2012/53

School staff autonomy and educational performance:
within school type evidende

Marijn Verschelde, Jean Hindriks,
Glenn Rayp and Koen Schoors

The word "CORE" in a bold, black, sans-serif font. A thin blue arc starts above the 'C', curves over the 'O' and 'R', and ends below the 'E'.

CORE

DISCUSSION PAPER

Center for Operations Research
and Econometrics

Voie du Roman Pays, 34
B-1348 Louvain-la-Neuve
Belgium

<http://www.uclouvain.be/core>

**School staff autonomy and educational performance:
within school type evidence**

Marijn VERSCHELDE¹, Jean HINDRIKS²
Glenn RAYP³ and Koen SCHOORS⁴

December 2012

Abstract

This paper shows the effect of school staff autonomy on educational performance. The distinctive feature with existing literature is that we employ variation in autonomy within the same country and within the same school type to reduce the omitted variables problems. To fully capture the informational advantage of local actors, we define autonomy as the operational empowerment of the school's direction and teachers. The Flemish secondary school system in Belgium is analyzed as it displays unique within school type variation in school staff autonomy. This variation originates from autonomously operating school governing bodies that can group multiple schools and are free to delegate responsibilities to the school staff. Combining detailed school level and pupil level data from the PISA 2006 study with a semiparametric hierarchical model, we find strong positive effect of school staff autonomy on educational performance. The result is shown to be robust to problems of reverse causality and simultaneity. Quantile regression shows that both low and high-performers benefit from school staff autonomy.

Keywords: educational performance, PISA, school autonomy, educational production function, semiparametric.

JEL Classification: I28, H52

¹ SHERPPA, Department of General Economics, Ghent University, B-900 Ghent, Belgium. E-mail: marijn.verschelde@ugent.be

² Université catholique de Louvain, CORE, B-1348 Louvain-la-Neuve, Belgium. E-mail: jean.hindriks@uclouvain.be. This author is also member of ECORE, the association between CORE and ECARES.

³ SHERPPA, Department of General Economics, Ghent University, B-9000 Ghent, Belgium. E-mail: glenn.rayp@ugent.be

⁴ CERISE, Department of General Economics, Ghent University, B-9000 Ghent, Belgium. E-mail: koen.schoors@ugent.be

We sincerely thank the participants of the Workshop 'Educational Systems and Human Capital' in Trondheim (March 2011), Bart Cockx, Gerdie Everaert, Meryem Fethi, Kristiaan Kerstens, Dirk Van de gaer, Sietse Bracke, Klaas Mulier and Joost Vandenbossche for their helpful suggestions and insightful comments on an earlier draft of this paper. Further, we thank Inge De Meyer of PISA Vlaanderen for her support. Marijn Verschelde acknowledges financial support from the Fund for Scientific Research Flanders (FWO-Vlaanderen). All remaining errors are ours.

1 Introduction and related literature

A remarkable stylized fact of educational economics is that higher school resources do not necessarily yield higher pupil performance. Evidence for an overall large effect of school resource policies on pupil performance is largely missing (Hanushek, 2003; Wößmann, 2003). It cannot be excluded however that the effect of input-based policies on pupil performance is moderated by the incentive structure of school actors (Hanushek, 2003). Since the incentive structure of school actors is embedded in school institutions, insight in the latter may be crucial to understand the relation between school resources and pupil performance.

There is accumulating cross-country evidence that getting incentives right by a combination of monitoring and autonomy is beneficial for educational efficiency (Wößmann, 2008). Since these studies compare institutions across countries the results may be biased because of an obvious omitted variable problem. Any other source of cross-country variation, like legal or cultural differences, may indeed bias the results. To identify the effect of school autonomy from within-country changes, Hanushek et al. (2011) use a panel estimation with country fixed effects on student level data from 42 countries from the Programme for International Student Assessment (PISA) 2000, 2003, 2006 and 2009 dataset. As school autonomy is considered as a country level average, within-country selection does not affect their estimates. Moreover, the use of country fixed effect estimation ensures that estimates are not affected by time-invariant country-specific heterogeneity. The authors find that the effect of school autonomy depends on the level of economic and educational development. In other words, in strong (weak) institutions, considerable academic gains (losses) are found from decentralized decision-making. In addition, the authors find larger gains from school autonomy if an adequate accountability system is in place such as central examination.

However, as secondary education is decentralized to the regional level in several countries (e.g. Belgium, Germany, Spain, United Kingdom), there is still regional level institutional variation that can affect the results from country fixed effects estimations.

Moreover, the assumption that institutional features such as the awareness of the importance of education and academic culture are time-invariant is hard in the specific setting. One example of time-varying institutional features is the change in institutional settings at country-level after the publication of dramatic scores for some countries in the first round of PISA (i.e., PISA 2000). This publication was the start of an “*an intense political debate that spread over almost all areas of the political and economic life, as the human*

capital acquired in a nation's schooling system is generally regarded as the most valuable resource of society" (Ammermüller, 2004). Not without reason, the PISA 2000 publication was called the '*PISA shock*' in Germany.

In studies that use within-country variation of monitoring and autonomy, the problem of adequately controlling for (time-varying) institutional variation at country level is of course avoided. However, almost all student level within-country evidence of positive effects of school autonomy comes from studies comparing different types of schools (see e.g. the charter school literature, referenced in e.g. Abdulkadiroglu et al. (2011)). As noted by Hanushek et al. (2011), it is difficult to extract school autonomy effects from school type effects such as parental choice, quality of information or constraints on school location. Clark (2009) uses a different kind of variation, namely the variation in autonomy by the formation of a new type of public school with more autonomy (i.e., the '*Grant Maintained*' schools) in the UK between 1988 and 1997. The authors use a regression discontinuity design to compare public schools in which the vote to become a more autonomous '*grant maintained*' public school barely won with those in which the vote barely lost. Significant and persistent achievement gains are found for schools that opted to become '*grant maintained*' schools. Still, also in this study, school autonomy effects are not fully separated from other school type specific effects as variation in school autonomy is between school type.

The first contribution of this paper is that we employ within-country, *within school type* variation of autonomy on a dataset of pupil level performance, which gives us the degrees of freedom needed for statistical inference, and allows us to better isolate the school autonomy effects from school-type and country-specific effects.

This within school type variation comes from the particular structure of secondary education in Flanders, one of the three regions to which education is decentralized in Belgium.

The constitutionally guaranteed freedom of education is the cornerstone of the Flemish educational landscape, illustrated in Figure 1 in Appendix.¹ Freedom of education implies free school choice and freedom to start a school and autonomously organize education for

¹See Devos and Tuytens (2006), OECD (2008a) and OECD (2011) for a complete overview of the Flemish education system.

any natural or legal person. Since the School Pact (May 25th, 1959)², freedom of education implies in addition that education should be costless. The autonomously operating school governing bodies receive government funding if they meet minimal requirements, in particular, reaching the legally imposed final standards.³ In practice, freedom of education has resulted in large autonomy for non-profit school governing bodies that can group multiple schools. The school governing bodies are clustered in three main education networks: 1) the Flemish community education network (GO!), 2) the publicly funded, publicly managed education network (OGO) and 3) the publicly funded, privately managed education network (VGO).

The publicly funded, privately managed education network (VGO) groups umbrella organizations of catholic schools (VKO) and Small Education providers (OKO; e.g. Steiner schools, protestant schools) and school governing bodies with no umbrella organization. About 75.1 percent of pupils in ordinary secondary education are in privately managed schools, with only a very small proportion in non-catholic schools.⁴

The publicly funded, publicly managed education network (OGO) groups schools of Flemish cities and municipalities and provincial schools. In the first, the local authority is the governing body of the school, whereas in the latter the provincial authority is the governing body of education. This network represents about 7.6 percent of pupils in comprehensive secondary education.

The Flemish Community Education Network (GO!) groups 17.3 percent of ordinary secondary education pupils. It has as meso-level school groups that are together with the education network the governing body of multiple schools.

All three educational networks have entrusted considerable school policy autonomy to school governing boards. The non-profit governing boards can either determine school policy themselves or delegate operational autonomy to the school principals and teachers. Between school type variation (with main school types: community schools, city schools, provincial schools, and subsidized private schools) exists because the number of schools per governing board can differ between school types. Table 1 illustrates that community school governing boards group on average 8.50 schools, while this is only 2.66 in subsidized

²The School Pact ended the so called ‘*school wars*’ between catholics and liberals.

³Additionally, the School Pact poses that each pupil should be able to follow neutral education if wanted, with as necessary condition a geographically disperse network of public schools.

⁴Data from 2011-2012 (Department of Education & Training, 2012).

private education. In all school types, there is large variation in the number of schools per school governing board. Further, there is considerable between school type variation in the composition of school boards. For example, while in public education school board members often have a political background or connection, in subsidized education many school board members have a connection with the Catholic Church.

<Table 1 about here >

Panel discussions between school principals (Van Petegem et al., 2009), case studies of schools (among others Caenepeel (1988), Devos et al. (1989) and Devos et al. (1999) and Van Petegem et al. (2009)) and an OECD review team (Day et al., 2008) document extreme differences in the responsibility structure within school governing bodies. In some school governing bodies, the school direction is delegated full operational responsibility over its own school and the school governing body only intervenes when large problems occur. In other governing bodies, the school principal is considered as a mere employee of the school governing body, with virtually no autonomy. Therefore, in Flemish Belgium, there is unique within school type variation in school autonomy. We use variation in the amount of autonomy that trickles down to the lowest level, the school's direction and teachers as a strategy to identify the effect of school actor incentives on the relation between school resources and output.

This variation originates in subsidized education from the fact that there are no rules that exhaustively define the role of school principals. For the Flemish Community Education Network (GO!), the Special Decree of 14 July 1998 stipulates which responsibilities should be delegated to the school direction.⁵ However, there is large variation in the interpretation of the law and the actual autonomy that is delegated to the school principals. Some governing boards take all financial decisions, while others stand aloof (Van Petegem et al., 2009, p. 20-22).⁶ OECD (2008b) concludes that “*Even in countries that do have legislative*

⁵Examples of school direction responsibilities are the general and pedagogic organization of the school, the organization of extramural activities and the allocation of the by the school group formulated school budget. Besides these by law delegated responsibilities, the school principal can be delegated extra responsibilities by the school group.

⁶In particular, Devos et al. (1999) and year reports of schools in GO! education show that in some school groups, each school is free to formulate and allocate the full budget for its own school and the role of the school board is only to ratify the budgets if there are no large problems. In other schools, financial

frameworks to define the responsibilities of school principals, there are concerns about the relevance and clarity of the legislation...in Flemish Belgium there is no comprehensive statutory description of the post of the school leader.”

However, selection issues and simultaneity problems can bias results from this kind of student level cross-sectional study. Therefore, we discuss the issues thoroughly and argue why our results are not driven by self-selection of students, reverse causality and the problem that more dynamic school teachers and principals will simultaneously boost educational performance and increase their operational autonomy, without there needs to be a direct effect of school autonomy on outcomes. In line with qualitative research, we argue that approximately random variation in characteristics and composition of the school boards is the main source of the variation in responsibility structures within school governing bodies.

The second contribution of this paper is that we restrict ourselves to a narrow definition of autonomy. We only look into the effects of autonomy of principals and teachers, the local agents that, through their local informational advantage, are supposed to boost educational outcomes. This identification strategy brings our work closer to a clean test of the supposed effects of autonomy in a principal-agent framework (see below), where the government is the principal and the local school actors (school’s direction and teachers) are the agents.⁷

The remainder of this paper is structured as follows. In a second section, we discuss the theoretical background for the expected effect of school autonomy on educational performance. In section 3 and 4, we present the PISA data and the semiparametric multi-level analysis. In section 5, we discuss the results on the effect of school staff autonomy on educational achievement. Section 6 concludes.

cells of the governing board formulate the school budgets and leave little room for budget allocation by the school principals (e.g. only small purchases of educational material).

⁷Hallinger et al. (1996) were the first to measure principals’ activities in key dimensions of a school’s instructional program and to relate these to student outcomes such as reading achievement. Wößmann (2003) is one of the first to look into the effect of individual teacher influence over teaching on student performance.

2 Theoretical background

The impact of school autonomy is linked to several strands of the literature. The decentralization of education may boost efficiency and productivity by eliminating unnecessary bureaucratic burdens (see Niskanen (1971) and Niskanen (1991), for seminal work on budget maximizing bureaucrats). School autonomy may help schools to overcome bureaucratic rigidity and in this way impact student performance positively (Bottani and Favre, 2001; Chubb and Moe, 1990).

Entrusting the provision of education to local agents may also lead to more efficient provision because local agents will be closer and more responsive to student needs and preferences since students can ‘vote with their feet’ by changing school or even community. Tiebout (1956) shows that decentralized public good provision may, under certain conditions, yield the efficient provision of public goods like education. Hoxby (1999) confirms this Tiebout hypothesis for local school productivity under much less restrictive conditions. This suggests that the combination of decentralization and free school choice may indeed provide greater opportunities for local citizens and students to monitor and discipline the local agents that are responsible for educational policy, thereby creating greater efficiency and productivity.

If the decentralization of education is accompanied by public information on school performance, it may also be conducive to yardstick competition (see Shleifer (1985), and Besley and Case (1995)) among schools, in this way encouraging the adoption of more effective teaching methods and more efficient operational procedures. Card et al. (2010) for example recently find significant effects of enhanced competition on the test score gains of students in Canada in all studied school systems. They however also point at a possible negative effect of this yardstick competition. It cannot be excluded that “in more competitive markets teachers and principals spend more time and effort preparing for standardized tests, and less on other aspects of learning. If “test skills” have limited intellectual value, the effort devoted to competing over test outcomes is socially wasteful, and the higher test score gains observed in more competitive markets may be counter-productive” (Card et al. (2010), p. 29-30).

In weak institutional environments, decentralization may have some additional negative implications, like increased levels of uncoordinated rent-seeking and corruption as government

structures become more complex and devoluted (Fan et al., 2009), increased coordination costs and slower institutional reform.

The most important negative consequence of increased autonomy may lie in a potential principal-agent problem (see Wößmann et al. (2007)). The government (principal) tries to improve cognitive skill creation by delegating responsibilities to schools (agents) that are assumed to have a local information advantage over the principal. A principal-agent problem appears when the interests of the government and the school diverge and information is asymmetric. Interests typically diverge for decisions that influence the financial position of the school or the workload for school actors. Budget formation and curriculum content are therefore policy areas with a high probability of divergence between the interests of the government and the school. In process and personnel decisions on the other hand, little divergence of interest is expected. This principal-agent problem requires to put in place appropriate accounting systems. With effective accountability, autonomy is expected to enhance educational performance. Central examinations are a widely used accountability mechanism to align incentives between schools and the government (Wößmann et al., 2007), but other mechanisms can be used to attain this goal.

In Flanders, instead of central examinations, inspection teams investigate on a regular basis whether the curriculum and teaching process are aimed at reaching the centrally imposed final standards and whether budget formation is in accordance with the posed requirements. Benchmarking by parents is possible as the inspection reports are publicly available. In addition, freedom in budget formation is limited to additional funding, above the centrally imposed funding system. The size of these additional budgets is very small in comparison to the school budget. It mainly consists of revenues from student enterprises (such as a bakery in a bakery school) and donations by parents to finance e.g. school trips or school material (Poesen-Vandeputte and Bollens, 2008). Consequently, discretionary power of schools are limited on divisive issues like budget formation and curriculum development. We therefore expect that the principal-agent problem will be limited in our case, and that the institution of school autonomy, through improved incentives for schools and teachers, will affect resource-allocation decisions and ultimately the educational performance of students positively.

It is worth noting that the positive effect of autonomy can also be supported by Oates' efficiency theorem (see e.g. Hindriks and Myles (2006, chapter 17) for an overview). Indeed

under Oates' approach, autonomy is beneficial to better match local preferences and needs (the preference matching benefit) but could be detrimental in terms of lack of coordination and spillovers (the spillover costs). To determine if autonomy is beneficial it is necessary to compare the magnitude of the costs and benefits. It is easily seen that most items in school policy (such as budget formation, course content, teacher selection, disciplinary policies, student admission, etc.) display both preferences matching benefits and spillover costs. However the relative magnitude of these cost-benefits vary from one item to the other. Student and teacher selection is probably the one with highest spillover costs and the lowest preference matching benefit. It is therefore natural that we observe little school autonomy on such issues. On the other hand, the budget allocation presents low spillover costs and high preference matching benefits so autonomy is expected to produce better outcome than centralized decision making with uniform policy choice. In fact without spillover, decentralization is always superior. With spillover, decentralization can still dominate if there is sufficient difference across school in terms of needs and preferences. This argument relies heavily on the assumption that autonomy leads to better differentiation in educational policy to match local needs, and that the spillover effects are limited.

Last but certainly not least, autonomy is linked with intrinsic motivation. Human behaviour is driven by both intrinsic and extrinsic motivation. Both economic and psychological literature (i.e., Frey (1993), Frey (1994), Frey and Oberholzer-Gee (1997) and Deci and Ryan (1985)) pinpoint the so called "*hidden cost of reward*", and cost of control by destroying the "*psychological contract*". Frey (1993) shows in a principal-agent framework that monitoring by the principal can be perceived by the agents as an indication of distrust, with lower work effort by the agents as result. Frey and Oberholzer-Gee (1997) shows that extrinsic motivation (such as price incentives) has a crowding-out effect on intrinsic motivation. Differently put, price incentives or external intervention that is perceived to be controlling can reduce the feeling of living up to the civic duty and diminish altruistic behaviour. This implies that the intrinsic motivation of the school staff and education quality is expected to be higher in schools where the school staff perceives to have considerable responsibilities.

3 Data

We hypothesize that a combination of school staff empowerment in budgeting and effective accountability will, after controlling for socio-economic and school-level institutional variation, have a positive effect on educational performance. We discuss in this section the used data, the dependent variable, the unique within school type variation in budgeting autonomy and the controls.

3.1 PISA 2006

We focus on the educational setting in Flanders, as its specific characteristics of education allow for a within school type analysis of school autonomy as we show below.⁸ We use the PISA 2006 dataset. This because only for the sampled schools in 2006, we were able to group the schools in the four main school types in Flanders (as discussed, education organized by cities, provinces, the Flemish Community and publicly funded, privately operating entities (mainly catholic education)), whereas PISA only groups the schools in ‘public’ and ‘publicly funded, privately operating schools’.

In 2006, the PISA survey was implemented in 57 countries. The main focus of PISA 2006 is on science, however all pupils are also requested to complete a standardized test on math, science and reading and fill out a survey with questions related to their family background, views on issues related to science, the environment, careers, learning time and teaching and learning approaches of science.

Tests are typically constructed to assess between 4,500 and 10,000 students of age 15 in each country. To sample the target population of 15-year old pupils that are at least in grade 7, PISA 2006 has implemented a two-stage stratified sample design. In stage 1, for each stratum⁹, schools are sampled proportionally to size from a list of schools in the region (PPS sampling). The target was 150 schools in each region. In stage 2, 35 pupils are randomly drawn from a list of 15-year old pupils in the school.¹⁰ Final student

⁸Since 1989, Belgian education is organized by the Flemish community, the French-speaking community and the German-speaking community. Hirtt (2007) argues that Flanders has the most effective accountability system of the three communities.

⁹A group of schools, formed to improve the precision of sample based estimates.

¹⁰If the school has less than 35 pupils, all pupils are included in the sample.

weights are constructed to correct for varying selection probabilities of the students.¹¹ In PISA 2006 the plausible value approach is used to estimate the pupil performance in respectively mathematics, science and reading literacy. These plausible values are random values from the posterior distribution and cannot be aggregated at pupil level (OECD, 2005). Therefore, in what follows, we use the first plausible value component to estimate educational outcomes in math, science and reading at pupil level.¹² In Appendix, we discuss the interpretation of plausible values. A Balanced Repeated Replication (BRR) procedure with 80 replication estimates - described in OECD (2005)- is used to construct standard errors and to account for sampling variation (OECD, 2009).

Pupils in special education or part-time education are dropped from the sample. Pupils in private-funded schools or with missing values for some variables are also dropped from the sample. In addition, we do not take pupils in schools with less than 4 pupils per teacher into account as we expect that these schools have among others a different educational approach.¹³ By this, the sample is reduced to 3603 observations. Sub-schools are defined to control for ability tracking in general, technical-arts and vocational education. A sub-school is defined as a unit that provides either general, technical-arts, or vocational education. When a school provides both general and technical or arts education, then the school is treated as two separate (sub-)schools. The sample consists of 126 schools and 245 sub-schools.

3.2 Student performance

Table 2 shows descriptive statistics of the educational achievement of pupils in Flanders. Standardized test scores for math, science and reading are high in Flanders (PISA average is 500). But the high standard deviation of educational outcomes indicates that the inequality in individual test scores is also high.

¹¹This occurs because certain subgroups that are over- or under-sampled, the information of school size at the time is not completely correct, school non-response, student non-response and the inclusion of trimming weights to ensure stable estimates.(OECD, 2009)

¹²As plausible values are random draws, the choice to take the first plausible value is arbitrary. Other plausible values could be taken as well.

¹³However, sensitivity tests available on request show that our results still hold when we do consider these schools with very few pupils per teacher as comparable and take them into the analysis.

<Table 2 about here >

3.3 School staff autonomy

School autonomy is a rather vague concept. In our study we will explicitly focus on autonomy of principals and teachers, using the data made available by PISA (2006). The PISA dataset among other things looks specifically into the roles that principals and teachers might play in educational decision-making and contains measures of centralization and decentralization for these different functions.

Table 3 illustrates how the level of school autonomy varies item-by-item in Flanders. In particular, the principal is asked who has the main responsibility for any specific item. The principal can tick multiple levels if there is joint decision making on a particular item. In line with Eurydice (2007) and Eurydice (2008), the PISA 2006 data show that Flanders is characterized by considerable school (group) autonomy in staffing, budget allocation and formation, assessment and discipline of pupils and textbook choice. Neither schools, nor intermediate government institutions have the autonomy to set the salaries of teaching and non-teaching staff. Although selection of students by schools is restricted to avoid exclusion of minority groups, the school's direction remains largely in charge of approving the admission of pupils to the school. There is noteworthy variation in school staff autonomy for the items on firing teachers, budget allocation, budget formation, course content and courses offered.

We only consider in our analysis the variation in budget formation and allocation. It is for these items that the school governing bodies have not equally decentralized decision making to the school staff. Since the autonomy in budget formation is rather limited (as it needs to be in line with the centrally imposed funding system), our main focus is on budget allocation. We defined school autonomy in budget allocation (formation) as a binary indicator, equal to one if the school principal ticks that he/she or the teachers have a considerable responsibility in the task of budget allocation (formation), zero otherwise. The reviewed theoretical studies do not pinpoint perverse effects of joint-decision making, i.e. when the school governing board and the school principal have considerable responsibility.

Therefore, we did not focus on a strict definition of school autonomy that excludes joint-decision making. Table 4 shows that over 80 percent of the sampled schools in both public and private education have considerable autonomy on budget allocation. Less than 40 percent of the sampled schools do not share this responsibility with higher levels. However, as shown further, all results hold when we alter the definition of school autonomy.

We did not focus on autonomy in curricular content and courses offered as we expect interpretation issues for these items. As discussed in the Introduction, the Flemish government sets the final standards, but schools have considerable autonomy in how to reach the final standards. In practice, this amounts to a centrally imposed programme of basic courses, and considerable autonomy in the curricular content of optional subjects. As the final standards are detailed and well defined (see Hirtt (2007)), the principals can either interpret they have considerable autonomy (in reaching the posed final standards) or little autonomy (as there is little room to teach other things than the centrally imposed programme). As a result, we note that principals tick both themselves and/or the educational authorities as decision makers in course content and courses offered.

In addition, we did not include autonomy in firing teachers into the analysis as we don't believe school actors can actually make use of the large authority to fire teachers, as regulations strongly limit the possibility to fire a teacher, unless a serious fault is established.

<Table 3 about here >

<Table 4 about here >

3.4 Control variables

Student characteristics We control for student-level heterogeneity by including family background, gender, education track, grade retention and the weekly followed lessons of the test subject in our model (see Table 5 and 6). To relate variation in outcomes to family background, we consider 2 socio-economic variables: socio-economic status and migration status. Family socio-economic status is estimated by PISA 2006 as a composite index of the Economic and Socio-Cultural Status (ESCS) of a pupil, derived from (1) the highest occupational status of each student's parents, (2) their highest educational level, and (3) a summary measure of household possessions. For the sampled students of all participating

OECD countries, the mean is 0 and standard deviation is 1. The ESCS score shows substantial variation across pupils in Flanders.

For migration status, three proxies are used. First-generation immigrants and second-generation immigrants are respectively defined as pupils that are not born in Belgium and pupils that are born in Belgium, but are children of immigrants. Pupils that are first- or second-generation immigrant and do not speak an official Belgian language at home are grouped in a third variable. The proportion of non-native pupils is around 5 percent. 2 percent of the pupils in the sample do not speak an official Belgian language at home.

Pupils are tracked in the first year of secondary education in either general, technical-arts or vocational education based on academic records. In our filtered sample, 50 percent of pupils are in general education (high track), 33 percent are in technical-arts education (middle track) and 17 percent in vocational education (low track). If a pupil has not reached the basic skills determined by the posed final standards in a school year, grade repetition and re-orientation to lower tracks are used. In our sample, 21 percent of pupils are lagging behind.

School characteristics To control for school-level heterogeneity, we include controls for variation in educational resources, teacher shortage, class and school size, school type, social segregation, selectivity by schools and urbanization (see Table 5 and 6).

1. *Educational resources.* Schools receive funding and ‘teaching hours’ according to the number of pupils. Schools with more disadvantaged pupils receive additional resources (‘GOK policy’). On average, schools have a modest lack of educational resources (e.g. instructional material, labs) (the average is above the PISA 2006 average of 0).
2. *Teacher shortage.* In line with Rivkin et al. (2005) and Kane et al. (2006), preliminary analysis showed that the relation between formal teacher quality and educational performance is not significant. As almost all teachers in Flanders are certified, we dropped this variable. In contrast, shortage in educational personnel can have severe negative effects on the true teacher quality and teaching process in a school. Therefore, a negative sign is expected. For math and science, there is a systematic

shortage in teachers.¹⁴ Therefore, we focus on shortage of adequate teaching staff in areas other than math, science and reading.

3. *Class and school size.* The effect of school and class size on performance is difficult to disentangle from the selection effect (i.e. parents choose better schools that are consequently of larger size). Therefore, we use school size and student-teacher ratio to control for heterogeneity in class and school size.
4. *School type.* We control for the 4 main school types in Flanders: Flemish community schools, city schools, provincial schools and subsidized private-operating schools. As discussed, private-granted schools are only a negligible proportion of the school population.
5. *Social segregation.* When schools organize different tracks, each school track is considered as a distinct sub-school. There is considerable variation in sub-school average ESCS, indicating social segregation between (sub-)schools. A quarter of the students are in sub-schools with an average ESCS below or equal to the OECD student average of 0, while the most elite sub-school groups students with an ESCS which is on average 64 percent higher than the OECD student standard deviation. As shown in Hindriks et al. (2010), there is less social segregation between school types than between school tracks.
6. *Selectivity by schools.* Selection by schools is officially not allowed within a track. However, Table 5 indicates selection on academic record or recommendation is frequently used.
7. *Urbanization.* Table 5 shows that 60 percent of the sampled pupils receive education in a town with 15,000 up to 100,000 inhabitants.

Variables related to school competition could be included. In Hanushek and Luque (2003), a significant positive effect is found of competition of private schools. Hoxby (2000) finds that Tiebout choice leads to better school performance in the US.¹⁵ However, as we did not find any effect of a proxy for the number of competing schools in preliminary analysis, we dropped this variable to reduce the number of missing values.

¹⁴In preliminary analysis, we did not find effects of shortages in math, science or language teachers.

¹⁵In Hoxby (2003), an overview of the economics of school choice can be found.

Overall, we try to obtain insight into the relation between school autonomy -adequately measured - and educational performance, while controlling substantively for heterogeneity in student composition and institutional settings between schools. To further control for heterogeneity, we allow for non-linearities by the use of a flexible semiparametric econometric methodology.

<Table 5 about here >

<Table 6 about here >

4 Methodology

Educational settings are complex and heterogeneous. First, the largest part of the empirical data have a multilevel structure (pupils are nested within classes, classes within schools, schools within regions and school types, etc.). It is necessary to include this highly multilevel data structure into the empirical analysis to obtain unbiased estimates (Raudenbush and Bryk, 2002). This can be done by the use of a so called ‘hierarchical’ or ‘mixed’ model. This implies that the intercept - and in some models also the slopes - is allowed to randomly vary between groups. To estimate the effects of school-level institutional factors and family background on student achievement, a multilevel regression analysis is carried out where covariates are distributed at two levels: the students and schools. In an educational setting, unobserved school effects are expected from school-level disparities in e.g. the unobserved academic culture of school staff. As students are clustered in different schools, the assumption of independent noise is violated. It is thus necessary to include random school effects into the empirical analysis to obtain unbiased estimates. However, to include random effects, we need to make the assumption that the unobserved school effects are not correlated with the included school-level variables.¹⁶

Second, as result of the complex, heterogeneous nature of the data structure, imposing parametric assumptions on the relationship between educational inputs and output can lead to biased estimates if there is misspecification. As it is unclear how all variables affect educational performance, it is advisable to use a more flexible approach. Nonlinearities can

¹⁶We confirm in estimates available upon request that all models hold when we exclude the random school effects from the respective models.

be addressed in different ways. First, polynomial expansions can be considered. This would be easy to implement, but the risk of introducing multicollinearity is very high. Second, nonparametric approaches can be considered. Fully non-parametric approaches do not impose parametric assumptions on the functional form, but imply the so called ‘curse of dimensionality’ - that is that including a large amount of regressors dramatically slows down convergence speed - and involves practical difficulties to include random effects. To avoid the ‘curse of dimensionality’, we use a semiparametric additive mixed model approach. We define pupil test scores of pupil i (with $i = 1, \dots, n$) in school j (with $j = 1, \dots, m$) as a function of socio-economic, institutional predictors and unobserved determinants such as innate ability and random noise at the pupil level $\epsilon_{i,j}$. To allow for hierarchically clustered noise, we define θ_j as the random effect of school j . The semiparametric varying-intercept model is defined as:

$$\begin{aligned}
\text{PISA test score}_{i,j} = & \beta_0 + \beta_1 \text{School staff autonomy}_j \\
& + \sum_{p=2}^{p=k} \beta_p \text{Student characteristic}_{p,i,j} \\
& + \sum_{q=k+1}^{q=k+l} \beta_q \text{School characteristic}_{q,j} \\
& + s_1(\text{ESCS}_{i,j}) + s_2(\text{Sub-school ESCS}_{i,j}) \\
& + s_3(\text{School educational resources}_j) \\
& + s_4(\text{Student-teacher ratio}_j) + s_5(\text{School size}_j) \\
& + \theta_j + \epsilon_{i,j},
\end{aligned} \tag{1}$$

where β_f , with $f = 1, \dots, k+l$ are the *fixed parameters* of the categorical variables related to school staff autonomy, student characteristics and school characteristics and s_g , with $g = 1, \dots, 5$ are the *smooth functions* for the 5 additive continuous variables.¹⁷

Semiparametric regressions can be estimated by the use of kernel weights or by using piecewise polynomial functions - splines. Each approach has its own merits and drawbacks in a particular setting. We opt for a spline based approach as it is less cumbersome to use

¹⁷Multivariate smooths can also be introduced, but are not used in this analysis as multivariate tensor products of B-splines (see further) imply a dramatic loss of degrees of freedom.

with large datasets and allows the inclusion of random effects. In particular, to smooth the continuous variables, we opt for the penalized splines (P-splines) approach of Eilers and Marx (1996), discussed in detail in Appendix.

The interest is not in the control variables per se. Therefore, if we find a non-linear effect of a smoothed variable, we only include information on the direction of influence. If the semiparametric model pinpoints towards a linear relationship between educational performance and a specific continuous variable, we drop the smooth term and include the variable parametrically.

5 Empirical results

Table 7 shows six different models in which we measure the effect of autonomy of the school's staff in budget allocation on its educational performance in math. The focus is on math as Flanders is in this subject persistently ranked as a top performer (see e.g. De Meyer and Warlop (2010)). In addition, many teaching hours are devoted to this subject (see Table 5).

In a first model (i.e., Math I, first column of Table 7), we only control for student-level heterogeneity, school type and urbanization. Model Math I explains 55 percent of the variation of educational performance between pupils. We find an effect of migration status over and above the effect of the socio-economic status of pupils. The effect is amplified if the non-native pupil does not speak a Belgian language at home. We also find significant effects of school type and educational tracks. However, due to strong self-selection of pupils in school types and educational tracks, based on unobserved variables, a value-added approach is needed to obtain more reliable evidence on this matter. As expected, the control variables for grade repetition and teacher shortage are significant.

Closer to our purpose, we find a clear positive effect of the autonomy in budget allocation on educational performance. Math performance is 13 points higher in schools with considerable autonomy in budgeting. As in all the following models, we do not find significant interaction between the effect of autonomy in budgeting and respectively school type or the average social position of pupils in a sub-school.

If we control additionally for school-level heterogeneity - by including teacher shortage,

selectivity of the school, sub-school average ESCS, school educational resources, student-teacher ratio and school size- the relation of interest is still significantly positive, but is estimated to be only 6.73 points. In line with Hindriks et al. (2010), we don't find an effect of the average sub-school ESCS after controlling for school type and educational track as social segregation occurs largely between tracks and between school types. In contrast to what we would expect, we find a non-linear negative association between school educational resources and performance and a positive association of performance with the number of students per teacher. The direction of association between performance and school size is not clear as we find the relation to be locally positive and locally negative (i.e., wiggly).

<Table 7 about here >

In Model Math III, we include random school effects to control for unobserved school-level heterogeneity. By taking this unobserved random school level heterogeneity into account, our model estimates it is optimal to employ no smoothing; we return to a fully parametric model. Results still hold.¹⁸ However, as discussed in Section 4, inclusion of random effects implies we assume that unobserved school-level heterogeneity is not correlated with the included school-level and pupil-level characteristics. Although we control for many pupil-level and school-level heterogeneity, this is still a hard assumption. Therefore, we confirm in alternative estimates (available upon request) that all further results are robust for the exclusion of random effects.¹⁹

As discussed, the PISA dataset groups pupils in 'Public schools' and 'Publicly financed, privately operating schools' to control for school type. However, as there are 3 public school types in Flanders (i.e., education organized by cities, provinces and the Flemish Community), we use anonymous data to control for the school type heterogeneity within public education. Model Math IV shows that the finding of a positive relation between

¹⁸Almost all schools come from different school governing bodies in our sample. There are only 2 governing bodies that have 2 schools in the sample. Therefore, we did not include random or fixed effects at the level of the governing body. As expected, there is no variation in school autonomy in budgeting issues within these 2 governing bodies.

¹⁹In particular, the quantile regression results in Appendix of model Math VI with no random effects, discussed further, show that results are robust for altering the approach to deal with unobserved school-level heterogeneity.

educational performance and autonomy in budget allocation is not driven by school type differences. In particular, we find that variation in budgeting autonomy explains 0.1 standard deviation of pupil performance in math.

Overall, we extensively controlled for the heterogeneity in student population and institutions between schools. As we use cross-sectional pupil level data, estimates can be sensitive for influences of reverse causality, simultaneity and unobserved selection. In the view of the following arguments, we don't think our results are substantially affected by these issues.

First, on the reverse causality problem, it is possible that the school direction in well-performing schools receive more autonomy. In other words, autonomy can be the result of performance, instead of the reverse. In our study in the Flemish context, we do not expect this kind of reverse causality.

1) Pupil examination is not centralized, implying many school governing boards have no information on pupil achievement that can be used in school principal evaluations. The PISA 2006 dataset indicates that in only a few schools (9 out of the 126 sampled schools), performance data (e.g. mean exam scores, average test results, rates of success in higher education) are used to evaluate the school direction. Model Math V shows that the significant positive relation between educational performance and school autonomy in budgeting also holds for the subsample of schools in which there is no evaluation of the school's direction, based on achievement data.

2) School principals have many and complex tasks. Therefore, the criteria to evaluate school principals are complex and case specific. In the words of a Flemish policy maker: "*No one knows about the quality of the principal*" (Day et al., 2008). It is thus probable that perceived principal performance is only weakly related with actual principal performance.

3) As discussed in OECD (2008a), in the period studied, there is a lack of school self-evaluation in Flemish secondary education. Only recently, programs for self-evaluation are installed (OECD, 2011). Thus even if there would be knowledge on the school principal's performance, in many governing bodies, this information will not be used in evaluations, as evaluations are more focused on being in line with regulatory requirements.

4) From our review of qualitative studies, referenced in the Introduction, we conclude that the characteristics and composition of the school board are the main drivers of variation in school autonomy. Most of the variation in school board characteristics and responsibility

structures are the result of (i) historical reasons²⁰, (ii) discontinuities caused by political elections and political appointments²¹, (iii) differences in the interpretation of the law and job description²² and (iv) other unobserved heterogeneity such as geographical development and budgetary tensions that can, in the Flemish context, be considered as approximately random.

Second, on the simultaneity problem, we do not a priori want to exclude the possibility that dynamic principals and teachers struggle for both more autonomy and higher educational achievement in the school, without there needs to be a causal relation between school autonomy and educational achievement. Dynamic staff can in more autonomous schools use their freedom to among others organize lectures, plan field trips or guide extracurricular projects to raise academic standards. Differently put, autonomy gives the local staff the possibility to exert their dynamism. Estimation issues arise when the variation in the school staff empowerment in budgeting is related to unobserved variation in school dynamism.

To obtain insight whether this is the case, we first investigate whether our variation in school autonomy in budgeting is correlated with variation in school dynamism. To proxy school dynamism, we use PISA school-level questionnaire items on the promotion of science, opportunities to learn about environmental topics and preparation for further education. Schools that among others participate in competitions, organize lectures or guide projects in these fields are expected to also organize these extracurricular activities in other fields and are labeled as dynamic. Table 8 shows there is little correlation between our proxies for school staff dynamism and school staff empowerment, indicating that our variation in staff autonomy is not simply reflecting the school staff dynamism. Therefore staff autonomy per se matters for educational performance

²⁰Some governing boards in catholic education originate from e.g. dioceses that were very actively involved in education and centrally structured, whereas others stem from orders, dioceses and congregations that left school policy in the hands of educational personnel, i.e. the school principals. (Devos et al., 1999)

²¹School case studies in Devos et al. (1999) illustrate that changes in the political composition of local authorities and provincial authorities (the governing bodies of respectively city schools and provincial schools) resulted in new responsibility structures within school governing bodies.

²²Some school governing bodies restrict themselves to daily management of schools, while others intervene in all facets of school policy. Other school governing bodies only have a formal existence. In one extreme case example, the governing board did not deliberate on school policy in the last three years. (Devos et al., 1999)

Further, if we include the proxies for school dynamism (separately or grouped) into our analysis, results for school autonomy do not change.²³ In particular, Model Math VI shows both a significant effect of two proxies for school dynamism (i.e., extracurricular science projects and lectures and/or seminars on environmental topics) and school autonomy in budget allocation. No interactions were found. The effect found of school autonomy in budgeting is only significant at the 10 percent level when we consider the first plausible value of math as dependent variable. However, if we use the four other plausible values, the effect is significant at the 5 percent level, indicating a robust significant positive effect of autonomy in budget allocation on math performance (see Table 9).

Third, on the self-selection problem, as discussed and argued above, approximately random school board characteristics drive the variation in school autonomy. We thus expect no endogeneity of assignment of treatment of school principals. Further, as it is unobserved for students and teachers that consider to enter a school whether or not the school governing body or school's direction is in charge of budgeting issues, we do not expect that school choice by pupils and teachers is related to school staff empowerment in our specific setting.

As discussed, autonomy in budget formation is limited to additional funding above a centrally imposed funding scheme. Table 10 shows a non-robust positive effect of school autonomy in budget formation. Once we control for the four main school types in Flanders, we do not find a (robust) significant effect of school staff empowerment in budget formation on math performance.

<Table 8 about here >

Finally, we test the sensitivity of our findings for test scores in different subjects and different definitions of school autonomy. We ran Model VI for science and reading (see Table 10). For science, we find for both autonomy in budget allocation and budget formation a robust positive effect. As the additional budgets are very small in comparison to the school budget, we expect that the effect of budget formation is not mainly driven by an informational advantage of the agents. It is more plausible that higher perceived budget formation autonomy motivates the school staff (see Frey (1993)), with better education quality as result. For reading, we find the relation to be insignificant for both budget

²³Results available on request.

allocation and budget formation. A possible explanation is that autonomy in budgeting is not used to promote reading literacy. Another interpretation is that for reading, the unobserved heterogeneity is larger. For reading, only 52 percent of variation can be explained by Model Read VI, whereas Math VI and Science VI explain respectively 57 and 58 percent.

As discussed above, we defined school autonomy in budget allocation (formation) as a binary indicator, equal to one if the school principal ticks that school direction or teachers have a considerable responsibility in the task of budget allocation (formation), zero otherwise. If we exclude joint-decision making (with the school governing board or higher levels) from the definition of school autonomy, results still hold.²⁴

We have tested the robustness of the findings for different model specification. We have regressed a fully parametric model with random school effects, included variation in probability weights and clustering within strata. In addition, we have tested the effect on the results of including the ‘dropped’ variables. The findings remain robust to all such specification changes. Results are available upon request.

To test for a possible unequal effect of autonomy on educational performance, we compared the effects at the bottom and the top of test scores distribution by a quantile regression approach. Results in Appendix show no indications that school staff autonomy affects top and low performers differently.

<Table 9 about here >

<Table 10 about here >

6 Conclusion

In this paper we have tested whether a combination of accountability and autonomy in education provision can improve educational performance as measured by PISA test scores.

²⁴Results available upon request. We find no indications that joint-decision making is less or more effective than strict autonomy. The coefficient of school autonomy is not significantly different, but results are statistically more significant. This is probably due to the fact that there is more variation in autonomy when using the strict definition.

There is ample cross-country and cross-school type (e.g. charter school literature) evidence for this. But these studies cannot separate the effects of school autonomy from (time-varying) country-specific or school type specific effects.

We test this conjecture on the PISA-dataset for Flanders, where there is substantial variation within school-type in autonomy and other institutional settings. In Flanders, the government delegates a lot of budgeting responsibilities to non-profit school governing bodies that can group multiple schools. There is variation in the extent this budgeting authority is further delegated to the school staff (the school's direction and teachers). The reviewed qualitative research shows that this variation in school autonomy mainly originates from approximately random school governing board characteristics. Higher school staff empowerment should lead to better use of local information and better performance, if the central government can align incentives properly. In Flanders, there are no central examinations, but inspection teams investigate on a regular basis whether the curriculum and teaching process are aimed at reaching the centrally imposed final standards, and whether budget formation is in keeping with the posed requirements. In addition, freedom in budget formation is limited to additional funding, above the centrally imposed funding system. This ensures that information asymmetries are not misused by local staff and so that autonomy should improve performance. Therefore Flanders is a very good testing ground for the theory that the institution of school autonomy, through improved incentives for schools and teachers, will affect resource-allocation decisions and ultimately the educational performance of students positively.

Our findings support this hypothesis. While including a large set of student-level and school-level controls, we find indeed that local staff empowerment clearly and significantly boosts educational outcomes. Results are robust for controlling for reverse causality or variation in school dynamism. Overall, we confirm cross-country evidence and within-country between school type evidence for a positive effect of school (staff) autonomy on educational performance by separating the effect of school staff autonomy from school type specific effects.

References

Abdulkadiroglu, A., Angrist, J. D., Dynarski, S. M., Kane, T. J., Pathak, P. A., 2011. Accountability and flexibility in public schools: evidence from Boston's charters and

- pilots. *Quarterly Journal of Economics* 126 (4), 2133–2134.
- Ammermüller, A., 2004. PISA: What makes the difference? explaining the gap in PISA test scores between Finland and Germany. ZEW Discussion Papers 04-04, ZEW - Zentrum für Europäische Wirtschaftsforschung / Center for European Economic Research.
- Besley, T., Case, A., 1995. Incumbent behaviour: vote-seeking, tax-setting, and yardstick competition. *American Economic Review* 85 (2), 25–45.
- Bollaerts, K., Eilers, P. H. C., van Mechelen, I., 2006. Simple and multiple P-splines regression with shape constraints. *British Journal of Mathematical & Statistical Psychology* 59, 451–469.
- Bottani, N., Favre, B., 2001. School autonomy and evaluation. *Prospects - Quarterly Review of Comparative Education* 31 (4), 166, issue 120.
- Caenepeel, L., 1988. Scholen besturen. Samenstelling, structuur en functioneren van inrichtende machten van katholieke scholen. Leuven: Acco.
- Card, D., Dooley, M., Payne, A., 2010. School competition and efficiency with publicly funded catholic schools. Canadian Labour Market and Skills Researcher Network, Working Paper 66, 61.
- Chubb, J., Moe, T., 1990. Politics, markets, and America's schools. Brookings Institution paper, 318.
- Clark, D., 2009. The performance and competitive effects of school autonomy. *Journal of Political Economy* 117 (4), 745–783.
- Day, C., Moller, J., Nusche, D., Pont, B., 2008. Chapter 6. the flemish (belgian) approach to system leadership. In: *Improving School Leadership VOLUME 2: Case studies on system leadership*. OECD Publishing.
- De Meyer, I., Warlop, N., 2010. PISA - Leesvaardigheid van 15-jarigen in Vlaanderen. De eerste resultaten van PISA 2009.
- Deci, E., Ryan, R. M., 1985. *Intrinsic motivation and self-determination in human behavior*. New York: Plenum Press.

Department of Education & Training, 2012. Vlaams onderwijs in cijfers 2011-2012. Tech. rep., Flemish Government.

URL <http://www.vlaanderen.be/nl/publicaties/detail/vlaams-onderwijs-in-cijfers-2011>

Devos, G., Tuytens, M., 2006. Improving school leadership - OECD Review. Background report for Flanders. Tech. rep., Improving School Leadership Activity Education and Training Policy Division.

URL <http://www.oecd.org/edu/schoolleadership>

Devos, G., Vandenberghe, P., Verhoeven, J., 1989. Schoolbeleid; mogelijkheden en grenzen; een empirisch onderzoek. Leuven: Acco.

Devos, G., Verhoeven, J., Beuselinck, I., Van den Broeck, H., Vandenberghe, R., 1999. De rol van schoolbesturen in het schoolmanagement. Garant, , Leuven/Apeldoorn.

Eilers, P., Marx, B., 1996. Flexible smoothing with B-splines and penalties. *Statistical Science* 11, 89–121.

Eurydice, 2007. School autonomy in Europe. Policies and Measures. Eurydice, ISBN 978-92-79-07522-3.

Eurydice, 2008. Levels of autonomy and responsibilities of teachers in Europe. Eurydice.

Fan, C., Lin, C., Treisman, D., 2009. Political decentralization and corruption: Evidence from around the world. *Journal of Public Economics* 93 (1-2), 14–34.

Frey, B., 1993. Does monitoring increase work effort - The rivalry with trust and loyalty. *Economic Inquiry* 31 (4), 663–670.

Frey, B., 1994. How intrinsic motivation is crowded out and in. *Rationality and Society* 6 (3), 334–352.

Frey, B. S., Oberholzer-Gee, F., 1997. The cost of price incentives: An empirical analysis of motivation crowding-out. *American Economic Review* 87 (4), 746–755.

Gu, C., Wahba, G., 1991. Minimizing GCV/GML scores with multiple smoothing parameters via the Newton method. *SIAM Journal on Scientific and Statistical Computing* 12 (2), 383–398.

- Hallinger, P., Bickman, L., Davis, K., 1996. School context, principal leadership, and student reading achievement. *Elementary School Journal* 96 (5), 527–549.
- Hanushek, E., Link, S., Wößmann, L., 2011. Does school autonomy make sense everywhere? Panel Estimates from PISA. CESifo Working Paper, No. 3648.
- Hanushek, E. A., 2003. The failure of input-based schooling policies. *Economic Journal* 113 (485), F64–F98.
- Hanushek, E. A., Luque, J. A., 2003. Efficiency and equity in schools around the world. *Economics of Education Review* 22 (5), 481–502.
- Hastie, T., Tibshirani, R., 1990. *Generalized Additive Models*. London: Chapman and Hall.
- Hindriks, J., Myles, G., 2006. *Intermediate Public economics*. MIT Press.
- Hindriks, J., Vershelde, M., Rayp, G., Schoors, K., 2010. School tracking, social segregation and educational opportunity: Evidence from Belgium. CORE Discussion Paper 2010/81.
- Hirtt, N., 2007. Pourquoi les performances PISA des élèves francophones et flamands sont-elles si différentes ? Appel pour une école démocratique, 27.
URL http://www.skolo.org/IMG/pdf/PISA_F.pdf
- Hoxby, C., 1999. The productivity of schools and other local public goods producers. *Journal of Public Economics* 74 (1), 1–30.
- Hoxby, C., 2003. *The economics of school choice*. University of Chicago Press.
- Hoxby, C. M., 2000. Does competition among public schools benefit students and taxpayers? *American Economic Review* 90 (5), 1209–1238.
- Kane, T., Rockoff, J., Staiger, D., 2006. What does certification tell us about teacher effectiveness? Evidence from New York City. National Bureau of Economic Research Working Paper (12155).
- Koenker, R., 2011. *quantreg: Quantile Regression*. R package version 4.67.
URL <http://CRAN.R-project.org/package=quantreg>

- Koenker, R., Bassett, G., 1978. Regression quantiles. *Econometrica* 46 (1), 33–50.
- Marx, B., Eilers, P., 1998. Direct generalized additive modelling with penalized likelihood. *Computational Statistics and Data Analysis*.
- Niskanen, W., 1971. *Bureaucracy and Representative Government*. Chicago: Aldine-Atherton.
- Niskanen, W., 1991. The budget-maximizing bureaucrat: Appraisals and evidence. In: Blais, A., Dion, S. (Eds.), *A reflection on Bureaucracy and Representative Government*. pp. 13–31.
- OECD, 2005. *PISA 2003 Data Analysis Manual: SAS users*. OECD Programme for International Student Assessment.
- OECD, 2006. *PISA 2006: Science Competencies for Tomorrow's World*. OECD Programme for International Student Assessment.
- OECD, 2008a. *Improving School Leadership, Volume 2: Case Studies on System Leadership*. OECD Publishing, Paris.
- OECD, 2008b. *Improving School Leadership, Volume 1: Policy and Practice*. OECD Publishing, Paris.
- OECD, 2009. *PISA 2006 Technical report*. OECD Programme for International Student Assessment.
- OECD, 2011. *School Evaluation in the Flemish Community of Belgium 2011, OECD Reviews of Evaluation and Assessment in Education*. OECD Publishing.
URL <http://dx.doi.org/10.1787/9789264116726-en>
- Poesen-Vandeputte, M., Bollens, J., 2008. *Studiekosten in het secundair onderwijs. Wat het aan ouders kost om schoolgaande kinderen te hebben*. Leuven: Katholieke Universiteit Leuven. Hoger instituut voor de arbeid.
- Raudenbush, S. W., Bryk, A. S., 2002. *Hierarchical Linear Models: Applications and Data Analysis Methods*. Thousand Oaks, CA: Sage.

- Rivkin, S. G., Hanushek, E. A., Kain, J. F., 2005. Teachers, schools, and academic achievement. *Econometrica* 73 (2), 417–458.
- Shleifer, A., 1985. A theory of yardstick competition. *RAND Journal of Economics* 16 (3), 319–327.
- Tiebout, C., 1956. A pure theory of local public expenditures. *Journal of Political Economy* 64, 416–424.
- Van Petegem, P., Devos, G., Mahieu, P., Dang Kim, T., Warmoes, V., 2009. Hoe sterk is mijn school? Het beleidsvoerend vermogen van Vlaamse scholen. Plantyn, Mechelen.
- Wahba, G., 1980. Spline bases, regularization, and generalized cross validation for solving approximation problems with large quantities of noisy data. In: Cheney, W. (Ed.), *Approximation Theory III*. Academic Press, New York, pp. 905–912.
- Wahba, G., 1990. Spline models for observational data. In: *CBMS-NSF Regional Conference Series in Applied Mathematics*. Vol. 59. Philadelphia: Society of Industrial and Applied Mathematics.
- Wößmann, L., 2003. Schooling resources, educational institutions and student performance: The international evidence. *Oxford Bulletin of Economics and Statistics* 65 (2), 117–170.
- Wößmann, L., 2008. Efficiency and equity of European education and training policies. *International Tax and Public Finance* 15 (2), 199–230.
- Wößmann, L., Lüdemann, E., Schütz, G., West, M., 2007. School accountability, autonomy, choice, and the level of student achievement: International evidence from PISA 2003. *Unclassified OECD Education Working Paper* 13, 1–85.
- Wood, S., 2006. *Generalized Additive Models: an introduction with R*. Texts in Statistical Science. Chapman and Hall/CRC.
- Wood, S., Augustin, N., 2002. GAMs with integrated model selection using penalized regression splines and applications to environmental modelling. *Ecological modelling* 157, 157–177.
- Wu, M., 2005. The role of plausible values in large-scale surveys. *Studies in Educational Evaluation* 31, 114–128.

Appendix

A Flemish educational landscape

<Figure 1 about here >

<Table 1 about here >

B Plausible values

PISA 2006 uses a plausible values approach to come to student population estimates of knowledge and skills in math, science and reading literacy. A plausible value approach was developed for and used in the 1983-84 US National Assessment of Educational Progress (NAEP). Thereafter, it is used in among others the TIMSS and PISA survey. A detailed discussion of the plausible value technique is given in Wu (2005) and OECD (2005, chapter 6). We briefly discuss the interpretation of plausible values.

The main problem in cognitive testing is that the latent pupil skills and knowledge is unobserved. Testing for skills by e.g. a PISA questionnaire involves thus measurement error above the sampling error. In social sciences, the measurement error is expected to be substantial, first, as result of the broadness of the concept that is measured and, second, because tested pupils may be affected by day-to-day (mental and physical) variation and conditions under which the test occurs (OECD, 2005). In result, the measurement error depends on the precision of the test and on pupil-level characteristics. Population statistics will be biased if the measurement error is not taken into account. To construct unbiased population estimates, first, the distribution of student ability is estimated, using the (discontinuous) test items and background variables. Second, random draws are taken from this so called ‘*posterior*’ distribution of student skills. Plausible values are thus multiple random draws from the unobservable latent student achievement. The standard error between the plausible values gives an indication of the magnitude of pupil-level measurement error. As discussed in OECD (2005), a priori averaging plausible values to conduct pupil-level inference leads to biased estimates. One should use the plausible values to do the regressions. Afterwards, one can take the average of the coefficients if wanted.

C The P-splines approach of Eilers and Marx (1996)

A large methodological literature has focused on the issue how to represent smooth functions and to choose the smoothness of these functions (Wood, 2006). The popular backfitting approach of Hastie and Tibshirani (1990) has the benefit that multiple smooth terms can be included, with the cost that the model selection (= selection of number of smooths) can be quite cumbersome (Wood and Augustin, 2002). The alternative approach of Gu and Wahba (1991) has solved the model selection problem but at a high computational cost limiting its use. The regression spline approach is a computationally efficient approach to estimate a semiparametric additive model with integrated model selection (see among others Eilers and Marx (1996), Marx and Eilers (1998), Wahba (1980) and Wahba (1990)). We use this approach as implemented in the *mgcv* package in R with automatic and integrated smoothing parameter selection (see Wood (2006)). The spline approaches are not suited to include categorical variables, and so we include those variables parametrically. We thus have a semiparametric partially linear mixed model.

The smooth function of a spline approach is a weighted sum of a basis of r overlapping splines. We use a cubic spline with local support (B-spline)²⁵. By altering the weight of the splines by weight parameter α_j , with $j = 1, \dots, r$ on usually evenly spaced knots in function of minimization of the squared error, we obtain a flexible nonparametric smooth. Formally, the smooth function $\hat{s}(x)_{(\alpha)_i}$ can be represented as the sum of r overlapping basis functions, multiplied by the respective basis parameters α_j , with $j = 1, \dots, r$.

$$\hat{s}(x)_{(\alpha)_i} = \sum_{j=1}^r \alpha_j B_j(x), \text{ such that } \forall x, \sum_{j=1}^r B_j(x) = 1. \quad (2)$$

To estimate a regression via P-splines, α is estimated by minimizing the squared error (known as the L_2 norm) with inclusion of a penalty on wiggleness for each smooth function to avoid oversmoothing. Usually, the second order differences are penalized ($d=2$), however other penalty structures are also possible. As in Bollaerts et al. (2006), we define the L_2 norm as follows:

$$L_2 = \sum_{i=1}^m (y_i - \hat{s}(x)_{(\alpha)_i})^2 + \lambda \sum_{j=d+1}^r (\Delta^d \alpha_j)^2, \quad (3)$$

²⁵A univariate B-spline of degree q smoothly joins $q+1$ polynomial pieces of degree q at q interior knots in the local support. The local support implies that outside the boundaries, the value is zero.

with $\Delta^d \alpha_j$ being the d^{th} order differences, that is $\Delta^d \alpha_j = \Delta^1(\Delta^{d-1} \alpha_j)$ with $\Delta^1 \alpha_j = \alpha_j - \alpha_{j-1}$ and with λ a non-negative smoothness parameter. It can easily be shown that the L_2 can be extended to include simultaneously a parametric part, random effects and univariate smooths in an additive approach.

D Effects at the Top and Bottom

To test for a possible unequal effect of autonomy on educational performance, we compare the effects at the bottom and the top of test scores distribution. For this, we estimate a quantile regression as initiated in the seminal work of Koenker and Bassett (1978). This approach allows a more complete picture of the conditional distribution of pupil performance. In this approach the conditional α th quantile ($\alpha \in (0, 1)$) is defined as the test threshold such that α percent of the pupils of the reference group perform worse. For example, in the socio-economic status x , a quarter of the pupils performs worse than the score threshold $q_{0.25}(x)$. It is common practice to use a so called ‘check function approach’ to estimate a quantile regression via minimization of weighted absolute deviations from the fit.

$$L_1 = \sum_{i=1}^n \rho_\theta(y_i - \mathbf{x}_i \hat{\boldsymbol{\beta}}), \quad (4)$$

with $\mathbf{x}$ a vector of regressors, $\boldsymbol{\beta}$ a vector of coefficients and with check function ρ_θ being defined as

$$\rho_\theta(\tau) = \begin{cases} \theta\tau & \text{if } \tau \geq 0 \text{ (resp. } \tau \leq 0) \\ (\theta - 1)\tau & \text{otherwise,} \end{cases}$$

with τ being defined as $y_i - \mathbf{x}_i \hat{\boldsymbol{\beta}}$. Weight factor θ indicates how positive and negative values of τ are weighted. If $\theta = 0.5$, positive and negative values are equally weighted and the median is estimated. If $\theta = 0.75$, positive values of τ receive a weight that is three times higher than the weight of negative values; the third quartile is estimated.

However, a drawback of a quantile regression approach is the lack of a consensus on how to include random school effects in the model. As such, the advantage of a more complete picture of the conditional distribution of pupil performance comes at the cost that we cannot control for random school effects.

We opt for the parametric quantile regression approach, as implemented in the package

‘quantreg’ in R of Koenker (2011). We estimate 20 quantile regressions of model Math VI (without random school effects) with θ between 0.05 and 0.95.

The results in Figure 2 and 3 show the relation between the conditional quantile (x-axis) and the estimated coefficient (y-axis) for model Math VI with autonomy in budget allocation included. The shaded area denotes the 90% confidence interval. The results show that the effects of family background, social segregation and shortage of adequate teaching personnel are larger for pupils in the lower end of the distribution of math performance. Further, the quantile regressions show robustness of our findings. School staff empowerment has a significant positive effect on pupil performance. Lastly, we find no significant differences in the effect of school autonomy in budgeting over the conditional distribution of pupil performance. In line with the semiparametric analysis, results for budget formation are less pronounced (see Figure 4).

<Figure 2 about here >

<Figure 3 about here >

<Figure 4 about here >

Tables and Figures

Figure 1: Flemish educational landscape

Note: School communities are voluntary collaborative partnerships between schools (see Day et al. (2008)). The relevance and influence of these school communities is rising in recent years (see Devos and Tuytens (2006) and OECD (2011)). The Flemish Ministry of Education and Training determines the playing field of the education networks taking into account advice of the Flemish Education Council.

Table 1: Number of schools per school governing body

	Mean	St.Dev.	Min.	25 perc.	Median	75 perc.	Max.
Organized by Flemish Community	8.50	2.99	4.00	6.00	8.00	10.25	14.00
Organized by city	2.50	4.50	1.00	1.00	1.00	2.00	22.00
Organized by province	6.40	4.77	1.00	2.00	7.00	11.00	11.00
Subsidized private school	2.66	2.64	1.00	1.00	2.00	3.00	21.00

Note: Data from the academic year 2012-2013. 337 school governing bodies and 1047 schools.

Source: Flemish Department of Education and Training.

Table 2: Pupil performance

Variable	Mean	St.Dev.
PISA 2006 Performance in math	560.3	(87.3)
PISA 2006 Performance in reading	543.0	(89.7)
PISA 2006 Performance in science	545.5	(82.0)
Difference PISA 2006 and PISA 2000 on reading	-10	(7.7)
Difference PISA 2006 and PISA 2003 on math	-10	(4.5)

Note: A SAS procedure for a Balanced Repeated Replication procedure with 80 replication estimates and 5 plausible values for each subject, described in OECD (2005), is used to construct the mean and standard error.

Source: OECD (2006) for last two rows.

Table 3: School-level variation in perceived school autonomy, total of 126 schools

Who has a considerable responsibility for the following tasks? (multiple ticks are allowed)	School's direction or teachers	Non-profit school governing body	Regional or local education authorities	National education authorities
Selecting teachers for hire	120	51	4	3
Firing teachers	101	87	1	2
Establishing teachers' starting salaries	1	1	20	104
Determining teachers' salaries increases	1	1	19	106
Formulating the school budget	110	88	7	9
Deciding on budget allocations within the school	107	72	4	10
Establishing student disciplinary policies	125	33	6	9
Establishing student assessment policies	121	31	10	10
Approving students for admission to the school	117	16	11	24
Choosing which textbooks are used	125	6	1	2
Determining course content	88	7	28	64
Deciding which courses are offered	108	37	31	58

Table 4: Summary statistics on school autonomy

Variables	Students (proportions)	Schools	Private	Public
Autonomy in budget allocation	0.85	107	80	27
- for school direction, not school board	0.40	49	35	14
- for school direction, not any other higher level	0.38	47	34	13
Autonomy in budget formation	0.88	110	81	29
- for school direction, not school board	0.28	36	26	10
- for school direction, not any other higher level	0.27	35	25	10
Number of observations	3603	126	92	34

Table 5: Summary statistics, categorical variables

Variable	Students (proportions)	Schools	Private	Public
Autonomy in budget allocation	0.85	107	80	27
Autonomy in budget formation	0.88	110	81	29
Teacher shortage (other disciplines)	0.20	27	18	9
Selection by schools on academic record or recommendation	0.67	81	56	25
Achievement data used to evaluate principal	0.07	9	6	3
Organized by city	0.03	5		
Organized by province	0.04	5		
Organized by Flemish Community	0.17	24		
Subsidized private school	0.76	92		
Village (< 3,000)	0.01	1	1	0
Small town (3,000 up to 15000)	0.29	35	29	6
Town (15,000 up to 100,000)	0.60	77	55	22
City (100,000 up to 1,000,000)	0.10	13	7	6
General education	0.50			
Technical-arts education	0.33			
Vocational education	0.17			
Female	0.48			
First-generation immigrant	0.03			
Second-generation immigrant	0.02			
Immigrant that speaks no off. Belgian language at home	0.02			
Not lagging behind	0.79			
Hours math per week: 0	0.04			
Hours math per week: less than 2	0.19			
Hours math per week: 2 up to 4	0.35			
Hours math per week: 4 up to 6	0.40			
Hours math per week: more than 6	0.03			
Hours Dutch per week: 0	0.04			
Hours Dutch per week: less than 2	0.22			
Hours Dutch per week: 2 up to 4	0.41			
Hours Dutch per week: 4 up to 6	0.31			
Hours Dutch per week: more than 6	0.01			
Hours science per week: 0	0.15			
Hours science per week: less than 2	0.31			
Hours science per week: 2 up to 4	0.32			
Hours science per week: 4 up to 6	0.13			
Hours science per week: more than 6	0.09			
Number of observations	3603	126	92	34

Table 6: Summary statistics, continuous variables

Variable	Mean	St.Dev.	Min.	25 perc.	Med.	75 perc.	Max
ESCS	0.29	0.85	-2.83	-0.32	0.27	0.94	2.99
Sub-school average ESCS	0.29	0.44	-1.30	0.02	0.32	0.63	1.64
School educational resources	0.10	0.84	-1.93	-0.38	0.09	0.46	2.14
Student-teacher ratio	9.27	2.38	4.11	7.56	9.20	11.30	14.04
School size	693.65	294.96	84	470	674	877	1712

Note: A SAS procedure for a Balanced Repeated Replication procedure with 80 replication estimates, described in OECD (2005), is used to construct the mean and standard error of the mean. The school educational resources index is a composite of the the quality of educational resources. It is composed from the principal's perception of shortage or inadequacy on 7 items of educational resources that can hinder instruction at school: 1) science laboratory equipment, 2) instructional materials (e.g. textbooks), 3) computers for instruction, 4) internet connectivity, 5) computer software for instruction, 6) library materials, 7) audio-visual resources.

Table 7: Effect of school autonomy in budget allocation, full model

Model	Math I	Math II	Math III	Math IV	Math V	Math VI
Plausible Value	PV1	PV1	PV1	PV1	PV1	PV1
(Intercept)	362.26*** (11.71)	362.62*** (13.45)	332.30*** (24.69)	327.36*** (23.91)	320.14*** (23.98)	310.20*** (23.29)
Autonomy in budget allocation	13.43*** (2.80)	6.73* (2.92)	10.68* (5.36)	9.78 ^o (5.25)	10.84 ^o (5.59)	10.45 ^o (5.38)
Privately operating school	18.48*** (2.40)	12.44*** (2.69)	14.78** (4.72)			
General education track	117.06*** (3.57)	107.68*** (4.72)	103.07*** (5.54)	103.90*** (5.50)	100.99*** (5.74)	99.34*** (5.72)
Technical-arts education track	65.90*** (3.28)	66.22*** (3.49)	65.74*** (3.64)	65.57*** (3.62)	63.93*** (3.79)	63.48*** (3.78)
Gender (female=1)	-20.81*** (1.97)	-20.34*** (1.97)	-18.47*** (2.07)	-18.19*** (2.07)	-19.06*** (2.15)	-19.19*** (2.15)
Small town	54.89*** (10.12)	74.50*** (11.75)	69.95*** (20.73)	68.55*** (19.80)	72.16*** (19.62)	80.29*** (18.97)
Town	47.30*** (10.05)	67.37*** (11.91)	61.75** (20.66)	63.29** (19.74)	66.03*** (19.57)	73.34*** (18.93)
City	43.63*** (10.50)	61.43*** (12.36)	56.00** (21.32)	54.48** (20.36)	57.71** (20.16)	64.32** (19.62)
Lessons test subject, less than 2 hours	2.85 (5.45)	1.13 (5.42)	-2.12 (5.36)	-2.50 (5.36)	-1.22 (55.11)	-1.49 (5.51)
Lessons test subject, 2 up to 4 hours	3.95 (5.51)	1.56 (5.48)	-2.98 (5.41)	-3.34 (5.41)	-3.05 (55.62)	-3.33 (5.56)
Lessons test subject, 4 up to 6 hours	27.00*** (5.68)	24.82*** (5.64)	20.20*** (5.55)	19.83*** (5.55)	21.23*** (56.98)	21.11*** (5.70)
Lessons test subject, 6 or more hours	33.66*** (8.02)	31.71*** (7.94)	24.78** (7.80)	24.33** (7.80)	23.93** (7.97)	24.56** (8.00)
First-generation immigrant	-21.42** (7.02)	-17.51* (7.00)	-10.76 (6.96)	-10.86 (6.95)	-12.06 ^o (7.09)	-11.56 (7.09)
Second-generation immigrant	-19.36** (7.25)	-21.51** (7.47)	-15.50* (7.34)	-15.24* (7.33)	-25.87** (8.26)	-26.46** (8.25)
Immigrant, no off. Belgian language at home	-15.84 ^o (8.86)	-16.36 ^o (8.89)	-18.46* (8.70)	-18.77* (8.70)	-14.44 (9.02)	-13.96 (9.02)
Not lagging behind	50.14*** (2.61)	49.34*** (2.59)	47.51*** (2.54)	47.41*** (2.54)	47.99*** (2.62)	47.62*** (2.63)
ESCS	6.05*** (1.27)	Pos.***	5.40*** (1.27)	5.40*** (1.27)	5.55*** (1.32)	5.51*** (1.32)
Teacher shortage		-12.09*** (2.68)	-9.37 ^o (4.81)	-9.65* (4.69)	-12.51* (4.95)	-11.92* (4.78)
Selectivity of school		1.64 (2.19)	4.73 (4.01)	6.21 (3.936)	7.04 ^o (4.07)	5.72 (3.94)
Average ESCS (sub-)school		2.33 (3.83)	2.14 (5.06)	2.21 (4.97)	3.21 (5.05)	4.47 (5.00)
School educational resources		Neg.***	-2.73 (2.21)	Neg.	-4.57* (2.27)	-3.70 ^o (2.20)
Student-teacher ratio		Pos.***	3.28*** (0.96)	3.07*** (0.92)	3.44*** (0.94)	3.09*** (0.91)
School size		Wiggly***	0.01 (0.01)	0.00 (0.01)	0.000 (0.01)	0.00 (0.01)
Extracurricular science projects (including research)						9.08* (3.79)
Lectures and/or seminars on environmental topics						8.86* (4.24)
Student-level control variables	Yes	Yes	Yes	Yes	Yes	Yes
School-level control variables	No	Yes	Yes	Yes	Yes	Yes
Random school effects	No	No	Yes	Yes	Yes	Yes
Detailed school type FE	No	No	No	Yes	Yes	Yes
Control for reverse causality	No	No	No	No	Yes	Yes
Control for school dynamism	No	No	No	No	No	Yes
R^2 (adj.)	0.554	0.566	0.56	0.565	0.567	0.569
Obs.	3603	3603	3603	3603	3346	3318

Significance levels : o : 10% : * : 5% ** : 1% * * * : 0.1%

Table 8: Correlation between proxies for school dynamism and school autonomy in budgeting

	Autonomy in budget allocation	Autonomy in budget formation
Aut. in budget allocation	1.00	0.36
Aut. in budget formation	0.36	1.00
Science clubs	-0.05	0.08
Science fairs	0.10	0.08
Science competitions	0.10	0.11
Extracurricular science projects (including research)	0.04	0.00
Excursions and field trips related to science	-0.03	-0.13
Outdoor education related to environmental topics	0.04	-0.12
Trips to museums (related to env. topics)	-0.11	-0.09
Trips to science and/or technology centres	-0.05	0.06
Extracurricular environmental projects (including research)	0.15	0.10
Lectures and/or seminars on environmental topics (e.g. guest speakers)	0.02	0.06
Job fairs	0.07	-0.05
Lectures (at school) by business or industry representatives	-0.08	0.04
Visits to local businesses or industries	0.01	-0.07

Table 9: Effect of school autonomy in budgeting, different plausible values

Model	Math VI	Math VI	Math VI	Math VI
Plausible Value	PV2	PV3	PV4	PV5
Autonomy in budget allocation	13.99*	11.72*	11.04*	11.04*
	(5.54)	(5.54)	(5.54)	(5.56)
R^2 (adj.)	0.57	0.57	0.57	0.58
Autonomy in budget formation	11.63*	8.59	9.34	8.07
	(5.80)	(5.79)	(5.77)	(5.81)
R^2 (adj.)	0.57	0.57	0.57	0.58
Model	Science VI	Science VI	Science VI	Science VI
Plausible Value	PV2	PV3	PV4	PV5
Autonomy in budget allocation	12.82**	10.72*	12.20*	11.00*
	(4.87)	(4.82)	(4.94)	(4.88)
R^2 (adj.)	0.58	0.58	0.57	0.59
Autonomy in budget formation	17.01***	13.90**	15.79**	15.60**
	(4.93)	(4.92)	(5.02)	(4.94)
R^2 (adj.)	0.58	0.58	0.58	0.59
Model	Read VI	Read VI	Read VI	Read VI
Plausible Value	PV2	PV3	PV4	PV5
Autonomy in budget allocation	8.74	8.67	10.77	9.79
	(6.81)	(6.49)	(6.87)	(6.92)
R^2 (adj.)	0.52	0.53	0.51	0.52
Autonomy in budget formation	10.69	6.73	9.80	10.98
	(7.05)	(6.77)	(7.17)	(7.18)
R^2 (adj.)	0.52	0.53	0.51	0.53
Student-level control variables	Yes	Yes	Yes	Yes
School-level control variables	Yes	Yes	Yes	Yes
Random school effects	Yes	Yes	Yes	Yes
Detailed school type FE	Yes	Yes	Yes	Yes
Control for reverse causality	Yes	Yes	Yes	Yes
Control for school dynamism	Yes	Yes	Yes	Yes
Obs.	3318	3318	3318	3318
Significance levels : ○ : 10% : * : 5% ** : 1% *** : 0.1%				

Table 10: Effect of school autonomy in budgeting

Model	Math I	Math II	Math III	Math IV	Math V	Math VI	Science VI	Read VI
Plausible Value	PV1	PV1	PV1	PV1	PV1	PV1	PV1	PV1
Autonomy in budget allocation	13.43*** (2.80)	6.73* (2.92)	10.68* (5.36)	9.78° (5.25)	10.84° (5.59)	10.45° (5.38)	10.91* (4.78)	11.12 (6.97)
R^2 (adj.)	0.55	0.57	0.56	0.57	0.57	0.57	0.58	0.52
Autonomy in budget formation	8.09** (3.00)	7.26* (3.11)	10.21° (5.73)	7.32 (5.60)	7.63 (5.82)	7.02 (5.61)	14.62** (4.86)	10.77 (7.28)
R^2 (adj.)	0.55	0.57	0.56	0.56	0.57	0.57	0.58	0.52
Student-level control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School-level control variables	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Random school effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Detailed school type FE	No	No	No	Yes	Yes	Yes	Yes	Yes
Control for reverse causality	No	No	No	No	Yes	Yes	Yes	Yes
Control for school dynamism	No	No	No	No	No	Yes	Yes	Yes
Obs.	3603	3603	3603	3603	3346	3318	3318	3318
Significance levels : ° : 10% : * : 5% ** : 1% *** : 0.1%								

Figure 2: Quantile regression results - Part I

Figure 3: Quantile regression results - Part II

Figure 4: Quantile regression results of school autonomy in budget formation

Recent titles

CORE Discussion Papers

- 2012/14. Claude D'ASPREMONT and Rodolphe DOS SANTOS FERREIRA. Household behavior and individual autonomy: An extended Lindahl mechanism.
- 2012/15. Dirk VAN DE GAER, Joost VANDENBOSSCHE and José Luis FIGUEROA. Children's health opportunities and project evaluation: Mexico's *Oportunidades* program.
- 2012/16. Giacomo VALLETTA. Health, fairness and taxation.
- 2012/17. Chiara CANTA and Pierre PESTIEAU. Long term care insurance and family norms.
- 2012/18. David DE LA CROIX and Fabio MARIANI. From polygyny to serial monogamy: a unified theory of marriage institutions.
- 2012/19. Carl GAIGNE, Stéphane RIOU and Jacques-François THISSE. Are compact cities environmentally friendly?
- 2012/20. Jean-François CARPANTIER and Besik SAMKHARADZE. The asymmetric commodity inventory effect on the optimal hedge ratio.
- 2012/21. Concetta MENDOLICCHIO, Dimitri PAOLINI and Tito PIETRA. Asymmetric information and overeducation.
- 2012/22. Tom TRUYTS. Stochastic signaling: Information substitutes and complements.
- 2012/23. Pierre DEHEZ and Samuel FEREY. How to share joint liability: A cooperative game approach.
- 2012/24. Pilar GARCIA-GOMEZ, Erik SCHOKKAERT, Tom VAN OURTI and Teresa BAGO D'UVA. Inequity in the face of death.
- 2012/25. Christian HAEDO and Michel MOUCHART. A stochastic independence approach for different measures of concentration and specialization.
- 2012/26. Xavier RAMOS and Dirk VAN DE GAER. Empirical approaches to inequality of opportunity: principles, measures, and evidence.
- 2012/27. Jacques H. DRÈZE and Erik SCHOKKAERT. Arrow's theorem of the deductible : moral hazard and stop-loss in health insurance.
- 2012/28. Luc BAUWENS and Giuseppe STORTI. Computationally efficient inference procedures for vast dimensional realized covariance models.
- 2012/29. Pierre DEHEZ. Incomplete-markets economies: The seminar work of Diamond, Drèze and Radner.
- 2012/30. Helmuth CREMER, Pierre PESTIEAU and Grégory PONTIÈRE. The economics of long-term care: a survey.
- 2012/31. Mathieu VAN VYVE, Laurence A. WOLSEY and Hande YAMAN. Relaxations for two-level multi-item lot-sizing problem.
- 2012/32. Jean-François MERTENS and Anna RUBINCHIK. Equilibria in an overlapping generations model with transfer policies and exogenous growth.
- 2012/33. Jean-François MERTENS and Anna RUBINCHIK. Pareto optimality of the golden rule equilibrium in an overlapping generations model with production and transfers.
- 2012/34. Hélène LATZER and Florian MAYNERIS. Income distribution and vertical comparative advantage. Theory and evidence.
- 2012/35. Pascal MOSSAY and Takatoshi TABUCHI. Preferential trade agreements harm third countries.
- 2012/36. Aitor CALO-BLANCO. The compensation problem with fresh starts.
- 2012/37. Jean-François CARPANTIER and Arnaud DUFAYS. Commodities volatility and the theory of storage.
- 2012/38. Jean-François CARPANTIER and Christelle SAPATA. Unfair inequalities in France: A regional comparison.
- 2012/39. Shui-Ki WAN, Shin-Huei WANG and Chi-Keung WOO. Total tourist arrival forecast: aggregation vs. disaggregation.
- 2012/40. Thierry BRECHET, Yann MENIERE and Pierre M. PICARD. The clean development mechanism in a global carbon market.
- 2012/41. Nikolaos GEORGANTZIS, Rafael MONER-COLONQUES, Vicente ORTS and José J. SEMPERE-MONERRIS. Theoretical and experimental insights on firms' internationalization decisions under uncertainty.

Recent titles

CORE Discussion Papers - continued

- 2012/42 Berardino CESI and Dimitri PAOLINI. Peer group and distance: when widening university participation is better.
- 2012/43 Arnaud DUFAYS. Infinite-state Markov-switching for dynamic volatility and correlation models.
- 2012/44 Miguel JARA, Dimitri PAOLINI and J.D. TENA. Management efficiency in football: An empirical analysis of two extreme cases.
- 2012/45 Guillaume ROELS, Philippe CHEVALIER and Ying WEI. United we stand? Coordinating capacity investment and allocation in joint ventures.
- 2012/46 Mikel BEDAYO, Ana MAULEON and Vincent VANNETELBOSCH. Bargaining and delay in trading networks.
- 2012/47 Pierre M. PICARD and Ridwan D. RUSLI. State owned firms: Private debt, cost revelation and welfare.
- 2012/48 Shin-Huei WANG, Luc BAUWENS and Cheng HSIAO. Forecasting long memory processes subject to structural breaks.
- 2012/49 Thierry BRECHET, Carmen CAMACHO and Vladimir M. VELIOV. Adaptive model-predictive climate policies in a multi-country setting.
- 2012/50 Vladyslav NORA and Hiroshi UNO. Saddle functions and robust sets of equilibria.
- 2012/51 Thomas BAUDIN, David DE LA CROIX and Paula GOBBI. DINKs, DEWKs & Co. Marriage, fertility and childlessness in the United States.
- 2012/52 David DE LA CROIX and Omar LICANDRO. The longevity of famous people from Hammurabi to Einstein.
- 2012/53 Marijn VERSCHELDE, Jean HINDRIKS, Glenn RAYP and Koen SCHOORS. School staff autonomy and educational performance: within school type evidence.

Books

- G. DURANTON, Ph. MARTIN, Th. MAYER and F. MAYNERIS (2010), *The economics of clusters – Lessons from the French experience*. Oxford University Press.
- J. HINDRIKS and I. VAN DE CLOOT (2011), *Notre pension en heritage*. Itinera Institute.
- M. FLEURBAEY and F. MANIQUET (2011), *A theory of fairness and social welfare*. Cambridge University Press.
- V. GINSBURGH and S. WEBER (2011), *How many languages make sense? The economics of linguistic diversity*. Princeton University Press.
- I. THOMAS, D. VANNESTE and X. QUERRIAU (2011), *Atlas de Belgique – Tome 4 Habitat*. Academia Press.
- W. GAERTNER and E. SCHOKKAERT (2012), *Empirical social choice*. Cambridge University Press.
- L. BAUWENS, Ch. HAFNER and S. LAURENT (2012), *Handbook of volatility models and their applications*. Wiley.
- J-C. PRAGER and J. THISSE (2012), *Economic geography and the unequal development of regions*. Routledge.
- M. FLEURBAEY and F. MANIQUET (2012), *Equality of opportunity: the economics of responsibility*. World Scientific.
- J. HINDRIKS (2012), *Gestion publique*. De Boeck.

CORE Lecture Series

- R. AMIR (2002), Supermodularity and complementarity in economics.
- R. WEISMANTEL (2006), Lectures on mixed nonlinear programming.
- A. SHAPIRO (2010), Stochastic programming: modeling and theory.