual ratio of students in a primary school continuing in secondary school type x and the mean of the estimated probability of x, given the individual characteristics. Note that as the choice model is nonlinear, the estimated school effects are conditional on the student composition of the schools.

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[4] The explicit estimation of school output as school effects not explained by the individual characteristics of the analysis is close to the approach of school effectiveness research (see e.g. Teddlie et al., 2000). Note, that in education production and cost function research usually either unadjusted test scores or the mean of the value added test scores measure the output. The estimation of school effects in the first step allows for modelling secondary school type choice.

Besides school quality estimated by the schools contribution to secondary school choice, another aspect of the output is measured by the share of students in child care after the classroom hours. This can be regarded as an additional service provided by schools, clearly increasing the size of the teaching staff.

Since the estimated school effects are conditional on the student composition on the one hand, and we cannot observe individual ability or prior achievement while schools may well have different intakes, on the other, the selection of students can not be ignored. In Hungary parents are allowed to choose among primary schools freely. Primary schools are not allowed to hold entrance exams but are able to sort students for example by offering specialised classes as signals of elite education. Another source of selection is that some general secondary schools extended their programme for the upper-cycle of primary schools, attracting the most able students. At the same time, primary schools left by many children with good abilities end up with a less favourable than the average student group. Though these selection processes can not be directly measured, school level data are available on several correlates. We carried out a factor analysis of these variables in order to get some measures of selectivity. Two factors represent most of the correlation structure among the indicators (Table 2). The first factor can be labelled as positive selection, correlating with a high share of students with highly educated parents, attending specialised classes in the first grade, many language classes and schools being part of a secondary school or a college for teachers. The second factor measures the share of students with problems in learning and extremely disadvantaged social background (special classes for low achievers, students who has not attended kindergarten, students exempted from school attendance, students with unemployed parents or students classified as endangered by the family circumstances). In the cost functions these factors are used as controls for the selectivity of schools, i.e. school composition by family background and unobserved individual ability, and possible peer group effects.

Besides the measures of school output and school selectivity, two further variables are controlled for in the cost function estimates. First, school size has an evident effect on average costs due to economies of scale. Second, the share of students with special education needs (attending special or non-special classes) can not be ignored, since their presence drives up the number of teachers needed, while decreasing the estimated school quality.

Demographic change is measured by two variables: the ratio of school age children in 2001 to those in 1991 at the community level and the ratio of total enrolment in 2001 to enrolment in 1993.

Two settlement level factors are examined as candidates to explain schools inefficiency: the rate of change in school age population between 1991 and 2001 and per capita income as a proxy for the fiscal position of local governments.

The analysis uses data from yearly school statistics of the Ministry of Education and student level data from the 2003 9^{th} grade student survey of the Institute of Public Education. The latter contains data collected in secondary schools. The survey encompassed all of the secondary schools, 15% of the school refused participation. Overall, more than a hundred thousand students, 77,5% filled the questionnaire. School quality was estimated only for those primary schools, of which at least 80% of students in the 8^{th} grade in the previous year responded for the 9^{th} grade survey (1852 schools, 63%). Primary schools operating as part of a secondary school, or together with a student hostel or elementary school of arts were excluded from the sample, since the teacher staff can not be unambiguously matched with students in distinct branches of the schools.

Results

As it has been argued, demographic change may affect the provision of education in two ways: by the quality of schooling or the efficiency of schools. The quality of schooling changes if the shrinking of cohorts has an impact on school resources per student (either by affecting the quality demanded or an inelastic adjustment of schools) *and* at the same time school inputs exert an effect on quality. The latter proposition can best be tested by estimating education production functions.

The results of simple production functions allowed for by the available data are presented in Table 3. School inputs, measured by class size and student per teacher ratio proved to be insignificant in each specification. This is not surprising in the light of many empirical studies (e.g. Hanushek, 2003); school input effects tend to successfully hide themselves from education economists. However, the fact that school inputs are measured for the entire period spent in primary school by a single cohort, probably cannot fully compensate for the lack of a value added specification.

Nevertheless, the available data reveals no sign of school input effects on our school quality measures. This suggests that demographic change, should it affect the amount of school inputs or not, does not exert a significant influence on the effectiveness of schools[5].

As opposed to the school inputs, student composition and school selectivity have a significant impact on school quality, with the expected sign. Selective schools provide better opportunity for the admission to general secondary schools, while higher share of disadvantaged students to some extent spoil these opportunities. This result can be interpreted in terms of either unobserved student endowment (independent of family background variables used in the estimation of school fixed effects) or peer group effects. However, note that only a minor fraction of the variance of our quality measures are accounted for by the school selectivity factors. Finally, the settlement type of the primary school have also been included as control variables, since the availability or the abundance of secondary schools within their community may affect individual choices of secondary school type. This factor should be levelled out from the estimated school fixed effects in order to get a reasonable measure of school quality.

The results from the production functions indicate that if demographic change had an impact on school resources at all, it should rather affect the efficiency than the effectiveness of schools. We directly test this hypothesis by estimating a cost frontier function for primary schools and modelling the inefficiency term as a function of demographic change in the past decade. Costs are defined in terms of teachers employed per student in 2001. Cross-sectional estimation is chosen since we can measure school quality only for one cohort of students. Cost frontier is estimated for the groups of smaller and larger settlements separately. Results are shown in Table 4.

First, the likelihood ratio test indicates that the presence of inefficiency is significant (based on the skewness of the distribution of OLS residuals). The estimated mean level of technical inefficiency is about 84%, while a quarter of schools is roughly below 80% and a tenth can not exceed 75% (Table 5). The results for the two groups of settlements are almost indistinguishable in these respects.

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[5] One could argue, that class size and the relative number of teachers are not sufficient mesures of school resources. In theory schools could have spent more money apart from salaries due to

The share of students taking child care after the classroom hours and student with special education needs has a positive effect on the teacher per student ratio, since these students requires additional teacher time. The school quality measures are insignificant, in line with the production function results. Again, the findings are fairly similar for the two subsamples.

The coefficient of school size indicates increasing returns to scale. Economies of scale are greater for smaller settlements, due to the higher share of small schools in this group. Above two hundred students school size seems not to substantially lessen average costs.

The effects of the school selectivity factors are the opposites for the two groups. In the case of smaller settlements, most of those hosting only one primary school, selective schools tend to have more teachers relative to the number of students. One plausible explanation for this can be found in fiscal disparities among communities. The higher share of high SES students may well correlate with the local tax base and the fiscal position of local governments. At the same time, wealthier municipalities can be expected to spend more on local education. In towns with more than one primary schools the association between school and community composition is necessarily weaker, as students may sort themselves among the schools within the community. This can explain the lack of significant effect of being a selective school. At the same time, factor 2, the share of disadvantaged students has a positive effect on the teacher per student ratio only in the group of larger settlements. At least two different mechanisms can generate this pattern. First, it is possible that this is a sign of redistributive politics within larger communities towards schools with disadvantaged students. Second, this can be a side effect of parental choice. While schools with less favourable student composition became less popular among the majority of parents, the decline in enrolment may raise the teacher per student ratio, unless the teaching staff is reduced accordingly. Meanwhile popular schools naturally have larger class size and lower teacher per student ratios. The present analysis can not test these hypotheses, but it has to be noted, that in smaller communities these mechanisms are limited. In settlements with one or two schools opportunities for both parental choice and redistribution among schools is very limited.

decreasing number of students and achieve better results this way. However, the lack of correlation between demographic change and school quality suggests that this is not the case.

The effect of demographic change is similar for the two subsamples and has the expected negative sign, in accordance with the inefficiency hypothesis. Measured by the change in the number of school age children, the larger is the student population in the community in 2001 relative to 1991, the smaller is the estimated surplus in the teaching staff above the efficiency frontier. However, in the case of towns, the effect is significant only at the 10% level. The less robust result is not surprising, as in larger towns the individual schools may not exactly face the same demographic environment. Certain quarters of a town may loose more of the residents, while others gain from in-migration. Larger room for parental choice may also amplify or moderate the effect[6].

An alternative measure of demographic change at the school level is provided by the change of enrolment from 1993 to 2001. This provides a direct measure of the change in the environment of the school. Unfortunately however, this measure can not be considered truly exogenous, thus the results has to be interpreted with some suspicion. The effect of change in enrolment seems to be more robust in both groups of settlements.

Beyond the statistical significance of the coefficients, the magnitude is worth to be explored, as well. Table 6 shows the marginal effects of demographic change on the teacher per student ratio and, to ease interpretation, the transformed marginal effects on the student per teacher ratio. The marginal effect on the latter of the change in the number of school age children is 1 for smaller settlements and 1,9 for the larger ones. That is, a 20% decrease in the student population of the community in the previous decade corresponds to a 0,2 or 0,4 less student per teaching staff than the efficient level. Compared to the mean of 12 this is a relatively modest effect. The marginal effect of the change in school enrolment is four and two times higher, respectively. These are more sizeable effects. Also, the effect is somewhat stronger for smaller settlements, where the room for adjustments is more limited due to smaller school size.

It is also interesting to compare the effect of demographic change by the estimated overall efficiency of schools. A simple indirect way of this is computing the linear correlation between demographic change and the efficiency scores, shown in Table 7. Regarding the change in the school age population the correlations are fairly

[6] Note, that in the group of towns the correlation between the two measures of demographic change is rather weak, both in absolute sense and compared to smaller settlements (Table 7).

weak, and even in the case of change in school enrolment are modest. This is a clear indication of that only a lesser part of the estimated inefficiency is explained by demographic change. Demographic change is related to but not the foremost determinant of the technical efficiency of schools at the local level. Does this mean that demographic change should be discarded as the culprit for efficiency problems? The answer is no, for two reasons. First, we estimated technical efficiency and the effect of demographic change holding school size constant. However, school size itself may well fall following the decreasing number of student population. Nevertheless, this relationship is not mechanical, since local governments close some schools and merge others. The correlation between change in school age children and change of school size is modest (see Table 7), though school size has decreased to some extent in smaller municipalities in the period considered (see Graph 1). Second, both technical efficiency and the effect of demographic change have been analysed at the local level, comparing a cross section of schools. It can not be ruled out that demographic change leads to lower efficiency at the country level, influencing central regulations, educational policy or negotiations with teacher unions. If a decrease in efficiency is common to each schools, it can not be detected in a cross section analysis.

Altogether, the results suggest, that demographic change is in fact related to the efficiency of schools, though the the size of the effect seems to be quite small. Two additional remarks are nedded her. First, short run and long run impacts of demographic decline may be rather different in size. If the change in the school age population represents the long run effect, it may happen, that the estimated impact is weaker, than that on the short run. The analysis of Hermann (2005) suggests that in fact this is the case: short run impact on the student per teacher ratio is somewhat stronger, though still quite weak compared to the overall change in the student per teacher ratio at the macro level. That is, the result that local adjustment can explain only a smaller share of observable macro level change, still holds. Second, comparing short run and long run effects provides another piece of evidence for the argument that demographic change has rather affected efficiency than quality in Hungary in the past decade. Borge et al. (1995) argue, that if the demanded level of educational expenditures are modified due to demographic change, it takes some time for this effect to be realised, i.e. while local administration adjusts expenditures to the demand. This implies that the long run effect is larger that the short run effect, expenditures “move away” from the initial level towards a new optimum. At the same time, if local municipal demand do not change, but due to the rigidities of the school system demographic decline suddenly changes student per teacher ratio (teachers can not be laid off immediately etc.), the opposite pattern can be expected. The decreasing number of students in this case has a relatively larger short run effect, which is mitigated later by local adjustment. Student per teacher ratio “moves back” towards the initial level with time, if demand has not changed, hence long run effects are smaller or even zero. Findings for Hungary (Hermann, 2005) support this second line of argument.

Finally, it is worth to evaluate the estimated technical efficiency in comparison with economies of scale, a frequently highlighted source of efficiency problems in Hungarian public education. Simple calculations of the potential savings by improving technical efficiency of schools or increasing the size of the smallest ones are shown in Table 8. These savings are upper limits when school size is considered, since increased travel costs of students are ignored. However, the calculations clearly demonstrate that improving technical efficiency offers considerably more benefits than forcing school mergers. Raising the minimum of technical efficiency to its current median value, 85%, could incur a 14% decrease in teaching staff for the group of municipalities with less than 7000 inhabitants and 11% for larger settlements. At the same time, raising the minimum school size to 150 would offer only 4% saving. Even a minimum size of 200, hardly conceivable regarding the share of schools concerned, could result in 7,5% saving, slightly exceeding the half of the potential gain from raising technical efficiency to the median level.

Conclusion

The paper analysed the effect of demographic change in the 1990s on the provision of primary school education. Production function estimates suggest that demographic change has no detectable impact on school quality via school inputs.

On the other hand, cost frontier estimates reveal substantial technical inefficiency, in part related to demographic change. This finding confirms the hypothesis of rising inefficiency due to the declining school age population at the local level. However, demographic change can account for only a minor part of efficiency problems. At the same time, the estimated costs of low technical efficiency well exceed those related to economies of scale, the other leading candidate of policy discussions for being the main source of efficiency problems. The calculations suggest that many local governments have some room to improve technical efficiency of schools, apart from the given level of demographic change.

References

Berryman, S. E. (2000): Hidden challenges to education systems in transition countries, World Bank

Borge, L-E. – J. Rattso (1995): Demographic shift, relative costs and the allocation of local public consumption in Norway, Regional Science and Urban Economics, 25, 705-726

Borge, L-E.– J. Rattso (1999): Generational conflict and the disadvantage of being part of a large cohort: empirical analysis of demography and welfare service production in Denmark

Borge, L-E. – J. Rattso – R. Sorensen (1995): Local government service production: the politics of allocative sluggishness, Public Choice, 82, 135-157

Craig, S. G. – R. P. Inman (1986): Education, welfare and the 'new' federalism: state budgeting in a federalist public economy, H. S. Rosen (ed.): Studies in state and local public finance, University of Chicago Press, Chicago

Cutler, D. – D. Elmendorf – R. Zeckhauser (1993): Demographic characteristics and the public bundle, Public Finance, 48, 178-198

Deller, S. C. – E. Rudnicki (1992): Managerial efficiency in local government: implications on jurisdictional consolidation, Public Choice, 74, 221-231

Dustmann, C. – N. Rajah – A. van Soest (2003): Class size, education, and wages, Economic Journal, 113 (Febr.), F99-F120

Education at a Glance, 2002, OECD

Grosskopf, S. – K. J. Hayes – L. L. Taylor – W. L. Weber (2000): Input regulations and allocative efficiency in the U.S. public schools, J. T. L. Blank (ed.): Public provision and performance, Elsevier, Amsterdam, 175-190

Grosskopf, S. – C. Moutray (2001): Evaluating performance in Chicago public high schools in the wake of decentralisation, Economics of Education Review, 20, 1-14

Halász, G. – Lannert J. (eds.) (2003): Jelentés a magyar közoktatásról, Országos közoktatási Intézet, Budapest

Hanushek, E. A. (1986): The economics of schooling: production and efficiency in public schools, Journal of Economic Literature, 24, 1141-1177

Hanushek, E. A. (2003): Publicly provided education, NBER w8799

Hermann Z. (2005): A demográfiai változás hatása az iskolai ráfordításokra, in Hermann Z. (ed.): Hatékonysági problémák a közoktatásban, National Institute of Public Education, Budapest

Harris, A. R. – W. N. Evans – R. M. Schwab (2001): Education spending in an aging America, Journal of Public Economics, 81, 449-472

Khumbakar, S. C. – C. A. K. Lovell (2000): Stochastic frontier analysis, Cambridge University Press, Cambridge

Ladd, H. F. - S. E. Murray (2001): Intergenerational conflict reconsidered: county demographic structure and the demand for public education, Economics of Education Review, 20 (4), 343-357

Merkies, A. H. Q. M. (2000): Economies of scale and school consolidation in Dutch primary school industry, J. T. L. Blank (ed.): Public provision and performance, Elsevier, Amsterdam, 191-218

Poterba (1997): Deomographic structure and the political economy of public education, Journal of Policy Analysis and Management, 16, 48-66

Ruggeiro, J. – W. Duncombe (1995): On the measurement and causes of technical inefficiency in local public services: with an application to public education, Journal of Public Administration Research and Theory, 5 (4), 403-429

Teddlie, C. – D. Reynolds – P. Sammons (2000): The methodology and scientific properties of school effectiveness research, C. Teddlie – D. Reynolds (eds.): The international handbook of school effectiveness research, Routledge, London, 55-133

Todd, P. E. – K. I. Wolpin (2003): On the specification and estimation of the production function for cognitive achievement, Economic Journal, 113 (Febr.), F3-F33

Worthington, A. C. (2001): An empirical survey of frontier efficiency measurement techniques in education, Education Economics, 9 (3), 245-268

Tables

	General vs vocational secondary school	General or vocational secondary school vs technical school
mother's education		
primary school	0,557***	0,324***
	(13,43)	(35,89)
technical school	0,579***	0,508***
	(17,49)	(25,30)
college	1,821***	1,983***
	(19,75)	(13,96)
university	2,400***	2,300***
	(16,97)	(7,90)
missing	0,948	0,546***
	(0,72)	(9,66)
father's education		
primary school	0,550***	0,403***
	(10,35)	(23,27)
technical school	0,646***	0,720***
	(16,38)	(12,53)
college	1,471***	1,662***
	(10,61)	(8,50)
university	2,084***	2,224***
	(16,14)	(8,71)
missing	0,721***	0,698***
	(6,11)	(7,21)
parent(s) unemployed in previous year	0,864***	0,590***
	(5,26)	(22,81)
learning foreign language outside school	1,712***	2,281***
	(17,99)	(17,58)
gender (male=1)	0,451***	0,465***
	(36,67)	(35,78)
Observations	49015	64595
Number of primary schools	1756	1817
LR χ^2	6055,14***	8495,84***

Table 1 Fixed effects logit regressions of secondary school type

Odds ratios
Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

		factor 1	factor 2
Share of students			
with parents education: primary school	2001	-0,127	0,158
with parents education: technical school	2001	-0,229	-0,114
with parents education: college	2001	0,209	0,032
with parents education: university	2001	0,231	0,083
with parent(s) unemployed in the previous year	2001	-0,162	0,099
learning foreign language outside school	2001	0,177	-0,018
taking part in roma programme in school	1996	-0,051	-0,079
having special lessons for low-achiever students in school	1994-95, 2001	-0,010	0,254
having free lunch	1994-99, 2001	0,034	0,156
exempted from school attendance	1994-99, 2001	0,083	0,358
classified as endangered by family circumstances	1994-99, 2001	0,038	0,385
with special education needs, in non-special classes	1996-99, 2001	-0,014	0,123
attended kindergarten	1994	-0,005	-0,163
in classes specialised for foreign language in 1st grade	1994	0,059	-0,075
in classes specialised for other subjects in 1st grade	1994	0,141	0,117
having extra foreign language classes	1997-99, 2001	0,076	-0,116
arriving into the school between 4th and 8th grade	1997/2001	0,007	-0,171
School			
being part of a general secondary school	1994	0,086	0,026
being part of a college/university educating teachers	1994	0,109	0,023
eigenvalue		3,764	1,814

Table 2 Pricipal component factors of school selectivity, rotated factor loadings

	School fixed effect, general vs vocational secondary school (1)	(2)	School fixed effect, general or vocational secondary school vs technical school (3)	(4)
Student per teacher ratio, 1-4 grades	-0,000 (1,01)	-	0,000 (0,25)	-
Student per teacher ratio, 5-8 grades	-0,001 (1,37)	-	-0,000 (0,49)	-
Class size, 1-4 grades	-	0,001 (0,86)	-	0,001 (0,89)
Class size, 5-8 grades	-	-0,001 (1,30)	-	-0,000 (0,22)
School selectivity factor 1	0,025*** (5,36)	0,025*** (5,24)	0,002 (0,58)	0,001 (0,17)
School selectivity factor 2	-0,008** (2,46)	-0,009*** (2,79)	-0,017*** (4,26)	-0,018*** (4,35)
Village dummy	-0,002 (0,22)	-0,002 (0,21)	-0,019** (2,42)	-0,015* (1,75)
Budapest dummy	-0,011 (0,90)	-0,011 (0,88)	0,052*** (5,36)	0,054*** (5,51)
Constant	-0,085*** (6,02)	-0,099*** (5,42)	0,399*** (27,59)	0,374*** (18,36)
Observations	1465	1438	1465	1438
F	10,01***	11,15***	11,62***	11,53***
R-squared	0,04	0,05	0,04	0,04

Table 3 Production function estimates

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

	Population below 7000		Population above 7000	
	(1)	(2)	(3)	(4)
School fixed effect, general vs vocational secondary school	-0,001	0,002	0,001	0,002
	(0,12)	(0,40)	(0,13)	(0,36)
School fixed effect, general or vocational secondary school vs technical school	0,002	0,003	-0,003	-0,005
	(0,48)	(0,68)	(0,55)	(0,88)
School selectivity factor 1	0,003**	0,003**	-0,00003	0,0004
	(2,30)	(2,41)	(0,04)	(0,59)
School selectivity factor 1	0,0001	0,00007	0,003***	0,002***
	(0,20)	(0,11)	(4,47)	(3,49)
share of students in child care after classroom hours	0,019***	0,020***	0,024***	0,023***
	(6,61)	(7,03)	(8,53)	(8,49)
Share of students with special education needs, in non-special classes	0,034*	0,035*	-0,032	-0,023
	(1,67)	(1,80)	(1,19)	(0,85)
Share of students with special education needs, in special classes	2,140***	2,094***	6,291***	6,214***
	(5,95)	(5,90)	(7,06)	(7,10)
Inverse of school size	5,050***	5,000***	3,400***	3,225***
	(29,95)	(31,59)	(7,79)	(7,52)
Constant	0,039***	0,041***	0,050***	0,052***
	(13,26)	(14,12)	(14,90)	(15,83)
$\ln\sigma_u^2$				
Change in school age population, 2001/1991	-,821**	-	-1,334*	-
	(2,02)		(0,067)	
Change in school enrolment, 2001/1993	-	-3,076***	-	-2,233***
		(5,75)		(5,64)
Constant	-6,892***	-5,038***	-7,005***	-6,015***
	(18,04)	(11,36)	(12,28)	(16,96)
σ_v	0,012	,012	0,009	0,009
Wald χ^2	997,26***	1142,21***	198,68***	180,35***
Observations	822	822	645	645
Likelihood ratio test of technical efficiency $H_0 : \sigma_u^2 = 0$	57,40***		64,82***	

Table 4 Cost frontier function estimates

Dependent variable: teacher per student ratio
All variables except of school selectivity factors and demographic change are measured for 2001
Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

	Population below 7000		Population above 7000	
	(1)	(2)	(3)	(4)
1	60,6%	65,6%	62,3%	61,6%
5	70,3%	72,7%	71,9%	71,7%
10	73,4%	76,0%	75,3%	75,9%
25	78,9%	81,7%	80,1%	80,8%
50	84,3%	86,5%	85,3%	86,4%
75	88,6%	90,1%	89,2%	89,9%
90	91,6%	92,8%	92,0%	92,6%
95	93,2%	94,3%	93,6%	94,0%
99	96,3%	96,7%	95,9%	96,2%
mean	83,2%	85,2%	84,1%	84,8%

Table 5 Percentiles of estimated technical efficiency

	Population below 7000		Population above 7000	
	Change in school age population, 2001/1991	Change in school enrolment, 2001/1993	Change in school age population, 2001/1991	Change in school enrolment, 2001/1993
Marginal effect on teacher per student ratio	-0,00009	-0,00029	-0,00012	-0,00019
Marginal effect on student per teacher ratio	0,0119	0,0385	0,0145	0,0230
Estimated effect of a 10% change ont he student per teacher ratio	0,1191	0,3848	-	-
Estimated effect of a 25% change ont he student per teacher ratio	-	-	0,2979	0,9620

Table 6 Marginal effect of demographic change

Marginal effects are computed at the mean values

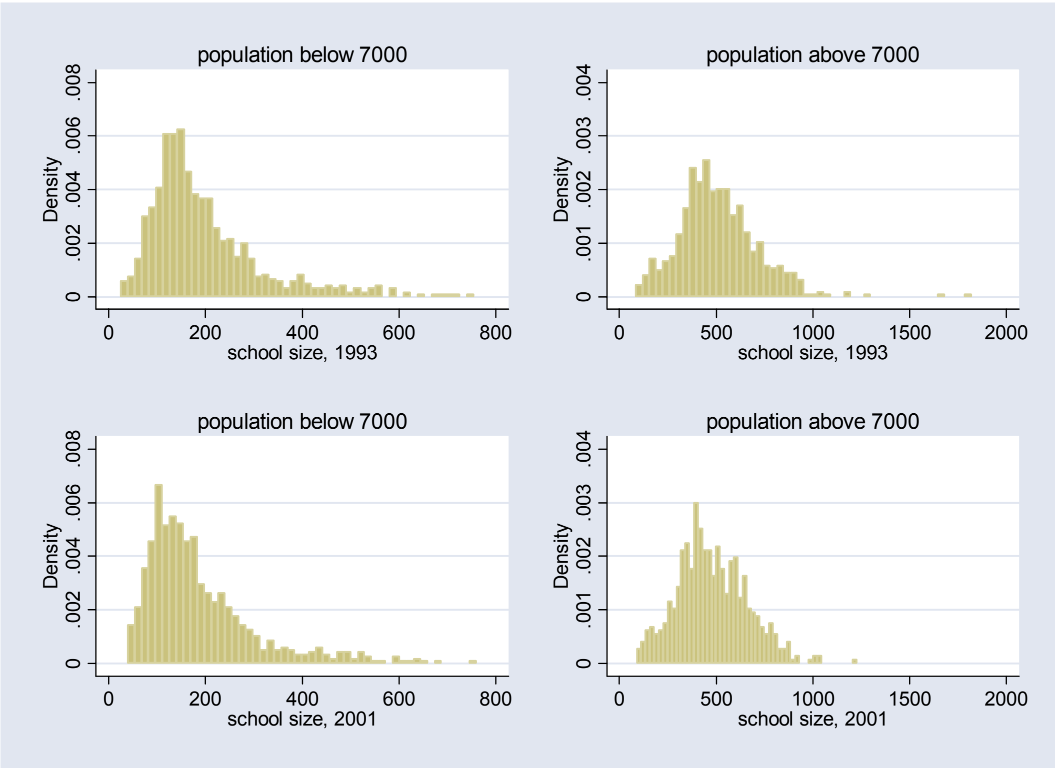
	Distance from the cost frontier due to inefficiency	Technical efficiency score	Change in school enrolment, 2001/1993
Population below 7000			
Change in school age population, 2001/1991	-0,124***	0,076**	0,489***
Change in school enrolment, 2001/1993	-0,383***	0,371***	-
Population above 7000			
Change in school age population, 2001/1991	-0,137***	0,143***	0,248***
Change in school enrolment, 2001/1993	-0,344***	0,382***	-

Table 7 Correlation coefficients between demographic change and technical efficiency

significant at 10%; ** significant at 5%; *** significant at 1%

		Savings in teacher employment within group relative to current employment	Share of schools affected within group
Population below 7000			
Minimum level of technical efficiency:	85%	14,4%	54,0%
Minimum level of technical efficiency:	90%	17,5%	82,7%
Minimum level of technical efficiency:	95%	18,4%	97,9%
Minimum school size:	100	1,3%	18,0%
Minimum school size:	150	4,2%	47,1%
Minimum school size:	200	7,5%	67,4%
Population above 7000			
Minimum level of technical efficiency:	85%	11,1%	47,6%
Minimum level of technical efficiency:	90%	15,2%	80,6%
Minimum level of technical efficiency:	95%	16,5%	98,1%

Table 8 Estimated savings by increasing technical efficiency or size of schools
Based on specification (1) and (3) of Table 4



Graph 1 The size distribution of primary schools in the sample, 1993, 2001