Social interaction, segregation and school achievement in Argentina *

María Ana Lugo†

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Abstract

Argentina is a highly unequal society with an increasingly segregated educational system. As economic gaps widen, children have fewer and fewer opportunities to interact with others from different social background. This paper explores the likely impacts of this trend on students' academic achievement and the potential effect of policies to redress segregation. The mechanism under examination is the within-school social interaction effect. Relaxing common assumptions of the standard model of peer-group effects, increasing segregation will have a significant effect on the level and distribution of academic achievement. The identification of effects is based on school fixed effects, given the random assignment of students across classes within schools. The study finds that richer kids are more able to capture the improvements in their peers' parental education. Also, the largest impact comes from peers whose parents achieved a secondary degree, but not tertiary. Finally, people are more sensitive to changes of others from similar the social background; more distant peers have a lower effect. As in the standard growth-inequality dichotomy, these results suggest that increasing economic segregation will raise the average education outcomes while widen the gap between the poor and non-poor.

JEL codes: D30, I20, O15
Keywords: Test scores, economic segregation, peer-group effects

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†Department of Economics, University of Oxford, Manor Road Building, Manor Road, OX1 3UQ, Oxford, UK. E-mail: maria.lugo@economics.oxford.ac.uk

If childrens performance at school depends on their peers, higher levels of social segregation lead to greater inequality in academic achievement and thence to greater inequality in later-life outcomes. And excessive segregation may threaten present-day social cohesion. In some circumstances, greater social segregation may even reduce average achievement levels" (Jenkins, Micklewright & Schnepf 2008, p. 1)

1 Introduction

The purpose of the paper is to understand the consequences of varying social segregation across schools. The mechanism under examination is the within-school social interaction effect. The study uses Argentinean data to estimate the impact that classmates' characteristics have on pupils' performance at school. Relaxing common assumptions of the standard model of peer-group effects, the specific allocation of children across schools on the basis of their socioeconomic background will have a significant effect on the level and distribution of academic achievement.

In the last couple of decades, the degree of social segregation of children across schools in Argentina has increased (Llach & Schumacher 2006).[1] While enrolment into primary schooling has risen significantly since 1980, particularly among less well-off students, the gaps in performance between poor and non-poor has widened. This is related to, but not only due to, the fact that poorer children attend poorer schools with worse governability, less experienced teachers and principals, and worse physical, social and human capacities (Llach & Schumacher 2006). The difference in achievement between private and public school pupils has broaden in the some areas of the country with weak technical capacities (Galiani, Gertler & Schargrodsky 2008) and the Gini coefficients of achievement has increased in the poorest provinces (Etchart, Gasparini, Bohorquez, Curia, Ferroni & Hontakly 2004). In a context of increasing income inequality, one can only expect that these gaps will not be reduced at least in the short run, perpetuating the already extreme economic inequality for future generations.

Economic segregation can be thought to affect educational attainments through two distinct channels (Mayer 2002). The first hypothesis emphasizes the distribution of financial and human resources across schools, whereby

[1] Social or economic segregation is defined in this paper as the allocation of pupils across schools on the basis of their social and economic characteristics. Complete segregation implies that pupils share the classroom only with others with the same social background. The opposite extreme is referred to as social integration.

higher segregation results in less spending in schools with higher proportion of worse-off students which in turn leads to lowering their academic performance. In addition, the degree of segregation of pupils on economic grounds determines the composition of students within the schools and thus, social environment that the children are exposed to. The more segregated the school system the less likely that a child from a poor background benefits from better role models, better monitoring and better institutions that result from having more advantaged students in the school (Mayer 2002, p. 154). Both these hypotheses imply that, as economic segregation increases, worse-off children tend to loose out and obtain lower educational attainments while richer students perform better.

This this paper uses a pupil level data-set for sixth graders in Argentina to test the second mechanism. The effect of the composition of classmates will be identified using the variations across classes within schools, so that the first set of factors –related to the political economy of school financing– will be controlled for rather than tested.[2] In principle, this approach will also allow to control for differences in monitoring and quality of institutions resulting from changes in segregation.[3] The aim is, through the study of the effects that peers have on pupils' performance, understand the impact of increase socioeconomic segregation on both the gap and the average academic achievement of children at school. In this sense, it falls within the area of within school peer-group effects studies. However, in order to understand the impact of economic segregation on achievement, two departures from the standard peer-group effects approach are considered. The impact of classmates on children's performance will be estimated allowing both for heterogenous effects according to the social background of the recipient student and for composition effects related to the distribution of socioeconomic characteristics within the classroom.

The study finds that, first, children from more educated families are more able to capture the improvements in their peers' parental education. Second, that classmates with parents who achieved a secondary degree (but not tertiary) are the ones that have the largest impact of others. Finally, combining heterogenous and class composition effects, I find evidence consistent with the idea that people are more sensitive to changes among those that are 'similar' to themselves or slightly better off. Improvements in the position of classmates that are socially distant have a lower –if significant–

[2]Using data from the US between 1970 and 1990, Mayer (2002) tested the relative relevance of the two hypotheses using between- and within-census track variances. A larger coefficient onthe between variance component, relative to the within-variance, implies that the political economy hypothesis has larger support. Indeed, the author finds this to be the case. Her study also shows that economic segregation lead to higher inequality between high-income and low-income children while, because the gains of the former were compensated by the losses of the latter, the effect on the average was practically unchanged.

[3]See section 3 for a detailed explanation of the estimation strategy employed.

effect than improvements of a socially closer person. These results point to a tension between promoting growth (of educational outcomes) and reducing inequality as social objective. Increasing economic segregation will raise the average education outcomes while widen the gap between the poor and non-poor. In addition, the poor will most benefit from integrating with non-poor when the disparity is social background between them is less stark.

The paper proceeds as follows. The next subsection presents succinctly the standard approach to estimating peer-group effects and the arguments for moving away from that specification. Section 2 describes the Argentinean educational system and the data employed. Section 3 introduces the empirical specification and the estimation strategy chosen. Section 4 presents the results from the estimations and section 5 concludes.

Beyond linear-in-means peer-group effects

In the context of schools, peer-group effects, also known as social interaction effects, refer to spill-overs between students within a classroom that affect student performance. Most often, the term is associated with the impact the characteristics of the classmates such as students' performance, parental background, household income, ethnicity or gender, have on a child's academic achievement. The general reduced-form specification of an education production function can be written as

$$A_{ics} = f(X_{ics}, Z_{cs}, \mathbf{X}_{(-i)cs}) \tag{1}$$

where A_{ics} is the academic achievement of student i attending classroom c and school s; X_{ics} is a vector of individual and family characteristics, such as gender, age, ethnicity, family income; and Z_{cs} includes school or classroom-level variables such as class size, teacher's experience, level of state funding, among others. The variable of interest here is $\mathbf{X}_{(-i)cs}$ which is a vector of characteristics of classmates of student i, excluding himself. In the present study, parental education of peers is used to proxy for socioeconomic background.

There are several ways in which the characteristics of others might affect a pupil's performance. Manski (1993) provides a useful classification of peer-group effects distinguishing between *'endogenous interactions'* and *'contextual interactions'*. The former category refers to the effect of classmates' behavior (such as academic performance) has on a child's own behaviour. Positive interactions can lead to higher quality of discussion in the class, and faster or better development of children's knowledge. Conversely, disruptive behavior may have a negative impact on other students' capacity to learn. Instead, contextual interactions refers to the effect of classmates' pre-existing personal characteristics –rather than their behavior in the classroom *per se*– on a child's performance.[4]

The standard approach to peer-group effect is to use a linear-in-means model (Manski 1993). Classmates characteristics $\mathbf{x}_{-i}$ are included in a linear regression model using the average level of the variable x within the classroom – the simple average when the variable is continuous such as income, parental education or classmates test scores, and proportions if it is categorical such as ethnicity or gender. The implication of using this formulation of the relationship between peers' characteristics and a student's achievement is that the precise allocation of children across schools on economic grounds does not affect the global average achievement in the country; it only affects the extent of the gap in achievement between different sectors of society. A more segregated society will achieve the same mean test scores as a more integrated one but the distance between the poor and the rich will be broader.[5]

Representing peer-group effects solely by the inclusion of the mean of x in a linear-in-means model is valid under two assumptions. First, that there are constant returns to the mean, so that the relationship between $\mathbf{x}_{-i}$ and A_i is linear. Second, that each classmate is assumed to influence all other students in an identical linear way, in other words, the marginal effects are equal for all recipient pupils and all classmates.

In a previous work, I use the same dataset as in the present paper to test the validity of the first assumptions (Lugo, 2007). The relationship between average classmates' parental education and students' achievement was found to be concave. In other words, there are decreasing returns to the mean parental education. Therefore, a more integrated schooling system does not only narrow the gap between the poor and the rich but also leads to a higher overall average academic achievement. At the same time, not only the mean peer parental education seem to have an effect on achievement but also its standard deviation. For the average pupil, the effect of the variance on achievement was found to be negative –thus increasing segregation would raise overall achievement– but positive for the poor suggesting that, controlling for the mean parental education, economic integration is to be preferred.

[4] Manski (2000) also delineates a third category of, potentially illusory, peer effects. These 'correlated effects' refer to classmates' shared –and possibly unobserved– characteristics that are related to similar outcomes. If not properly accounted for, such correlated factors can lead to overestimation of the effect of peer interactions. The challenge in empirical work, therefore, is to be able to identify endogenous or contextual interactions when correlation effects are also present. The next section discusses the issues of identification and estimations related to correlated effects.

[5] This assumes that the peer-group effect is positive, in that a richer class lead to higher test scores. Alternative, one could imagine a competition story in which worse-off children actually loose out from being around a better off group. The evidence, however, tends to support the former type of relationship.

Fueled by the latter result, the present paper investigates alternative ways in which class composition may affect performance. The first assumption is relaxed in two distinct ways. *Heterogenous effects* allow the parental education of the recipient student to determine the marginal effect of peers' background. In other words, I investigate whether children from different socioeconomic background are differently receptive to others' influence. Let us assume that student i and student j share all personal and school characteristics other than they own parental education level. Also, while the attend different classes, the distribution of peers' characteristics is exactly the same $\mathbf{x}$ for both pupils. Then, heterogenous effects permit that $\frac{\partial A_i}{\partial \mathbf{x}} \neq \frac{\partial A_j}{\partial \mathbf{x}}$, for at least some i, j.

Second, *composition effects* weighs differently each classmates characteristics, depending on their position in the distribution of parental education. The idea is that the effect that two middle-class children have on others might differ from the effect of one rich and one poor child, even if the average class parental education is the same. In terms of behaviour, it might be true that the impact of a terribly wild student is more disruptive than two moderately attentive, even if the wild is compensated by an extremely studious companion. In this example, class composition effects implies that $A_i(3,3) \neq A_i(1,5)$ for at least some i, where $1, 3, 5$ are the family background levels of the fellow students. In other words, composition effects permit that $\frac{\partial A_i}{\partial x_j} \neq \frac{\partial A_i}{\partial x_k}$, for at least some j, k.[6]

The approach followed in this paper is related to that of Hoxby (2000). In her paper, Hoxby estimates the effects of increasing the proportion of children from the different ethnic groups, by running separate regressions according to the ethnic group of the recipient student and allowing for the coefficient to differ depending on the initial proportion of classmates in each group. The author does also a similar analysis using gender instead of ethnicity. In short, she finds that raising the proportion of black students in the class has a negative effect on all students but that the effect is larger (and negative) on other black students. A similar result is found among hispanics (in relation to the Hispanic population). Both these results are consistent with the last results of the present paper, that people are 'more sensitive' to changes in the proportions of their own group. Quite interestingly, however, she also finds that in the case of Hispanics, the effect is negative if the initial proportion is relatively low but positive if it is high.

[6]The class composition effect involves a different weighting at different points of the distribution of socioeconomic background. When the variable is ordinal, as in many studies, the different weighting can be interpreted as an issue of measurability, where the distance between subsequent categories might differ. In this case, computing the mean of the ordinal variable becomes meaningless.

2 Argentina

"Argentina is a rich and educated country", or so goes the popular refrain. It is certainly true that among other countries in the region, Argentina is one of the wealthiest and is well positioned in terms of educational indicators. Per capita GDP is around US$11,000, the literacy rate is nearly 98%, primary net enrolment is close to 100%, and secondary school enrolment is just above 80%.[7] However, as in much of Latin America, wealth is distributed extremely unequally and poverty is far from eradicated. According to the latest official figures, the Gini index of per capita household income is 0.51, 16% of people live below the two-dollar-a-day poverty line, and 45% below the national poverty line.

While enrolment rates are consistently high for all provinces and socioeconomic groups, the quality of education received is much less equal. Publicly provided primary education is universally available, and the public school system accounts for approximately 78% of the total student population. Public schools are free and, in theory, offer the same instruction across the country. Still, it is argued that schools with a high proportion of poor students might either receive less resources or/and are less efficient in using these resources to produce good results (Fiszbein 1999, Llach & Schumacher 2006). In terms of achievement, average performance in test scores of public schools varies from a minimum of 35 to a maximum of 80 (out of 100).[8] These differences are exacerbated if one considers private establishments, were the average is twelve points above that of public schools.

In this context, it seems natural to wonder whether indeed economic inequality affects students' performance at schools, in particular, through the allocation of students across schools on economic grounds.

2.1 The primary education system and segregation

Formal education in Argentina is compulsory until the ninth grade (approximately 15 years of age). The provision of primary schooling, its financing, curriculum and administration are independently controlled by each province. Most of the funding of public schools comes from the provincial government. Payment of teachers salaries, large construction work, and school canteens are centralized at the provincial level. The allocation of teachers is determined by the central authorities in the system, and in most cases, local school authorities have no say in the selection of teachers. Public schools also have school cooperatives (*asociación cooperadora*) to which parents contribute (voluntarily) a relatively small monthly fee, money which is then used to cover small repair and maintenance work. Finally, in the context of a compensatory programme for specially disadvantage schools and

[7]Source: INDEC, *Censo Nacional de Población y Vivienda* (2001).
[8]Source: Author's calculation from *Operativo Nacional Educativo* 2000.

students, state schools might receive restricted resources from the federal government which can only be used to pay for infrastructure work, provision of didactic material, support of special schools initiatives, and training (Fiszbein 1999, p. 11).

Beside the formal mechanisms of distribution of resources across publicly funded schools, some authors have argued that schools with better-off pupils are able to capture more resources from the State (better infrastructure, more computers and books) because high- and middle-income families can exert greater pressure on the educational system (Llach & Schumacher 2006, Veleda 2005).[9] Private schools, on the other hand, are funded mainly by fees charged to students and by subsidies from the central government. Subsidies are in the form of salaries for teachers, and vary between 20% and 100% of the total salary, the latter mainly in the case of schools run by churches. Unsurprisingly, the physical and social capitals of private schools are, on average, larger than in public institutions (Llach & Schumacher 2006) and increasing in relation to the charged fee.

Other than monetary resources, human resources may be distributed unequally and biased across school depending on the composition of the student body. In the public sector, teachers can choose where to be posted, with priority given according to a points system. Points are accrued by tenure, training, and evaluations from school directors. In practice, the less experienced teachers and school principals are those teaching in the less favourable schools (i.e. with a relatively high proportion of poor children) (CIPPEC 2004, Llach & Schumacher 2006). While points data are not released, publicly available teachers' experience data provides a means of computing the quality of instruction across schools. These data, described in detail on the next section show substantial variance between schools. Most of this variation is found within public schools. Average experience in public and private schools does not differ substantially (in both cases it is around 10 years), however the variance is twice as high in the public sector as in the private sector. Within the pool of publicly funded schools, the higher the level of parental education of pupils, the higher the experience (Llach & Schumacher 2006).

The level of segregation across schools in a neighbourhood is the result of choices made by families and the recipient schools. Parents choose which school to apply to for the education of their children studies, and school authorities choose the pupils they are willing to receive, based on their preferences and certain policy restrictions. These choices may be determined by observed and unobserved characteristics of all participants. Students are segmented in a first stage when choosing between private and public schools. The ability to pay fees, in a context of scarce scholarships, clearly contributes

[9]Some local governments are also able to contribute to the school financing, through funding special construction work or extra-curriculum activities (Veleda 2005).

to the disparity in incomes between public and private schools. As of 2001, in urban Argentina 65% of children in the upper quantile of the income distribution attended private establishments, while only 7% of children in the lowest quantile did so.[10]

Within the pool of public schools, there is still some degree of segregation of students. The 1994 Federal Education Law enshrines the principle of parental school choice, meaning that children are allowed to apply to any school, irrespective of their place of residence. According to the law, the selection of pupils should be on a first-come-first-serve basis, with priority given to children with siblings or parents in the school. The new regulation represent a change from the previous rules whereby children were usually given priority by residence.[11] There was, therefore, in theory and in practice a geographical segmentation given by the existent (and increasing) polarization of the neighbourhoods (Veleda 2005). Once (and if) the new regulation is in place, any child is free to attend any school irrespective of the distance from the place of residence.[12] In practice, however, parents still are more likely to send their children to the neighbourhood school, and school authorities do manage to apply some level of discretion in the selection of students on non-reasonable basis (Fiszbein 1999, Veleda 2005).[13] Together, they lead to a particular composition of students according to their socioeconomic status and school segmentation within the state system.

Private schools, on the other hand, have several (legal) ways of selecting students. Family background, psychometric tests, recommendations, or interviews are among the common criteria. Naturally, the ability to pay the fee as a requirement is in itself enough to determined a relatively homogeneous composition of students according to their family background.

[10] Source: *Encuesta de Calidad de Vida* 2001, carried out by the National Ministry of Social Development (SIEMPRO). The sample is representative of the whole country urban areas - above 5,000 inhabitants.

[11] The 1994 Federal Education Law can only be interpreted as a 'recommendation' from the central government, as provincial governments maintain their autonomy in these matters. In some provinces the free choice system was in place before 1994, while other provinces did change the admission system in response to the law, while still even others, notably the City of Buenos Aires, continue to selects pupils according to neighbourhood of residence. Veleda argues that even before the Law "the freedom of choice of school is perceived and valued today by all actors of the community as a unalienable and fundamental right, particularly in the context of extreme deterioration of some establishments" (Veleda 2005, p. 27, own translation).

[12] Children wearing state school uniform (*guardapolvos*) are allowed to travel for free in any public transport.

[13] Fiszbein finds qualitative evidence of the system being 'far from transparent' and that some families are able to circumvent regulations and either have priority in the preferred school in the district or even be able to enrol the children in schools in other districts. From interviews to parents and school principals, Veleda (2003) finds that a prefabricated image of prestigious schools as being 'difficult to get in' makes self-exclusion by parents the most predominant mechanism of selection (or discrimination) on economic grounds.

In sum, there are three main potential sources of disparities in physical and human resources between schools and in the composition of the student body. First, public schools tend to be on average poorer than private schools as they do not charge fees. Second, provinces may differ in the amount of funding per student given to schools, while teacher quality or voluntary contributions to the school cooperative may differ across schools within and across provinces. Finally, parents may differ in their ability to 'sort' between schools, either through moving to an area with better schools or, where the new 1994 Law is in place, by choosing the school within the neighbourhood.

2.2 Data: The national evaluation assessment

The National Evaluation Assessment (*Operativo Nacional Educativo*, ONE) is an evaluation mechanism set up by the Argentine Ministry of Education in 1993. The assessment administers standardized achievement tests in Mathematics and Spanish at different levels of the educational system, two in the primary school level and two in the secondary school level. Tests are multiple-choice, and build on basic knowledge and capacities previously agreed among all provincial offices. The evaluation has been carried out periodically since 1993 on a randomly selected sample of schools, and on the whole student population in the year 2000.[14] I restrict my analysis to the students of the sixth grade (approximately 10 years of age) in the census year 2000.

Data are available at the level of the student. The dependent variable used in this paper is test scores in Spanish (and Maths for robustness), computed as the percentage of correct answers to multiple choice questions. All students present at the day of the survey in the chosen class were tested.[15] Of tested pupils, all have either results for Math or Spanish, and approximately 7% of the students have missing values in one of the tests.

Once the test is completed, students are asked about their personal characteristics (gender, age, educational history) and their family background. In particular, children above a certain age are asked about the maximum level of education achieved by the parents and the family possession of more than a dozen assets, and access to basic infrastructure services. In the present exercise, I use the average years of education to represent the student's socioeconomic background when both parents are present and the

[14]The evaluation has been carried out annually from 1993 till 2000, then in 2002 and every two years since 2003. Currently, only the data-sets until 2000 are publicly available.

[15]Unfortunately, it is not possible to know the proportion of absentees on that day in each school, so there is a possible bias if, for instance, teachers suggested students of lower ability not to come on the day of the test. In 2003, the proportion of absentees to the tests was on average 13% and 16% for Spanish and Maths, respectively (DINIECE 2003). No similar figure is available for the year 2000.

years of education of the present parent, otherwise.[16] I replicate the same analysis using a composite index of durable goods and access to service and find the results to be more or less consistent (more on this to come). Finally, it is possible to complement the pupils' data with information on the school and teachers' characteristics from the principals and teachers questionnaires.

Of the total number of schools surveyed, for the purpose of estimation I exclude schools with only one class per year. This exclusion allow me to identify the peer-group effects in a convincing way.[17] The resulting sample includes 3,819 schools (half the schools with valid information), 11,912 classes and 300,533 students distributed across the country.

Table 1 presents basic summary statistics for all students, according to the average level of education achieved by both parents. I group the years of education according to the level achieved: incomplete primary (including no education), complete primary (including incomplete secondary), complete secondary (including incomplete tertiary), and complete tertiary. More than a third of the students come from families with complete primary and another third with complete secondary education. The more educated the parents, the better their own performance in the Spanish and Maths tests. A child whose parents have a tertiary degree achieves in Spanish on average 11 points more than a child with parents who have no education or did not complete primary school. As expected, the better the social background, the lower the proportion of children repeating school years and the higher their attendance to private institutions.

Table 2 and the accompanying figure 1 depict the extent of social segregation across schools. Students from more educated background tend to share the classes with other children from similar better background. In the lower part of table 2 present the proportion of peers in each parental education group (rows) according to their own parents' education (columns). The higher the proportion of children along the diagonal, the greater the segregation. This should be look in relation to the first column which includes all pupils. In the present case, a child whose parents did not complete any education (second column) shares her class with 22% of children from the same social group while only half of that come from the highest group. In contrast, someone whose parents obtained a tertiary degree is three times more likely to share the class with others whose parents also complete tertiary education, and only 8% with no education degree.

[16]The original variable is expressed in six categories, according to complete and incomplete levels (primary, secondary, tertiary). I impute years of education using the data from the Permanent Household Survey (October round, year 2000). For incomplete level categories, I impute the median value.

[17]See next section for a detailed explanation of the estimation and identification strategy employed.

Table 1: Summary statistics of main variables, by own parents' education.

		Own parents' education			
	Total	I1	C1	C2	C3
Obs	300,477	41,738	112,846	89,791	56,102
	100.0	13.9	37.6	29.9	18.7
Parental education (years)	10.72	3.81	8.24	13.12	17.00
Spanish test score	63.28	56.92	61.78	65.10	68.12
Maths test scores	59.81	52.50	57.97	62.17	65.06
Assets index	26.53	19.88	24.35	28.66	32.41
Male	0.49	0.45	0.47	0.52	0.52
Repeat	0.17	0.32	0.19	0.13	0.09
Private school	0.23	0.09	0.16	0.27	0.40
Class size	26.66	25.51	26.35	27.03	27.52

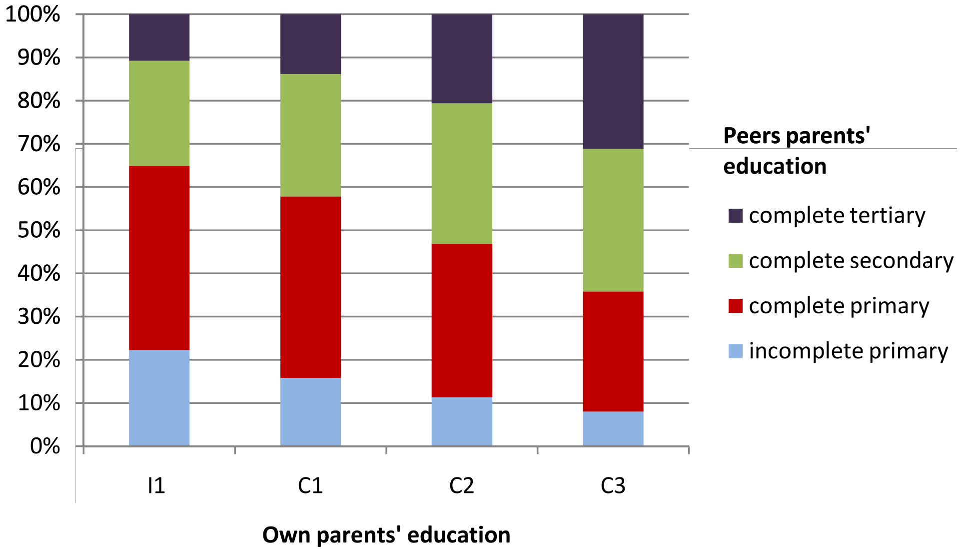
Notes: 'I1', 'C1', 'C2', 'C3' means the maximum level of education achieved by the parents (average) of the student, representing incomplete primary, ... complete tertiary, respectively. Author's calculation based on Operativo Nacional Educativo, 2000.

Table 2: Classmates parental education, by own parents' education.

		Own parents' education			
	Total	I1	C1	C2	C3
Class mean parental edu	10.72	9.16	10.06	11.21	12.42
Class median parental edu	10.64	8.55	9.70	11.37	12.93
Proportion of peers whose					
parents' education is ...	100.00	100.00	100.00	100.00	100.00
incomplete primary	13.89	22.22	15.79	11.31	8.00
complete primary	37.56	42.69	42.05	35.58	27.84
complete secondary	29.88	24.34	28.31	32.50	32.97
complete tertiary	18.67	10.75	13.84	20.60	31.19

Notes: 'I1', 'C1', 'C2', 'C3' means the maximum level of education achieved by the parents (average) of the student, representing incomplete primary, ... complete tertiary, respectively. Author's calculation based on Operativo Nacional Educativo, 2000.

Figure 1: Proportion of peers in each parental education group, by own parents' education



3 Empirical specification and estimation strategy

This section explains the specification of the equations to be estimated to test for the existence of heterogenous and composition effects, first, separately, and then combined. The section also describes the estimation strategy followed in order to address various identification and estimation concerns.

3.1 Specification

As explained in the second section, peer-group effects are standardly estimated using a linear-in-means model, that is, peers characteristics are entered through the average class level of some variable representing socioeconomic background. The validity of this model depends crucially on two assumptions; first, that all the pupils are equally affected by others' characteristics and, second, that the marginal effect of peers is constant across the socioeconomic background space. I will estimate peer-group effects using a more flexible formulation, relaxing both these assumptions.

Heterogeneous effects: Some people are more receptive than others to people's influences. One of the commonly argued mechanism through which peer-group effects work is through providing the student with alternative role models, outside those that she obtains from home. It is then reasonable to imagine that children from different socioeconomic environment are differently receptive to the influences of their peers. A direct way of testing this idea is to permit heterogenous coefficient on the peer-group variable, according to the recipient's parental education. This is done through interacting class mean parental education –expressed in years– with student i's parents education. The latter component is included through an indicator function for the category of parents' education achieved.[18]

$$A_{ics} = \alpha + \sum_{g=1}^{G} \gamma_g Qg_{ics} * \text{mean(x)}_{(-i)cs} + \beta(Y_{ics}, Z_{cs}) + \eta_s + \epsilon_{ics} \quad (2)$$

where Qg_{ics} are dummy variables indicating the level g of parents' education of student i in class c at school s, and g = {incomplete primary, complete primary, complete secondary, complete tertiary}. $\text{mean(x)}_{(-i)cs}$ is the average parents' education of peers, excluding student i. Also, Y_{ics} and Z_{cs} are vectors of individual and class characteristics, while η_s is the school fixed effect, and ϵ_{ics} is the individual error term.

Composition effects: The second relaxation of the classic assumption involves permitting non-linearities in the effect that peers' characteristics have on student i. Using the average parental education of classmates implies that all peers have the same marginal effect on i. Instead, I estimate peer-group effects using three variables representing the proportion of classmates whose parents fall within one of the categories of completed levels of education. The baseline category is 'incomplete primary' and the included categories are 'complete primary', 'complete secondary', and 'complete tertiary'.

$$A_{ics} = \alpha + \sum_{h=2}^{G} \delta_h Ph_{cs} + \beta(Y_{ics}, Z_{cs}) + \eta_s + \epsilon_{ics} \quad (3)$$

where Ph_{cs} is the proportion of classmates in group h, with h = {complete primary, complete secondary, complete tertiary}.

Heterogenous and composition effects: Most likely both effects can be at work simultaneously. Students are differently receptive to others, depending on both their own social group and that of the peer. For instance, children might be more affected by changes happening to those that are socially close than to those socially distant. This might reflect the fact that children integrate more with those coming from a similar environment. I combined heterogenous and class compositions effects in a multiplicative way.

[18] Although not the main focus on their article, Ammermueller and Pischke (2009) include an estimation of the peer effect interacted with the individual variable of socioeconomic background (number of books). Their results for France and The Netherlands are in line with those found in Argentina.

$$A_{ics} = \alpha + \sum_{g=1}^{G} \sum_{h=2}^{G} \gamma_{gh} Qg_{ics} * Ph_{cs} + \beta(Y_{ics}, Z_{cs}) + \eta_s + \epsilon_{ics} \quad (4)$$

The baseline category used is own parents' education equal to 'primary complete' and peer parents' education equal to 'incomplete primary'. The estimated coefficients should be interpreted in reference to this category.

3.2 Identification and estimation concerns

The literature on peer-group effect has paid careful attention to three identification and estimation difficulties. I will describe these concerns and explain the strategy followed in the paper to address them.[19]

The first issue is a problem of identifying separately endogenous and exogenous effects. This concern is known in the literature of social interactions as the *reflection problem* and has been introduced in the area by Manski (1993). The standard formulation of peer effects is a linear-in-means model, where the student's achievement is determined by the average classmates' achievement and average characteristics. The estimated coefficient on the first term defines the endogenous peer effect and the coefficient on the second is the contextual effect. The reflection problem is the inability to separate these two effects due to the fact that there is a feedback loop in the endogenous variables. A great number of papers have proposed alternative methods to tackle the endogeneity problem and identify separately endogenous and exogenous peer-group effects.[20] My approach here is, instead, to avoid the problem altogether. Rather than estimating the endogenous and the contextual effects separately, my purpose is to estimate the reduced form equation, where the peer effects is often referred to as the *general social effects* (Moffitt 2001). I argue that to my purpose at hand –the study the effect of increase segregation– estimating general social effects using a reduced form is sufficient.[21]

Given the relative parsimony of the empirical models, the second econometric concern is that the the estimates of the parameters in (2), (3) and (4) will suffer from omitted variable bias due to the failure to control for

[19] Soetevent (2006) presents a comprehensive literature review of the most common econometric problems in estimating peer effects and the solutions proposed.

[20] Manski (1993) suggest to find a variable that affects the achievement but not the contextual effect; Brock and Durlauf (2001, 2002) use a binary or multinomial choice model; Katz et al. (2001) take advantage of group-changing intervention in the Boston area; and again Katz et al. (2001) and Gaviria and Raphael (2001) employ instrumental variables.

[21] "To the extent, therefore, that it does not matter for the purpose at hand whether social interactions are of the endogenous or exogenous type, estimation of the reduced form equations (...) is sufficient" (Moffitt 2001, 57).

numerous student and school characteristics. To clarify the possible sources of endogeneity, consider the decomposition of η_{ics} into three elements

$$\eta_{ics} = a_{ics} + b_{cs} + c_s, \tag{5}$$

where a_{ics}, b_{cs} and c_s represent unobserved or unmeasured individual, class and school characteristics, respectively.

Examples of unobserved factors that will potentially bias the estimates of the peer parameters include individual innate ability and school location (captured in the a_{ics} and c_s terms respectively). The problem stems from the possibility that parents choices of school are endogenous to the quality of education provided. A standard concern in the literature is that peer effects may simply reflect a tendency for eager parents to send brighter children to high-achieving schools with, say, wealthier peers and better principals. This problems is generally known as self-selection or endogenous group formation. In general, ignoring the selection problem can lead to large overestimation of the coefficients accompanying the peer-group variables.

To address such difficulties, this paper uses a standard approach, which involves using school panel data fixed effects estimation (Hanushek, Kain, Markman & Rivkin 2003). Due to the characteristics of the data (there is no unique student ID that permits tracking individual students across years) I am only able to control for school fixed effects. Thus, strictly speaking, I control for the c_s term and not the individual a_{ics} effects. However, in as much as the parents' selection of school due to reputation is common across all children that attend a particular school, the school fixed effect component is able to address the most significant part of the problem.

It should be clear that with the inclusion of school fixed effects, econometric identification of peer effects relies on the existence of perturbations in the school composition of students across classes. As expected, these variations are small relative to the overall variation across schools, which makes the identification more demanding, but also more reliable.[22] To give a sense of the consequences of using school fixed effects, Table 8 in the appendix presents the estimated values of the coefficient on the mean years of peers parents' education using OLS and school fixed effects. While in both cases positive and significant, the fixed effect coefficient is a tenth of the OLS estimate. This difference is greater that the one that Ammermueller and Pischke (2009) found for Germany, France and Sweden but smaller than that of The Netherlands and Norway. If the fixed effects estimation were

[22] There are number of other ways to address the problem of selection. For some the most convincing way of dealing is to include a model of selection of schools with Heckman's classic selection correction (Ioannides & Zabel 2003, Ginther, Haveman & Wolfe 2000, Kingdon 1996, Kingdon 2006). Other options include using individual fixed effects estimation with partial treatment of members of groups (Moffitt 2001) and instrumental variable estimation (Evans, Oates & Schwab 1992, Rivkin 2001). None of these options are feasible with the ONE data.

correct, this would point to a large overestimation of the OLS results. Interestingly enough, while the peer effect is much reduced, it is still three times larger than the coefficient on own parents' education. This means that raising one year the average years of education of the peers has three times the effect of a student's test score than increasing his own parents' education by one extra year.

School fixed effects, however, cannot address all sources of bias. Apparent peer effects may still be driven by differences in the quality of instruction or school management across classes, whenever these differences are correlated with the peer variables. This concern would arise if, for instance, richer parents are able to exert pressure on the school for a better teacher or if the school tracks children according to their performance. In terms of the previous equation, the problem stems from the correlation between b_{cs} and peer characteristics.

To address these concerns, I exploit random variation in peer-groups between sixth-grade classrooms in a given school. Two-thirds of the schools in Argentina have more than one class in each grade. The assignation of pupils to a class is determined at the beginning of primary school (at 6-7 years of age) and remains unchanged throughout the whole seven years of education. This assignation is done with no clear systematic procedure and, for our purpose, is completely random. Also, unlike the United States or the United Kingdom, in Argentina children are not streamed on the basis of their performance along the years. Instead, the initial allocation of classes is done randomly and it remains fixed for the entirety of the primary education. In other words, b_{cs} and peer characteristics are not systematically related. Combined with school fixed effects, the effect of the peers on a student's performance is identified by the existence of variations in class composition across classes within a given school.

The randomization of students across classes within the school is the key element of the estimation strategy. The identifying assumption used, consequence of the randomization, is that students share characteristics at the school level, but not at the level of the classroom. I test the validity of this assumption using a three-step procedure exploiting the multi-level structure of the data. In the first instance, I regress the variable representing socioeconomic background (parents' education, edu_{ics}) on a constant for each school (school fixed-effect, u_s). This is to purge the variable of interest (parents education), from the part that is common to all children attending the same school, due to observed and unobserved common characteristics that determined the selection of a particular school.

$$edu_{ics} = cons + u_s + \epsilon_{ics}$$

The residuals obtained from the above estimation (ϵ_{ics}) are then regressed using class fixed effects.

$$\epsilon_{ics} = cons + v_{cs} + \omega_{ics}$$

If schools do not distribute students into classes according to their socioeconomic background, there should not be a systematic different across classes. This can be tested using a joint significance F-test of the class fixed effects, that is, testing whether the v_{cs} are jointly equal to zero. The test was carried out for the whole sample and separate for public and private schools. In all cases, one cannot reject the hypothesis that the class fixed-effect terms are all equal to zero (see table 7 in the appendix). In other words, the evidence is consistent with the absence of a systematic assignation of pupils to classes on socioeconomic grounds.

The strategy of combining school fixed effects when there is a random assignment of students across classes is closely related to that of Ammermueller and Pischke (2009) who use primary school data for six European countries, McEwan (2003) with secondary school data in Chile, and Vigdor and Nechyba (2004, n.d.) for fifth graders in North Carolina. In all of these cases, however, the peer effects were estimated using the mean of the peer characteristics and no composition or heterogenous peer effects were allowed.[23]

Finally, standard errors are clustered at the school level to adjust for intra-school correlation, and are robust to heteroscedasticity.

4 Results

In this section I test the existence of heterogenous effects -differences in impact of peers according to socioeconomic background of the recipient student- and composition effects -non-linearities of the peer-group effects. I then estimate the combined effect of both these forces. The interpretation of results will focus on the estimation including school fixed effects -OLS results are also included for comparison. The magnitude of the peer-effects from the fixed effect regressions are relatively small as these effects are identified by the existence of variation across classes within a given school. In all cases, standard errors are clustered by school.

Table 3 presents regressions of the standard peer-group effects using the mean classmates' parental education (columns 1 and 3) and combined with

[23] Ammermueller and Pischke also cast doubts on the validity of the random assignment in McEwan (2003) and in Vigdor and Nechyba (2004, n.d.) for different reasons. Other papers estimating peer group effects based on random assignment of students include Hoxby (2000) and Gould et al. (**?**) even though both studies exploit year-to-year variations of successive cohorts of students. Sacerdote et al. (2001) is also in a similar vein, exploiting the random assignment of college students to dorms. Related approaches are used by Duflo and Saez (2003), Duflo et al. (2004), Duflo et al. (2008) and Miguel and Kremer (2004) all of which use partial population experiments with random assignment of treatment.

the level of education of parents of the recipient student (columns 2 and 4) on student's test scores in Spanish. II focus on the last two regressions, where school fixed effect is used. There is a positive and significant effect of the mean peer parents' education. Increasing one standard deviation the mean of parental background of classmates increases the test score by half a point.[24] While the magnitude of the effect may appear to be small, it has more than three the impact of increasing her own parental education (for a student with average social background). Column 2 shows that this effect is not the constant across the level of education of the recipient student (test of equality of coefficients can be found in the appendix, table 9). Children whose parents are more educated seem to be 'more able' to capture the benefits from her peers' background. One implication of the result is that children from more disadvantage origins not only are likely to perform worse than the rest due to the background at home but also they loose out in the social interaction game, unable to obtain much benefits from others in the class. These result also point to the possibility that looses of the better off from mixing with others from lower social background are larger than the gains of the worse off from that mixing. All in all, the heterogeneity of peer-group effect at least questions the validity of the standard model of estimating the impact of social interactions within the class.

The next set of results (table 4) estimates equation (3) to examine whether the influence of the peers on a student's performance is monotonically increasing and linear. The first column presents the OLS estimation while the second includes school fixed effects. The evidence is consistent with the idea that raising the proportion of classmates coming from more educated families (while reducing that with no formal education), increases the test score of the average pupil. Contrary to what could be expected, the largest effect comes from raising the presence in the classroom of children whose parents completed secondary education -and not tertiary. This points to a non-linear relationship between peers' family background and student's performance at school. The different between the coefficients on the two upper groups (.038 versus .027) is statistically different at an 8 percent level -see table 10 in appendix. At worst, they indicate that there is no gain from having peers whose parents obtained a tertiary degree relative to those who completed secondary education. At best, these results suggest that it is preferable to integrate students from less educated families with others from middle class children than with those from the top of the parental educational distribution. In both cases, the conclusion of non-linearity of peer-group effects remain. In other words, the specific conformation of the class in terms of the socioeconomic background of the students matters for the total effect on test scores. These coefficients estimate effect, however, for

[24]Standard deviation of main variables are presented in table 6 in the appendix. For the present computation, standard deviation of peer parents' education is 2.31.

Table 3: Test of heterogenous peer-group effects

	Dependent vle: Test scores in Spanish			
	(1)	(2)	(3)	(4)
Class mean parental edu (-i)	2.231		.215	
	(.037)***		(.054)***	
I1i * mean class parents edu(-i)		1.853		.094
		(.047)***		(.058)
C1i * mean class parents edu(-i)		2.025		.159
		(.039)***		(.055)***
C2i * mean class parents edu(-i)		2.280		.263
		(.037)***		(.055)***
C3i * mean class parents edu(-i)		2.558		.380
		(.039)***		(.057)***
Own parents' education	.737	.872	.559	.615
	(.045)***	(.096)***	(.037)***	(.080)***
(Parents education)^2	-.028	-.060	-.023	-.036
	(.002)***	(.004)***	(.002)***	(.004)***
school fixed effects			✓	✓
Obs.	300477	300477	300477	300477
e(N-g)			7469	7469
R^2	.169	.171	.063	.064

Notes: 'Parents' education' is the average years of education completed by both parents, whenever present. 'I1'i, 'C1'i, 'C2'i, 'C3'i are dummy variables representing student i parents' education categorized in four groups, incomplete primary, ... complete tertiary, respectively. Additional variables used in the regression are student's gender, whether she or he repeated a previous year, and class size. Standard errors are clustered by school. Source: Operativo Nacional Educativo 2000.

the average child. It might very well be that class composition have different effects depending on the parental background of the recipient student. I do this in the next table.

Table 4: Test of composition effect

	Dependent vle: Test scores in Spanish	
	(1)	(2)
Prop peers from C1 (baseline = I1)	.126	.023
	(.008)***	(.007)***
Prop peers from C2 (baseline = I1)	.219	.038
	(.007)***	(.007)***
Prop peers from C3 (baseline = I1)	.304	.027
	(.007)***	(.008)***
Own parents' education	.779	.578
	(.039)***	(.038)***
(Parents' education)^2	-.026	-.024
	(.002)***	(.002)***
school fixed effects		✓
Obs.	300477	300477
e(N-g)		7469
R^2	.166	.064

Notes: 'C1', 'C2', 'C3' represents incomplete primary, ... complete tertiary, respectively. 'Parents' education' refers the average years of education completed by both parents of student i, whenever present. Additional variables used in the regression are student's gender, parents' education and its square, and whether she or he repeated a previous year, and class size. Standard errors are clustered at the school level. Source: Operativo Nacional Educativo 2000.

Table 5 presents the estimation of a single regression, as described in equation 4. Results are organized as in the summary table, with columns representing the background of the student and the rows the parental education of her classmates. The baseline category is the proportion of peers from the poorest category, as used in table 4. All the estimated coefficients should be interpreted in reference to this category in each column.

The table shows that the effect of peers is not constant across socioeconomic groups, as defined by a pupil's own parents' education. Most importantly, the results suggest that students experience the strongest positive externality from being surrounded by peers of their own social group. Children from the lowest group loose out if there is an increase of the proportion of peers from more educated backgrounds. Equally, students whose parents have a tertiary degree benefit most from increasing the proportion of

Table 5: Test of class composition effect by student's background. Fixed effects estimation

Dependent vle:		Own parents' education			
Spanish test score		I1	C1	C2	C3
Peers parents'	I1				
education (%)	C1	-0.011	0.024	0.042	0.081
		(.010)	(.008)***	(.009)***	(.011)***
	C2	-0.024	0.020	0.074	0.135
		(.010)**	(.008)**	(.008)***	(.010)***
	C3	-0.052	-0.011	0.064	0.138
		(.012)***	(.009)	(.009)***	(.011)***

Notes: All coefficients belong to a single estimation, interacting student parents' education (column) with peers parents' education (row). Variables used as control include student's gender and previous repetition of grades, his or her own parents' education, its square and dummy variables, and class size. Source: Operativo Nacional Educativo 2000.

peers from their own group. Exogenously increasing the proportion of peers in the highest educational group by 10% leads to a 1.4 point increase in the test score of students in the highest socio-economic group, but reduces the test score of the students in the lowest group by 0.5 points.

Simulations

To be included.

5 Conclusions and policy implications

This paper has argued that the standard approach to estimating peer-group effects, does not help understand fully the consequences of changing levels of economic segregation. After relaxing two assumptions of the linear-in-means model, this study finds that first, the more educated the parents, the more the child is able to benefit from her classmates. The consequence of this result is that peer-group effect is another source of increasing gap between social groups. Second, there is evidence that the effect of peers is non-linear so that the composition of the classmates background (other than their mean) matters for determining the test score levels. The form of the effect found suggest that mixing with peers from the middle group may increase overall performance. Finally, when disaggregating the composition effect by the parents' education of the recipient it appears that the class composition matters differently depending on the socioeconomic group of the recipient student. The strongest positive externality comes from being surrounded by peer of their own social group.

There is a tension between promoting growth and reducing inequality as social objectives. Defining growth and inequality only in terms of academic performance, and limiting our focus to a single policy tool –assigning students between schools and classroom– this study finds that the optimal policy to promote growth in mean scores is to segregate students with other students of the same socioeconomic class as much as possible. It is worth noting that this growth in mean outcomes from segregation is driven disproportionally by benefits experienced by children in the highest socioeconomic bracket; it is the rich kids that gain from being with other rich kids more than poor benefit from being with other poor children. Because of this, promoting growth will not only maintain but exacerbate the socioeconomic inequality in educational outcomes. Furthermore, the results suggest little potential for integration within public school to serve as leveling devise to reduce intergenerational inequality.

Appendix

Table 6: Summary statistics, by type of school.

	Total			Public			Private		
	obs.	mean	st. dev	obs.	mean	st. dev	obs.	mean	st. dev
Parental education (years)	300,477	10.72	4.40	231,050	10.13	4.33	69,427	12.68	4.04
Spanish test score	300,477	63.28	19.25	231,050	60.27	19.00	69,427	73.27	16.49
Maths test scores	288,404	59.81	20.40	220,643	56.98	20.26	67,761	69.03	17.98
Assets index	294,678	26.53	13.51	225,967	24.67	13.38	68,711	32.66	12.05
Male	300,477	0.49	0.50	231,050	0.50	0.50	69,427	0.48	0.50
Repeat	300,477	0.17	0.38	231,050	0.21	0.41	69,427	0.04	0.21
Private school	300,477	0.23	0.42	231,050	0.00	0.00	69,427	1.00	0.00
Class size	300,477	26.66	5.64	231,050	26.03	5.40	69,427	28.75	5.91
Peer parents' education (years)	300,477	10.72	2.31	231,050	10.13	1.97	69,427	12.68	2.30

Notes: Author's calculation based on *Operativo Nacional Educativo* 2000.

Table 7: Test of random assignment of students across classes within a school.

	F test that all u_i=0:	Prob > F
Total	F(19,797; 280,679) = 0.98	0.9420
Public	F(15,869; 215,180) = 0.99	0.7353
Private	F(3,927; 654,99) = 0.87	1.0000

Table 8: Regression of Spanish test scores on own parents' education and peers mean parents' education. OLS and school fixed-effects estimations

	OLS	OLS2	FE
	(1)	(2)	(3)
Parental education (years, average)	.640	.145	.067
	(.008)***	(.008)***	(.009)***
Class mean parental edu (-i) (years)		2.214	.214
		(.016)***	(.054)***
School fixed-effects			Yes
Obs.	300,477	300,477	300,477
e(N-g)			7,469
R^2	.117	.169	.063

Notes: Control variables include sex and whether the student repeated previous years, and class size. Standard errors are clustered by school. Source: *Operativo Nacional Educativo* 2000.

Table 9: Test of equality of coefficients, heterogenous effects (from Table 3, column (4)

	p-value				F(2, 7468)			
	I1	C1	C2	C3	I1	C1	C2	C3
I1	.	0.001	0.000	0.000	.	10.93	43.78	93.46
C1	0.001	.	0.000	0.000	10.93	.	70.88	92.15
C2	0.000	0.000	.	0.000	43.78	70.88	.	60.81
C3	0.000	0.000	0.000	.	93.46	92.15	60.81	.

Table 10: Test of equality of coefficients, composition effects (from Table 4, column (2)

	p-value			F(2, 7468)		
	Prop C1	Prop C2	Prop C3	Prop C1	Prop C2	Prop C3
Prop C1	.	0.005	0.495	.	8.05	0.47
Prop C2	0.005	.	0.081	8.05	.	3.05
Prop C3	0.495	0.081	.	0.47	3.05	.

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