Regional school comparison and school choice : how do they relate to student performance ?

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‘Regional school comparison and school choice: how do they relate to student performance? Evidence from PISA 2003’

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Abstract:

School choice and accountability have become popular educational policies in the US and the UK. In Europe, such policies are less often applied and therefore less subject to research. The present paper uses recent international data to study the impact of schools comparing their pupil’s results to a regional or national performance standard and that of regional school choice on student test scores. School performance comparisons and school choice by parents are assumed to complement eachother in increasing both school and teacher effort. We estimate an education production function controlling for the hierarchical nature of the data. We also estimate our model using quantiles of student test scores to identify potentially different effects at different levels of student performance. We find that both a higher regional percentage of schools comparing their results and regional intensity of school choice significantly improve student test scores. This positive effect varies in size according to whether we consider low or high-performing students.

JEL classification: I20, I28

Keywords: School choice, school performance standards, education production function, pupil performance, hierarchical models.

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1. Introduction

One of the first empirical studies of the factors that influence student's scholastic results was the 'Coleman Report' (Coleman et al.1966). The authors found that, in the US, allocating more financial resources to schools had no significant impact on student test scores. To the contrary, the most important predictor of test scores was the socio-economic background of pupils. Since then, international research has not produced clear-cut evidence on the effect of additional funding on student performance (Hanushek, 2003). Moreover, attention turned to other factors that could have a significant impact on student test scores. In particular, authors turned to the incentives to teacher and student effort that resulted from the institutional settings of educational systems (Hanushek, 1997; Woessmann, 2000). This paper fits into the latter category. We look at how the practice of schools comparing their pupil's results to a regional or national performance standard and that of parents choosing their children's school based on reputation or study program relate to student test scores. In the United States as well as in the United Kingdom, school accountability and school choice have become popular guidelines of educational policy. The idea behind this type of policy is that school choice combined with information on school quality will result in school competition sanctioning the lowest performing schools, as in a classical market. Abundant recent research in those countries has shown that student performance does tend to respond positively to school choice and accountability. However measured effects are small, on average less than ten percent of a standard deviation in scores for a one percent increase in competition (Levacic 2001, Belfield and Levin 2002, Carnoy and Loeb 2003). Recent evidence from Sweden is in line with these results (see e.g. Sandström and Bergström 2002)

In continental Europe, there is a certain political reluctance to submit public schools to competition and accountability. One of the most important reasons could be a strong concern for equity of opportunity. Indeed, school choice involves a risk of social segregation between schools if information on school quality is poor. If parents do not have access to reliable information on school performance that takes into account pupil intake, they will choose schools according to the quality of peer pupils they provide. As a result, schools are pushed to compete for better students. This is the ideal setting for segregation, i.e. grouping of pupils into schools as a function of observable background characteristics. However, the evidence on peer effects for low-performing pupils in the literature is mixed (see e.g. Levin 2001, Rangvid 2003) so it is not clear how segregation affects performance. Secondly, education is not a private good and in most European states it is largely funded by the public sector. School comparisons to a national or regional standard and school choice will therefore have an effect on school quality only if budget allocation by the State takes them into account. Thirdly, low-performing schools and pupils could suffer from discouragement as they are informed of their relative performance, and decrease effort (e.g. Betts and Grogger 2002). If inter-school performance-based competition increases the average required level of performance for degree obtention then discouragement might be reinforced. The effects on low-performing students of performance-based school competition is not clear-cut. Some studies find a particularly important positive impact on low-performing and disfavoured students (e.g. West and Peterson 2005), others find a positive but less important impact on low-performing students' achievement (e.g. Hanushek and Raymond 2004).

In this paper, we look at the effect of school comparison and school choice in an international setting. To this purpose we use responses to the PISA 2003

questionnaires in 18 countries. First of all, we have information as to whether schools compare their pupil's results to a regional or national performance standard. Secondly, we look at whether parents chose their child's school on the basis of reputation or program rather than just location. We then estimate an education production function controlling for unobserved differences that could exist between countries and between schools. In a second stage, we split up the data into subsamples of low versus high performing students by school to estimate differences in the effect on low versus better-performing pupils. In section 2 we explain the choice of our explanatory variables and present our data. In a third section, we present our estimation strategies and section 4 is devoted to the results. Our conclusions are given in a final section.

2. Data and choice of variables

2.1. Our measure of the presence of an external standard and school choice

In order to estimate the effect of the existence of an external standards of school performance on student test scores, we would ideally like to know whether there is an external student evaluation at key levels of schooling such as e.g. the French Baccalauréat. However, such truly centralised exams are rare and typically constitute a country characteristic. This is an important constraint on the number of observations. Moreover, educational systems are generally not easily classifiable as either having or not such a generalized external evaluation system because of the broad variety of exams existing in each country and the broad range of intermediate levels of centralisation. Thirdly, we do not have this information in our database. As a result, we choose to use available information in the PISA school questionnaire as to whether schools compare their student's test score results to a national or

regional standard or not. If the school claims to do so the dummy ‘school compares to a standard’ equals one, zero otherwise. Schools may compare their results with national or regional performance levels for different reasons. For instance, schools could use it as a means to check their relative efficiency on a voluntary basis whereas other schools may be submitted to a public control of performance. In either case, the comparison of a school’s results to that of the region or the country should provide the type of incentive we are looking for, as schools obtain information on their relative performance.

As a measure of school choice, we use the pupil questionnaire. We therefrom know whether the pupil is in its school because it is known to be of high quality (reputation) or because of the study program provided. If the pupil responded yes to one or both of these questions we consider there has been quality-based school choice (dummy ‘school choice’ equals one, zero otherwise).

We then aggregate these dummy variables to regional percentages. There are two important reasons to do so. Foremost, the percentage of schools comparing their results in a given region is used as a proxy for the existence of external student performance standards that facilitate performance-based competition. An external student performance standard is defined as a set of criteria for student skill evaluation that is set by an authority higher than, and independent of the school, such as a federal or national ministry of education. To the opposite, internal student performance standards are criteria for student skill evaluation set by the teacher or the school. External performance standards are thought to improve school (and student) effort for several reasons. First of all by ensuring comparability of school performance for parents and controlling authorities. A school's students' average results according to external performance criteria are a signal of school quality. The

information on the relative performance of a given school will be all the more significant for parents and controlling authorities if many schools compare their results. The incentive for schools to improve their relative performances should therefore become stronger when the percentage of comparing schools increases, as the relative position of a school compared to the standard becomes more and more revealing. If schools then feel pressure to improve student achievement as a result of the school quality information available to parents and authorities who provide their financial means, then school effort can be expected to increase(Bishop et al., 2000). A second possible positive influence of school comparability on student performance could result from a direct effect on student effort in the last year of schooling. Indeed, if employers and universities can use high school test scores as a reliable signal of pupil skills, it is likely they will use this information as a criterion for hiring. In the long run this should increase the incentive to perform for students, as they learn the importance of this signalling (Betts and Costrell 2000, Bishop and Mane 2001).

Our second main explanatory variable, the percentage of parents that chooses their child's school based on reputation or proposed study programs, is a measure of the intensity of school choice in a given region. The intensity of school choice by parents can be a result of legislation (that determines whether they may choose at all) but also of geography (if there are few local schools choice is limited) or variance in school quality (if all schools are high quality, residence becomes the main criterion). The relevance of school choice obviously increases with the proportion of parents participating and the schools' incentive to perform should be maximal when all parents use quality criterions.

The second reason why we choose to use regional variables is that the dummy variables of school comparison to a standard and school choice are subject to a potential endogeneity problem. Indeed, it could be that only more motivated or well-performing schools choose to look at their relative performance. To the contrary, it could also be the case that for instance public schools that are considered “at-risk” are more closely monitored on performance by the authorities than are more average schools. Also, parents that choose a school on the basis of reputation or program might be more educated and/or motivated as they want to provide their children with best possible learning environment. We believe that the regionally aggregated variables are not subject to the type of endogeneity bias mentioned above. We assume that the intrinsic motivation of schools (e.g. that related to an enthusiastic principal or particularly efficient cooperation between teachers) is normally distributed in all the regions. If there is larger proportion of schools comparing their test scores in a given region, we assume that this is due to the institutional setting or regional common practice. The impact of the regional preference for or common practice of school comparisons is precisely what we want to estimate. The proportion of parents choosing their children’s school based on quality related criteria on the other is likely to be related to the average level of education and wealth in the region. We take this into account by including several regional characteristics we think could be related to school choice.

Descriptive statistics of the regional percentage of schools comparing their students' results and the regional percentage of parents choosing the school based on reputation or study program are presented in graph 1 at a national level. We can observe that there is important variation in this percentage. The latter is true also at the regional level as can be seen in graphs 2-19 and 20-39. Note that in our

estimations we use only the regional percentages. Coming back to graph 1, we observe that the national percentages correspond at first sight to what we know of national education systems. Belgium, Italy and Brazil for instance show a very low level of school comparisons (less than 10% of schools compare to a standard) and a very high level of school choice (more than 60% of parents choose school for quality of program). These are countries where parents have full school choice but there is no central standard for school performance. On the other hand, countries like Iceland and Finland have strong national standards for student performance (more than 60% of school compare to a standard) but there is very little school choice for parents (less than 20 %). The latter are strongly centralised public educational systems. Another group of countries including Germany, Greece, Spain and Switzerland, have no centralised performance standard but grant parents only limited school choice. These countries often present important regional autonomy to decide upon student curricula and allocate pupils to schools by residence. Fourthly, countries like the United Kingdom, Australia or Canada give full school choice to parents and have centralised curriculum standards to assess school achievement. Finally, the rest of the countries in our sample have partial curriculum guidance from the State and a variable degree of school choice. These correspond to very different institutional settings (many of these countries have heterogeneous regions) that yield variable degrees of school comparison to a regional or national standard and variable intensity of school choice.

2.2. Database and choice of control variables

This paper uses cross-section data from the OECD survey conducted in 2003 as part of the Program for International Student Assessment (PISA). The PISA 2003 database contains comparable math, science and reading test scores of a sample of

15 years-old pupils coming from 40 OECD and non-OECD countries. We have regional information only for the 18 countries that we use in our analysis. This corresponds to 116092 observations after removal of missing data. Pupils are nested within schools, potentially attending different grades. All the students in the sample took a standard reading, math, and science test, which provided the test scores. The scores are comparable across countries but not across disciplines. The sampling procedure ensures that schools and pupils inside them are randomly selected and that the sampled set of students is representative of the country's student population. Moreover, for each pupil *i* trained in school *j*, the PISA data provides us with a large number of variables characterizing the student, its family and the school it is attending, from which we selected the variables relevant to our analysis. Following a common practice in the literature (Brown, 1991; Vignoles *et al.*, 2000), we use the test scores normalized to mean 500 and variance 100 as a measure of educational output.

Besides our variable of interest, the percentage of schools comparing their student's test scores to a regional or national average, and the percentage of parents choosing the school because it has a good reputation or a special program, Table 1 gives summary statistics of our dependant and explanatory variables. The latter were chosen in order to avoid correlations, while staying as close as possible to the conceptual framework sketched in the theoretical literature (e.g., Creemer, 1994; Scheerens, 1997; Creemers *et al.*, 2000). A small number of factors are herein put forward to explain pupils' success: (1) their initial aptitudes, (2) perseverance or effort, (3) the opportunities offered to them, and (4) the quality of instruction. First of all, relying on an extensive literature (e.g. Ehrenberg, Goldhaber *et al* 1995; McNabb, Sarmistha *et al*, 2002), we control for gender (the dummy BOY) and age

as observable individual characteristics that may affect **initial aptitudes**. Secondly, in order to include some measure of perseverance and **effort**, even though it is most likely correlated with parental effort, we added the number of hours each pupil spends doing homework each week (HOMEWORK) and information on whether it attends a vocational or general type of education (VOCED). We then chose relevant measures and/or proxies for the two remaining groups of factors listed above, starting with the **opportunities** offered to pupils. These are represented firstly by the size of the city the pupil lives in (CITY SIZE). A larger city may e.g. provide more social services, a better library or simply have access to better teaching materials. Another very important determinant of overall opportunities available is the pupil's family background. This includes information on whether the pupil lives with both parents (NON-NUCLEAR FAMILY dummy), the level of education of the highest educated parent (PARENT EDUCATION), the highest OECD socio-economic index in the household (PARENTS SOCIO-ECO STATUS), and the language, foreign or not, spoken at home (FOREIGN LANGUAGE AT HOME). We also included the number of books in the house, as estimated by pupil in number of shelves (NUMBER OF BOOKS), and the relative availability of learning resources at home (HOME EDUC. RESOURCES). Several studies (e.g. Murnane *et al*, 1981) suggest that the number of books at home is a fairly reliable proxy to describe a family's inclination towards learning. Home educational resources is an index based on the availability at home of a desk to study at, a quiet place to study, a calculator and a dictionary as well as books useful for homework. For more details on the construction if this index please refer to OECD (2003). The **quality of instruction** was captured by several school variables. We first introduced the type of funding the school relies on. If the school the pupil is attending relies for more than 50% on public funding our dummy

PUBLICSCHOOL equals one, zero otherwise. We also include information on the school's educational resources (SCHOOL EDUC. MATERIAL) based on the availability of books, computers, software, calculators, library materials, audio-visual and laboratory equipment. And we include the ratio of computers for student use per student. As mentioned before, however, many studies (Hanushek 1997, 2003; Hoxby, 2000) underline that the effect of material resources is not systematic, and suggest that institutional factors and incentives structures may have a stronger effect. Woessmann (2000), using country-level data from PISA, found that students' performance could stem primarily from institutional and school organizational characteristics, such as autonomy in school management decisions. To explore this possibility, we added four school-level institutional indicators that complete our description of the **quality of instruction**: the degree of centralization of the decisions made on teacher hiring and wage increases, the size of the school budget, and defining course contents. These are dummy variables equal to one if the decision is taken outside the school, zero otherwise.

The percentage of schools comparing to a national or regional standard and the percentage of parents choosing school for quality or program are regional variables. It could be that unobserved regional level characteristics are correlated to test scores and our main explanatory variables, biasing results. By definition we cannot include the unobserved regional variables. However, it is possible to test that percentcompare and percentparentchoice are robust to including a set of observed regional variables. The regional variables we include are the regional average socio-economic status of parents, regional average parent education and the regional unemployment rate to control for the regional economic and social situation. As to the regional level of school quality, we control for it by using the regional average

of school educational resources, its variance, and an index of regional school segregation. The latter is a segregation index measuring the average proportion of pupils of a school that should change schools in order to have a homogeneous distribution of minority pupils across the region. If there are e.g. thirty percent of foreigners in a region, then the index indicates what proportion of students should change schools for each school in the region to have one third foreign pupils. The minority considered for segregation here are pupils whose parents have less than general secondary schooling. It is therefore a measure of social segregation. Please refer to Zoloth (1976) for the exact definition of the segregation index. The segregation index is standardised at mean 0 for ease of interpretation. The variance of the regional level of school educational resources might affect the degree of school choice. If all schools have a comparable quality level there is no incentive to practice school choice. To the contrary, if schools are very different in quality, we expect concerned parents to do more effort for choosing an acceptable school.

3. Econometric modelling and estimation strategy.

3.1. The mixed model

We estimate an education production function. It is defined as an efficient technology (Cooper and John, 1997) turning a vector of educational inputs X into a vector of output Y:

$$Y = f(X) \qquad (1)$$

In Equation (1) above, X may include such inputs as a child's abilities, his/her family background and/or educational resources, and where Y may be a set of test scores or exam results. In theoretical works, the education production function *f* may appear as a "black box", with its the functional form left unspecified. Applied

analyses, however, generally rely on a classical regression approach, which assumes a linear (or log-linear) shape for *f*. In this study, we expand the linear regression method by taking into account the hierarchical (or clustered) nature of the PISA 2003 data. Indeed students are grouped in schools that function in a particular country. It is to be expected that test scores of students in a same school are correlated with each other as a result of unobserved school characteristics. For instance, there could be a nice atmosphere in the school, or stimulating teachers that work together in a particularly efficient way, or even a specific grouping of pupils or the availability of a good library that enhance the performance of all school pupils but that we cannot observe. In a similar way, average achievement of schools in a same country could be correlated as schools and pupils are submitted to a common political and economic environment that we can again not measure. Using a so-called mixed model allows us to take into account the hierarchically correlated structure of the test score variance. We include country dummies to capture unobserved country effects, and nested school effects that are assumed to be drawn from a normal distribution. We do not observe all schools therefore the assumption that the unobserved school effects in our dataset are randomly drawn from a normal distribution of positive and negative influences is plausible. The unobserved school effects are called 'nested' because they may be correlated inside a same country. The resulting mixed model is written:

$$Y_{ijk} = \beta_k + X_{ijk}.\beta + \gamma_{jk} + \varepsilon_{ijk} \qquad (3)$$

where, for student *i* in school *j* in country *k*, Y_{ijk} is the test score in a given discipline, X_{ijk} is the vector of explanatory variables, and β its associated vector of parameters. The X variables include the individual, family, school and regional

control variables as well as PERCENTCOMPARE and PERCENTPARENTCHOICE. β_k is a set of country dummies, γ_{jk} (the unobserved school effect) is assumed to be drawn from a normal distribution and nested within country *j*) and ε_{ijk} the residual term. Similar models, also known as multilevel models (Yang, Goldstein et al, 2002), have been used to analyse examination results in a single country (the United Kingdom) and a single discipline (Mathematics). The model we applied here is both simple and convenient, and fitted to the analysis of several countries and disciplines. Mixed models are estimated using the Maximum Likelihood technique imposing the particular hierarchical structure to the variance-covariance matrix. Singer (1998) provides a detailed summary of this estimation procedure.

It could be the case that the effect of PERCENTCOMPARE and PERCENTPARENTCHOICE varies across different countries. We test whether the coefficients of these variables are the same for all countries and whether each country's coefficients are significantly different from those of the reference country Canada. This is done by including crossed effects of these explanatory variables with the country dummies.

Moreover, we expect the impact of schools comparing their performance to a regional standard and the practice of parent school choice to depend on a series of factors. First of all, we test for a potentially different effect on test scores of PERCENTCOMPARE and PERCENTPARENTCHOICE according to whether the school is publicly funded. Indeed, we could expect that schools that do not depend on private funding are less affected by competition since public funding less often depends on school quality. On the other hand, if the state applies sanctions to low-performing schools or to the contrary grants them extra support, then publicly funded school

might react to school choice and comparison. We test this hypothesis by including crossed effects PUBLICSCHOOL*PERCENTCOMPARE and PUBLICSCHOOL* PERCENTPARENTCHOICE.

Secondly, we expect that more autonomous schools, i.e. schools that have decision-making power on teacher hiring and wages, school budget and course contents, should be more capable of reacting efficiently to a given performance standard and competition. For example, schools that can decide which teachers to hire and how much to pay them, should be able to choose those teachers that correspond best to their specific pupils and environment. This hypothesis is tested using crossed effects PERCENTCOMPARE times the four central decision making dummies and PERCENTPARENTCHOICE times the four central decision making dummies. The results of the estimations for the three disciplines (maths, reading and science) are given and commented in the next section.

3.2. Low versus high-performing pupils

It is well established in the theoretical literature that low versus high-performing pupils might react differently to an external performance standard. It seems that high and average-performing pupils should be stimulated to more effort by an external standard as it provides them with a valuable signal on the labour and academic market. To the contrary, lower performing pupils might be discouraged by a standard they feel unable to reach and diminish effort (Betts and Grogger 2002, Bishop and Mane 2001). School choice in turn might lead to higher standards or to segregation between schools that may have both positive or negative impacts on student results, as explained in section 2.1. In order to test whether school choice and school performance comparisons affect low versus high performing pupils differently in our model, we split up our dataset into subsamples based on quantiles

of the test scores distribution by school. The subsamples correspond to pupils belonging to different quantiles of the test scores distribution in their school. This means that we take the 5% lowest performing pupils from each school to constitute our first subsample. The 10% lowest performing pupils from each school constitute the second subsample. We then take the pupils that have test scores in the interval from 10 to 25% lowest test scores in their school to be in another subsample, between 25 and 50 percent of lowest test scores, 50 to 75 percent, 75 to 90, 10 percent highest test scores and 5 percent highest test scores. All these subsamples are estimated separately using the mixed model. In order to test whether coefficients are significantly different from one subsample to another we create dummy variables for each subsample. If a pupil belongs to subsample 1 then the dummy QUANTILE5 equals one, otherwise zero. Following this principle, we create eight dummy variables: QUANTILE5, QUANTILE10, QUANTILE25, QUANTILE50, QUANTILE75, QUANTILE90, QUANTILEH10 and QUANTILEH5. We include these dummies and these dummies crossed with the variables of interest PERCENTCOMPARE and PERCENTPARENTCHOICE in the mixed model to test for differences in the coefficients across subsamples.

4. Empirical results

4.1. Mixed model

Table 2 gives the parameter and standard deviation estimates of the mixed model for mathematics, reading and science test scores respectively. Recall from Section 2 that test scores are standardised at mean 500 and standard deviation 100 for all countries. This means we can interpret the coefficients as percentages of standard deviation in student test scores. The results of the estimations appear to be quite consistent across disciplines. Individual and family characteristics have a very

significant effect on test scores, in line with the literature. The case of gender is interesting, since it shows that female students can expect lower scores in mathematics and science, but higher scores in reading. This result is similar to what is generally observed in the literature (e.g., Ehrenberg, Goldhaber *et al.*, 1995). Possibly, innate differences in ways of assimilating maths and reading between boys and girls and/or unconscious different expectations from each gender in each discipline by teachers may yield this gender gap. Parents education and socio-economic status as well as the family structure, the language spoken at home and the number of books at home play a very significant role in predicting scholar achievement. As expected, the type of school attended by pupils has a very significant impact on test scores in all disciplines. Being in a vocational track decreases scores by around 25 points on average across disciplines.

Sufficient availability of educational material in a school significantly improves student performance, more computers available for student use do not. Note that school educational material here measures the sufficient availability of a library, software and laboratory equipment which are very specific material resources and they are measured in terms of need rather than mere quantity. This could explain why this material resources variables has a significant effect. The centralisation of teacher hiring determination of school budget has a significant negative effect (of around 10 points) on student test scores. This result pleads in favour of school autonomy in making these decisions. Intuitively we can explain the negative influence of central decision-making by the idea that schools are more efficient in making certain decisions as they now their needs and constraints better than a central authority. This is not true of teacher wage decisions and course contents, the

degree of centralised decision-making on those topics has no significant impact on test scores.

The percentage of schools comparing to a regional or national standard has a small but significant positive effect on pupil's test scores in all three disciplines. Coefficients are between 7 (science) and 10 (reading), meaning that each 1 percent increase in the number of schools comparing themselves to a standard in the region is related to an improvement in student test scores of around 2 points (coefficient times 0.27, the standard deviation of PERCENTCOMPARE). The regional percentage of parents making school choice based on reputation or program also has a significantly positive effect on test scores in all disciplines. Each percent increase in parents choosing schools for program or quality is related to an increase in test scores of between 3.5 (science) and 5.7 (reading) points. These results are robust to including regional control variables (Table 3). Noticeably, the coefficient of PERCENTCOMPARE increases a little (to an effect of around 2.5 test score points) whereas that of PERCENTPARENTCHOICE remains the same. Both coefficients are highly significant and of the same sign and magnitude as in the first specification. Two of the regional control variables also have a significant effect. One percent additional unemployment is correlated with a 7 points decrease in test scores on average and the average regional level of school educational resources also positively affects student results.

Crossed effects of the variables of interest times the country dummies yield a mixed impression as to the similarity of the effects across countries (see tables 4 and 5). Overall, the coefficients of both coefficients are significantly different from one country to another. More of half of the country coefficients for both variables are not significantly different from that of the reference country Canada. However, the

percentage of country coefficients that are comparable to that of Canada is larger for PERCENTCOMPARE. The lowest percentage of comparable coefficients for the latter variable is that for science test scores (53%) , but another 5 country coefficients out of 17 (another 30%) are significantly different only at a 10 percent confidence level. Differences in country coefficients for PERCENTPARENTCHOICE on the other hand concern about half of the countries in the sample. We conclude that country differences in the impact of the regional percentage of parent school choice are more pronounced than in the impact of regional school comparisons. Note that we present only coefficients of the crossed effects but the estimations are done using the same specification as before. This is the case for all tables with crossed effects.

Our finding that the percentage of schools comparing their results to a regional or national standard and school choice have a small but significant positive impact on student performance is in line with results on school accountability from the US and the UK mentioned in the introduction.

4.2. Are more autonomous schools more responsive to school choice and comparisons?

In a next step, we would like to test whether schools are more responsive to regional school comparisons and school choice if they have more decision-making autonomy. Therefore we include in our mixed model crossed effects of the autonomy of decision-making variables times PERCENTCOMPARE and PERCENTPARENTCHOICE. Centralisation of decisions relate to setting teacher wages, hiring teachers, budget and course content. As can be seen in Tables 6 and 7, all of these yield no evidence of relevance of such autonomy. None of the crossed effects are significantly different from zero. Hence according to our specification,

more decision-making autonomy does not make schools more able to respond to school comparison to a regional or national standard or to parent school choice.

Another point of interest was to determine whether schools that are publicly funded benefit less from school comparisons to an national or regional standard and from school choice than schools that depend on private funding. As we can see in Table 8, though our results as to the positive impact of schools comparing to an external standard and school choice are preserved, the coefficients of the crossed effect are not significantly different from zero. So relying on public funding does not seem to modify the effect of school comparison or school choice.

4.3. Low versus high-performing pupils

The results of the mixed model estimations on different quantiles of student test scores are presented in graphs 40 to 45. They represent the coefficients of PERCENTCOMPARE and PERCENTPARENTCHOICE for the eight subsamples of pupils defined in section 3.2. When the quantile's coefficients are not significantly different from zero (at a 10% level of confidence) the line is dotted instead of full. In all disciplines, it appears that there is a decreasing trend in the coefficient of PERCENTPARENTCHOICE (this can be seen on graphs 40 to 42). Whereas the regional percentage of parents choosing schools based on reputation or program has a large significant positive impact of around 80*0,16= 12,8 test score points on the 5% lowest performing pupils' results, it has a much smaller but significant effect of around 4 test score points for the 5% highest performing pupils in all disciplines (on average). These coefficients are all significantly different from each other and from the 50% quantile sample coefficient as you can see in Table 9. This indicates that it are the less than average performing pupils that benefit most from the intensity of regional school choice. How should we interpret this result? The data have been

divided into subsamples of pupils by level of performance. This means that e.g. the coefficient of percentparentchoice for the lowest performing quantile represents the effect of the percentage of parents school choice among the lowest performing pupils in each school. According to our results, more school choice has a positive effect on test scores for all pupils. However, if more low-performing pupils parents exert school choice in a region based on quality or program this has a more positive impact on their children's test scores than if more high-performing parents do so.

From charts 43 to 45 we conclude that the regional percentage of schools that compare their results to a national or regional standard has no significant effect on the lowest nor the highest performing pupils (from the 25 percent lowest performing quantile and the 10 percent highest performing quantile). The largest group of average performing pupils in each school on the other hand benefits significantly by about 3 test scores points from schools comparing to a standard in the region. This is true for all disciplines. Coefficients are not significantly different from each other in different quantiles in maths and in science. Only in reading are the extreme quantiles significantly different from the coefficient in quantile 25, 50 and 75 (Table 10). The latter correspond to the average performing group of pupils, the only one that benefits from school comparison to a standard.

5. Conclusion

In this paper, we used the PISA 2003 cross section data to estimate the impact of the percentage of schools comparing their students performance to a regional or national standard and that of the regional intensity of parent school choice on student test scores in math, reading and science. In order to take into account the hierarchical nature of the data, we used a so-called mixed model that allows for correlation of test scores in a same school nested in a same country to estimate an "education production function". Our results echo the findings of the existing literature from the United States and the United Kingdom, in the sense that school choice and accountability seem to play a small but significant role to improve student performance. We find that the percentage of schools comparing their students results in a given region significantly increases students test scores by about 3% of a standard deviation in all specifications. Autonomous decision-making as to teacher hiring also significantly increases test scores (by around 4% of a standard deviation). We do not find evidence of more autonomous schools or privately funded schools reacting more efficiently to the percentage of regional comparisons or school choice. Finally, we do find differences in the impact of the percentage of schools comparing their results regionally and school choice along the test scores distribution for all disciplines. Only average performing students seem to gain from an increase in the regional percentage of school comparison. The effect of the intensity of school choice is decreasing with pupil performance meaning that low-performing students benefit most from increased school choice by their parents.

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Table 1: Descriptive statistics

	Mean	Std. Dev.
Dependant variables		
Score in maths	500	100
Score in reading	500	100
Score in science	500	100
Explanatory variables		
Initial aptitudes		
Boy	0.49	0.50
Age	15.81	0.29
Effort		
Homework (hours per week)	5.42	5.44
Vocational education	0.17	0.38
Opportunities		
City size	2.99	1.13
Number of books at home	3.30	1.45
Non-nuclear family	0.28	0.45
Foreign lang. At home	0.03	0.18
Parents education	4.10	1.70
Parents socio-eco status	48.06	17.23
Home Educ. Resources	0.00	1.00
Quality of instruction		
School Educ Material	0.00	1.00
Ratio computers/student	0.09	0.10
Central course content	0.40	0.49
Central teacher hiring	0.37	0.48
Central budget	0.29	0.45
Central teacher wage	0.78	0.42
Publicly funded school	0.87	0.34
Regional variables		
Percentcompare region	0.49	0.26
Percentparentchoice region	0.48	0.16
Unemployment rate region	0.03	0.02
School Segregation region	0.00	1.00
Average socio-eco status region	48.06	4.88
Average parent education region	4.12	0.78
Average school material region	0.00	0.50
Variance school material region	0.84	0.19
Number of Obs.	116092	

Table 2 : Mixed model, dependant variable: test scores

	MATH		READ		SCIENCE	
	Coeff.	StdErr	Coeff.	StdErr	Coeff.	StdErr
Intercept	274.82***	13.01	283.09***	13.81	200.59***	13.98
Initial aptitudes						
Boy	18.46***	0.43	-24.92***	0.46	13.83***	0.47
Age	9.51***	0.75	9.87***	0.80	13.51***	0.82
Effort						
Homework	1.49***	0.04	1.80***	0.04	1.71***	0.05
Vocational track	-26.46***	1.44	-23.66***	1.48	-24.75***	1.47
Opportunities						
City size	4.39***	0.56	5.03***	0.55	3.68***	0.54
Number of books	9.67***	0.18	8.33***	0.19	10.24***	0.20
Non-nuclear family	-7.58***	0.47	-6.36***	0.50	-6.78***	0.51
Foreign lang. at home	-20.23***	1.19	-32.88***	1.29	-33.47***	1.31
Parent education	0.25	0.16	0.63***	0.17	1.05***	0.17
Parent socio-eco status	0.53***	0.01	0.56***	0.02	0.56***	0.02
Home Educ. Resources	7.27***	0.24	8.43***	0.25	7.40***	0.26
Quality of instruction						
School Educ. Material	5.75***	0.67	5.62***	0.65	5.38***	0.64
Ratio computer/student	8.63	7.78	9.11	7.61	-0.52	7.44
Central course content	1.40	1.42	2.08	1.39	2.16	1.36
Central teacher hiring	-10.77***	1.77	-11.47***	1.73	-9.85***	1.69
Central school budget	-3.60**	1.55	-3.89**	1.52	-4.52***	1.48
Central teacher wage	4.36**	1.73	3.16*	1.69	1.79	1.65
Publicly funded school	-3.57*	2.03	-2.82	1.98	-4.03**	1.94
Regional variables						
Percent compare	8.41**	3.76	9.93***	3.68	7.09**	3.59
Percentparentchoice	31.69***	9.58	35.79***	9.35	21.87**	9.14
Number of obs	116092					

,**, respectively stand for significance at the 10, 5 and 1% levels of confidence.**

Table 3: mixed model with regional control variables, dependant variable: test scores

	MATH		READ		SCIENCE	
	Coeff.	StdErr	Coeff.	StdErr	Coeff.	StdErr
Intercept	297.85***	19.55	303.74***	19.85	230.88***	19.79
Initial aptitudes						
Boy	18.46***	0.43	-24.92***	0.46	13.83***	0.47
Age	9.55***	0.75	9.91***	0.80	13.53***	0.82
Effort						
Homework	1.49***	0.04	1.80***	0.04	1.71***	0.05
Vocational track	-26.97***	1.44	-24.26***	1.47	-25.16***	1.47
Opportunities						
Number of books	9.68***	0.18	8.35***	0.19	10.25***	0.20
City Size	4.11***	0.58	4.75***	0.56	3.54***	0.55
Non-nuclear family	-7.57***	0.47	-6.35***	0.50	-6.77***	0.51
Foreign lang. at home	-20.22***	1.19	-32.87***	1.29	-33.45***	1.31
Parents education	0.25	0.16	0.62***	0.17	1.05***	0.17
Parents socio-eco status	0.53***	0.01	0.56***	0.02	0.56***	0.02
Home Educ. Resources	7.24***	0.24	8.39***	0.25	7.37***	0.26
Quality of instruction						
School Educ. Material	4.63***	0.68	4.57***	0.67	4.69***	0.65
Ratio computers/student	2.34	7.73	3.37	7.57	-5.23	7.43
Central course content	1.69	1.41	2.38*	1.38	2.33*	1.35
Central teacher hiring	-9.59***	1.75	-10.50***	1.71	-9.03***	1.68
Central school budget	-3.22**	1.54	-3.43**	1.51	-4.04***	1.48
Central teacher wage	3.71**	1.71	2.41	1.67	1.45	1.64
Publicly funded school	-3.90*	2.01	-3.09	1.96	-4.20**	1.92
Regional variables						
Average socio-eco status region	-0.81*	0.45	-0.96**	0.44	-0.34	0.44
Average parents education region	5.45	4.02	6.61*	3.93	-1.76	3.86
Average school material region	11.65***	2.52	11.00***	2.46	6.98***	2.41
Variance school material region	1.82	4.27	7.04*	4.17	3.56	4.09
Regional school segregation	0.38	1.01	0.92	0.98	0.78	0.96
Unemployment rate region	-383.70***	42.52	-355.21***	41.55	-306.61***	40.81
Percentcompare	10.24***	3.79	11.31***	3.70	8.56**	3.64
Percentparentchoice	33.84***	10.34	34.93***	10.10	22.77**	9.91
Number of Obs.	116092					

,**, respectively stand for significance at the 10, 5 and 1% levels of confidence**

Table 4: Coefficients of percentcompare by country: do they differ from the coefficient for reference country Canada? Mixed model with same specification as table 2 plus crossed effects. Dependant variable: test scores

	MATH			READ			SCIENCE		
	F Value			F Value			F Value		
Test: slopes are equal	6.94	<.0001	Different	5.43	<.0001	Different	6	<.0001	Different
Australia	5.11	0.024	Different	2.55	0.110	Equal	3.45	0.063	Different
Belgium	84.7	<.0001	Different	69.48	<.0001	Different	59.98	<.0001	Different
Brazil	5.57	0.018	Different	1.22	0.270	Equal	3.14	0.076	Different
Czech Republic	3.07	0.080	Different	2.54	0.111	Equal	2.91	0.088	Different
Finland	0.16	0.685	Equal	0.2	0.658	Equal	0.01	0.929	Equal
Germany	0.03	0.855	Equal	0.19	0.663	Equal	0.13	0.722	Equal
Greece	2.66	0.103	Equal	0.67	0.415	Equal	0.07	0.792	Equal
Iceland	0.55	0.456	Equal	1.78	0.183	Equal	2.95	0.086	Different
Italy	0.01	0.920	Equal	1.31	0.253	Equal	3.26	0.071	Different
Mexico	0.18	0.672	Equal	2.03	0.155	Equal	1.16	0.282	Equal
Portugal	1.93	0.165	Equal	0.56	0.455	Equal	2.23	0.135	Equal
Slovakia	0.39	0.532	Equal	0.95	0.330	Equal	0.79	0.373	Equal
Spain	0.67	0.414	Equal	0	0.960	Equal	12.93	0.000	Different
Switzerland	2.69	0.101	Equal	2.38	0.123	Equal	0.82	0.366	Equal
Tunisia	1.47	0.225	Equal	0.53	0.467	Equal	2.2	0.138	Equal
Turkey	7.46	0.006	Different	3.68	0.055	Different	4.34	0.037	Different
United Kingdom	0.33	0.565	Equal	0.04	0.837	Equal	0.1	0.751	Equal
Percentage equal	0.71			0.88			0.53		

Table 5: Coefficients of percentparentchoice by country: do they differ from the coefficient for reference country Canada? Mixed model with same specification as in table 2 plus crossed effects. Dependant variable: test scores

	MATH			READ			SCIENCE		
	F Value	Pr > F		F Value	Pr > F		F Value	Pr > F	
Test slopes are equal	5.13	<.0001	Different	5.86	<.0001	Different	4.26	<.0001	Different
Australia	4.9	0.027	Different	5.14	0.023	Different	6.44	0.011	Different
Belgium	23.71	<.0001	Different	17.27	<.0001	Different	20.43	<.0001	Different
Brazil	17.53	<.0001	Different	24.86	<.0001	Different	13.78	0.000	Different
Czech Republic	0.92	0.337	Equal	0.75	0.387	Equal	1.21	0.272	Equal
Finland	2.7	0.100	Equal	4.05	0.044	Different	4.37	0.037	Different
Germany	0.72	0.398	Equal	0.36	0.550	Equal	0.42	0.519	Equal
Greece	0.04	0.837	Equal	1.32	0.251	Equal	2.22	0.136	Equal
Iceland	0.99	0.319	Equal	2.75	0.097	Different	3.97	0.046	Different
Italy	11.08	0.001	Different	20.66	<.0001	Different	0.05	0.820	Equal
Mexico	0.09	0.768	Equal	0.14	0.704	Equal	0.4	0.529	Equal
Portugal	0.48	0.487	Equal	0.33	0.565	Equal	0.66	0.415	Equal
Slovakia	0.17	0.682	Equal	0.16	0.690	Equal	0.22	0.639	Equal
Spain	0.26	0.609	Equal	3.38	0.066	Different	9.7	0.002	Different
Switzerland	4.57	0.033	Different	5.5	0.019	Different	7.95	0.005	Different
Tunisia	0.15	0.699	Equal	0.34	0.558	Equal	0.19	0.659	Equal
Turkey	1.63	0.202	Equal	0.73	0.393	Equal	1.72	0.190	Equal
United Kingdom	11.98	0.001	Different	6.82	0.009	Different	0.1	0.750	Equal
Percent equal	0.65			0.47			0.59		

Table 6: Mixed model (as in table 2) with crossed effects centralised decision-making times percentparentchoice. Dependant variable: test scores

	MATH		READ		SCIENCE	
Effect	Estimate	StdErr	Estimate	StdErr	Estimate	
Intercept	179.32***	13.37	191.04***	14.16	114.69***	14.39
Percentcompare	10.47***	3.41	12.22***	3.34	9.18***	3.34
Percentparentchoice	3.64	12.25	11.85	12.03	-0.49	12.01
Central course content	-4.80	3.81	-1.27	3.74	-1.79	3.74
Central teacher hiring	-6.93	4.55	-12.87***	4.46	-8.42*	4.45
Central school budget	-9.67**	3.89	-7.76**	3.82	-7.81**	3.82
Central teacher wage	-0.24	5.32	0.57	5.23	-1.67	5.22
Percentparentchoice*central course content	13.76*	7.53	7.59	7.38	8.93	7.37
Percentparentchoice*central teacher wage	8.15	10.34	3.99	10.17	5.96	10.15
Percentparentchoice*central teacher hiring	-1.70	9.25	9.46	9.06	2.90	9.04
Percentparentchoice*central school budget	11.92	7.76	7.30	7.61	6.09	7.60

,**, respectively stand for significance at the 10, 5 and 1 percent levels of confidence.**

Table 7: Mixed model (as in table 2) with crossed effects centralised decision-making times percentcompare. Dependant variable: test scores

	MATH		READ		SCIENCE	
Effect	Estimate	StdErr	Estimate	StdErr	Estimate	StdErr
Central course content	-0.01	2.55	0.50	2.50	0.06	2.50
Central teacher hiring	-8.61***	3.20	-10.34***	3.14	-8.69***	3.14
Central school budget	-4.65	2.98	-1.89	2.92	-2.63	2.91
Central teacher wage	-5.10	3.95	-2.79	3.88	0.47	3.87
Percentcompare	-4.00	5.90	3.11	5.79	5.91	5.78
Percentparentchoice	21.76 **	8.69	25.72***	8.52	12.14	8.50
Percentcompare*central course content	4.00	4.80	4.09	4.71	5.15	4.70
Percentcompare*central teacher wage	15.09 **	6.32	9.61	6.20	1.69	6.19
Percentcompare*central teacher hiring	2.23	5.79	3.77	5.67	3.20	5.66
Percentcompare*central school budget	0.86	5.28	-5.00	5.17	-4.47	5.16

,**, respectively stand for significance at the 10, 5 and 1 percent levels of confidence**

Table 8: Mixed model (as in table 2) with crossed effects publicschool times percentcompare and percentparentchoice. Dependant variable: test scores

	MATH		READ		SCIENCE	
Effect	Estimate	StdErr	Estimate	StdErr	Estimate	StdErr
Intercept	157.64***	14.78	175.09***	15.45	97.78***	15.65
Publicschool	7.15	9.05	3.96	8.89	4.42	8.88
Percentcompare	13.55*	7.54	22.34***	7.39	17.07**	7.37
Percentparentchoice	39.86***	15.07	30.83**	14.79	22.19	14.76
Percentparentchoice*publicschool	-20.93	14.18	-11.43	7.50	-8.78	7.49
Percentcompare*publicschool	-3.13	7.66	-5.32	13.93	-10.78	13.90

,**, respectively stand for significance at the 10, 5 and 1 percent levels of confidence.**

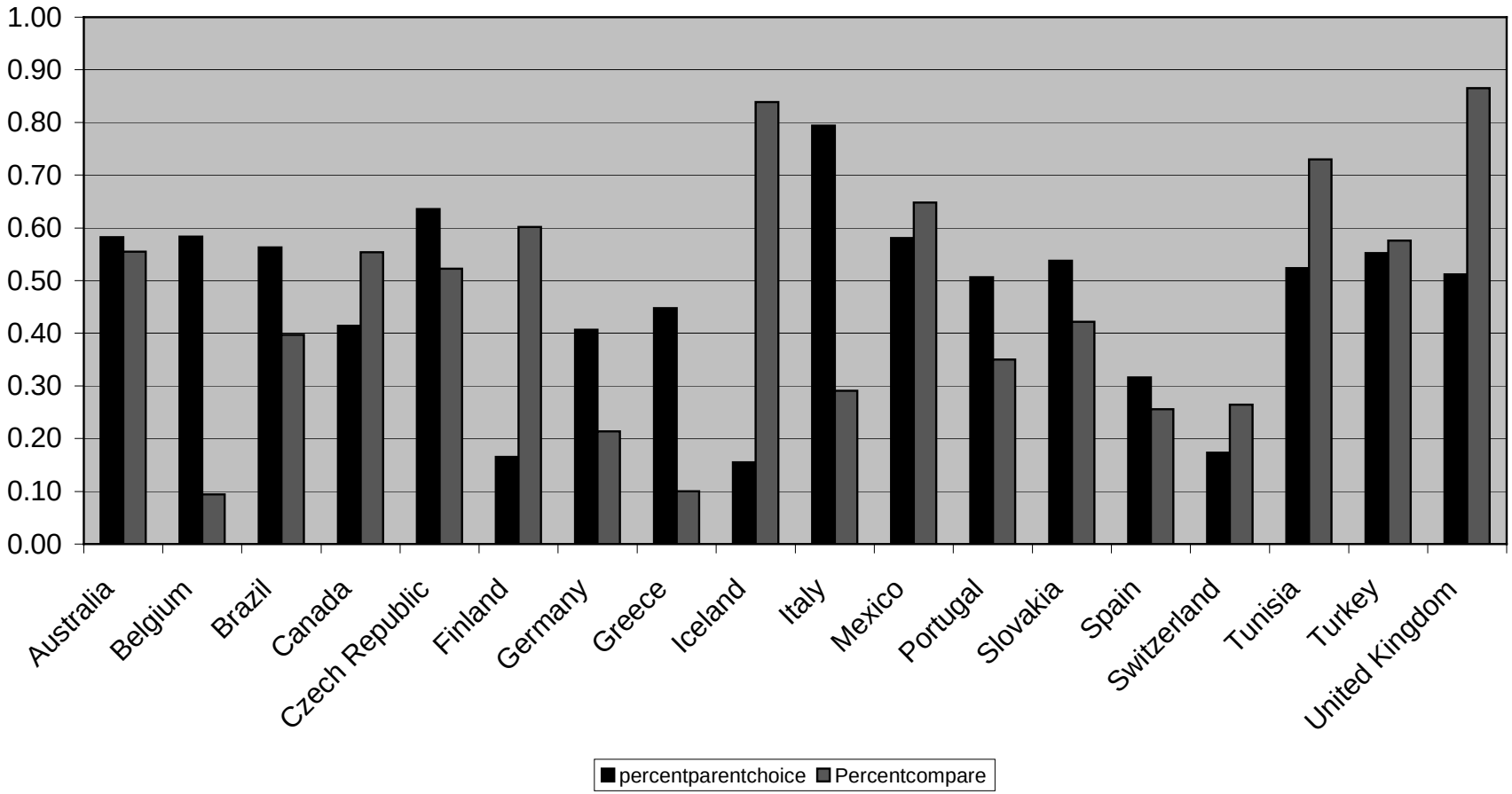
Table 9: test differences in coefficients of percentparentchoice between quantiles. Dependant variable: test scores

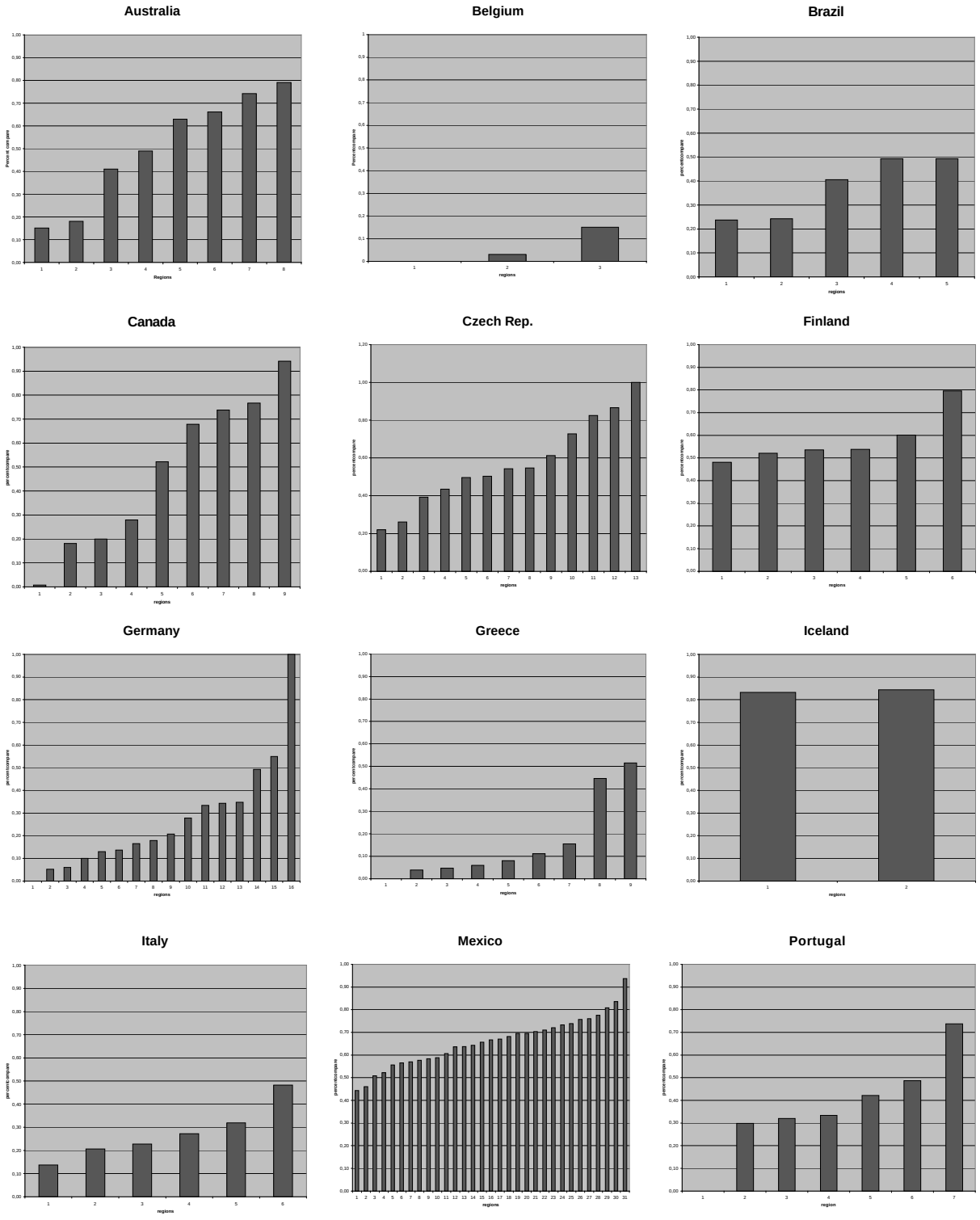
Label	F Value	Pr > F		F Value	Pr > F		F Value	Pr > F	
Test all coefficients are equal	268.1	<.0001	Different	158.22	<.0001	Different	236.4	<.0001	Different
Test q10=q50	246.26	<.0001	Different	203.24	<.0001	Different	119.94	<.0001	Different
Test q25=q50	97.97	<.0001	Different	73.88	<.0001	Different	67.04	<.0001	Different
Test q75=q50	94.51	<.0001	Different	50.34	<.0001	Different	116.22	<.0001	Different
Test q90=q50	231.46	<.0001	Different	105.65	<.0001	Different	299.57	<.0001	Different
Test q95=q50	301.79	<.0001	Different	118.74	<.0001	Different	316.9	<.0001	Different

Table 10: Test differences in coefficients of percentcompare between quantiles. Dependant variable: test scores

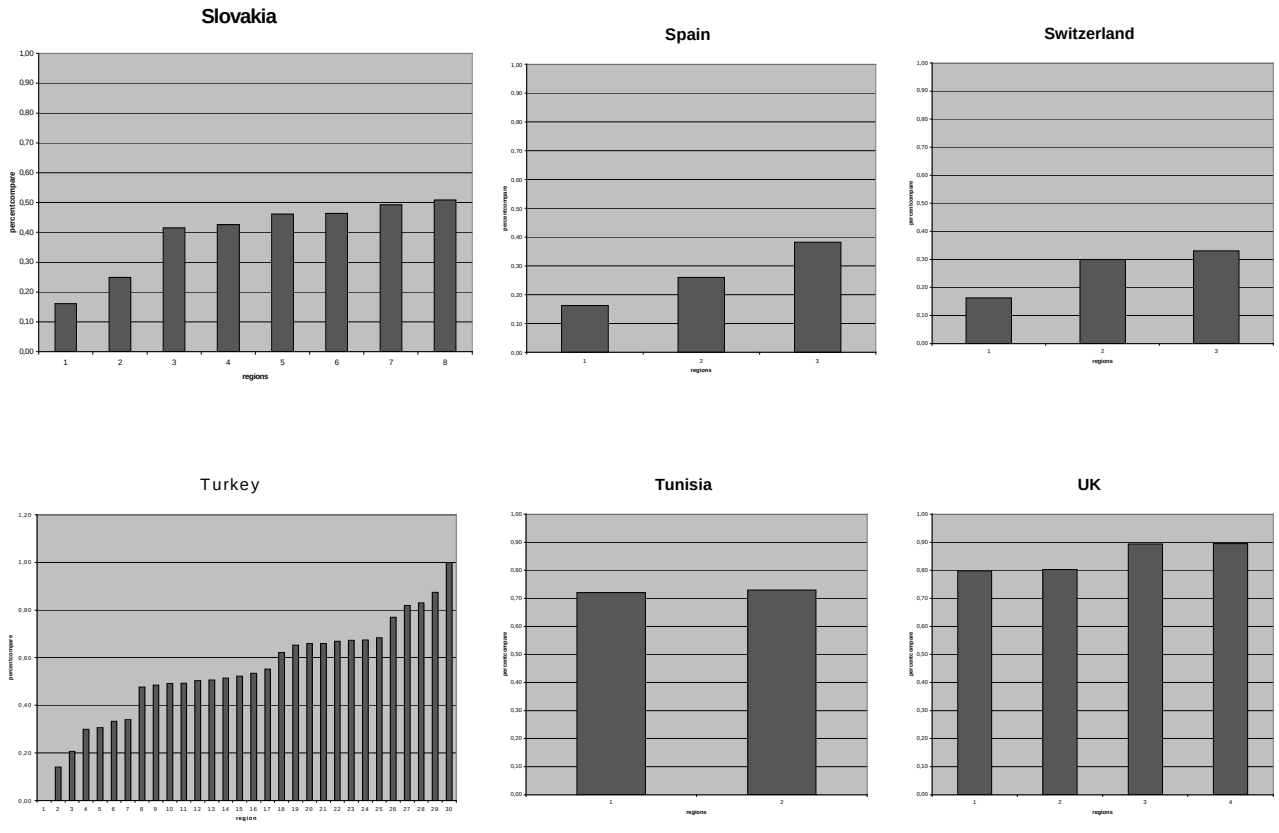
	MATHS			READ			SCIENCE		
Label	F Value	Pr > F		F Value	Pr > F		F Value	Pr > F	
Test all coefficients are equal	1.42	0.212	Equal	10.48	<.0001	Different	1.71	0.128	Equal
Test q10=q50	0.70	0.402	Equal	17.38	<.0001	Different	2.29	0.130	Equal
Test q25=q50	0.02	0.887	Equal	2.66	0.103	Equal	2.07	0.150	Equal
Test q75=q50	0.91	0.340	Equal	0.19	0.660	Equal	0.47	0.493	Equal
Test q90=q50	1.00	0.318	Equal	3.60	0.058	Different	0.20	0.652	Equal
Test q95=q50	4.09	0.043	Equal	13.43	0.000	Different	0.70	0.401	Equal

Graph 1: PERCENTPARENTCHOICE and PERCENTCOMPARE, by country

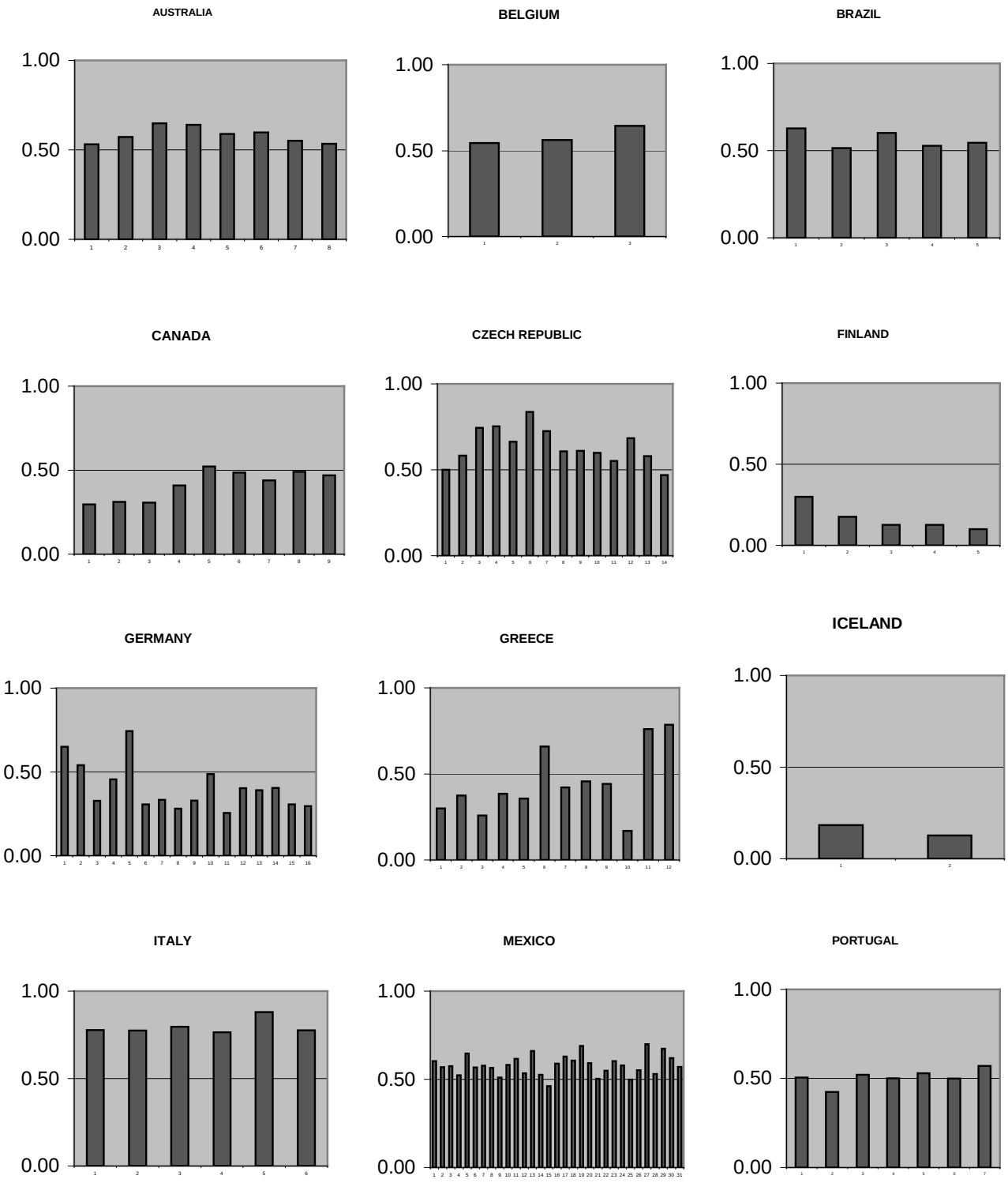




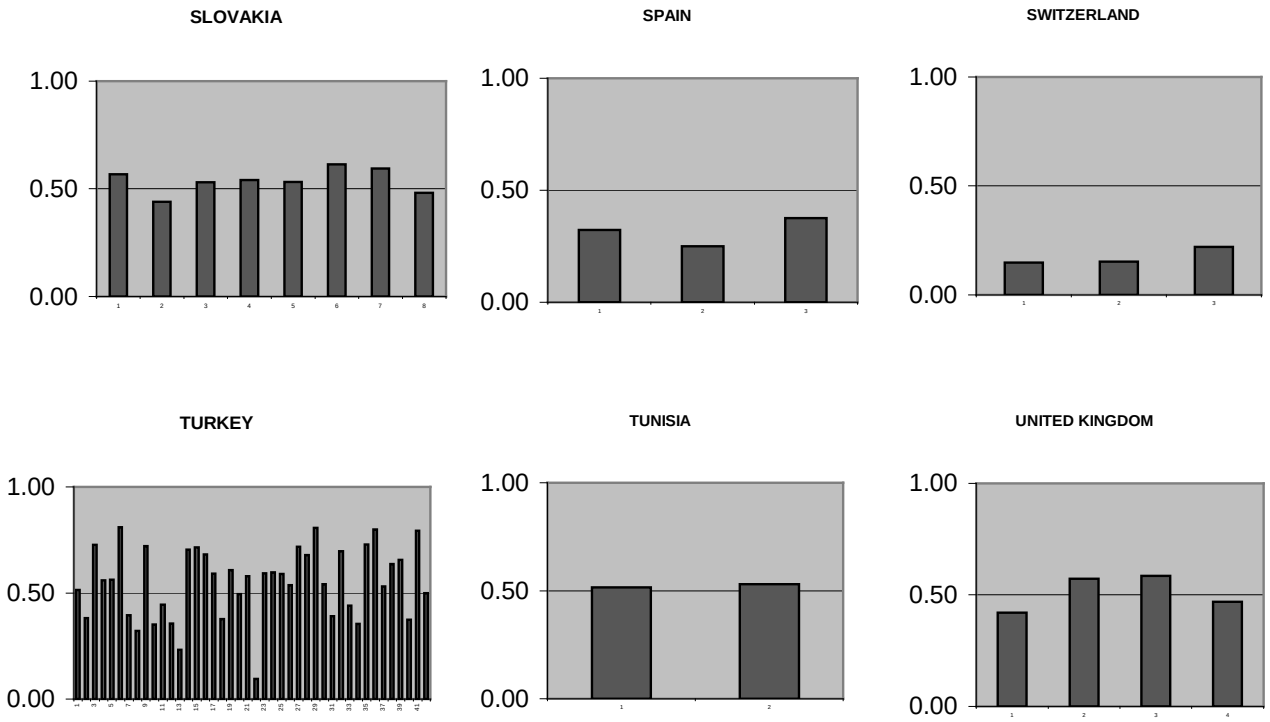
Graphs 2-13 : Percentage of schools comparing their pupils results' to a national or regional performance level, by country and by region.



Graphs 14-19 : Percentage of schools comparing their results to a national or regional standard, by country and by region.



Graphs 20-32 : Percentage of parents choosing their children's school based on reputation or program, by country and by region.

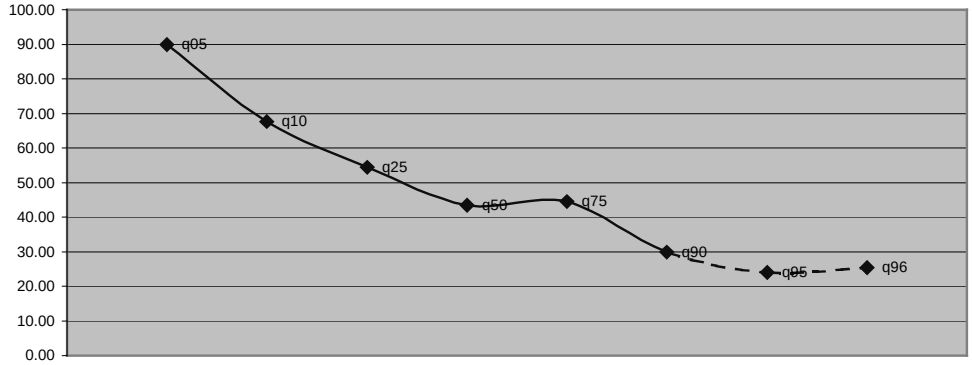


Graphs 33-39 : Percentage of parents choosing their children's school based on reputation or program, by country and by region.

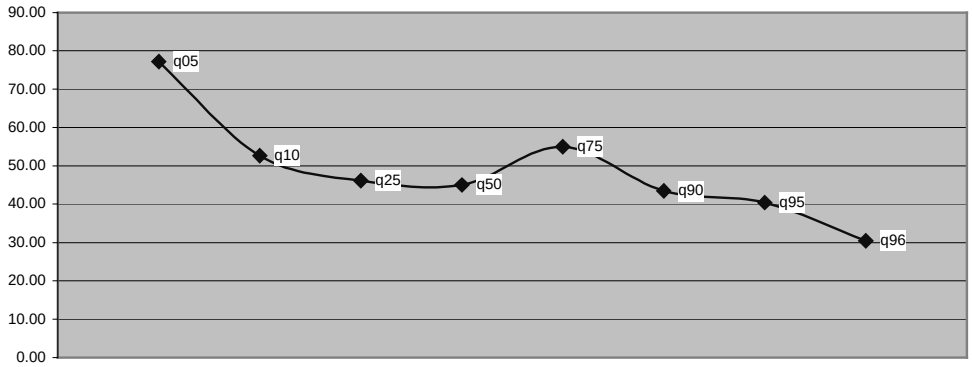
Graphs 40-42 : By quantile of pupils test scores, variable percentparentchoice.

Dependant variables: pupils' test scores in respective disciplines.

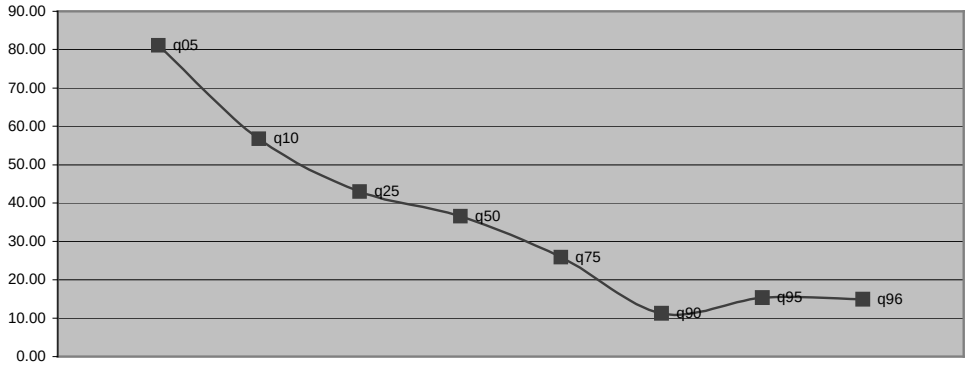
Coefficients of Percentparentchoice by quantile,
Dependant variable: Maths test scores



Coefficients of PERCENTPARENTCHOICE by quantile,
Dependant variable: reading test scores

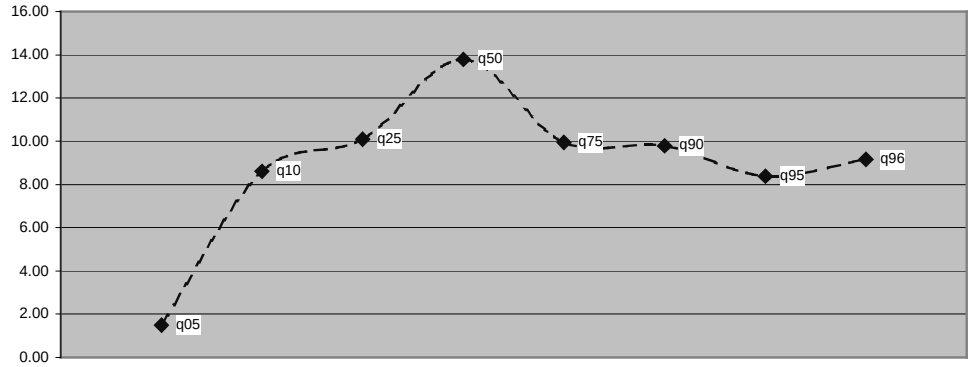


Coefficients of PERCENTPARENTCHOICE by quantile,
Dependant variable: science test scores

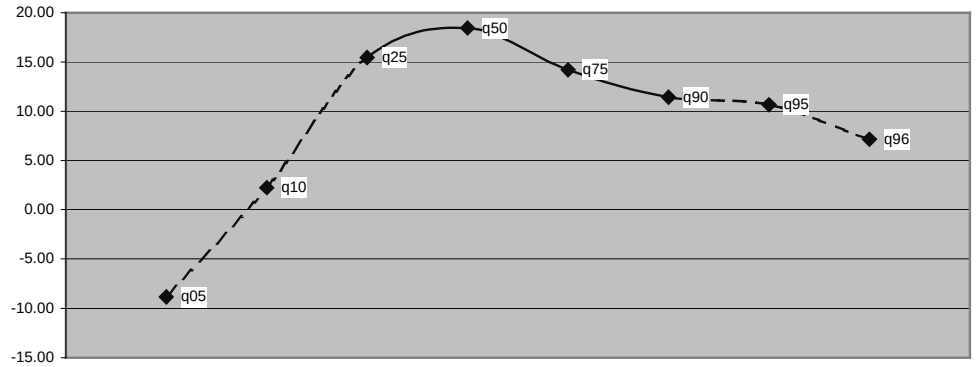


Graphs 43-45 : By quantile of pupils test scores variable percentcompare.
Dependant variables: pupils test scores in respective disciplines.

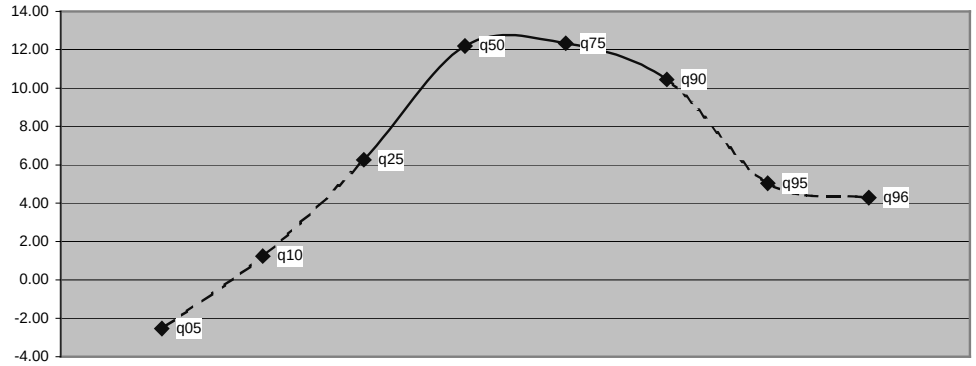
Coefficient of PERCENTCOMPARE by quantile,
Dependant variable: Maths test scores



Coefficient of PERCENTCOMPARE by quantile,
Dependant variable: reading test scores



Coefficient of PERCENTCOMPARE by quantile,
Dependant variable: science test scores



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