Divergent historical experiences and inequality in academic achievement: the case of Poland

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Abstract

Divergent histories and changing country boundaries can lead to substantial within country variation in economic and social structures and inequality in economic and social outcomes. Given its changing borders and turbulent history, Poland provides a fertile setting for an examination of the effects of social and economic structures. In this paper we investigate regional variation in academic achievement in Poland in order to gain a better understanding of the effects of local social and economic structures on educational outcomes. The results suggest that economic dislocation following the transformation and the absence of long-lasting social institutions as a result of population relocation have had longer term adverse effects on academic achievement.

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Introduction

Borders change, at times dividing nations and at other times bringing together areas with divergent political, economic, and social structures under one flag. Such differences can lead to regional inequality in income, educational attainment, and other outcomes that persist well after unification and place pressure on central governments to redistribute resources toward less developed regions. Germany, the United States, and Italy provide prime examples of nations with sharp regional differences that have devoted substantial effort and resources to address inequalities resulting at least in part from divergent paths taken prior to unification as a single nation. Although some effort goes toward lessening regional income inequality, substantial attention is also devoted to the reduction of regional differences in educational opportunities and academic attainment in order to reduce future inequality.

Myriad factors related to political, social and economic structures at the time of unification, the structure of government policies going forward, economic conditions, and other variables affect the rate of regional convergence educational outcomes. In Italy, a country that was unified in the mid 19th century, academic achievement is much higher in the northern region, in line with the differences in per capita income (Lynn 2010). The United States also exhibits significant inequality in achievement that tends to line up with average income differences (Parcel and Dufur 2009). However, the interdependence of economic performance and educational achievement is not the universal rule; in the case of Germany the economically lagging east recently outperformed the much richer West on the international PISA test. (Welt-Online 2008).

In this paper we investigate regional inequality in academic achievement in Poland, a country that has experienced a turbulent recent history of dramatic changes in economic and social structures, reconfiguration of borders, and population resettlement. Though Poland was not divided following

WWII as was the case with Germany, its borders were reconfigured and there was substantial population relocation. Moreover, the intensity of agricultural collectivization and economic dependence on heavy industry varied significantly by historical region. Of particular interest to us is the interrelationship among the divergent social and economic structures prior to WWII, imposed political and economic changes under communism, and the post-communist transformation begun in 1989.

Researchers describe inequality along a number of dimensions in Poland, but we focus on differences in academic achievement.[1] Recent work by Hanushek and Woessmann (2007) highlights the contribution of cognitive skills to economic growth. Because measures of education quantity such as years of schooling fail to capture important skill differences, standardized test scores have been receiving increased emphasis internationally. The development of standardized achievement tests in Poland that are comparable over time and administered and evaluated outside schools provides a source of information with which to evaluate the determinants of geographic differences in cognitive skill acquisition.

The inter-related nature of historical events and consequent differences in social and economic structures complicate efforts to assign a specific role to each. Therefore we focus on the relationship between academic achievement on the one hand and a set of current family, social, and economic factors that have been influenced by many historical events. Rather than treating history as a "black box" or a cultural "cloud" hanging over some territories, we attempt to identify the impacts of specific factors that themselves can be linked to particular historical influences.

[1] This includes substantial geographic differences in the level income and economic growth (Herbst 2008), labor market structure (KPRM 2009), roads, railroads, and telecommunication network (MRR 2009) and politics (Zarycki 2000).

The availability of multiple years of test score data enables the use of panel data methods to account for other regional differences that could contaminate the estimates.

The results suggest that economic dislocation following the transformation and the absence of long-lasting social institutions as a result of population relocation have had longer term adverse effects on academic achievement. They also show that achievement is significantly related to standard education production function variables including per-student expenditure, teacher qualifications, and parental income, illustrating specific policy levers that could be used to mitigate inequality resulting from the divergent historical processes.

The paper has the following structure. In the next section we describe the various data sources used in the empirical analysis. Section III briefly describes the historical evolution of Polish regions and current regional differences in education and economic outcomes. Section IV develops the empirical model used in the analysis of test scores, and Section V presents the results. This section also discusses the implications of the findings for particular hypotheses regarding the channels through which historical events have influenced geographic inequalities today. Section VI summarizes the analyses and considers implications for education policy.

Section II. Data

The test scores and data used to construct the explanatory variables come from a number of sources. Test scores come from the Polish Central Examination Committee. Poland introduced its national testing system in 2002 with tests in grades six and nine and added grade twelve in 2005 (the 6^{th}, 9^{th}, and 12^{th} grades are the final grades of the primary, lower secondary and upper secondary tiers, respectively). Test structure differs by grade: the sixth grade examination is a single test verifying students' basic

cognitive skills; the test for lower secondary school leavers (ninth grade) is divided into math-science, humanities and foreign language parts; and the twelfth grade examination, after which students attain full secondary education, is divided into subjects, with the possibility of choosing regular or extended versions of the test.

Because of a growing body of research that showing that schools have a larger effect on mathematics than on reading achievement and that mathematics achievement has a larger impact on wages, we focus on the ninth grade math-science test. We transform the test score into a standardized score with a mean of zero and standard deviation of one in each year. Note that we use municipality populations to weight the municipality average scores in the construction of the standardized score.

Information on the explanatory variables comes from several sources. The data on the proportion of locally born residents among those born before 1945 and on educational attainment in the parents' generation (population 35-50 years old) is derived from the national census conducted in 2002. Because there is no more recent census information, the 2008 parental attainment variable was constructed from 2002 information on younger cohorts (aged 30-44). Consequently this variable does not account for the limited movements for this age group among regions or countries between 2002 and 2008. To account for the effects of selective migration into particular municipalities we use data on migration flows between municipalities averaged over 8 years preceding the observed school tests (thus 1994-2001 and 2000-2007 respectively) provided by the Polish Central Statistical Office. This office is also the source of information on per student expenditure, the local unemployment rate, and the proportion of the population living in rural areas. Finally, data on teachers' formal qualifications comes from the Ministry of Education SIO Database.

The research is performed at the level of the 2,478 Polish municipalities for the years 2002 and 2008. The year 2002 was first year in which the nationwide achievement tests were administered, and 2008 is the most recent year for which all data are available. Although 9th grade's test scores are reported annually between 2002 and 2009, other important information is not available for most of this period. Therefore we limit our analysis to the two years. Most of the variables are available at the municipality level, though unemployment rate and educational attainment data are only available at the higher level of aggregation of 379 counties. This aggregation does not introduce bias in a linear model, and we adjust the standard errors accordingly by clustering at the higher level of aggregation.[2]

Section III. Regional Differences in Poland

This section begins with a description of the geography of Poland and a brief discussion of historical events related to the divergent experiences of the different regions. It then describes current geographic variation in income and achievement as a first cut at understanding the potential importance of different historical processes and as a description of the variation to be used in the education production function analysis.

IIIa. Brief History

The recent history of the territories that make up Poland today reveals that the four historical regions illustrated in Figure 1 took very divergent paths to statehood and that the entire nation has undergone a series of profound social and economic changes following WWII. Although many focus on the impact of communist rule on current economic and social conditions, some sources also emphasize the importance of the period prior to WWI in understanding current geographic differences.[3]

[2] See Theil (1971) for a discussion of aggregation in linear models.

[3] Some Polish sociologists, economist, and geographers provide arguments and evidence that these divergent paths contribute to current regional differences in Poland. These include Bartkowski (2003), Gorzelak and Jalowiecki (1997, and Działek (2009).

Regional differences at the onset of communist rule may well have influenced the nature of the imposition of economic and social structures in ways that affect the development following the transformation in 1989.

Between 1772 and 1795, following a series of military defeats, Poland was divided among three neighboring powers – Russia, Prussia and Austria. This division took place in three stages and eventually involved the entire Polish territory. The territory under Prussian rule (post-Prussian region in Figure 1) was the most developed part of Poland at the time of the partition, while the eastern territories under Russian rule were the least developed. Up until the reunification of Poland following WWI the three regions were exposed to very different political and administrative cultures and experienced very different rates of economic growth, with territories under Russian rule being generally less advanced economically and lagging in terms of the development of modern social and political structures.

Following WWII the Yalta agreement redefined Polish borders: Poland lost its most eastern territories to the Soviet Union and in compensation it gained some formerly German territories in the west and north-west. This resulted in the expulsion of the German population from the areas acquired by Poland and mass relocation of Polish citizens from the remaining parts of the country and the territories lost in the east to the west and north-west. Between 1945 and 1950 the inflow of population to the new territories in the west and north reached 2.9 million, 55% of which came from the areas ceded to the Soviet Union (Gawryszewski 2005). The composition of the post-German territories and rest of Poland remained relatively stable in the subsequent decades, as mobility was limited under the centrally planned economy.

The newly acquired (post-German) territories were characterized by a relatively high level of infrastructural development (road density, water management facilities, urbanization level) as compared to the remaining part of the country, especially the eastern regions. However, the expulsion of German nationals and the repopulation of the post-German territories with families from the far less developed east created a region with a largely uneducated population that lacked both human and social capital.[4]

Although poorer and far more rural that the post-German region, the post-Austrian region consists of communities with deep social roots, and with the exception of some areas in the east, haven't experienced the large scale dislocation after the World War II. A strong asset of the region is the city of Cracow (Krakow), its economic and cultural center.

The collapse of communism and subsequent transformation caused substantial economic dislocation in Poland, the intensity of which varied by region. The territories acquired by Poland after World War II as well as the industrialized Wielkopolskie and Slaskie regions (see Figure 1) in the mid-west appear to have been particularly hard hit due to the economic structure of these areas. The large proportion of the labor force employed in big state owned companies contributed to a sharp increase in unemployment and a decrease in family income during the 1990's.

[4] The concept of social capital, developed in the classical works of Bourdieu (1986), Coleman (1988), and Putnam (1993) refers to common characteristics of groups of people, such as beliefs, social norms, or confidence towards others, which exert influence on individual achievements of group members in many areas of their life. There exists strong international evidence for school and community level of social capital influencing education outcomes through issues related to school management, cooperation between parents and school, student motivation, peer interactions, and out-of-school learning (Coleman, Armor et al. 1966; Israel and Beaulieu 2004; Andersson and Subramanian 2006; Gordon and Monastiriotis 2007).

In the case of the post-German territories, the repopulation of the areas with migrants from the east appears to have facilitated the imposition of the socialist economic paradigm, which placed the area at a disadvantage during the transformation. Perhaps most important was the establishment of large, state owned farms (PGRs) as a predominant economic form in rural areas of this region. They were employing farmers as workers, without granting them ownership of land. In many areas the PGRs were not only major employers but also institutions responsible for organizing local social life. The collapse of the state farms after the end of communist rules in Poland (they all went bankrupt in early 1990's) has driven structural unemployment rate to 40% in some areas, leading to the material and social degradation of entire communities (Domańska 2002), (Gorzelak, Herbst et al. 2006). By comparison, the central government was far less successful in collectivizing agriculture in the "traditionally" Polish regions, where social networks and even some of the pre-war ownership structures (with respect to land and other real estate) were preserved.

IIIa. Regional Variation in Income and Achievement

Figure 2 illustrates regional variation in per capita GDP and achievement. The left panel shows that income in eastern Poland remains generally well below income in the west, with the exception of Warsaw. Note that Eastern Poland generally relies much more heavily on the traditional agricultural sector, is far more conservative in voting preferences and has less developed infrastructure of any kind than the areas in the west.

By comparison, the right panel shows that average achievement in 2002 was highest in central and eastern Poland and lowest in the relatively affluent regions in the west and north. The absence of a strong, positive correlation between municipality average income and educational achievement contrasts the pattern observed in many but certainly not all countries. The pattern observed for Poland hints at the possibility that some factors favorable to high income such as a developed manufacturing

sector may actually dampen educational attainment, possibly by reducing the expected return to schooling and incentive to acquire human capital.

Section IV. Empirical Framework

The inter-relationship among the various achievement determinants complicates an analysis of the contribution of historical events to inequality in academic achievement. Preferences, economic opportunities, social conditions, the quality and availability of public schools, and myriad other factors affect the choices of where to live and send children to school, and all of these factors are influenced by history. This interdependence introduces many pathways through which historical factors can influence academic outcomes, particularly in Poland where changes in geography, political, and economic institutions have had a profound effect on many aspects of life.

Our approach focuses on achievement differences among the four Polish historical regions and the degree to which specific family, school, economic, and social factors account for those differences. The four areas are frequently referred to in Polish literature with historical names, such as Galicia, Congress Kingdom, Eastern Prussia etc. In this paper, for simplicity we will use the labels: post-Russian (for the territories under Russian rule before WW I), post-Prussian (for these under Prussian power in the same period), post-Austrian (for the territories controlled by Austria and then the Austro-Hungarian Empire before WW I), and post-German (for Poland's territorial gains after WW II)[5]. Although Warsaw (the capital of Poland) is located within the post-Russian area, we treat it as a separate region because of its far higher average income and average years of schooling and very different economic and social structures than the surrounding municipalities.

[5] As one can see on Figure 1 the historical borders do not fully overlap with the current administrative division of Poland.

In order to identify the effects of specific factors on achievement the empirical model must control for confounding factors that can introduce bias. Given the limited information on schools, families, and communities, the available variables will not account for relevant confounding factors. Fortunately, the multiple years of test score data facilitate the use of models that control for unobserved differences among municipalities that are constant over time. We will use these fixed effect models to estimate the effects of specific variables and to describe residual average achievement differences among regions not explained by the included variables.

One limitation of fixed effects models is that variables whose values do not change over time cannot be included in the model. In this context historical information cannot be included directly, and we must investigate the relationship between achievement and historical factors using a different approach. We look at the average values of the municipality fixed effects in the historic regions to see whether the regional differences in achievements remain significant after we control for the family, school, and community related factors. Then we discuss the residual differences in the context of diversity of historical experience, as expressed by the regional averages of the history related variables.

IVa. Regression Specifications

In this section we describe the models used in the empirical analysis. Because we do not have access to student level data and are unable to follow students as they age, we develop the model at the municipality-year level of aggregation. Note that some municipalities consist of a single or small number of schools, and others include many schools. In addition, information on some variables is provided only

at the more aggregate county level, and we account for both enrollment differences and aggregation to the county level in the estimation.

Equation (1) highlights key issues that must be addressed in order to generate consistent estimates of the causal effects of characteristics on achievement. Here average achievement A for students in municipality s in year y is a function of average family (X), school (S), economic (E), and social (M) characteristics:

$$(1) \qquad A_{sy} = \beta X_{sy} + \delta S_{sy} + \lambda E_{sy} + \gamma M_{sy} + \theta_s + e_{sy}$$

Family background is measured by the distribution of parental education into four categories, schools are characterized by teacher qualifications and spending per-pupil, economic activity is measured by the local unemployment rate, and the social environment is measured by proportion of the municipal population living in rural areas, the share of the elderly population living in the same municipality in which they were born, and the average inflow of the population to the municipality in the previous 8 years (see the next section for descriptive characteristics). The error has two components, θ and *e*. θ is a municipality fixed effect that captures unobserved factors at the municipality level that do not vary between 2002 and 2008. These can include aspects of family background, infrastructure, industry composition, schools (including building quality), and other determinants of achievement. Finally, *e* is assumed to be a random error that varies by municipality and time.

If the included variables were uncorrelated with θ and *e,* OLS would yield unbiased estimates of the parameters. But given the non-random sorting of students and teachers into schools and communities and the plethora of omitted determinants of achievement, it is highly unlikely that the limited number of controls would account for all potential confounding factors.

Our basic approach is to use the availability of two observations per municipality to control for

observed and unobserved differences among municipalities in student, family, school, and community factors by including municipality fixed effects. First differences is equivalent to fixed effects in the case of two time periods, and Equation (2) writes the difference in achievement between 2008 and 2002 as a function of the difference in the variables and the errors:

$$(A_{s2008} - A_{s2002}) = \beta(X_{s2008} - X_{s2002}) + \delta(S_{s2008} - S_{s2002}) + \lambda(E_{s2008} - E_{s2002}) + \gamma(M_{s2008} - M_{s2002}) + (\theta_s - \theta_s) + (e_{s2008} - e_{s2002}) \quad (2)$$

Taking first differences eliminates the time invariant error component, effectively accounting for all fixed differences among municipalities. Consequently time-invariant unobserved determinants of achievement do not introduce bias in the first-differences model. Only variables that change over time can contaminate the estimates, and a key identifying assumption is that the included variables are orthogonal to any such factors. This assumption cannot be tested, but we discuss its plausibility and potential violations to it in the next section.

Section V. Results

This section begins with a description of regional differences in average student achievement and its potential determinants and then turns to the regression results. We are interested in both the extent to which specific characteristics account for regional variation in achievement and the implications for education policy. Consequently we discuss both the magnitudes of the individual estimates and the overall variable contributions to region differences.

Va. Regional Differences

The top panel of Table 1 shows sizeable regional differences in student achievement. Measured as the average for both years, the mean test score in math-science in the post-German and post-Prussian territories lies far lower than the mean in the post-Austrian and post Russian regions; the difference is roughly three fourths of a standard deviation. The regional differences do decline between 2002 and 2008, particular the gap between the post-German and post-Russian regions.

Note, however, that the regional convergence in test scores has not remained constant throughout the time period. Figure 4 shows that the regional differences fell between 2002 and 2006 (the year that the differences were smallest in most cases) and tended to increase slightly and stabilize in the subsequent years. Therefore it does not appear that these differentials are likely to disappear over the next few years.

One gap that has actually increased substantially over time is the differential between Warsaw and the other regions. As shown in Figure 4, achievement increased every year between 2002 and 2008. By the end of the period average achievement in Warsaw exceeded the national average by roughly two standard deviations.

The extent to which the observed characteristics account for achievement differences both among regions and over time is one of the main questions explored in the regression analysis. In order for a variable to account for a substantial portion of one of these differentials it must be significantly related to achievement and vary substantially by place or time. We now summarize the distributions of these characteristics by region.

Ignoring Warsaw for the moment, the bottom panel of Table 1 reveals generally small regional differences in the explanatory variables and a lack of systematic ordering by region. Consider first parental education, approximated by school attainment distribution of those 35 to 50 years old. The share of population aged 35-50 with higher or general secondary education attainment is between 18.6% in the post-Prussian region and 19.6% in the post-German region (the region with the lowest average test scores). Figure 3 does reveal substantial variation in the share of residents with the highest educational attainment level within regions, largely reflecting differences between rural and metropolitan areas. Most of the darkest areas on the maps (the areas with the highest shares) are large metropolitan areas including Warsaw, Cracow, Poznan, Wroclaw and Gdansk.

The distribution of the population share with only a primary education produces a slightly different pattern, though again the region differences are small and not strongly ordered by region average achievement. Although the low scoring, post-German region has the highest share (15.5%), the difference between the post-German and high-scoring post-Russian region is only 0.3 percentage points.

In terms of the school characteristics, the patterns are mixed in terms of the potential to account for region achievement differences. On the one hand, differences in per student spending on lower secondary schooling are not strongly related to achievement in the expected direction. Rather average spending is lowest in the highest-scoring historical region (post-Austrian) and highest in the low-scoring post-German region, with the differences between the four regional averages not exceeding 3%. On the other hand, differences in the share of teachers who are highly qualified (4^{th} level of professional status) correspond to differences in achievement. As Figure 3 illustrates, municipalities across the higher scoring post-Austrian and post-Russian regions tend to have higher proportions of highly qualified teachers.

The unemployment rate variable also indicates that differences in economic activity following the transformation could contribute to achievement differences. The average unemployment rate of 17.8 percent in the low-scoring, post-German region indicates that this area experienced deeper transition problems than the other regions. Remaining regional differences are small, ranging between 10.5% and 12.8%.

Finally, the variables describing population movements and community type exhibit little variation in one case and substantial variation in the other two variables. On the one hand, the share of population that arrived in the past eight years ranges from 1.0 to 1.2 percent, indicating that recent population movements are unlikely to account for much of the achievement differential. On the other hand, there are meaningful differences in the proportion of the population living in rural areas and in the share of the elderly living in the municipality where they were born. Interestingly, the share of the population living in rural areas appears to be positively related to achievement, as the two regions with highest average achievement have the two highest rural shares. As many as 52% of residents in the Post-Austrian territory live in rural settlements, while the corresponding figure for the post-German and post-Prussian regions is one third. Not surprisingly, the share of elderly born in their municipality is much lower for the post-German region acquired by Poland after the World War II (7.2%); the values for the other regions range from 36.7% in the post-Prussian to 52.7% in the post-Russian region.

Vb. Regression Results

In order to understand the contribution of specific factors to regional achievement differences we estimate two regression specifications. The first uses both cross-sectional and time series variation, while the second includes municipality fixed effects and therefore uses only within metropolitan area

variation over time. Because unobserved factors that differ across municipalities almost certainly bias the estimates from the first specification, we believe that the fixed effect specifications produce more compelling estimates of both variable effects and unexplained differences among regions as measured by region average residuals. Nonetheless, the fixed effect specifications remain susceptible to confounding factors that vary over time, and we discuss this issue below. Note that both regressions are weighted by the municipality population and that t-statistics and p-values are reported in the tables.

A comparison of the estimates in Columns 1 and 2 of Table 2 shows that the inclusion of the municipality fixed effects tends to increase the magnitude and significance of the estimates. This suggests that unobserved differences among municipalities likely bias downward the estimates of most school and family background effects. The one exception is rural share, and it is not surprising that the fixed effect estimates are small and insignificant given the generally small changes in rural share during the period in question. Cross-sectional differences in rural share are almost certainly correlated with a number of factors.

In terms of the specific factors, the share of parents with at least a secondary level academic education is significantly related to achievement, consistent with virtually universal finding that higher parental education raises achievement. Surprisingly, the share that has completed a secondary vocational degree is negatively related to achievement. This suggests that a strong vocational orientation may not be conducive to academic achievement, though it also raises the possibility of omitted variables bias since it is surprising that additional parental schooling, even with a vocational emphasis) would reduce the achievement of children.

The coefficients on school spending and teacher qualifications support the belief that higher spending and more qualified teachers raise achievement. All are positive and significant at the 0.01 significance level in the fixed effects specification. The one anomaly is the larger coefficient on share with 3rd level as opposed to 4th level qualifications; the magnitude of the coefficient on share with 4th level qualifications is quite similar to that of the share with 2nd level qualifications coefficient.

Two phenomena likely contribute to the non-monotonic relationship between teacher credential level and student performance. The first is that changes in the distribution of teacher certification levels come from both changes in the stock of teachers and the acquisition of higher level credentials by current teachers. If these credentials serve as signals of quality, acquisition of a higher level credential by a teacher already in the municipality should have little or no effect on the quality of instruction. As it takes longer to achieve the highest level credential, a larger share of teachers in the 4th level category in 2008 were teaching in the municipality in 2002 albeit with a lower level credential in many cases. Therefore the changes over time in the share of teachers with the highest level credential provides a noisy measure of the change in teacher quality associated with hiring teachers able to achieve that credential, likely attenuating the coefficient.

The second phenomena concerns teacher cohort differences in quality that would also tend to attenuate the coefficients for the higher levels of certification. Improvements in pay and working conditions beginning in the late 1990s made teaching a more attractive profession in Poland and likely increased the quality of new entrants. As the highest certification levels have minimum experience requirements that preclude new teachers from attaining those levels regardless of their skills, any negative relationship between experience and teacher quality would tend to introduce negative bias into the estimates of the highest level certification coefficients in the absence of experience controls.

The unemployment rate and share of population new to the area coefficients are also highly significant. In the case of the unemployment rate, the negative estimate indicates that economic problems adversely affect academic achievement. Whether the underlying mechanism is a lack of family resources or poor family environment caused by job loss is not clear. In the case of population movement, the positive and significant estimate suggests that a higher share of new entrants is associated with higher rather than lower achievement. This indicates that any disruption caused by migration is offset by other factors which could include population movement to areas with better schools or economic opportunities or a stronger commitment to academic success on the part of movers.

Vc. Sensitivity Analysis

Violation of the strict exogeneity assumption biases the estimates, and the underlying processes through which families select communities and schools and teachers obtain credentials suggests that time varying factors may well contaminate the estimates. If families with greater resources or a higher emphasis on schooling tend to live in municipalities with better schools, the parental education variables will capture the effects of school quality not captured by the teacher credential and per-student expenditure variables. And if more highly motivated and future oriented families tend to leave areas with high unemployment, the unemployment rate effect in part reflects unobserved differences in family environment.

Although it is not possible to measure the biases introduced by unobserved factors, we can use information on the sensitivity of the estimates to the exclusion of particular variables in order to get a sense of the likely effects of unobserved factors.[6] For example, if family commitment to schooling is related to unobserved aspects of school quality and local labor market conditions, one would also

[6] Altonji, Elder and Taber (2005) discuss selection on observables and unobservables and develop an informal method for assessing the probability that selection on unobservables introduces substantial bias.

expect it to be related to the municipality unemployment rate, per-student expenditure, and teacher qualifications; these are tangible factors perceived to capture important difference in school quality and the local economic environment. Therefore the sensitivity of the estimates on the parental education variables to the exclusion of both the unemployment rate and school quality variables, all highly significantly related to achievement, provides information on the likely impact of unobserved factors. If the estimates are not sensitive to the exclusion of these variables it reduces the likelihood that unobserved factors introduce substantial biases.

Using a similar rationale the exclusion of the parental education variables provides information on the extent to which changes in the composition of families influence the estimated unemployment rate and school quality effects on achievement. In terms of the former, if the exclusion of parental education does not significantly change the unemployment rate coefficient it is unlikely that unobserved family factors orthogonal to parental education introduce substantial bias through family mobility in response to job opportunities. In terms of the latter, if the exclusion of parental education does not significantly change the school quality coefficients it is unlikely that unobserved family factors orthogonal to parental education introduce substantial bias through family mobility in response to school quality.

Table 3 reports both least squares and fixed effect estimates with subsets of variables excluded from the specifications, and the results suggest that some fixed effect estimates might be more susceptible to bias from confounding factors. On the one hand, the exclusion of school characteristics and the unemployment rate has little impact on the estimated effect of the share of parents with higher education, reducing the magnitude of the estimate by less than 10 percent; the remaining parental education variables are not significant with or without the set of variables, though their magnitudes are a bit more sensitive to specification.

On the other hand, the estimated effects of the teacher characteristics and unemployment rate are generally somewhat sensitive to the inclusion of the parental education variables, though the changes in coefficient magnitudes are small. In the case of the teacher certification variables, the pattern of the estimates is invariant to the exclusion of the parental education variables, and their exclusion has virtually no effect on the magnitude of the third level certification effect (1.56 to 1.60) and only modest effects on the estimates for the other two levels (1.08 to 0.77 for the 2nd level and 1.06 to 0.74 for the 4th level). In the case of the unemployment rate the magnitude of the effect decreases by roughly 30 percent.

All in all the pattern of estimates provides some support for the belief that contamination from omitted factors is likely to be minor, though the strength of the support differs by variable. Importantly, the first three columns of Table 3 show that the weighted least squares estimates are far more sensitive to the exclusion of variables, reinforcing the belief that fixed differences among municipalities are likely to introduce substantial biases in the absence of the fixed effects.

Vd. Regional Differences

We now use the coefficients to measure average achievement differences among regions not explained by the included variables. The first column of Table 4 reports unadjusted region means, the second column reports the region coefficients from the regression without municipality fixed effects, and the third column reports region average municipality fixed effects obtained from the fixed effect regressions. A comparison of the differences in unadjusted means with the differences in region average fixed effects shows the extent to which region differences in the included factors account for the raw

region differences. Note that the residual differences could actually exceed the raw differences in some cases if differences in the included characteristics actually offset differences due to unobserved factors.

In fact a comparison of Columns 1 and 3 shows that controlling for the characteristics reduces region differences in most but not all cases. The included variables more than fully account for raw achievement differences in one case (post-Prussian v post-German), fully account for differences in one case (post-Austrian v post-Russian), partially account for the gap between the post-Austrian and post-German regions, inflate the gap between the post-Russian and post-Prussian area, and have little or no effect on the remaining differences (post-Austrian v post-Prussian and post-Russian v post-German).

The region differences in characteristics reported in Table 1 and regression results reported in Table 2 point to the unemployment rate but not to the school characteristics as important determinants of regional achievement differences. Based on both sizeable regional differences and a significant coefficient, the more difficult economic climate as measured by a higher unemployment rate appears to be a primary cause of lower achievement in the post-German region. This appears to provide a link between the post-WWII communist economic policies including the collectivization of agriculture and low academic achievement in subsequent generations.

Although the coefficients on school spending and teacher qualifications are also significant, the region differences are small. In all four regions roughly 7 percent of teachers lack any qualification beyond the first level. Thus while school quality may contribute to region differences in achievement, the included characteristics do not capture salient differences by region.

Vc. Historical factors and remaining regional differences

The substantial explanatory power of the local unemployment rate in explaining the regional gap supports the hypothesis that communist economic policies had deleterious effects on subsequent generations, but this and the other variables do not account for the bulk of the regional achievement differentials. Because of the difficulty accounting for the many factors that differ by region and potentially affect achievement, efforts to explain the residual variation with cross-sectional regressions are unlikely to produce compelling results. Therefore we take a less ambitious path and compare residual achievement differences with a small number of factors in an effort to learn whether differences in particular factors are consistent with their contributing to the observed achievement differences. We are particularly interested in factors potentially related to social capital and those related to the manufacturing share of the regional economy.

Table 5 illustrates region differences in achievement, the average fixed effects, the share of elderly that were born in the same municipality as the currently reside, the share of elderly born abroad, the share of total agriculture area under production that was collectively operated in 1992, just following the transition, and the share of workers employed in manufacturing in 2008. Patterns for the population and economic variables provide suggestive evidence that both a lack of social capital (absence of longstanding educational and social institutions) and the structure of the local economy contribute to the current achievement differences.

Columns 3 and 4 in Table 5 show that the elderly living in the post-German region were far less likely to have been born in their current municipality (fewer than half) and far more likely to have been born abroad (mostly in territory ceded to the Soviet Union) than the elderly living in the other regions. Although there is some variation in the share born in a different municipality among the other three regions the post-German region is strikingly different in the case of the share born abroad. More than

16% of the elderly now living in post-German region were born abroad; the corresponding values for the remaining three historical regions range from 3.1% to 4.5%. Thus migrants to the post-German region experienced more profound changes in terms of both physical and cultural distance. The magnitude of these changes almost certainly hindered the development of social institutions supportive of academic achievement in the post-German region. This provides a plausible explanation for the lower achievement in that region despite an income level that far exceeds that in the higher achieving post-Austrian region.

Of course these simple comparisons are far from definitive, and both the higher share of agricultural land that was collectivized as of 1992 and the higher share of workers in the manufacturing sector in 2008 for both the post-German and post-Prussian regions are consistent with alternative explanations for the lower achievement in these regions. Column 5 of Table 4 shows the average shares of collectively operated agricultural areas in 1992 (beginning of the transformation period) are 5-6% in the post-Russian and post-Austrian territories but 13.5% and 20.6% respectively for the post-Prussian and post-German regions. As a result of the mass relocation to the post-German region and unacceptable (to the communists) dominance of large private land owners in the post-Prussian region, following 1945 the western territories experienced economic collectivization at larger scale than the eastern regions of Poland. This almost certainly made the post-German and post-Prussian regions more vulnerable to the transformation shock of the 1990's, as state owned companies, both in manufacturing and agriculture proved largely unable to compete on the free market. Although the much higher unemployment rate in the post-German region during the 2000s captures a portion of the economic dislocation experienced by those in communities with a high degree of collectivized agriculture, it is certainly possible that it failed to capture all of the lingering effects of that economic structure on current day social and economic conditions.

The higher share of manufacturing employment in the post-German and post-Prussian areas (greater than 37 percent) in comparison to the post-Austrian region (30 percent) and the post-Russian region (25 percent) is consistent with another channel through which the economic structure could affect achievement: the expected return to investment in education. If a greater likelihood of working in manufacturing weakens the demand for schooling and emphasis on higher school quality by families and government officials in the more manufacturing intensive regions this would be expected to reduce achievement. The fact that the share of teachers with highest level qualifications is far higher in the post-Austrian than in the post-German or post-Prussian regions provides some support for this hypothesis, though the regression estimates do not find that having a highest level qualification raises teacher quality relative to someone with a third level of qualification. In any case, this explanation would appear to be particularly relevant to the post-Prussian region given its much lower rate of population dislocation (particularly from abroad) and a level of unemployment during the 2000s that is quite similar to the post-Austrian and post-Russian regions despite having a experienced significant economic upheaval in the immediate aftermath of the transformation.

Unfortunately, Polish data limit the possibilities for analyzing directly regional variation in the returns to various types of schooling. Household survey data can be used at the geographic level of the 16 administrative provinces to produce ratios of the average earnings of those with a higher education to those with a vocational secondary education. Figure 5 illustrates this earnings ratio for the 16 administrative provinces and shows that indeed the returns to higher education in western Poland appear to be lower than in the east. Because college graduate wages are lower in the east than in the west, if students used average earnings of college graduates at the national level in forming expectations the regional differential in the expected rate of return would be even larger. In fact, other

research show that the ability of cities in eastern Poland to retain local university graduates is substantially weaker than in the case of western metropolises (Herbst 2009).

In summary, the patterns observed in Table 5 are certainly consistent with the view that extensive population relocation and communist economic policies exerted long-term adverse affects on academic achievement, particularly in the post-German and to a lesser extent in the post-Prussian territories. These patterns also suggest that the high living standards produced by the advanced manufacturing sector in the post-Prussian region may have had a negative influence on achievement by reducing the incentives for families to invest in education and communities to invest in school quality. Yet much more work needs to be done to identify the actual effects on social structures, family choices, and current economic activity prior to drawing strong conclusions on the contributions of these historical factors on subsequent achievement.

VI. Conclusions

Regional differences in historical circumstances and academic achievement suggest the possibility that the divergent histories of the various Polish regions contribute to current inequality in academic achievement through their effects on social and economic structures, school quality, and family resources. Of course history involves a series of interrelated events, complicating efforts to isolate the importance of any one. Therefore we take an indirect path in our efforts to understand better the effects of any single event or set of circumstances. First we investigate the effects of a set of family, school, economic and social factors measured during the 2000s on academic achievement and describe their variation among regions. Second, we compute residual regional differences in achievement that remain once we account for the influences of these variables. Finally, we compare the patterns of these residual differences with differences in social and economic factors such as the collectivization of

agriculture and population relocations that are directly related to historical events. These comparisons along with the findings on the specific variables in the regression analysis that can be linked with historical events (such as the regional rate of unemployment) provide a rich set of information with which to consider the past and current determinants of academic achievement. Our approach does not provide definitive answers to the role of specific factors, but it does provide a richer fabric of information with which to consider both the legacy of particular historical events and arrangements and appropriate policies to address deficits in educational achievement in particular locales.

The results find some support for the belief that longer term differences in industrial development contribute to current regional achievement differences and stronger support for the belief that events following WWII including massive population relocation and collectivization of both agricultural and non-agricultural production had particularly adverse effects on the post-German region. The regression estimates also indicate that standard measures of school quality including teacher qualifications and spending are significantly related to achievement in the expected direction.

In terms of policy, the findings on the school and teacher variables indicate that improvements to the quality of schooling as measured by teacher qualifications and spending translate into higher achievement in Poland. It should be noted that this finding is not always replicated in other studies, highlighting the importance of delving deeper into the determinants of Polish school quality. Moreover, other reforms may be more cost effective mechanisms for raising the quality of education. Nonetheless, it confirms the importance of school quality as a lever with which to improve the academic outcomes in Poland.

The strong negative effect of local unemployment and patterns of relationships between achievement on the one hand and population movements and agricultural collectivization on the other present less clear policy prescriptions. More in-depth investigation, perhaps through descriptive and ethnographic research, might paint a clearer picture of the channels through which high unemployment, a high rate of agricultural collectivization, and extensive population mobility affect achievement could enable sharper and more targeted policies. The evidence certainly suggests the desirability of targeted efforts to increase aggregate demand to reduce unemployment and efforts to bolster social and educational institutions that support academic attainment, but these are blunt and potentially not very effective means of raising educational outcomes.

Finally, areas such as the post-Prussian region with historically advanced manufacturing economies may have weaker incentives to invest in schooling. If students in these locales have opportunities to earn good wages in manufacturing for the foreseeable future the lower investment in education would appear to be an appropriate response. However, given the global economic changes including the increase in the return to schooling such choices may be myopic and harmful to students in the long run, justifying policy interventions.

Table 1. Descriptive Statistics by Historical Regions of Poland. Population Weighted Means Calculated on Pooled 2002 and 2008 Data (Standard Deviations in Parentheses).

Variable		**Post-Austrian region**	**Post-Prussian region**	**Post-German acquired 1945**	**Post-Russian region (w/o Warsaw)**	**Warsaw**
Standardized 9th grade test score in math-science pooled		0.38	-0.37	-0.42	0.185	1.26
		(0.93)	(0.72)	(0.91)	(1.03)	(0.53)
Standardized 9th grade test score in math-science(2002)*		0.46	-0.51	-0.47	0.34	0.66
		(0.93)	(0.68)	(0.87)	(1.05)	-
Standardized 9th grade test score in math-science(2008)*		0.29	-0.21	-0.37	-0.00	2.08
		(0.84)	(0.81)	(0.99)	(0.86)	-
% of population 35-50 years old by educational attainment	*higher or general secondary*	19.0	18.6	19.6	18.7	40.8
		(9.1)	(7.8)	(8.4)	(7.4)	(6.3)
	Vocational secondary	30.8	28.5	30.2	31.6	36.6
		(3.7)	(3.8)	(3.7)	(4.8)	(0,9)
	Basic vocational	38.1	40.0	34.7	34.5	13.5
		(8.7)	(7.5)	(7.3)	(7.0)	(0.3)
	Primary	12.1	12.9	15.5	15.2	9.1
		(4.8)	(5.0)	(6.2)	(6.1)	(6.8)
Unemployment rate		12.4	12.8	17.8	10.5	3.8
		(5.1)	(7.9)	(9.7)	(5.2)	(2.7)
Per student spending on lower secondary schools (log)		8.41	8.42	8.44	8.43	9.01
		(0.39)	(0.39)	(0.41)	(0.40)	(0.61)
% of teachers by the level of qualifications	*2nd level*	20.7	19.8	19.8	19.4	21.6
		(9.9)	(7.8)	(8.1)	(9.1)	(4.9)
	3rd level	44.5	52.1	51.6	50.8	51.8
		(17.1)	(14.8)	(15.5)	(17.8)	(11.4)
	4th level	27.7	20.9	21.1	23.0	19.6
		(21.3)	(18.0)	(18.3)	(20.4)	(19.4)
Municipality share of recent arrival (yearly average over eight years in %)		1.0	1.2	1.2	1.1	1.0
		(0.3)	(0.6)	(0.5)	(0.6)	(0.0)
rural population share in municipalities		51.7	32.3	33.0	46.8	0.0
		(44.9)	(40.3)	(39.8)	(45.5)	(0.0)
Locally born share among population 60 years old or above		52.7	36.7	7.2	46.4	32.6
		(20.6)	(12.4)	(11.7)	(18.4)	-

*When reported separately, scores for 2002 and 2008 are also separately standardized, so that each year data have the mean of zero and the standard deviation of one.

Table 2. **Weighted Least Squares and Fixed Effect Coefficients from Achievement Regressions (Standard Errors in Parentheses)**

Column	**1**		**2**		**3**	
Estimation method	Weighted Least Squares		Fixed effects		Fixed effects	
	Coef-ficients	p-value	Coef-ficients	p-value	Coef-ficients	p-value
Regional dummy variables						
Post-Prussian	-3.689	0.000				
	(0.563)					
Post-Austrian	-2.885	0.000				
	(0.563)					
Post-Russian (w/o Warsaw)	-2.971	0.000				
	(0.557)					
Warsaw	-2.989	0.000				
	(0.569)					
Post-German	-3.573	0.000				
	(0.559)					
Parental Education						
Parental education-higher	5.282	0.000	15.144	0.000	13.742	0.000
	(0.429)		(1.358)		(1.358)	
Parental education-secondary vocational	-0.600	0.125	-3.609	0.045	-3.534	0.053
	(0.391)		(1.902)		(1.822)	
Parental education- basic vocational	1.741	0.000	2.075	0.143	2.032	0.156
	(0.449)		(1.415)			
School variables						
Log spending per student	0.093	0.050	0.212	0.004	0.271	0.000
	(0.047)		(0.073)		(0.073)	
Teacher qualifications - 2nd level	0.576	0.038	1.075	0.004	1.231	0.001
	(0.277)		(0.372)		(0.375)	
Teacher qualifications – 3rd level	1.022	0.000	1.564	0.000	1.707	0.000
	(0.249)		(0.342)		(0.344)	
Teacher qualifications – 4th level	1.127	0.000	1.058	0.005	1.102	0.000
	(0.259)		(0.372)		(0.376)	
Local unemployment rate						
Unemployment rate	-2.047	0.000	-3.780	0.000		
	(0.242)		(0.536)			
New arrivals						
Population inflow	5.183	0.035	25.609	0.001	26.331	0.001
	(2.460)		(7.562)		(7.647)	
Share rural						
Rural population	-0.164	0.000	0.323	0.784	0.531	0.655
	(0.037)		(1.176)		(1.189)	
N	4594		4594		4594	

Table 3. **Weighted Least Squares and Fixed Effect Coefficients For Specifications that Differ by Included Variables (Standard Errors in Parentheses)**

Column	**1**		**2**		**3**		**4**		**5**		**6**	
Estimation method	Weighted Least Squares						Fixed effects					
	Coef-ficients	p-value	Coef-ficients	p-value	Coef-ficients	p-value	Coef-ficients	p-value	Coef-ficients	p-value	Coef-ficients	p-value
Parental Education												
Parental education-higher	5.282		7.008				15.144		13.974			
	(0.429)	0.000	(0.371)	0.000			(1.358)	0.000	(1.292)	0.000		
Parental education-secondary vocational	-0.600		-0.265				-3.609		-3.098			
	(0.391)	0.125	(0.382)	0.489			(1.902)	0.045	(1.751)	0.077		
Parental education- basic vocational	1.741		2.87				2.075		1.313			
	(0.449)	0.000	(0.422)	0.000			(1.415)	0.143	(1.388)	0.344		
School variables												
Log spending per student	0.093				0.223	0.000	0.212				0.412	
	(0.047)	0.050			(0.048)		(0.073)	0.004			(0.073)	0.000
Teacher qualifications - 2nd level	0.576				0.503		1.075				0.773	
	(0.277)	0.038			(0.287)	0.079	(0.372)	0.004			(0.383)	0.044
Teacher qualifications – 3rd level	1.022				0.858		1.564				1.601	
	(0.249)	0.000			(0.258)	0.001	(0.342)	0.000			(0.353)	0.000
Teacher qualifications – 4th level	1.127				0.871		1.058				0.743	
	(0.259)	0.000			(0.268)	0.001	(0.372)	0.005			(0.384)	0.053
Unemployment rate	-2.047				-4.134	0.000	-3.780				-2.648	0.000
	(0.242)	0.000			(0.215)		(0.536)	0.000			(0.547)	

Table 4. **Historical Region Raw and Regression Adjusted Achievement Differences**

Column	**1**	**2**	**3**
Region	Mean weighted test scores	WLS coefficients	Mean fixed effects
post-Austrian	0.381	-2.885	0.414
post-Prussian	-0.369	-3.689	-0.392
post-German	-0.417	-3.573	-0.216
post-Russian	0.185	-2.971	0.413
Warsaw	1.263	-2.989	-1.584

Table 5. Means of history related variables by historical region

Column	**1**	**2**	**3**	**4**	**5**	**6**
	Standardized test score	Mean fixed effect	Share of elderly born in the same municipality	Share of elderly born abroad	Share of area under collective agricultural use (1992)	Share of employed in manufacturing (2008)
post-Austrian	0.381	0.414	52.7	3.5	6.3	30.0
post-Prussian	-0.369	-0.392	36.7	4.5	13.5	37.3
post-German	-0.417	-0.216	7.2	16.7	20.6	33.6
Post-Russian w/o Warsaw	0.185	0.413	46.4	2.8	5.0	25.5
Warsaw	1.263	-1.584	32.6	5.1	6.4	16.1

Figures

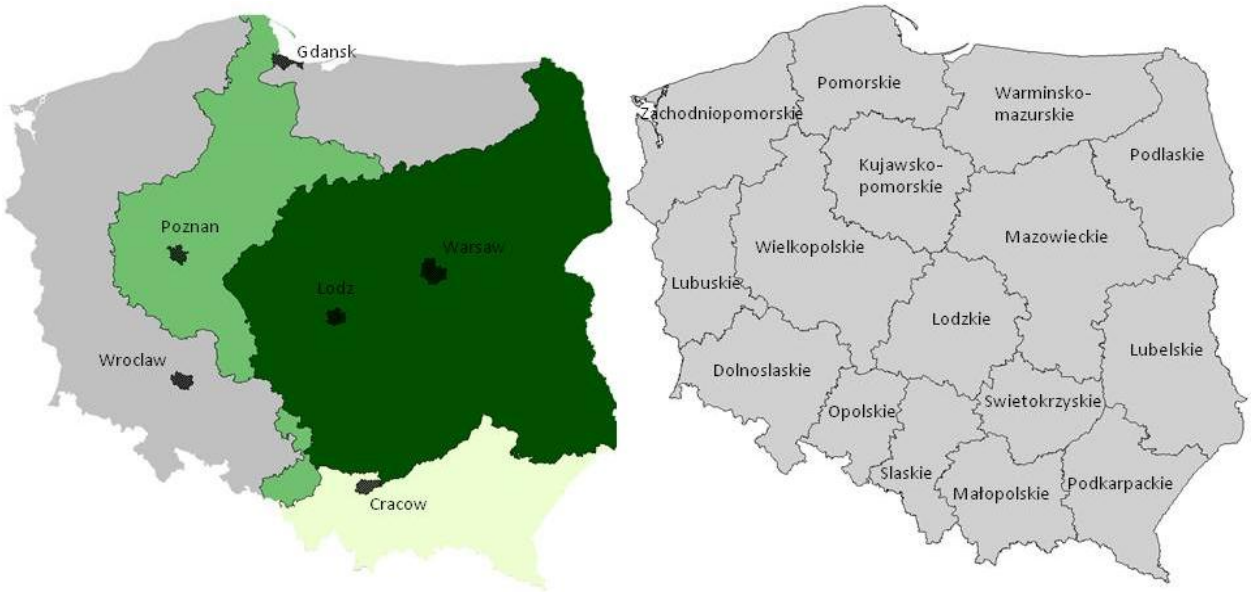

Figure 1. Historical borders on today's Poland territories (left) and current administrative division (right) Areas under Russian rule prior to WW I area shaded dark green on the left map. Areas under Prussian(German) rule prior to WW I are shaded medium green. Areas under Austrian (Austro-Hungarian) rule prior to WW I are shaded light green. Grey areas on the left map represent German territories acquired by Poland after WW II. Dark spots denote largest Polish cities.

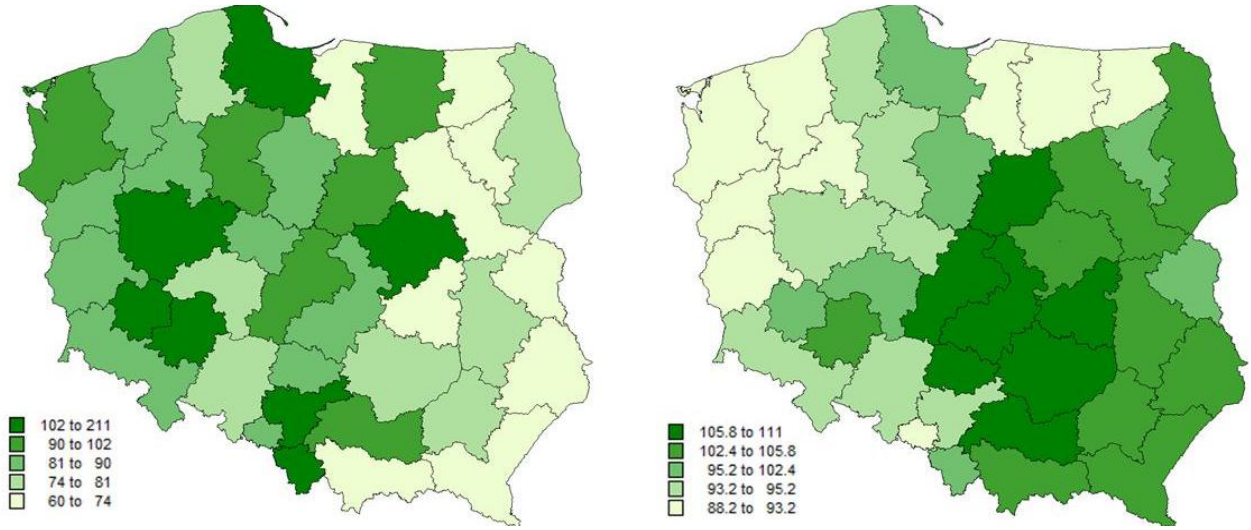

Figure 2. 2003 GDP per capita (left) and the 2002 average score in the 9th grade math-science test (right) by subregions. Poland=100

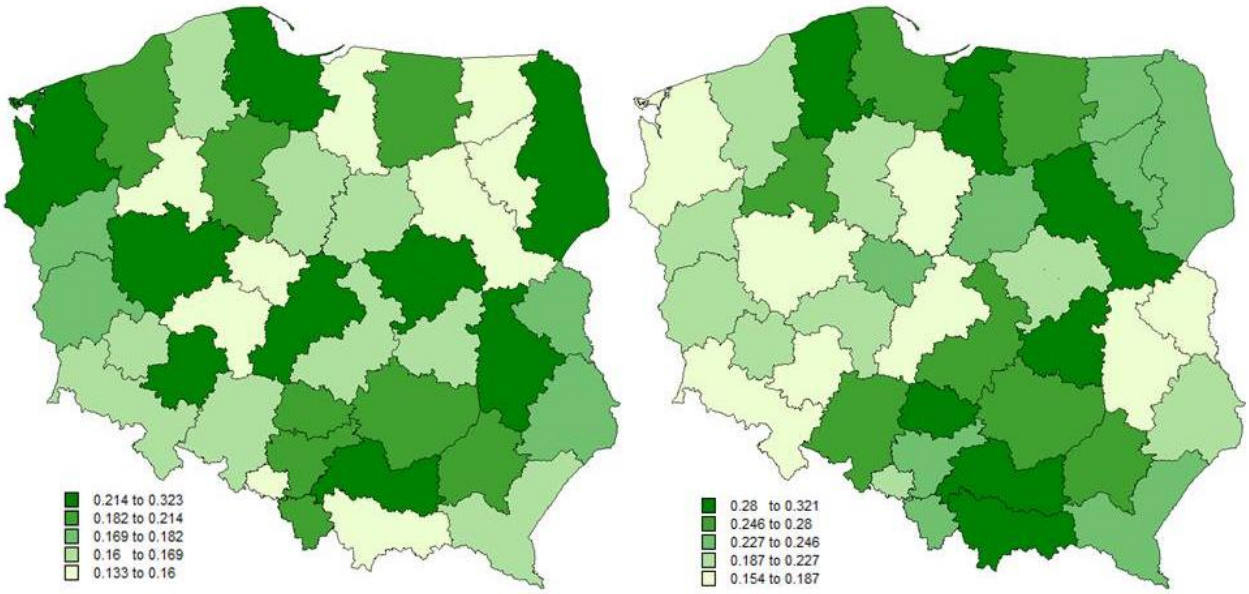

Figure 3. The share of population 35-50 years old holding higher or general secondary education (left) and the share of lower secondary school teachers holding the highest (4th) level of formal qualifications. Averaged 2002 and 2008 data.

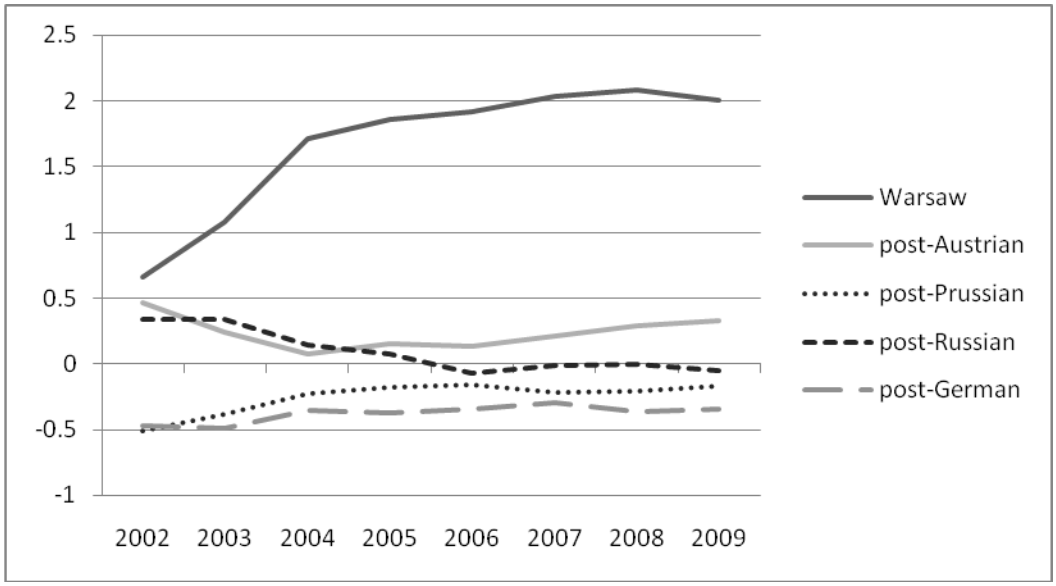

Figure 4. The standardized test scores by region over 2002-2009

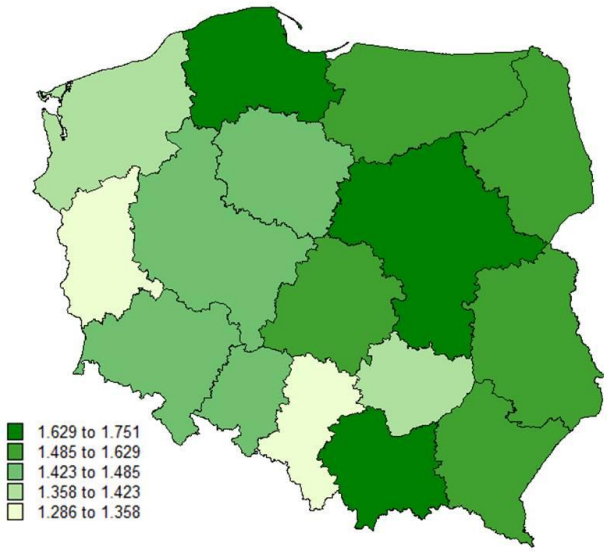

Figure 5. Regional returns to higher education as compared to vocational secondary education in 2008. (Per capita household income for individuals holding higher education degree versus vocational secondary education.)
Source: Household Budget Survey, Central Statistical Office 2008

References:

Altonji, Joseph G., Todd E. Elder and Christopher R. Taber. 2005. "Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools," *Journal of Political Economy*. vol. 113(1): 151-184.

Andersson, E. and S. V. Subramanian (2006). "Explorations of neighbourhood and educational outcomes for young Swedes." Urban Studies (Routledge) **43**(11): 2013-2025.

Bartkowski, J. (2003). Tradycja i polityka. Warszawa, Żak Wydawnictwo Akademickie.

Bourdieu, P. (1986). The forms of capital. Handbook for Theory and Research for the Sociology of Education. J. G. Richardson. New York, Greenwood**:** 241 – 258.

Coleman, J. (1988). "Social capital in the creation of human capital." American Journal of Sociology **94**: 95-121.

Coleman, J., D. Armor, et al. (1966). Equality of educational opportunity, US Government Printing Office

Domańska, L. (2002). Deprywacja potrzeb byłych pracowników państwowych przedsiębiorstw gospodarki rolnej. Toruń, Uniwersytet Mikołaja Kopernika.

Dzialek, J. (2009). Social capital and economic growth in Polish regions, MPRA Paper No. 18287.

Gawryszewski, A. (2005). Ludność Polski w XX wieku. Warszawa, IGiPZ PAN.

Gordon, I. and V. Monastiriotis (2007). "Education, Location, Education: A Spatial Analysis of English Secondary School Public Examination Results." Urban Studies **44**(7): 1203-1228.

Gorzelak, G., M. Herbst, et al. (2006). "Jak poprawić sytuację na trudnym rynku pracy?" Studia Regionalne i Lokalne **23**(1).

Gorzelak, G. and B. Jałowiecki, Eds. (1997). Koniunktura gospodarcza i mobilizacja społeczna w gminach. Studia Regionalne i Lokalne. Warszawa, EUROREG, Uniwersytet Warszawski.

Hanushek, E. A. and L. Woessmann (2007). The role of school improvement in economic development. Program on Education Policy and Governance, research paper 07-01, Program on Education Policy and Governance, research paper 07-01.

Herbst, M. (2008). "Prognoza wzrostu gospodarczego polskich regionów do 2015 roku." Studia Regionalne i Lokalne **32**(2).

Herbst, M. (2009). "Tworzenie i absorpcja kapitału ludzkiego przez polskie miasta akademickie." Studia Regionalne i Lokalne **38**(4).

Israel, G. D. and L. J. Beaulieu (2004). "Laying the Foundation for Employment: The Role of Social Capital in Educational Achievement." Review of Regional Studies **34**(3): 260-287.

KPRM (2009). Polska 2030. Wyzwania rozwojowe Kancelaria Prezesa Rady Ministrów.

Lynn, R. (2010). "In Italy, north-south differences in IQ predict differences in income, education, infant mortality, stature, and literacy." Intelligence **38**(1): 93-100.

MRR (2009). Rozwój regionalny w Polsce. Raport 2009. Warszawa, Ministerstwo Rozwoju Regionalnego RP.

Parcel, T. L. and M. Dufur (2009). "Family and school capital explaining regional variation in math and reading achievement." Research in Social Stratification and Mobility **27**(3): 157-176.

Putnam, R. (1993). "Thevprosperious community: social capital and public life." American Prospect **13**: 35-42.

Welt-Online (2008). Pisa Study Results. East German education outperforms West. Die Welt.

Zarycki, T. (2000). "Politics in the Periphery: Political Cleavages in Poland Interpreted in Their Historical and International Context." Europe-Asia Studies **52**(5): 851-873.