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April 2004

UNIVERSITÀ DEGLI STUDI DI TRIESTE

DIPARTIMENTO DI SCIENZE ECONOMICHE E STATISTICHE

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DISES Working Paper - N° 99

April 2004

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Human capital formation in Poland. Where does educational quality come from?*

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Abstract

Theory and empirical literature relates educational quality to four main explanatory factors: intergenerational transfer of human capital, quality of schools, school composition and economic conditions. Basing on these findings I propose the model explaining territorial differentiation of educational quality. Dependent variable is test score of 6th grade students averaged at municipality level. As it turns out, educational outcome is highly conditioned on school composition, most likely as a result of high vulnerability to inequalities in school community. Of great importance is also local human capital stock. The role of traditionally meant school quality is minor (although higher in rural areas than in cities), partly because of decreasing returns to scale of school resources. Average school outcome differs significantly along historical divisions of Poland, not only in level, but also in parameters of determination function. Legacies of the past and related socioeconomic processes have substantial impact on the sensitivity of educational quality to different explanatory factors.

Introduction

The goal of this paper is to examine a territorial differentiation of educational quality. Some previous studies reveal significant correlation between achievements at school and performance at work (Bishop 1992) or, in the cross-country framework, between international test scores and measures of economic development (Bishop 1989, Hanushek and Kim 1995, Barro 1998). Those results suggest that educational quality should be considered as important feature of human capital in addition to it's quantity (stock), emphasized by the literature of the subject. For example, Hanushek and Kim (1995) estimate that one standard deviation change in measured average cognitive skills among the panel of 100 countries translates into one percentage point

* I am grateful to Romeo Danielis, Gaetano Carmeci, Lucia Rotaris, Jacopo Zotti and Sergio Zappa from Univeristy of Trieste for all the help they provided me during the research.

shift in average annual growth rate - an effect much stronger than one caused by the change in average years of schooling.

If the quality of human capital accounts for significant part of variation in workers' productivity, identifying it's determinants may be of great interest in order to work out an efficient public education policy in underdeveloped regions and localities.

This paper follows the first edition of standardized school tests, conducted in Poland in 2002. It relies on regressing primary schools outcomes in Polish, averaged at the level of municipality, on several explanatory factors. Specification of the model follows Lee and Barro (1997) approach to schooling quality, but their framework is substantially extended and applied it to cross-municipal instead of cross-country analysis. The basic questions that the research is going to address are:

- To what extent educational quality depends on local human capital stock accumulated by the family and neighborhood?
- How much educational quality depends on school quality?
- What is the effect of school composition on educational outcome?
- How strong is the impact of economic conditions on human capital quality?

Conceptual framework

According to Lee and Barro (1997), the general form of educational quality determination function is:

$$Q = Q(f, r)$$

where "*f*" and "*r*" refer respectively to family factors and availability of school resources and *Q* is measured by school test scores. In this simple framework "f" is supposed to capture the whole effect of widely considered environment on educational outcome of individual, while "r" refers to educational processes taking place at school.

In this paper both school quality and the role of socioeconomic environment are subject of further decomposition. The following extended framework is then applied to explain the empirical differences in average educational outcome among Polish municipalities.

$$Q_l = g(f_l, s_l, m_l, p_l) + \varepsilon_l$$

where

Q_l is educational quality in locality *"l"*

$f_l -$ intergenerational (family) and neighborhood factor

$s_l -$ school quality (value added by school & school resources)

$m_l -$ economic motivation factor

$p_l -$ school composition effect

School outcome in locality "l" is to be expressed at municipal level by average test score at primary school's 6th grade in academic year 2001/2002.

Family & neighborhood factor

The conviction that individual's human capital level is partly predetermined by family and neighborhood educational endowment is very common in related economic literature.[1] Family factor, usually proxied by parents' education level, appears in most estimated Mincer-like equations (Card and Krueger 1996a). Controlling for it allows isolating the net effect of schooling on earnings. Obviously, as demonstrated by Hanushek (1986) or Lee and Barro (1997), family/neighborhood characteristics have crucial impact not only on quantity of education, but also on the achievements within particular tiers and grades, that is, on educational quality. The effect of human capital accumulated both within family and wider social environment on individual's educational achievements is expected to be positive and significant.

Besides direct human capital transfer one may also think of another type of family/neighborhood effect on school outcome. Usually higher income is associated with better conditions for studying: access to books and other equipment, possibility to attend additional courses etc. Income should therefore be positively correlated with educational quality. Empirical investigations bring however ambiguous conclusions. McCulloch and Joshi (2001) show that in UK family poverty has a significant association with lower test scores of children of all ages (4-18) and neighborhood poverty matters at least for youngest children of 4-5 years. In turn Shea

[1] For the example of theoretical model see Becker (1993)

(2000), using data on American families, finds that if parents' abilities are controlled, parent's income have a negligible overall effect on children's human capital, although it does matter for families whose father has low education.

School quality

It seems obvious that educational quality (school outcome) depends heavily on the quality of schools. The problem is how to measure the latter. Those authors who referred to this issue in their empirical works used different proxies to express school quality: per student expenditures on public education, pupil/teacher ratio, average class size, average teacher's wage etc. (see Wilson 2002, Lee and Barro 1997). One may find these measures unconvincing and incomplete since they reflect only the quantity of school resources and omit what we would intuitively mean by the "quality" or "value added" by school. Betts (1995) proves that although performance at work (earnings) differ between workers who attended to different school in USA, all 'traditional" measures of school quality based on availability of resources are insignificant for the students' future wage. Also the association of school resources level and student achievements, although confirmed by Lee and Barro (1997) in their cross-country research, is often questioned when examined at less aggregated level (see Hanushek 1986, Marlow 2000).

In this paper I try to estimate separately the effects of school resources and "non-resources-based" school quality, referred to as value added by school. It is commonly recognized by pedagogical literature that while some abilities valuated in standardized school tests are highly conditioned by the out-of-school education, others are learned mostly during school courses. In particular, as stressed by Popham (1999), achievements in mathematics depend heavily on the performance of school. Few parents spend much time teaching their children algebra or how to prove the theorem. In turn, general humanistic abilities of a child, such as fluency in reading and writing are more vulnerable to socio-economic status of the family and neighborhood. They clearly depend on family education, access to cultural events and books, possibility of traveling etc.

A simple measure of value added by schools in a given locality may be thus constructed by dividing standardized average result in mathematics and nature sciences by the average standardized result in humanistic part of the test:

$$S_{VA} = \frac{Q_{ml} / \overline{Q}_{ml}}{Q_{hl} / \overline{Q}_{hl}}$$

Because of an obvious endogenity, Q_{ml} and Q_{hl} can not be calculated using data on primary school test scores, being dependent variable in our model. Instead I use data from simultaneously conducted tests in middle schools, assuming that value added by schools results from the quality of school system in a given area and is common among the tiers of education.

Economic motivation

Basing on theoretical concepts and experience from various countries, the effect of unemployment on average educational quality in a given area should be considered twofold. On one hand, positive shift in unemployment rate is expected to provide an incentive for investing in human capital. Well educated, highly productive workers are more likely to keep the jobs in the periods of high unemployment. Also, prolonging education delays the entrance of an individual to labor market, hopefully until 'better times'. Assuming that there is a link between performance at school and productivity at work and that school achievements at lower tiers serve as students selection criteria for higher tier schools, we obtain two good reasons for unemployment rate being positively correlated with educational quality.

On the other hand however, empirical evidence from Poland (Herczynski and Herbst 2002) shows that pathologically high level of structural unemployment results in common feeling of desperation and de-motivation that, transferred from parents to children, is often reflected by low school outcomes. More formally, Mauro and Carmeci (2003) argue that knowledge gained at school and working experience are complementary types of human capital. While not working individual is not able to take advantage of accumulated school knowledge. Therefore, by lowering expected returns to education high structural unemployment depresses student's motivation to invest in further education, hence also to work hard in order to get higher score on the tests[2]. Mauro and Carmeci restrict their attention to the relation between stock (quantity) of human capital and GDP in cross-country framework. They demonstrate that only when including structural unemployment rate in GDP accounting equation, human capital measures (both secondary school enrollment rate and change in the years of schooling) become significant and positively affecting per capita GDP.

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[2] As for primary and middle schools it may not happen directly, since we can hardly believe that 12-15 years old people plan consciously their professional life, but indirectly, via the pressure put upon the children by the parents.

It seems reasonable to assume that both two mechanisms relating demand for human capital and labor market situation (call them 'investment' effect and 'and de-motivation' effect) have impact not only on the stock of human capital but also on it's quality. Therefore, as long as economic motivation factor is expressed by a single variable (as it is in this research), it's impact on educational quality is likely to be nonlinear. In Poland of 2001, with unemployment rate reaching 20% one may expect de-motivation effect to dominate over the incentive for human capital investment.

School composition

School achievements of an individual depend not only on his/her ability, but also on the achievements of schoolmates (see for example Agrys, Rees and Brewer 1996). This type of school externality is generally referred to as peer group effect. For example, one can expect student's performance to depend on teacher's availability. The amount of time devoted by the teacher to work with particular student is clearly a function of student's ability, but since teacher's time is limited, obviously depends also on performance of the whole group/class. School and class composition determines also the sense of competition among students, providing a stronger or weaker incentive to work hard.
Obviously it is impossible to test efficiently any detailed hypothesis on peer pressure using aggregated data, which currently is the only available for Poland. These issues should become subject of profound studies when more disaggregated dataset is developed. However, a general significance of school composition for average student achievement may be verified using within-school score dispersion measure, such as standard deviation. The lower dispersion of scores, the more homogenous, in terms of abilities, is school community. And the heterogeneity of skills in a group of students is proved to have significant impact on individual (and thus also average) achievements. According to numerous researchers ability grouping (that is lowering intra group skill dispersion of abilities) tends to increase the achievements of at least high skilled students (Kerckhoff 1986, Agrys, Rees and Brewer 1996, Betts and Shkolnik 2000). The effects of school composition according to prior achievements of students were also subject of the influential report by Coleman et al. (1966). The important role of peer pressure for the efficiency at work was demonstrated by Falk and Ichino (2003). The general relevance of these findings for primary school outcomes n Poland may be tested using data one average within-school score dispersion for each municipality. However, any more detailed hypothesis will obviously require careful investigation applied on the level of school, class and individual students.

Econometric framework and data

The estimated equation takes following linear form:

$$(1)\ Q_l = \beta_0 + \beta_1 V_{1l} + \beta_2 V_{2l} + \beta_3 V_{3l} + \beta_4 V_{4l} + \gamma_l$$

where Q_l represents average test score in municipality l, $\beta_i V_{il}$ is a vector of explanatory variables representing factor $i = 1 \text{ to } 4$, and γ_l is error term. Previous analysis of test scores by Herczynski and Herbst (2002) revealed that, despite training programs for teachers, grading strictness differed slightly among eight Regional Examination Committees. Naturally, this might have an adverse effect on the efficiency of estimates. To overcome the problem error term γ_l will be considered as composed of a standard regression residual ε_l, and a term ν_r, representing measurement error reflecting failure in applying common grading rules.

$$\gamma_l = \varepsilon_l + \nu_r \quad \text{for r} = 1 \text{ to } 8$$

Therefore, instead of (1), the following equation is to be estimated:

$$(2)\ Q_l = \alpha_r + \beta_1 V_{1l} + \beta_2 V_{2l} + \beta_3 V_{3l} + \beta_4 V_{4l} + \varepsilon_l$$

where

$$\alpha_r = \beta_0 + \nu_r$$

In other words the intercept will be allowed to differ among eight regions, hopefully capturing the measurement error resulting from uneven strictness.

The most efficient way to identify the determinants of educational quality, at least in the part related to family and school effects, would by to run regressions on individual student data. Unfortunately such dataset, covering all fields involved in the framework above, is not available for Poland, although there is a chance it will be constructed within next few years[3]. In this paper the model developed in previous section is applied on aggregated (municipality) level, to explain how the local average educational quality is related to averaged characteristics of the family/neighborhood, local labor market, average school quality within the district and the measures of school composition, also averaged at municipal level. Usefulness of aggregated framework in terms of possible application of the results comes from the fact that primary schools in Poland are maintained and administered by municipal local governments. The analysis conducted on municipal level may therefore result with direct policy recommendations.

Nonetheless, important question concerning data aggregation is whether or not it leads to biased estimates. Although it is generally assumed that general conclusions drawn from aggregated dataset hold also at the micro level, it must be noted that some previous research indicates the opposite. Soobader and LeClere (1999) show that income inequality exerts an independent adverse effect on self-rated health at the county level, but this effect is substantially reduced when measured at lower aggregation or individual level. However, as the authors admit, it does not necessarily mean that the importance of income inequality estimated using individual data is more *'real'* than one observed in aggregated framework. It may also happen that inequality is partially identified through individual socioeconomic status at lower levels of aggregation. That is, controlling for individual status absorbs the effect of income inequality.

In fact, some authors (e.g. Card and Krueger 1996b) argue that using aggregated data in the analysis of school quality and performance is advantageous because it allows to lessen endogeneity bias in the models involving family, environment and school effects. If for example school policy is to assign children who perform poorly to smaller classes, the estimates of class size effect on school outcome will definitely be downward biased when calculated with individual school data. The same reasoning apply if highly skilled pupils are attracted to selected schools with higher per student spending, leading to upward-biased estimate. Moreover, as individual data on students and school quality is usually reported once a year, it provides only a snapshot of the long-term processes. The aggregation to district or county level may help to overcome the measurement error resulting from year-to-year fluctuations.

The above argumentation, although shared by numerous researchers, has been also subject of some criticism. Rivkin (2001) demonstrates that when estimating peer group effects at school,

[3] The project 'Polish Education System and the Challenge of Socio-Economic Deelopment' is to be run atWarsaw University in 2004.

data aggregation doesn't reduce the endogeneity and/or measurement error in the way described by Card and Krueger.

Table1. Factors assumed to determine educational quality and corresponding variables

Factor	Variable (municipality average)
dependent variable	average 6th grade test score
intergenerational transfer	human capital stock (average years of schooling) in 1988
	change in human capital stock between 1988 and 2002
	collected PIT per capita
school quality	per student expenditures
	value added indicator
economic motivation	unemployment rate
school composition	intra-school standard deviation of score

Dependent variable of educational quality model is 6th grade test score in academic year 2001/2002. Municipality level averages are provided by Central Examination Committee (CEC). A direct family effect on human capital is represented by two variables: average years of schooling in 1988 and change in average years of schooling between 1988 and 2002. Both variables come from National Census Data. While the former is expected to capture the impact of parents' generation educational level on school outcome, the latter is meant to measure the effect of recent educational boom observed in Poland in the 90's. Since the children of people achieving their final education grade between 1988 and 2002 are unlikely to reach 6th grade of elementary school in 2002, the recent change in years of schooling represents within-generation effect an increase in human capital stock.

The effect income on average school outcome is proxied by personal income tax collected per capita. More precisely it is the average of 2000 and 2001 PIT per capita values provided Databank on Localities of Central Statistical Office. CSO is also the source of data on school resources (expenditures per students). The variable applied in the analysis is constructed as the average of 1996-2001 values.

The concept and construction of school value added indicator is explained in previous section. Data for academic year 2001/2002 is provided by CEC

Unemployment rates (December 2001 value) are provided by Polish Ministry of Economy, which collects data from County Labor Offices. This variable is available only at county level.

Finally, the variable describing school composition – intra-school deviation of test score is calculated by Central Examination Committee.

As it comes out from the above discussion, the impact of aggregation level on efficiency of model estimates is uncertain. One adverse side effect of conducting the analysis on aggregated dataset is reduced variability in data, with respect to individual observations. According to CEC country report on standardized exams in 2002, a standard deviation of 6^{th} grade test score calculated at individual level was 6,83 (with mean score of 29,49) which is reduced to 1,72 due to aggregation at municipal level. The effect of estimates depend naturally on how much the variability of other data is affected by the aggregation (we don't know it), but one may expect weak stochastic relationships between the endogenous variable and the regressors to be harder to detect at the aggregate than at the individual level. This must be taken under consideration when interpreting the results of the estimations.

Empirical part of the paper consists of three sections. First one is devoted to general model of educational quality, estimated separately for urban and rural environment. In second section, the linearity assumption is relaxed with respect to some explanatory variables following assumptions made in conceptual framework and observations from preliminary regressions. Finally, last part of the paper investigates the role of historical processes in determining educational quality.

Educational quality in cities and rural environment

Basic statistics on endogenous and exogenous variables used in the analysis are presented in Table 2, separately for each type of settlement unit, as a ratio to Poland's mean.

Table 2. Decriptive statistics on variables in cities and rural areas. Poland's mean=100

Variable	Cities		mixed areas*		rural areas	
country mean=100	mean	std deviation	mean	std deviation	mean	std deviation
average test score	103,12	85,37	99,09	90,93	99,75	102,60
intraschool std deviation	97,65	81,86	100,62	88,97	100,21	106,23
Value added by school	95,44	56,09	97,01	82,73	101,92	108,85
PIT per capita	193,46	144,43	106,80	70,58	80,40	69,31
unemployment rate	96,65	109,90	107,03	106,45	98,09	94,59
per student expenditure	79,24	82,56	89,96	73,42	107,26	89,73
average human capital stock	108,69	106,65	101,09	61,76	98,06	55,35
change in hc stock	140,97	49,49	111,11	68,96	88,68	100,09

* municipalities consisting of a city (town) and surrounding rural area

As it turns out, schools in cities achieve on average higher results than in rural municipalities. Test scores in urban areas are also characterized by lower within-school average variation.

Not surprisingly, urban communities are better endowed with human capital stock. Their advantage over rural municipalities has been recently deepening which is reflected by the change in average years of schooling between 1988 and 2002.

Although because of specific regulations concerning agricultural activities PIT revenues are not an efficient proxy of personal income in rural environment, the level of wealth is, with no doubt, higher in cities than in rural areas. Cities are also less touched by unemployment, that achieves its' highest average rate in mixed municipalities.

School characteristics seem to be the weak point of urban areas. Following pro-rural redistribution policy applied by the Polish Ministry of Education, school expenditures per student are much lower in cities than in rural areas. Also the value added measure achieves lowest average value in cities.

Urban and rural areas differ not only in average level of school outcome and explanatory variables, but also in the way educational quality is determined. Chow test run on pooled samples resulted in rejection of null hypothesis $\beta_{ri} = \beta_{ui}$. The coefficients for rural municipalities differ significantly from those obtained in urban environment. As a consequence of this finding, further estimations will be conducted separately for different types settlement unit.

Table 3. OLS estimation by the type of administration unit*

Variable	1	2	3	4	5	6	7	8
log intra-school std dev.	**-0,2158** (-6,28)	**-0,2173** (-6,20)	**-0,2204** (-6,28)	**-0,2385** (-7,49)	**-0,2316** (-25,5)	**-0,2305** (-25,3)	**-0,2353** -(25,7)	**-0,2312** (25,4)
log value added by school	-0,0128 (-0,41)	-0,0123 (-0,40)	-0,0117 (-0,39)	-0,0225 (-0,73)	**0,0271** (2,95)	**0,0289** (3,13)	**0,0280** (3,01)	**0,0267** (2,86)
unemployment rate	-0,0650 (-1,88)	-0,0555 (-1,56)		-0,0680 (-1,87)	**-0,1172** (-5,03)	**-0.1129** (-4,87)		**-0,1147** (-4,92)
human capital stock	**0,0260** (4,32)	**0,0200** (3,03)	**0,0210** (3,29)		**0,0163** (4,44)	**0,0103** (2,45)	**0,0093** (2,24)	
human capital change	**0,0259** (3,22)	**0,0209** (2,66)	**0,0215** (2,75)		**0,0138** (4,72)	**0,0098** (2,61)	**0,0113** (3,02)	
log PIT		0,0145 (1,43)	0,0176 (1,78)	**0,0380** (4,04)		**0,0099** (2,19)	**0,0121** (2,65)	**0,0192** (6,07)
log school expenditure	-0,0231 (-1,74)	-0,0243 (-1,89)	-0,0202 (-1,54)	**-0,0289** (-2,36)	**0,0170** (2,26)	**0,0159** (2,10)	**0,0152** (2,01)	**0,0163** (2,15)
German sector	-0,0128 (-1,57)	-0,0159 (-1,90)	**-0,0186** (-2,26)	**-0,0217** (-2,51)	**-0,0339** (-6,17)	**-0,0339** (-6,20)	**-0,0386** (-6,99)	**-0,0341** (-6,26)
Russian sector	-0,0017 (0,28)	-0,0023 (-0,39)	-0,0027 (0,45)	-0,0036 (-0,62)	-0,0050 (-1,34)	-0,0042 (-1,14)	-0,0007 (-0,20)	-0,0058 (-1,59)
select by urban	Y	Y	Y	Y	N	N	N	N
select by rural	N	N	N	N	Y	Y	Y	Y
intercept allowed to vary	Y	Y	Y	Y	Y	Y	Y	Y
N	271	271	271	281	1544	1544	1544	1558
F(r,df)	41,87	39,69	41,73	46,41	111,5	105,1	108,5	118,8
	(15,255)	(16,254)	(15,255)	(14,266)	(15,1528)	(16,1527)	(15,1528)	
F prob	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
corrected R^2	0,70	0,70	0,70	0,69	0,51	0,51	0,51	0,50

*Heteroscedasticity-adjusted t-statistics in parentheses, all equations contain also intercept varying among regional examination committees

The proposed linear model of educational quality offers quite good explanatory power, with R^2 about 0,7 and 0,5 for urban and rural environment respectively. All explanatory factors are significant in at least one of the specifications.

Of great importance for educational quality is school composition factor. Both in urban and rural areas higher variation in students' ability is accompanied by lower average test score. When controlling for human capital stock, economic motivation and school quality, a shift of one standard deviation (0,11) in intra-school dispersion of score is associated with approximately 2,5% change in educational quality. The effect is slightly stronger in rural areas, but also in cities of high magnitude and statistical significance. Educational outcome in primary schools seems to be highly vulnerable to heterogeneity of school communities. Obviously, working with aggregated municipal data we are not able to distinguish between the impact of socioeconomic inequalities and the role of school policies in determining school composition. In other words, we don't know to what extent the observed effect is 'imported' to school system from the society. Since it has turned out that inequalities are of crucial importance for educational quality, this issue should become a subject of profound research at school level.

Both in urban and rural environment the level of educational quality is significantly and positively related to human capital stock accumulated by previous generations and also to recent (within-generation) change in average education level. As we observe, within-generation effect is of similar magnitude as intergenerational one. In urban environment one additional year of education in parents generation is associated with 2-2,6% positive shift in average school outcome, depending on specification. Since national average of test result is about 30 points, it corresponds to 0,6-0,8 point increase in average score. Independently, a recent change in average human capital stock by one year of education have 2,1-2,6% effect on educational quality. Although significant for both samples, the impact of accumulated human capital on educational quality is much weaker in rural environment than in cities. In the countryside, a change in average school outcome associated to one additional year of education in population over 13 is about 1%, also here with negligible difference between the previous and present generation effect. This result shows that, compared to cities, educational achievements in rural areas are less dependent on family education. Natural question is therefore whether they rely more on the efficiency of schooling institutions. As we can see from columns 5 and 6 of Table 3, educational quality in urban and rural environment differs strongly in it's sensitivity to school quality related factors. Indeed, the role of school in determining local human capital quality is higher in rural areas, where the impact of increased school expenditures on average school outcome is positive and statistically significant, although small in magnitude. A standard deviation (about 15% of the mean) shift in expenditures would affect the average test score only by 0,2%. An increase of similar scale in school value added measure will have an independent positive effect of 0,4%. The power of school quality impact on school outcome does not change significantly if one of the related variables is excluded from the specification. Meanwhile in urban environment both value added measure and expenditures on schools have negative coefficients and are statistically insignificant.

The difference in importance of school resources between cities, where schools are generally better equipped, and rural areas, where municipal authorities still have to invest in basic educational infrastructure, suggest decreasing returns to educational expenditures. If this is the case, a quadratic specification of school resources would be more appropriate that simple linear form. Nonlinearity with respect to educational expenditures impact on test scores will be tested in further part of this paper.

In cities, as local stock of human capital is controlled in the specification, there seems not to be an independent, statistically significant effect of average personal income on educational quality. Since PIT per capita is expected (and confirmed) to be correlated with human capital endowment and unemployment rate, specifications 1-4 for the cities and 5-8 for rural areas were run in order to compare how the model behaves with different sets of variables included. If human capital measures are present in urban specification, the independent effect of income is insignificant at 5% level, although positive. Only when years of schooling variable is excluded, PIT per capita turns out to be significant, and quite remarkable determinant of school outcome. A 10% increase in average personal income would be associated with 0,4% improvement in educational quality.

Differently from cities, in rural areas, where educational quality is less conditioned on local human capital stock, income level seems to have an independent, although weak, effect on average test score. A 10% positive shift in income is transformed in 0,1% increase in average school outcome in the municipality. Taking into account that the standard deviation of PIT per capita reaches 40% of sample mean, we get 0,4% change in test score as a response to standard change in average income. Obviously, PIT is far from perfect as a measure of average in Polish countryside. Since agricultural activities are not covered by PIT system (farmers do not pay income tax), PIT per capita reflects the ability of a given area to disobey from monocultural (agricultural) model of the economy rather than directly informs about average wealth. This may explain why income variable turns out to be significant in rural specification, while being totally 'captured' by human capital stock in urban environment.

The importance of economic motivation factor for local educational quality differs substantially in magnitude an significance for urban and rural sample. In rural environment, as the unemployment rate raises by ten percentage points one can expect a 1,1% drop in average test score, ceteris paribus. A change in unemployment by it's standard deviation (6,4 percentage points) is associated with a shift in educational quality by 0,7%. In the cities, the impact of economic motivation is reduced by the half and remains below the bound of statistical significance.

Although the effect of unemployment on school outcome may seem negligible, it has to be taken into account that Poland, being still in transitional period from centrally planned to free market economy, experiences currently high structural unemployment and huge disproportions in labor market performance among regions and municipalities. As the average unemployment rate measured at county level reached 20% in 2001, a difference of 10 percentage points between localities or a rapid change of similar magnitude in a given locality is quite likely to happen. In such conditions the role of economic motivation in determining educational quality is clearly higher than it would be in stable economy characterized by low unemployment.

Negative sign of unemployment rate coefficient indicates that of two possible effects of labor market on average school outcome described in methodological section of this paper, the 'pathological de-motivation' dominates over 'human capital investment'. It seems perfectly consistent with the nature of both effects, given that in the examined period unemployment remained pathologically high in the whole country.

Besides explanatory factors introduced in conceptual framework section, all specifications included in Table 3 are endowed with two dummy variables indicating location in one of three historical regions of Poland. They refer to XIX and early XX century history when today's Polish territories remained divided between Prussia (Germany), Russia, and Austria (Austro-Hungarian Empire)[4]. As demonstrated in numerous publications (see Gorzelak 1998, Gorzelak Jałowiecki et.al. 1999), cultural and economic differences following this division still have a tremendous impact on regional development in Poland. A more detailed analysis on the role of historical burden in determining educational quality is presented in a separate

[4] The model includes two regional dummies (German and Russian), with Austrian sector considered as the reference one.

section of this paper. At this stage we can however observe that there exist a gap in educational quality between former German sector and the rest of the country, in favor of the latter. This gap seems not to be fully explained by explanatory variables included in the model, at least in it's current functional form. In urban environment German sector dummy remains at the edge of statistical significance and indicates that if all municipalities are equally endowed with respect to explanatory factors, average school outcome in German sector would be 1,5% lower than elsewhere. The gap is much wider in the case of rural areas, where, with explanatory factors controlled, average school outcome in former German sector is over 3% lower than in remaining two historical regions. Differently than in urban environment, this result is of great statistical significance.

Nonlinear effects in determining educational quality

As signaled in previous sections, empirical relationship between some explanatory variables and educational quality is likely to be nonlinear. This implies in particular to the effect of unemployment rate and school resources.

The results so far have shown that unemployment has negative impact on educational quality. When the effect is modeled as linear, it turns out to be statistically significant both in urban and rural environment. However, in theoretical introduction to this paper we identified two separate effects within economic motivation factor, that are supposed to work in opposite directions. Human capital investment effect is expected to be strong in areas of relatively low structural unemployment. An increase in unemployment rate leads to higher demand for human capital which should be reflected in a positive shift in average educational quality. In the presence of high structural unemployment however, further worsening of labor market situation results in de-motivation and common feeling of rejection that, transferred from parents to children, lowers school achievements.

The dominance of the latter effect has been confirmed in preceding section, as the overall linear effect of unemployment on educational quality is negative. By including squared unemployment rate in specifications 9, 11,12 and 14 we will test the presence of human capital investment effect.

Besides unemployment, also non-linearity of school expenditures effect on test scores is to be verified. Linear estimations have shown that significance of school resources varies for urban and rural environment. In particular, in rural areas, where additional expenditures are usually aimed at improving basic educational infrastructure, school resources have significant and positive impact on test scores. In cities, where basic needs are already satisfied and schools' condition and equipment is generally better, the coefficient by school expenditures is statistically insignificant and negative. This suggests decreasing returns to scale of school expenditures. Specifications 10,11,13 and 14 are meant to test whether this phenomenon is observed also within urban and rural subsamples.

Table 4. Estimations with nonlinear parameters*

Variable	2	9	10	11	6	12	13	14
Log intra-school std dev.	**-0,2173** (-6,20)	**-0,2173** (-6,21)	**-0,2140** (-6,32)	**-0,2140** (-6,33)	**-0,2305** (-25,3)	**-0,2311** (-25,2)	**-0,2305** (-25,3)	**-0,2311** (-25,2)
log value added by school	-0,0123 (-0,40)	-0,0165 (-0,54)	-0,0010 (-0,03)	-0,0053 (-0,16)	**0,0289** (3,13)	**0,0282** (3,04)	**0,0289** (3,12)	**0,0281** (3,04)
unemployment rate	-0,0555 (-1,56)	0,1927 (1,44)	-0,0509 (-1,45)	0,1861 (1,37)	**-0.1129** (-4,87)	0,1156 (1,00)	**-0,1139** (-4,86)	0.1152 (1,00)
unemployment rate sq		-0,5760 (-1,78)		-0,5502 (-1,69)		**-0,5327** (-1,95)		-0,5326 (-1,94)
human capital stock	**0,0200** (3,03)	**0,0234** (3,53)	**0,0205** (3,16)	**0,0237** (3,56)	**0,0103** (2,45)	**0,0105** (2,43)	**0,0102** (2,42)	**0,0105** (2,40)
human capital change	**0,0209** (2,66)	**0,0198** (2,62)	**0,0231** (3,03)	**0,0221** (2,81)	**0,0098** (2,61)	**0,0096** (2,55)	**0,0097** (2,59)	**0,0096** (2,53)
log PIT per capita	0,0145 (1,43)	0,0146 (1,42)	0,0096 (1,01)	0,0097 (1,04)	**0,0099** (2,19)	**0,0103** (2,26)	**0,0102** (2,24)	**0,0106** (2,30)
log school expenditure	-0,0243 (-1,89)	-0,0211 (-1,56)	**1,1744** (2,07)	**1,1531** (1,98)	**0,0159** (2,10)	**0,0158** (2,06)	0,2938 (0,65)	0,2928 (0,63)
log school expenditure sq			**-0,0759** (-2,11)	**-0,0743** (-2,01)			-0,0171 (-0,62)	-0,0171 (-0,60)
German sector	-0,0159 (-1,90)	-0,0141 (-1,66)	-0,0139 (-1,64)	-0,0123 (-1,43)	**-0,0339** (-6,20)	**-0,0311** (-5,48)	**-0,0338** (-6,16)	**-0,0310** (-5,45)
Russian sector	-0,0023 (-0,39)	-0,0035 (0,58)	-0,0015 (-0,24)	-0,0026 (-0,43)	-0,0042 (-1,14)	-0,0037 (-1,01)	-0,0041 (-1,12)	-0,0037 (-0,99)
select by urban	Y	Y	Y	Y	N	N	N	N
select by rural	N	N	N	N	Y	Y	Y	Y
intercept allowed to vary	Y	Y	Y	Y	Y	Y	Y	Y
N	271	271	271	271	1544	1544	1544	1544
F(r,df)	41,87	37,93	38,78	37,14	105,1	99,46	98,89	93,02
	(15,255)	(17,253)		(18,252)	(16,1527)	(17,1526)		(18,1525)
F prob	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
corrected R^2	0,70	0,71	0,72	0,72	0,51	0,52	0,51	0,52

*Heteroscedasticity-adjusted t-statistics in parentheses, all equations contain also intercept varying among regional examination committees

*Specifications 2 and 6 are repeated after Table 3

Estimations presented in Table 4 do not unambiguously confirm the existence of two opposite effects of economic motivation on educational quality. When both squared and 'raw' unemployment rate is included, the former remains below significance bound in urban specification and on the edge of statistical significance in rural environment.

The impact of school resources on school outcome seems to be non-linear only in urban sample. In linear specification (2) the coefficient of school expenditures is insignificant at 95% level and negative. As squared expenditures are introduced both raw and quadratic term become significant, respectively with positive and negative sign. Thus, in urban municipality with low expenditures per student, an increase in resources would lead to the improvement in educational quality. However, as the expenditures rise, their productivity drops, revealing decreasing returns to scale. Non-linearity of school resources effect on test score reflect the difference in the level of educational infrastructure between small towns and large, wealthy cities. In the first group, return (in terms of school outcome) to resources spent per one student is probably close to this in rural areas, while in metropolitan cites, additional spending doesn't contribute to educational quality as other factors remain unchanged.

Within rural sample the relationship between school expenditures and educational quality is confirmed linear, as quadratic term turns out to be insignificant at 95% level.

Although introducing nonlinear effects in the specification for rural areas clarified some doubts on the relationships between school outcome and explanatory factors, it did not help much to explain the underperformance of German sector. The coefficient by German dummy in rural areas has decreased from 0,034 to 0,031, still leaving a 3% average gap between this area and the rest of the country unexplained by the four factors defined in the initial section of this paper.

Historical legacy and determination of educational outcome

Between 1795 and 1918 today's territory of Poland remained divided between three countries: Germany (Prussia), Russia and Austria (Austro-Hungarian Empire). The occupation lasted over 120 years, during the period of formation of modern European economies and societies. Important processes, such as mass industrialization and the twilight of feudal agriculture, not to mention democratization and decentralization of public life, took different forms and started at different time in three historical regions of today's Poland. Those differences had long term consequences for socio-economic potential of the regions. Numerous researches confirm that western and north-western part of contemporary Poland (formerly under German rule) is better developed in terms of technical infrastructure and entrepreneurship that the East, formerly belonging to Russia (Gorzelak 1998, Gorzelak et.al.1999) . Also the south-eastern part of the country, conquered by the end of XVIII century by Austro-Hungarian empire tends to perform better than former Russian sector, although much of it's territory is consists of scarcely populated mountain area.

A brief look on the map illustrating the geographical distribution of average test scores in Polish primary schools (Figure 1) suggests that historical legacy may also account for substantial part of variation in educational quality. Surprisingly enough, north-western (ex-German) part of the country achieves visibly lower average school outcome than eastern (ex-Russian) or Southern (ex-Austrian) regions. In fact, test score map looks like a mirror reflection of usual findings on Poland's regional development.

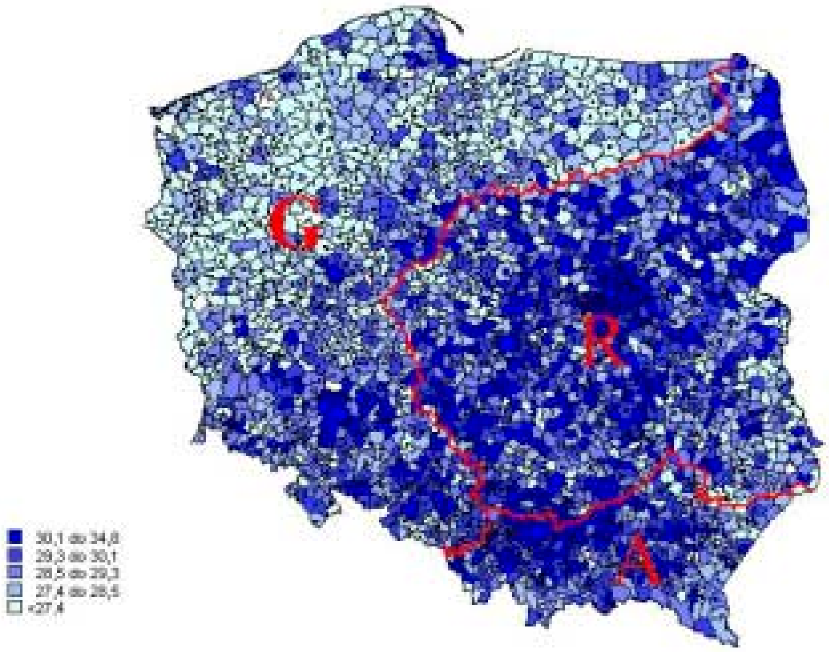

Figure 1 – Average test scores in municipalities and 1914 borders between Germany (G), Russia (R) and Austria (A) on today's Poland territory.

In previous sections the impact of explanatory factors on educational quality was generally assumed as common among historical regions. Regional dummies were supposed to capture eventual interregional differences that the model has failed to explain, but they were meant as a correction for functional misspecification rather than for significant differences in coefficients. Such approach was useful for urban-rural type of analysis, but with respect to historical divisions it provided only averaged results. In fact the linear restriction equalizing model coefficients among historical regions has been rejected by the Chow test. In this section the model will be estimated separately for the three regions in hope to put some more light on the role of explanatory factors in determining educational quality.

Descriptive statistics show that average school outcomes in German sector are lower than in remaining two sectors both within urban and rural sub-sample. The results in previous sections revealed that the gap is more efficiently explained when the model is applied in rural environment, as German sector dummy remains below 95% significance bound. Meanwhile for rural areas the gap remains significant regardless explanatory factors included in the model, and it's importance is only slightly decreased as a result of introducing non-linear specifications of unemployment and school resources. From Table 5 we know that the difference between average educational quality in former German and Austrian rural territories is about 5%. Since the value of German sector dummy in specification (14) is 0.03, we may conclude that the model based on four explanatory factors has explained less than a half (2% out of 5%) of between-sector gap.

The comparative analysis conducted in this section will be restricted to rural municipalities, since in rural environment the differences historical sectors are more striking and less efficiently captured by the country-level model.

Table 5. Average values of endogenous and explanatory variables in rural municipalities. Poland's mean for rural areas=100

	German sector		Russian sector		Austrian sector	
POLAND (rural) =100	Mean	std dev	mean	std dev	mean	std dev
average test score	96,78	98,81	101,56	93,09	101,94	76,46
intraschool std deviation	103,89	85,63	98,47	111,51	96,56	72,80
value added by school	93,81	85,76	103,79	104,66	101,08	82,66
PIT per capita	110,49	92,97	90,88	102,45	106,29	98,00
unemployment rate	123,72	112,81	87,75	69,13	88,10	59,94
per student expenditure	100,45	106,00	100,68	102,67	96,90	73,03
average human capital stock	100,52	131,17	99,55	74,78	100,31	79,99
human capital change	134,32	103,09	49,23	94,74	187,13	68,82

As shown in Table 5, beside low average school outcome, rural part of German sector is characterized by relatively low value added by school, high unemployment rate and variation of test score within schools. When compared to remaining part of the country, it also has high average level of PIT collected per capita.[5]

Although average human capital stock in adult population of German sector is close to national average for rural areas (100,5%), it's variation among municipalities is much higher than in other regions (131,2%). During last 14 years the young inhabitants of former German territories have been investing extensively in education. The change in average years of schooling reached 134,3% of country mean, which decidedly exceeds the corresponding value in Russian sector (49,2%), but is lower than the result of Austrian part (187,1%).

There is no doubt that XIX century has left it's mark on development potential of the three historical regions. The statistics included in Table 5 suggest however, that the key for the explanation of educational quality differentiation in Poland may be also related to the events that took place in the middle of XX century, after World War II. Large part of what in this paper is referred to as German Sector (namely it's western and northern part) has not been included into Poland in 1918, when the country has regained it's independence, but only in 1945, as a consequence of Germany's defeat in the war. New territories in the west and north became the compensation for the eastern provinces, lost at the same time to USSR. As a result of border changes a huge campaign of expulsions and resettlements was launched: German population has been forced to leave their homelands and move behind newly established border, and Polish citizens were have been transferred from the eastern peripheries of pre-war Poland to the new areas in the west and north.

As already noted, newly acquired territories were generally better endowed than central and eastern Poland in terms of development infrastructure: roads, railway, electricity and telephone network, water distribution system etc. These advantages are continuously reflected in numerous statistics on local development, wealth and business activities in today's Poland. However, 're-colonization' of the west involved also some long term negative effects on socio-economic situation of the region. A new property system had to be established. As the power has been taken over by the communist party, most of the pre-war private property, including enterprises, buildings and land was nationalized. This was common for the entire area of Poland, not only new territories. The exception was made for small agricultural plots that were left to it's owners and remained private property for the whole communist period (1946-1989). In newly acquired part of the country, where there was no continuity between pre-war and post-war ownership,

[5] However, as it has been already noted, in rural environment this indicator measures rather intensity of non-agricultural economic activity than directly wealth or income, since farmers are not PIT payers.

large state farms (PGR) have been extensively created in rural areas. PGRs were employing agricultural workers, but both land and output remained property of the state. In rural areas of north-western Poland state farms became principal employers, and in some districts their share in agricultural land possession exceeded 20%. Also in mid-west, in the part of German sector that belonged to Poland yet before World War II, public ownership of agricultural land became very common, although not as dominant as it happened in recently acquired areas.

After 1989, when Poland entered the transformation path towards free-market economy, all PGRs have bankrupted, leaving unemployed thousands of workers, unprepared to compete on the labor market. Pathologically high structural unemployment, inability to break through the misery, and the feeling of being betrayed by the authorities are still, after 15 years, common in those areas, often referred to as 'post PGR'. On the basis on conceptual framework and results presented in this paper we may suspect that low educational quality in former German sector is related to 'post PGR' syndrome. However, if the underperformance turns to be territorially restricted to the area included to Poland after the war, we should rather speak of 'new territories' syndrome, and look for direct explanations in cultural and social consequences of resettlements campaign and the phenomenon of 'society without roots', widely documented by Polish sociologists .

To put more light on historical sources of educational quality differentiation, the estimations in Table 6 are conducted separately for each of the historical regions. In column 16 a dummy variable has been included in order to verify whether there exist statistically significant (and not captured by the model so far) gap in educational quality between two parts of German sector: one included to Poland in 1918 and one acquired after World War II. Both '1918' and '1945' dummies are included in column 15, where model is estimated on pooled samples covering all rural municipalities in Poland.

Table 6. Model estimates for rural areas by historical region*

Variable	15		16		17		18		19	
log intra-school std deviation	**-0,2286**	(-25,3)	**-0,2541**	(-12,6)	**-0,2473**	(-12,5)	**-0,2181**	(-19,8)	**-0,2481**	(-10,6)
log value added by school	**0,0277**	(3,00)	-0,0071	(-0,38)	-0,0094	(-0,50)	**0,0340**	(2,83)	**0,0517**	(2,87)
unemployment rate	**-0,0952**	(-3,92)	**-0,1105**	(-2,98)	**-0,0966**	(-2,53)	-0,0359	(-0,97)	-0,0958	(-1,43)
human capital stock	**0,0103**	(2,36)	**0,0264**	(3,45)	**0,0254**	(3,30)	0,0095	(0,75)	0,0277	(1,64)
human capital change	**0,0092**	(2,45)	**0,0276**	(3,70)	**0,0258**	(3,47)	0,0004	(0,09)	**0,0223**	(2,02)
log PIT	**0,0111**	(2,46)	-0,0014	(-0,15)	0,0019	(0,18)	0,0100	(1,62)	0,0153	(1,78)
log school expenditure	**0,0151**	(2,02)	0,0065	(0,52)	0,0058	(0,47)	0,0163	(1,55)	0,0226	(1,33)
German sector 1918	**-0,0264**	(-4,67)			**0,0146**	(2,48)				
German sector 1945	**-0,0438**	(-6,59)								
select by German sector	N		Y		Y		N		N	
select by Russian sector	N		N		N		Y		N	
select by Austrian sector	N		N		N		N		Y	
intercept allowed to vary	Y		Y		Y		Y		Y	
N	1544		520		520		776		248	
F(r,df)	100,5	(17,1526)	41,19	(11,508)	38,84	(12,507)	47,35	(13,762)	29,22	(8,239)
F prob	0,000		0,000		0,000		0,000		0,000	
corrected R^2	0,52		0,46		0,47		0,44		0,48	

*Heteroscedasticity-adjusted t-statistics in parentheses, all equations contain also intercept varying among regional examination committees

Educational quality function differs substantially among historical regions of Poland. In German sector (16) it is conditioned mostly on out-of-school factors, such as local human capital stock and economic motivation (unemployment). One additional year of schooling in 'old' or 'young' generation is associated respectively with 2,6% and 2,7% positive shift in school outcome, ceteris paribus. A reduction in unemployment rate by ten percentage points would lead to educational quality improvement of 1,1%.

As in all equations estimated in this paper, educational quality in German sector is highly sensitive to school composition. Negative effect of heterogeneity on students' outcomes may be related both to socio-economic inequalities between students and the consequences of within school policies, such as hidden curricula or ability grouping. Any detailed analysis in this matter has to be conducted on individual school and student data. Aggregated framework used in this paper does not allow to distinguish between different aspects of school composition, especially between natural and within-school created inequality.

It is worth noting that both variables referring directly to school quality - school resources and value added measure, are of very small magnitude (the latter even negative) and statistically insignificant as determinants of educational quality in former German territories. Also private income variation does not have remarkable effect on average school outcome as human capital stock is controlled.

In contrast, in Russian sector the only two variables affecting significantly educational quality are those related to local school system. Again, of great importance, although slightly weaker than in former German territory, is school composition factor. An increase of score dispersion by one standard deviation is associated with a drop in school outcome by 3,1%. School value added contributes to overall educational quality with 0,5% positive response to a change by standard deviation. Although the effect of school resources is below 95% significance bound, it's coefficient reaches the value of 0,016, as compared with 0,006 in German sector. We may thus conclude that, with respect to German specification, educational quality in Russian sector relies more on the performance of school. It seems in turn quasi independent on socio-economic characteristics of the locality. Economic motivation and both variables referring to average human capital stock turn out statistically insignificant and their coefficients take much lower values than it happens in former German territory.

Finally, educational quality in Austrian sector (19) seems to be sensitive to both school and socio-economic factors. Similarly as in other areas, inequality has a strong negative impact on school outcome. Average test score in Austrian sector is however much more responsive to school quality measured by value added indicator. A 10% increase in value added is transformed in 0,5% gain in educational quality. Therefore, a change of one standard deviation results in 0,7% gain in average test score. As in ex-Russian territory, school resources are below statistical significance bound, but their nominal impact on school outcome is highest among all historical regions: 0,2% as a result of 10% increase in expenditures per student.

Differently than in preceding two specifications, in Austrian sector we do not observe a school versus non-school factors trade off. Educational quality is significantly affected by school quality, but relies also on socio-economic situation of the family and neighborhood. The strength of this latter relationship is similar as in German sector, with the exception of income effect, being much stronger in former Austrian region. A 100% increase in average income would lead to 1,5% gain in local educational quality, independently on shifts human capital stock.[6]

The results in column 15 and 17 provide the evidence that there exists a within sector gap in average test scores between the area belonging to Poland since 1918 and remaining part of ex-German territory. Independently on the level of explanatory factors, the average result in the 'old' part is higher by 1,5% than in the 'new' one. If fixed effects of both areas are measured within pooled (all country) regression, the difference turns out to be even more striking. As we remember from columns 6 and 14, the average underperformance of German sector with respect to the rest of the country exceeded 3%. When estimated separately, educational quality in recently acquired area is almost 4,5% lower than in other regions, and the underperformance of 'old part' is about 2,6%. We may intuitively locate the 'old' part of the sector more or less in halfway between recently incorporated ex-German territories and central and eastern Poland.

There is no doubt that 'post PGR' syndrome provides an important and useful explanation of lower educational quality in German sector. In those areas where large, state-owned farms were extensively developed, average test scores are significantly lower that in remaining part of the country, independently on other explanatory factors. The difference between two parts of the sector is probably the reflection of uneven intensity of public sector involvement in agriculture, but may also represent a social consequence of post war resettlements campaign. In the absence

[6] Coefficients in the equation for Austrian sector are generally characterized by lower t-statistics than it happened in remaining two historical regions. This is partly justified by relatively small number of observations. Unless the magnitude of variables' impact on educational quality was high as compared to preceding specifications, corresponding factors were considered as contributing to average school outcome, even if reported t-probability level remained slightly below 95% level.

of precise, municipal level data on land ownership structure before 1990, this issue requires more careful investigation on school and individual students level.

Whether we refer to post-PGR syndrome, or to ‘resettlements syndrome’, it is clear that the underperformance of German sector is not sufficiently explained by the combination of four explanatory factors included in educational quality model. Disproportions in average school outcome between historical regions of Poland are only partly caused by uneven socio-economic development or distribution of the resources. For profound historical and cultural reasons in some areas (Austrian sector) educational institutions perform better and are able to combine endogenous and exogenous resources more efficiently, while in others (German sector) educational quality relies rather on out-of-school education.

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