Demographic Change, Educational Policy and Redistribution of Resources: Evidence from East Germany

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ABSTRACT

After the fall of the iron curtain, the fertility rate in East Germany dropped to a historically low rate of about 0.75 children per woman. As a consequence, student enrolment to primary schools decreased sharply in the middle of the 1990s and by 2003 the number of pupils in East German primary schools has more than halved as compared to the early 90s. Numerous papers have presented evidence that demographic change does not have an important influence on total education expenditures (see Poterba, 1997 for U.S. evidence or Baum and Seitz, 2003 for evidence on West Germany). However, these studies have examined data from countries that lived to see rather modest changes in the number of young people. The objective of this study is to investigate the response of educational policy in times of a sharp decline of the number of students taking East Germany as an example. Contrary to other studies, the present paper does not focus on expenditure adjustments but on physical education resources – such as the number of teachers and school infrastructure – as well as on the major determinants of students' learning environment (class size and teaching time per class) to account for distributional effects.

Keywords: demographic change, educational policy, education finance, distributional effects
JEL classification: H72, I22, J18

1. INTRODUCTION

In the years after German Reunification (1990), the fertility rate in East Germany hit an all-time low of 0.75 children per woman. At the end of the decade, East Germany still had the lowest fertility rate in the EU-15 along with the northern CC.AA. of Spain. In addition, a significant share of families with school-age children migrated to the western part of the country. As a consequence, student enrolment to primary schools decreased sharply in the middle of the 1990s and by 2003 the number of pupils in East German primary schools has more than halved as compared to the early 90s. Recent population forecasts suggest that this is not a transitory development and student enrolment in primary schools will stay fairly constant at about 50 percent of the 1993 level (see figure 1).

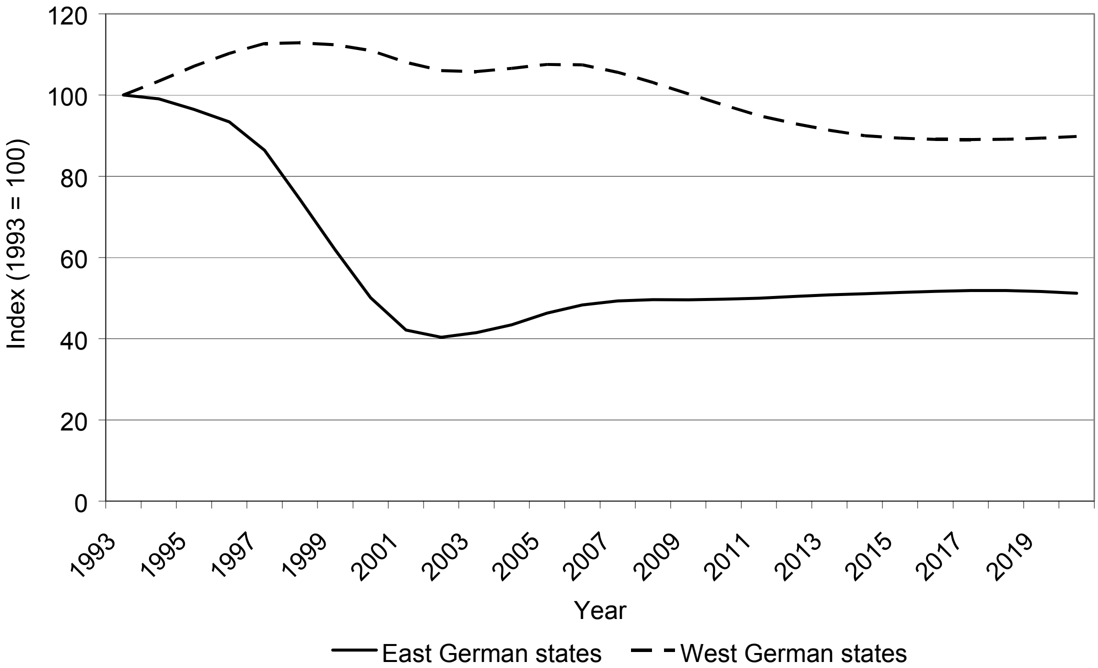

Figure 1: Student enrolment to elementary schools in East and West Germany. Normalised time series (1993 = 100). Source: KMK (2005a): 1993-2003 and KMK (2005b): 2004-2020.

Numerous papers have presented evidence that demographic change does not have an important influence on total education expenditures. Borge and Rattsø (1995) find that public school spending is adjusted less than proportionately to a diminishing number of students in Norway. Poterba (1997) uses a panel data set for the U.S. states from 1960-1990. He estimates a -1.0 elasticity of per-child school spending to changes in the population share aged 5-17. His result suggests that total education spending is not adjusted to a varying number of students. Fernandez and Rogerson (2001) confirm these findings for the U.S while Baum and Seitz

(2003) examine a panel data set for the West German states (1975-1999) and estimate results similar to those of Porterba.

Given constant teacher wages and price levels, higher education expenditures per student imply a different provision of physical school resources e.g. a lower student/teacher ratio, smaller average school-size, lower class size or more teaching time per class. Few studies have investigated the effect of a varying number of students on such physical resource indicators. However, considering physical resource variables rather than expenditure data allows accounting for redistributional effects between students, teachers and public budgets. Baum and Seitz (2003) find that a varying number of students has hardly any effect on the number of teachers in West German schools. They conclude that teachers and students in smaller age cohorts earn a "demographic rent" from smaller class-size (less workload for teachers, more intense teaching for students). For the U.S., Gramlich (1994) reports that the stock of public educational buildings has not been adjusted proportionately to a diminishing number of students from 1975 to the early 1990s. However, all studies mentioned above examine data from countries with rather modest changes in the number of young people. Poterba (1997, 59) demands: *"further analysis of the link between cohort size and per-pupil spending, perhaps using changes in enrollment that result from exogenous shocks such as changes in school district boundaries…"*. German Reunification in 1990 induced such an exogenous shock in East Germany. The East German states can therefore be taken as a natural laboratory to examine adjustment in times of demographic shocks. Elementary schools are the first compulsory schools that have completed the drop in student numbers in 2002 (see figure 1). Thus, primary school data is the first data available to provide information on the adjustment of school resources in response to demographic changes.

The present study investigates the educational policy response to the dramatic demographic changes in East Germany. To account for distributional effects that might occur due to the adjustment of public resources, education expenditures are split up into the most important physical resource indicators (teachers and school infrastructure). The major determinants of students' learning environment (teaching time and class size) are controlled for. After outlining the most important institutional aspects of education in Germany section 2 briefly discusses basic theoretical adjustment options and their implications for resource distribution. Section 3 describes the data employed, specifies the empirical methodology and reports the results. The implications for resource distribution are derived and discussed. The article ends with a brief conclusion.

2. ADJUSTMENT OPTIONS AND DISTRIBUTIONAL EFFECTS

The German educational system is dominated by the public sector. About 95 percent of all students in primary and secondary education attend public schools. In the German federal system, education is a major responsibility of the 16 states. This leads to a rather heterogeneous structure of educational institutions across states. However, elementary education is organized quite homogeneously in Germany. Students enter primary schools at the age of 6 and stay there for 4 years. Berlin and Brandenburg are the only exception, teaching students in elementary schools for 6 years (KMK, 2002, 118 ff.).

While the expenditures for teaching staff are borne by the state budgets, financing educational facilities and non-teaching staff is the responsibility of the local government sector, which, however, receives quite substantial grants for theses tasks by state governments. Education expenditures account for an important share of the state governments' budgets as well as for the local governments' budgets. In East and West Germany, teaching staff expenditures make up about 40 percent of total personnel spending. About 25 percent of all teachers employed are assigned to primary education.

Teachers and school infrastructures are the basic inputs in the school system and account for the bulk of education expenditures. Therefore, they also constitute the major instruments for educational policy adjustment to demographic change. As for teachers, state governments – explicitly or implicitly – can respond by:

- reducing the number of teachers (alternatively reducing teaching time per teacher with a corresponding reduction in teacher wage, "compulsory part-time")
- reducing teaching time per full time equivalent teacher without reducing full time equivalent teacher wage
- changing class size
- increasing teaching time per class

As a matter of course, these measures can be combined to adjust public resources to a changing number of students. With respect to school infrastructure policy, *one* of the following options for adjustment can be selected:

- changing the number of schools
- changing the average size of public schools
- changing the catchment area or the maximum length way to school

These policy measures have quite different distributional effects for teachers and students as well as for state and local public budgets and the taxpayer. These effects can be formalized along the following general line:

(1) $$\Delta RPB = f(\Delta Teacher, \Delta School)$$

(2) $$\Delta U_T = f(\Delta ClassSize, \Delta TeachingTime, \Delta Teacher)$$

(3) $$\Delta U_S = f(\Delta ClassSize, \Delta TeachingTime, \Delta School)$$

ΔRPB denotes the effects of the changing provision of educational resources for the public budget. Adjusting the number of teachers or the provision of school infrastructures has expenditure effects which depend on the intensity of adjustment. ΔU_T denotes the effects on teachers' utility which might be negatively affected by adjustment measures of the state government if a certain share of teachers loses its job. Teachers' utility is affected positively if class size or teaching time per teacher is reduced (without a corresponding reduction in teacher wages). The former would imply less workload caused by correcting fewer tests, etc. ΔU_S is the effect on students' utility. Students' utility is affected negatively by the close-down of schools (longer ways to school) and is affected positively by additional teaching time per class or lower class sizes.

In the empirical analysis in the next section, we examine the quantitative importance of different adjustment tools and qualitatively inspect the distributional effects. Unfortunately, due to the lack of test-score data, the effects on student performance cannot be investigated.

3. DATA DESCRIPTION, EMPIRICAL METHODOLOGY AND RESULTS

The panel data set used in this analysis covers yearly data (1993-2003) for the five East German states (see table 1). Earlier years are not included because of the transformation process in the East German educational system (Weiss and Weishaupt, 1999: 114).

Table 1: Variable definitions and sources

variable	definition	source
TEACHER	number of teachers in elementary schools (full time equivalents)	KMK (2003, 2004, 2005a)
CLASS	number of classes in elementary schools	KMK (2003, 2004, 2005a)
TIME	total teaching hours in elementary schools	KMK (2003, 2004, 2005a)
SCHOOL	number of public elementary schools	Stabu. (various years) and BBR (various years)
STUDENT	number of students in elementary schools	KMK (2003, 2004, 2005a)
FORSTUDENT	share of foreign students in elementary schools	Stabu. (various years) and BBR (various years)
REVENUE	real public revenue per capita („reale bereinigte Einnahmen", deflator: public sector consumption)	Stabu. (various years)
INSQKM	inhabitants per square kilometre	Stabu. (various years)

Note: KMK: Permanent Conference of the states' education ministries ("Kultusminister-konferenz"). Stabu: German Federal Statistical Office ("Statistisches Bundesamt")

The number of teachers has been calculated by summing up the number of teachers weighted with their working time (see KMK, 2005a). Thus, the number of teachers represents full time equivalents and possible reductions of teacher's working time are controlled for. To avoid endogeneity problems, the variables are not normalised by the number of students. Figure 2 gives a descriptive overview of the adjustment process in the five East German states. Descriptive evidence suggests that East German state governments significantly adjusted resources to the diminishing number of students.

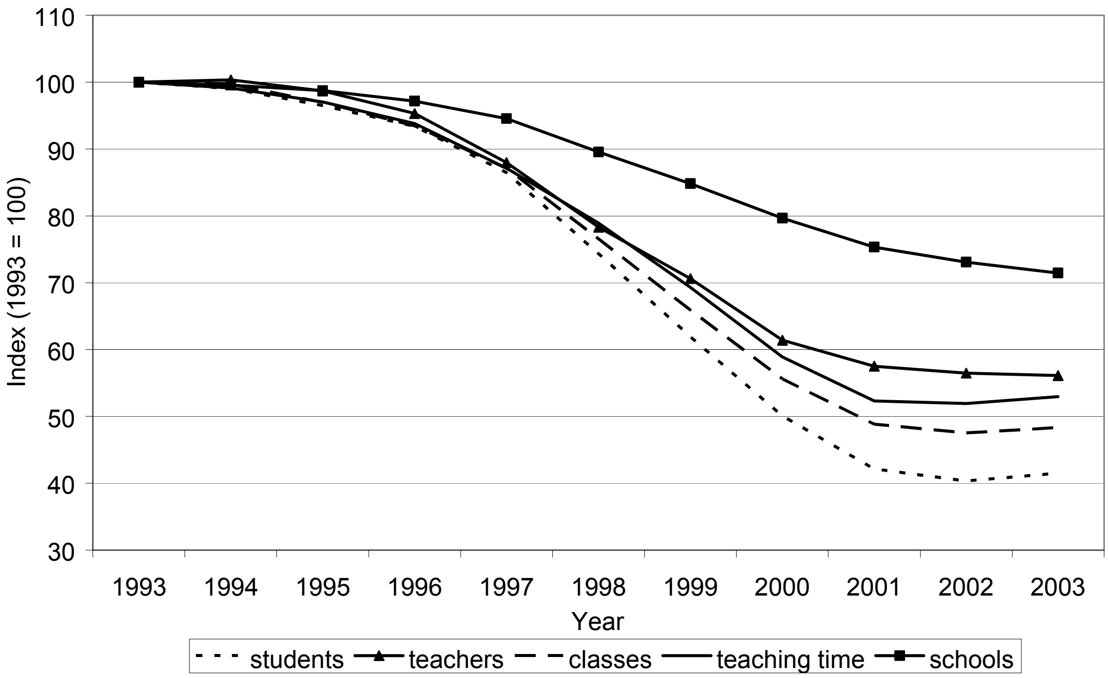

Figure 2: Adjustment of educational resources to a decreasing number of students: teachers, classes, teaching time and schools in East Germany. Normalised time series (1993 = 100). Source: KMK (2005a), Statistisches Bundesamt (various years), BBR (2005).

The objective of the empirical investigation is to estimate how educational policy responded to the falling number of students. The following regression models will be estimated:

$$Y_{ijt} = \beta_{0j} + \beta_{Sj} \cdot STUDENT + \beta_{FSj} \cdot FORSTUDENT + \beta_{Rj} \cdot REVENUE + \beta_{INj} \cdot INSQKM + \beta_{SEj} \cdot state\_effects + \varepsilon_{ijt} \tag{4}$$

Y_j denotes the four endogenous variables *TEACHER, CLASS, TIME* and *SCHOOL*. While i denotes the cross-section dimension of the panel, the five East German states, t denotes the years. The coefficient of the exogenous variable *STUDENT* is of major interest in the regression model. *REVENUE, INSQKM* and *FORSTUDENT* are control variables for the states' financial strength, the population density and the students' ethnic composition. All variables enter the estimation in logs, the only exception being *FORSTUDENT*. The results can therefore be interpreted as elasticities. Furthermore state effects are included in the models. Surprisingly, the Hausman-test opts for random effects in the *TEACHER, TIME* and *CLASS* model whereas fixed effects are preferred in the *SCHOOL* model. This might be caused by the substantial variation in the data (Pindyck and Rubinfeld, 1998, 255). Thus, the regression model is modified to (5) for the *TEACHER*, *TIME* and *CLASS* estimations:

$$Y_{ijt} = \beta_{0j} + \beta_{Sj} \cdot STUDENT + \beta_{FSj} \cdot FORSTUDENT + \beta_{Rj} \cdot REVENUE + \beta_{INj} \cdot INSQKM + u_{ij} + \varepsilon_{ijt}, \tag{5}$$

where u_{ij} denotes a state-specific random element. GLS is used to estimate the random effects models. The results are reported below (table 2). Due to non-significance in all of the models, *FORSTUDENT* is dropped from the equations. This is not surprising as in the East German states only about 2 percent of the population / students are foreign residents and students.

Table 2: Regression results for the East German states (1993-2003) (LOGs)

Estimation technique: **GLS, one-way RE (state effects)**			
independent variables	dependent variables		
	TEACHER	*TIME*	*CLASS*
STUDENT	0.644***	0.717***	0.817***
	(18.36)	(38.84)	(68.57)
REVENUE	-0.137	-0.112	0.116**
	(0.77)	(1.08)	(2.43)
INSQKM	0.346***	0.249***	0.095**
	(6.26)	(11.89)	(2.23)
adjusted R^2	0.966	0.992	0.989
No. of observations	55	55	55
DW	0.765	1.066	0.317

Note: *z*-statistics in parentheses. *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level. All data are in logs.

The results show that there has been considerable resource adjustment. The number of teachers has been reduced by 0.65 percent in response to a 1 percent decrease in the number of students. The elasticities of instructional time and the number of classes are even higher. The number of classes has been reduced by more than 0.8 percent for every percentage decrease in the number of students. Public revenue does not seem to be an important factor for explaining resource adjustments and even has a negative sign in the *TEACHER* and *TIME* equations. This effect is consistent with the result of Baum and Seitz (2003). The population density is an important factor as it is highly significant in all of the equations. Moreover, it has the expected sign and a coefficient below 1 indicating additional costs for sparsely populated areas which is consistent with previous results (Seitz, 2002, 76). However, all equations are plagued by serial correlation as can be seen from the Durbin-Watson statistic. To correct for serial correlation, the same models are estimated using growth rates. As in the log-equations, random effects are chosen for the *TEACHER*, *TIME* and *CLASS* equations based on the Hausman-test. The results are reported in table 3.

Table 3: Regression results for the East German states (1993-2003) (GROWTH RATES)

Estimation technique: **GLS, one-way RE (state effects)**			
independent variables	dependent variables		
	TEACHER	*TIME*	*CLASS*
STUDENT	0.558***	0.751***	0.812***
	(6.58)	(11.04)	(44.36)
REVENUE	-0.054	-0.108	-0.079*
	(0.28)	(0.70)	(1.89)
INSQKM	-2.513	-1.387	-0.905**
	(1.62)	(1.15)	(2.05)
adjusted R^2	0.577	0.774	0.979
No. of observations	50	50	50
DW	1.685	2.228	1.686

Note: *z*-statistics in parentheses. *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level. All data are in growth rates.

The transformation successfully removed serial correlation, although the Durbin-Watson test statistics in the *TEACHER* and *CLASS* equations are rather close to the zone of indecision (the upper limit for k=3 and N=50 is 1.674). Whereas the *CLASS* and *TIME* results do not change much, the student-coefficient in the *TEACHER* equation shows somehow greater variation. However, several robustness checks have been performed using the Cochrane-Orcutt procedure in the fixed effects model as suggested by Greene (2003, 318) or estimating pooled regressions in which neither random nor fixed effects are taken into account. The coefficients do not show much variation in the different models and/or different estimation methods and can therefore be considered as quite robust within the range given by the log and growth rate results in tables 2 and 3.

Table 4: Regression results for the East German states (1993-2003)

Estimation technique: **OLS, one-way FE (state effects)**				
independent variables	dependent variable: *SCHOOL*			
Variable form, estimation method	*logs, OLS*	*growth rates, OLS*	*logs, Cochrane-Orcutt*	*growth rates, Cochrane-Orcutt*
STUDENT	0.254^{***} (10.04)	0.217^{***} (6.26)	0.247^{***} (9.10)	0.236^{***} (7.00)
REVENUE	-0.058 (0.61)	-0.095 (1.35)	-0.052 (0.54)	-0.097 (1.18)
INSQKM	2.366^{***} (4.00)	3.202^{**} (2.42)	2.62^{***} (2.96)	3.44^{**} (2.61)
adjusted R^2	0.909	0.517	0.998	0.663
No. of observations	55	50	50	50
DW	0.379	1.202	1.223	1.855

Note: *t*-statistics in parentheses. *** denotes significance at the 1 percent level. ** denotes significance at the 5 percent level. * denotes significance at the 10 percent level.

As recommended by the Hausman-test, the *SCHOOL* model should include fixed effects rather than random effects. The results of alternative model specifications are given in table 4. Here again the estimated student-elasticity of the provision of public school infrastructure shows some degree of variation but is approximately 0.24. Public revenues do not have a significant influence on the provision of schools. Surprisingly high is the positive effect of the population density. This effect is neither plausible nor consistent with results from the literature (Seitz, 2002, 76).

These results have some interesting implications for the distribution of educational resources. Besides strong and considerable adjustment efforts, state governments' budgets have to bear a significant "demographic burden". The student-elasticity of the number of teachers (0.55 in the growth rates model, 0.65 in the log model) implies that the student-elasticity of the student/teacher ratio is about 0.45 - 0.35. Thus, the 50 percent drop of the number of students from 1993 to 2003 induced a rise in student/teacher ratios by approximately 20 percent. The increase in education expenditures per student is likely to exceed 20 percent in consequence of the sharp decrease in the average size of public elementary schools. The student-elasticity of school size is 0.75. Thus, school size decreased by more than 30 percent in the last 10 years. Due to the character of the analysis, the cost-increasing effect of demographic change cannot be quantified exactly but spending per student is likely to have increased by more than 20 percent (see Kempkes and Seitz, 2004).

The findings show that contrary to the periods and countries/regions studied in Poterba (1997) and Baum and Seitz (2003), in East Germany there has been a significant adjustment to dramatically shrinking age cohorts. However, the results also indicate that educational resources probably cannot be adjusted perfectly and instantly to demographic changes. As the number of full time equivalent teachers in some East German states already showed an upward trend in 2003/04, further resource adjustment is not likely to take place. Thus, public budgets are obviously inclined to spending higher resources per student for members of smaller age cohort. To some extent, the findings from Poterba (1997) and Baum and Seitz (2003) can be confirmed for a region with dramatically shrinking school-age cohorts.

Even more interesting in the light of the results are the effects on students and teachers. Students do not benefit entirely from the increased resources per student. This can be seen from the differentials between the student elasticities of *TEACHER* and *CLASS* or *TEACHER* and *TIME*. The number teachers has been reduced to a smaller extent than the number of classes and teaching hours, indicating a gap between students' additional benefits and additional public resources per student. Student-elasticity of class size is only approx. 0.18. Thus class size decreased by approx. 10 percent due to the 50 percent drop in the number of students.

The differential between the student-elasticity of classes and the student-elasticity of teaching time (growth rates: 0.06, logs: 0.10) shows that teaching time per class increased up to 5 percent caused by the diminishing number of students. However, students do not only earn rents from demographic change. As stated above, the student-elasticity of the number of schools is 0.25. This implies that the average catchment area of a public elementary school increased by approx. 12 percent bringing about longer ways to school.

Student-elasticity of the number of teachers (0.55-0.65) implies that about 20 percent of the teachers have lost their jobs. Alternatively retired teachers have not been replaced, or teachers work part time with correspondingly lower income. The remaining teachers teach smaller classes (-10 percent) and therefore profit from demographic change as their workload is reduced. Moreover, there is a surprising differential between the adjustment of teachers and teaching time. The log-model (table 2) suggests a differential of 0.06 points in the elasticity whereas the growth rates-model (table 3) even suggests a gap of 0.2 points. Thus, teaching time per teacher has been reduced in a range of 3 to 10 percent due to demographic change. This finding is confirmed by cross sectional evidence for the year 1999: full time teachers in primary education in the East German states had to teach 23.56 hours while their West German counterparts had to teach 25.4 hours. However, there are big differences across East German states. Teachers in Brandenburg for instance teach 25.9 hours whereas teachers in Thuringia only teach 20.8 hours. Another possible explanation for the differential between the elasticities of teachers and teaching time are increasing times absent from work in the East German states (i.g. for medical condition, see KMK, 2002, 108).

4. CONCLUSIONS

Contrary to results from other periods and other countries/regions, East German educational policy significantly adjusted educational resource endowments to smaller student cohorts. However, educational expenditures per student increased at least 20 percent. Students receive some benefits from the additional resources per student (smaller classes, more teaching hours per class) but a significant share of the additional resources per student is also spent on less teaching time per full time teacher. This effect could be identified qualitatively rather than measured properly due to inaccuracy in the estimations. Future research should evaluate if demographic change indeed induces a bias towards inefficiency in the education sector and whether this effect is temporary or permanent.

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