UNIVERSITA' CATTOLICA DEL SACRO CUORE
MILANO

Dottorato in Economia e Finanza dell'Amministrazione Pubblica
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# A POLICY PERSPECTIVE OF EDUCATIONAL ISSUES

Tesi di Dottorato di: Virginia Maestri
Matricola: 3406147

Anno Accademico 2007/08

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*to Sofia*

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# Introduction

The essays composing this dissertation are three independent works, grouped by a common perspective: a policy point of view of educational issues. All the three studies relate to socio-educational situations in which, in some way, people select into. This research attempts to understand whether the socio-educational input and output considered are causally related. Chapter 1 investigates the relationship between residence in public housing and educational achievement. Chapter 2 explores the role of the ethnic class composition on pupils' test scores. Chapter 3 is an evaluation of a policy sponsoring scientific faculties.

The first Chapter originates from the evidence of the low school achievement of children living in public housing, even after controlling for important determinants of schooling. These kids may perform badly only because of their disadvantaged family background or because some projects may represent a deleterious ghetto environment in which school attitudes can be poorly developed. The aims of this paper are twofold: one is to verify the existence of a "ghetto" peer effect, the other is to verify the existence of an increasing "ghetto" effect (in the size of the project) and/or the existence of an amenity effect (high-rise projects). The first aim is an extension of the US literature about this topic to the Italian case, in a non-randomized "moving out" experiment. Although the evaluation of randomized experiments is more reliable than field studies, the volunteering participation to this kind of programs may limit the external validity of the results. Moreover, the effect of living in public housing may be long-standing and it may be difficult to disentangle the effect of "moving out" from moving itself, in the short run. The second point aims at verifying whether there exists an heterogeneous "ghetto" effect within projects. We exploit the history of the Italian inter-regional migration and the size of the projects as our identification strategies. The analysis suggests an unfavorable causal effect of public housing on school evasion for girls. It also seems that the effect on grade repetition is stronger the higher the number of units in the project, especially for girls living in big cities. For other educational outcomes the difficulty to

isolate the family background effect does not allow us to draw conclusive comments.

The second Chapter explores the issues of ethnic diversity in the context of schools. Ethnic diversity can stimulate the creativity of students, can push them to be proficient in the instructional language and culture, can reduce the scope of ethnic identification with all its possible drawbacks, but it may also make the job of teachers more difficult. The literature on the economics of education has mainly investigated the effect of the ethnic share on school achievement: this study looks at how diverse is the ethnic minority share and its socio-educational consequences. The contribution of this paper is to investigate whether ethnic diversity has an impact on the test scores of children, applying a concept introduced by the macro and political economy literature and by experimental studies about the firm's performance. We also investigate for whom diversity matters and shed some light on the mechanisms there can be behind. We exploit the within school time variation in ethnic diversity of a rich data-set about primary education in the Netherlands as our identification strategy. We find that ethnic diversity has a positive impact on the test scores of minority students, especially for language skills and older students. We also find a negative relationship between ethnic diversity and school's social environment, that can partly explain the gains in test scores as a results of a more competitive environment.

The third Chapter is about the topic of policy intervention in the field of college studies, in a context of declining enrolments in scientific tracks. Policy can intervene in the choice of college major by helping students in forming their expectations about earnings associated with these majors and by stimulating their interest in scientific subjects. In 2005, Italy launched an important promotion policy to boost enrolments in selected scientific bachelors, providing various activities to high school students. The aim of this study is to evaluate the efficacy of this policy. Moreover, following the suggestion of the literature on the choice of college major about the differential behaviour of male and female, we check whether the policy has been effective for both male and female. Finally, we check whether the program generates effects outside the scope of the policy. It happened that within the same school some students participated to the program, while others did not. Besides, in order to avoid the problem of self-selectivity of individuals and classes into the program, we adopt an "exposure" approach in which we define as treated all students of a cohort within a school that were eligible for these activities. We match the records of the students enrolled in two big universities with the records of the participating schools. The results show a positive and significant effect of the policy "Progetto Lauree Scientifiche" on targeted and non

targeted scientific bachelors and positive cross treatment effects across subjects. However, if the policy has a considerable impact on the bachelor's choice for males, it does not appear to have any effect for females.

# Chapter 1

# Poor schooling of kids living in Italian public housing: ghetto effect?

## 1.1 Introduction

In Italy since 1903, public housing have been offered to workers and needy people. This policy originated as a workers' achievement, but it slowly and steadily changed into a government policy to cushion emergency situations. Already during the Fascism the politics of public housing started to be narrowed and restricted to emergency situations, with a clear segregation motive. Afterward, the huge demolition of buildings during war years led to an expansion of the public housing policy (Delera, 2005) (Wendt, 1962). In the 1960s, the economic boom driven by the urban areas of the North attracted laborers from the South, from the countryside and from the poor regions of the North[1]. From 1951 to 1971, with a peak between 1955 and 1963, about ten millions Italians were involved in interregional migrations, among them 4.2 out of 18 millions Southerns migrated to the North. Besides, 550000 Italians emigrated in Northern Europe, out of which 3/4 were from South Italy. Just to give an example, the urban population of a North industrial city like Turin increased by 56% from 1951 to 1967 due to the major migration from the South and partly from its poor regional countryside (Necco, 2004). Once again, housing shortage was a problem that governments tried to solve with a rapid construction of public developments. Suburbs and then the (yet isolated) areas surrounding the big industrial cities in the North started to host the new projects (Delera, 2005; Irer, 2004).

[1] Veneto and Friuli Venezia Giulia.

Notwithstanding the effort, the State never succeeded to fully meet the size of the demand for affordable housing. Moreover, by the second half of the 1980s the public agencies charged to manage the construction and maintenance of the projects had accumulated a huge debt. They were thus forced to sell a considerable part of their housing stock and to stop the maintenance of the other buildings. The concentration of extremely poor and distressed people in the popular neighborhoods was further aggravated.

Nowadays children living in projects perform dramatically worse in education than children living elsewhere. In the North, children living in public housing are roughly three times more likely to fail a grade during middle school, more than five times more likely to skip compulsory schooling, more than twice more likely to end education after compulsory requirements and have, on average, about two years less of education. Controlling for observable family background merely reduces these ratios but does not change much the picture.

The concentration of disadvantaged people into the projects raises the issue of whether this concentration could worsen the already deprived conditions of these families. A question that has primarily been addressed for the US context [2]. There is no clearcut consensus on the answer. Some studies report that moving out of public housing does improve some educational and behavioural outcomes (Katz et al., 2001). Some other studies do not find any effect of public housing (Jacob, 2004; Newman et al., 1999), while others suggest that public housing is helpfull for the education of children (Currie et al., 2000). The design of projects itself is deemed to be responsible for the social distress inside projects (Newman, 1972). The theme of "ghettoization" of projects is alive not only in the international academic literature. In Italy, newspaper articles[3], new complementary housing policies [4] and volunteering organizations[5] support the same feeling.

[2]Even tough Italy and US presents many similarities in the housing arena (incentives for house property, low share of public housing in the rental sector, long waiting lists, etc.) they undertook different paths. The US tried to switch toward a tenant-based assistance, Italy chose a side policy to public housing. The mere fact that policies' answers are different in the two countries rises the question if the underlying environments are indeed different. Second, Italy is marked by a different story of public housing, above all in its expansion part in the 1960s due to the structural migration. Still, management, design, dimension, location and social composition of projects cannot assumed to be the same in the two countries.

[3]See for example, Corriere della Sera 29 August 2003.

[4]See the Italian Ministry of Infrastructure's website: www.infrastrutture.gov.it.

[5]Comitato Inquilini Molise-Calvairate, an organization that provides social and educational assistance to children living in projects.

Since its inception, the Italian housing policy for low-income households has never undergone radical changes. To notice, children are the indirect and involuntary recipients of the public housing policy. Does public housing help its disadvantaged recipients when targeted to (families with) kids?

This paper tries to investigate whether the Italian public housing of the North constitutes a ghetto that worsens the condition of children or, instead, if that policy does not add anything to the already disadvantaged conditions of its young recipients. As (in kind) rent subsidy, public housing could also make these children better off. The existence of a (positive or negative) causal relationship between residence in public housing and children's educational outcomes is important for a more ample understanding of the current Italian public housing policy.

We use a pooling of the 1995, 1998, 2000, 2002 ans 2004 Italian Survey on Income and Wealth (SHIW) and the 2001 Census data. The striking advantage of using the Census is its huge sample size and the information on the numbers of units in the building, that we need in our further attempt to estimate the causal effect of (high-rise) public housing without the use of an instrument. On the other hand, the Census does not contain information on income, while the SHIW does.

We exploit the history of Italy for the construction of our instruments. As in the North migrants from the South or other regions are more likely to apply and live in a project, we use having both parents born in the South or having both parents born in another region as instruments for children's residence in a project of the North. Both types of migrants are roughly three times more likely to end up in a project than native households. We also compare the outcomes of children living in high-rise projects with those living in small/medium-rise ones.

We find that living in a project has an unfavorable effect on the educational outcomes of children. However, for most school outcomes this result is sensitive to our choice of the instruments and we cannot exclude it is due to the disadvantaged conditions of these families. Only for the effect of projects on female school evasion we can more convincingly think of a ghetto effect. For high-rise public housing there is some evidence of a ghetto effect, though this effect is not the same for male and female and it seems to work in a different way in big cities.

The paper is organized as follows. Section 1.2 introduces the literature on the topic, the functioning of the public housing policy in Italy and the sociological theories behind the relationship between educational outcomes and living environment. Section 3.4 presents the econometric model and, in more details, our two identification strategies. Section 3.3 describes the data-sets we use and the characteristics of our sample. In

Section 3.6 the results of the instrumental variable and difference in difference approaches will be presented, together with some informal test on the validity of our instruments. Section 2.6 exposes some refinements of our analysis and Section 1.7 draws some conclusive comments.

## 1.2 Background

### 1.2.1 Related literature

The existing literature on the connection between residence in public housing and socio-educational outcomes is almost entirely focused on the US case and it is substantially concerned about the evaluation of policies alternative to projects. In particular, a considerable stream of the literature deals with the evaluation of socio-geographical mobility experiments.

Kling et al. (2007) exploit the Moving to Opportunity program[6] to evaluate the (short-term) causal effect of tenant-based assistance on a wide spectrum of outcomes. After five years from the experiment, they find beneficial effects of the MTO on mental health (in particular), risky behaviour and education for teenage girls and an adverse effect on the same outcomes for teenage boys. Three years after the experiment, for the only city of Chicago, they had found reduced behavioural problems for boys, but not for girls and reduced number of friends in the new neighborhood for girls but not for boys (Katz et al., 2001). Results are restricted to the families that voluntereered for the experiment.

Similarly, Jacob (2004) uses the information on projects' slated for demolitions to evaluate the causal impact of public housing and high-rise project on Afro-American students' achievement. In his study, notification for public housing's closure does not seem to have an independent effect on educational outcomes of children. Notification does only increase the probability of school drop-out, but it has no effect on test scores, absences and credits. Also high-rise projects do not seem to entail negative effects on children outcomes. He estimates the effect on the outcomes three years after notification.

The relevance of these studies for our purpose is that if the concentration and/or the design of projects causes the distress, once children

[6]A program in which public housing tenants were offered, through a lottery, a house-voucher to move into the private housing market. The offer of a house voucher was of two type: one with no geographic restrictions and one conditional on moving in a census tract with poverty rate below 10%, plus mobility counseling. The program was limited to the cities of Baltimore, Boston, Chicago, Los Angeles and New York.

move out (and their parents still benefit from a housing subsidy) they should be better off. If children in and out projects (in both cases with a housing subsidy) have the same outcomes it means that projects do not make them worse off than they already are. However, the effect of having lived in a project can be long-standing and, as some sociologists underly about this topic, people mantain relationships in the old neighborhood (Souza Briggs, 1997). Moreover, short-run evaluations of these kind of experiments may be not enough to purge the effect of "moving out" from moving itself.

Outside of an experimental environment, Newman et al. (1999) use the number of assisted housing units per income-eligible family in each county to asses the long-term impact of assisted housing on children educational attainment in the US. It may be expected that households living in places where there is a higher supply of assisted housing are more likely to receive housing assistance. To avoid that factors affecting the supply of assisted houses also affect children's educational outcomes, they use the residual of the supply measure from a regression that controls for local area characteristics. They find that having ever lived in public housing, the duration of that residence and at which stage of the childhood it took place has no causal effect on children's educational outcomes.

Currie et al. (2000) use sibling sex composition to estimate the effect of public housing on, among others, the probability to be held back for male. The choice of the instrument originates form the US Department of Housing and Urban Development policy to assign a three-bedroom apartment for families with a boy and a girl and a two-bedroom flat for families with siblings of the same gender, unless they are very young. Since the benefit of getting a three-bedroom is higher than getting a two-bedroom apartment, families with mixed-gender children are expected to be more likely to apply for public housing. They restrict the analysis to male to avoid the argued correlation between sibling sex composition and educational outcomes for girls[7]. They find a favorable and significant effect of public housing on grade repetition, while the same effect is still favorable but insignificant with OLS. It is possible that in this way they identify the effect of having one room more, for instance, to study. However, it would have been interesting to apply the same strategy in our data, but the regional housing policy in Italy does not distinguish families according to the gender of their children. It merely assigns flats of different sizes according to the number of household' members.

For the Italian set-up we have no experiments neither suitable data regarding projects' demolitions. Thus, our work will be on the motive

[7]See Butcher and Case (1994).

of the instrumental variable approach outside an experimental setting. Also, we add a different approach that does not require the use of an instrument, though it will asses a somehow different effect of public housing and more precisely, the existence of a increasing in project's size ghetto effect and/or the effect of the design of the high-rise projects.

### 1.2.2 Public housing in Italy

Italy is the EU-15 country with the lowest share of expenditure for housing on the total welfare expenditure: 0.2% versus an average of 3.8% of the former 15 European countries. The main housing policy has always been to boost house property. Indeed, the rental sector decreased from 36% of the total stock to 20% between 1980 and 1999. Between 1991 and 2001 the Italian public housing stock decreased by 14.3%, thought in the North the reduction was only 3.3%. In 2000 the national public housing stock was 23.1% of the rental stock, in the North-East 19.7% and in the North-West 27.7% (Federcasa, 2002). In Lombardy public housing represents 4% of the total housing stock, Milan has the highest percentage: 6.8%. 2.6% of the Milan population live in projects located in the city, while 4% live in project in the surrounding areas (Irer, 2004).

Though small, public housing is the main policy instrument for the housing of low income households. An alternative instrument is a system of rent control[8], introduced in 1978. However, in 1992 the private rental market was liberalized. Nowadays, the "fair rent" still exists, mainly in the South and as a marginal policy (Federcasa, 2002). In the context of a free housing market, in 1998 was introduced a tenant-based policy, that is a rent subsidy for low income households. Still, only 5% of renters apply for this subsidy and the policy itself can only meet 82% of the requests, overall, and even less in urban areas (75%). Also, the funds for this subsidy have been substantially decreased in 2002 (Federcasa, 2002). In the late 1990s some regions started to introduce a house voucher for new married couples for the purcahse of their first house, continuing the policy in favor of house porperty. These families have to satisfy some weak crtiteria, like income requirements, limits for square meters of the desired flat, etc.

The only new relevant policy for low income households is the "area contracts" introduced for the first time in 1994. The area contracts aim at revaluating the individual through his habitat, in areas of social malaise and lack of economic opportunities that have often been identified

[8]The so called "fair rent" (or "equo canone").

with the most distressed project's neighborhood[9]. Still, this policy is in support of the problems originated in the projects or, maybe, by the projects themselves.

As the stock of public housing is rather small, slots are assigned through strict eligibility and priority criteria. The main criterion for the assignment of a flat in a project is household's income. The income thresholds are determined by each single region and they considerably vary from one region to the other. For example, in 2001 the maximum income to apply for a household of two members was around 11000 euro in Lombardy and 24000 euro in Emilia-Romagna. There are also income limits to maintain the flat, once assigned. Regional laws provide numerous regulations that in practice allow families whose income exceed the limit to continue to stay in the project by paying a higher rent (Federcasa, 2002).

On one side the imposition of strict criteria does not allow to satisfy the demand for public housing. Hardly more than 8% of the applications for public housing are satisfied. On the other, the strict criteria define a very disadvantaged social composition of projects. Moreover, the considerable difference between the social and the market rent boosts these families to continue to (unlawfully) live in the project even when requirements are no more satisfied (Federcasa, 2002; Irer, 2004). In 2000 the ratio rent over income was 16.7% in the private market and 4% for public housing tenants.

Other assignment criteria vary by region but in general priority is given to elderly, lonely parents, handicapped or families with handicapped, households that live in sub-standard apartments and emergency assignment occur for evicted families. Just to have an insight at the consequences of these assignment criteria, we present some concentration indexes for projects for the key Northern Province of Milan.

For every ex-prisoner living outside public housing, there are four ex-prisoners inside. The percentage of people over 75 is almost two times and an half higher in public housing than elsewhere. The index of concentration of non-EU citizens (mostly from countries such as Morocco, Egypt, Eritrea, etc.) into public housing is 143 and for some project is much higher (Irer, 2004). Overall in the North, for every handicapped outside projects there are 3.24 handicapped inside[10]. In the next subsection we explain how the concentration of these disadvantaged categories might affect children outcomes.

[9] Anecdotal evidence suggests that the bureaucratic regulation of these contracts impeded the expected results.

[10] 1995 SHIW data for Italian families with children and living in the North.

### 1.2.3 Conceptual framework

That fact that close neighbours matter is well documented in the literature (Goux et al., 2007). Projects are a scoially and geographically defined context. There are many ways in which public housing can affect the educational outcomes of children living in there. As a premise we can assume that offspring of disadvantaged families are more susceptible to peer influence. Whereas, children of affluent households might be preserved from the neighborhood environment. The reason is that low-status parents may spend less time than affluent parents in the informal education of their children, leaving more chances for their children to be influenced by the external environment. The role of families as mediators of neighborhoud influence is recognised, for instance, in de Briggs (Souza Briggs, 1997).

The channels through which public housing can affect children achievement can be divided into six groups. The first mechanism is contagion. Contagion may occur in terms of a pure preference: children mimic the (bad) behaviors they see in their neighborhood just because they like it. Children can also be harmed by other peers' behaviors, as in the case of violent peers. In this case peers' contagion is a pure externality: it is not necessary that children deliberately interact with other residents of public housing. Contagion may also indirectly come through the stigma or value attached to particular activities (Souza Briggs, 1997). For instance the cost associated with pursuing a criminal activity is lower the more people in your reference group practice it. Similarly, the lower is the value of schooling for the peers you refer to, the lower will be the stigmatization for not studying.

The second effect comes from adults rather than from peers, the so-called adult role model (Souza Briggs, 1997). Since children in public housing are likely faced with low status workers, unemployed and so on, we can think they will form their expectations, their attitude toward school and work on the basis of the adults they regularly meet.

The effect of public housing could also overlap with the effect of the quality and quantity of local public goods (such as the efficacy of police, the number and quality of schools) in which the projects are located. De Briggs Souza Briggs (1997) defines this mechanism as the institutional model. In this case are the neighborhood characteristics rather than, more narrowly, the projects themselves that affect children outcomes.

On the other hand, a homogeneous environment, as it may be expected within public housing, can provide support and social networks for the people that live in it. While a more heterogeneous environment can induce a competition over scarce resources in which disadvantaged

children would be the losers (Souza Briggs, 1997).

The design of projects itself can be at the origin of young's problems. As Newman (Newman, 1972) writes, the quality of the community depends on the control tenants have on their homes, what he defines as "defensible space". When this control lacks or is weak, the environment becomes a fertile ground for criminal activities and all its consequences. He identifies high-rise apartment building, especially projects, as the socio-physical environments where problems arise. In his paradigm the territorial definition of space defines proprietary feeling, the positioning of windows allows residents to control the exterior environment, the building form and idioms generate the stigma attached people living in certain places, the location of the residential developments with respect to activities has an effect on safety and so on. This is to explain how the design of a building can influence the attitudes of its inhabitants. If his seminal intuition in true, if it can be extended to educational outcomes and if high-rise projects in Italy correspond to a lack of "defensible space", it means that there may be an heterogeneous effect of public housing across projects.

Finally, participation in public housing entails receiving an in kind benefit that, in turn, increases the household's available income. As long as this income relief is devoted to children care and educational expenses, participation in public housing should positively influence children educational attainment.

In the following analysis we will not investigate through which of these mechanisms the effect of public housing (if any) shows up. However, the empirical counterpart will be a balance of all these mechanisms. The effect of the in kind housing subsidy on children educational outcomes is expected to be non-negative. Whether the final coefficient for the effect of public housing will be positive or negative (or null), depends on the balance between the former effect and the combination of all the mechanisms explained above, discounted by the role parents exercise as mediators for neighborhood influence.

## 1.3 Method

The baseline model is an OLS of the effect of public housing participation on children educational outcomes of the form:

$$y_{if} = \alpha_1 + \beta_1 X_{if} + \gamma_1 F_{if} + \delta_1 H_{if} + \varepsilon_1 if \tag{1.1}$$

where $y$ is the educational outcome of child $i$ in family $f$, $X$ is a vector

of individual characteristics (such as age and gender), $F$ is a vector of family characteristics (parents' level of education, household's income, etc.), $H$ is a dummy variable equal to one if family $f$ the child currently lives in public housing and $\varepsilon$ is the individual error term.

However, there is a good reason to believe that project participation is endogenous and hence the OLS coefficient $\delta$ biased. In order to get a slot in a project households have to apply, but not all entitled households apply. Thus, we may expect that applicants are systematically different from non-applicants, also in terms of unobservable characteristics. If more disadvantaged individuals are more likely to apply for public housing and less likely to achieve education, then the coefficient $\delta$ in (1.1) should be upward biased.

We adopt two approaches to tackle the problem of endogeneity: instrumental variable and difference in difference. With the instrumental variable approach we try to get rid of the unobservable determinants of residence in a project by predicting the probability of living in public housing according to some observable characteristics. As identifying characteristic of residence in public housing we choose two alternative variables, that will be further illustrated in next paragraphs. One is having both parents born in the South and the second is having both parents coming from a region different from that of current residence. The sample is restricted to residents in North Italy and properly selected, as explained in the next subsection.

In our application we approximate the probability of living in a project by a linear form, corrected for heteroskedasticity, for ease of the two-step estimation. The first stage is as follows:

$$H_{if} = \chi + \varphi X_{if} + \phi F_{if} + \pi M_{if} + \upsilon_{if} \tag{1.2}$$

where $H$ is a dummy for residence in public housing, $X$ and $F$ are defined as in (1.1) and M is a dummy for migrant parents (from the South or from other regions).
The second stage is:

$$y_{if} = \alpha_2 + \beta_2 X_{if} + \gamma_2 F_{if} + \delta_2 \hat{H}_{if} + \varepsilon_2 if \tag{1.3}$$

where the variables are defined as before.
Partially because of suggestion from the existing literature, partially for technical reasons we also adopt a difference in difference approach. Moreover, the instrumental variable approach can be easily criticized on the ground of the chosen instrument. Thus, we estimate the following model:

$$y_{if} = \alpha_3 + \beta_3 X_{if} + \gamma_3 F_{if} + \delta_3 H_{if} + \zeta R_{if} + \xi H_{if} * R_{if} + \varepsilon_3 if \tag{1.4}$$

where R is a dummy equal to one for high-rise buildings, that is buildings with more than a given number of units.
Although this model does not allow for a causal interpretation of $\delta$, it allows for a causal interpretation of $\xi$. In other words, $\xi$ is the effect of living in a high-rise project on educational outcomes, with respect to children that live in different types of public buildings. However, the causal interpretation of high-rise projects cannot be extended to the more general effect of public housing. That is, the coefficients obtained by instrumental variable and by difference in difference are not directly comparable, as the first is the effect for children that change housing residence due to the instrument and the second is the effect for children that live in (a particular type of) public housing.

### 1.3.1 The choice of the instrument

12.5% of the Southern population resident in Northern Italy lives in public housing, compared to only 3.5% of the local population. From the early 1950s through the early 1970s, 4.3 millions Southern plus about 5.8 millions interregional migrants were looking for an accommodation in the main cities of the North. A massive construction of public housing initiated to address the serious housing shortage.

New and old migrants, generally, may attach a lower stigma than natives of living in public housing, as when they arrive in the new place they have less relatives, friends or acquaintances to compare their social status with. The migration flow during the Italian economic boom was caused by structural deficiencies of the Southern regions and by the endemic poverty of the countryside. We may expect a less selective migration effect in this case that when migration is a subjective and isolated choice. These facts are at the origin of our choice of having parents from the South or from another region as instruments for public housing participation in North Italy.

We define two instruments, that we use separately. The first, from now on SOUTH, is equal to one if both parents of the child were born in the South, or only one in case of single parents. The second, from now on OTHER, takes value one if both parents, or only one in case of single parents, were born in a region different from that of current family residence. In order for these instruments to be relevant and valid, they should be correlated with the probability of living in a project but uncorrelated with the unobservables influencing children educational outcomes.

As for the first requirement, rough descriptive statistics show that the probability of living in a project for children whose parents were born in the South is around three times larger than for children whose parents

were not born in the South. Similarly, children whose parents come from a region different from that of residence have a probability of living in public housing more than two times higher than children with native parents.

The second requirement is more cumbersome. We now provide some theoretical motivations as why this choice could produce an exogenous variation in the treatment, conditional on observable characteristics. If living in public housing was merely due to the aforementioned specific housing shortage, we should not be worry about the validity of our instruments. On the other hand, children of parents with a weaker social network and, hence, attaching a lower stigma of living in public housing could have systematically different educational outcomes. What we believe may cushion the problem in our data, is that the parents we identify as born in the South are, with a high chance, offspring of the economic boom's migrants that we use as identifying determinant of project's residence[11]. Thus, the parents of our children sample may be born in the South (or in a region different than that of residence), emigrated with their parents when they were (very) young and then they may have studied, worked and constructed their social life in the North. A survey of public housing tenants for the Province of Milan, indeed shows that 55.5% of migrants tenant arrived between 1950 and 1970 (Irer, 2004). The "second generation motive" would also reduce the concern about the selectivity of migrants.

If these parents are just the offspring of the 1950s-1970s migrants why should they still have a higher probability of living in public housing than native parents? A possible answer rests on the high intergenerational transmission of homeownership in Italy, even within low-income families. As many former migrants initially moved into projects, their offspring (the parents of our children sample) were likely disadvantaged in homeownership because they did not inherit any property. Being in the rental sector and with a low income increases the probability of applying for public housing. Moreover, intergenerational transmission of public housing apartments is quite common and allowed by Regional Regulations[12].

Still, migrants can have easily been discriminated in a series of aspects. Labour market discrimination can be partially controlled by income. Then, lack of information, for instance about school quality, and

[11] A 25 year-old child in the 2001 Census means that he was born 1976 and his parents most probably in the late 1940s or early 1950s. If his parents arrived in the Northern cities during the massive economic boom's migration (1955-1963), they likely came as offspring of the first generation migrants.

[12] See, for example, Lombardia Regolamento Regionale n.1 10/02/04 Art.20.

dialect differences[13] can be less important for second generation migrants.

The research of Ichino et al. (1999) might cast some doubts on our choice of the instruments. They investigate whether South-born and North-born employees have different preferences with regard to working versus shirking, among other explanations for the North-South shirking differential. They indeed find that to be born in the South increases absenteeism and misconduct. However, for those born in the South[14] and working in the North they find that the effect is much milder, due to a selective migration of low-shirking individuals to the North. In the North, the region of birth makes no significant difference on absenteeism. For our purposes, we should also underly that parents' characteristics, as the unobservables correlated with being born in the South, are not transmitted one to one to children. Moreover, for "second generation" parents the fact of being merely born in the South might not constitute a distinguishing characteristic.

Among other possible critiques are persistent discrimination of migrants, persistence in welfare dependency, etc. This is why we will devote a section for an informal statistical testing of these assumptions.

### 1.3.2 The choice of the high-rise project treatment

The second source of identification of our analysis is the presumed non systematic assignment of public housing applicants to high-rise or medium and low-rise projects[15]. If the allocation of households to these two kind of projects is random or at least uncorrelated with the household's unobservable, by differencing the outcomes of children living in high-rise and those in medium/low-rise buildings we get the causal effect of living in high-rise public housing for recipients. Waiting lists to get a flat into a project are considerably long (a matter of years). Households are assigned to flats according to the available slots in each municipality. These households are ranked according to an index of the accommodation need and the period of residence in the region. Some criterion for the assignment of flats concern the type of the flat and not the type of

[13]Istat data "La lingua italiana, i dialetti e ele lingue straniere" ((2006) show that dialect is used slightly more in the South, even if in Veneto (in the North) the use of dialect is more widespread than in Calabria (that is the Southern region where dialect is most used) but it does not refer to the language spoken at home by migrants.

[14]These migrants moved in the North after being hired. Ichino and Maggi do not have data on migrants before being hired, that could further reduce the role played by the region on birth on the shirking level.

[15]In the US literature high-rise is defined as buildings with more than 75 units.

the building[16]. Rents in public housing are determined according to the household's income and not according to the project's amenities.

We want to test if high-rise can be different from small/medium size projects, for several reasons. For example, Jacob (2004) distinguishes between high-rise and small/medium rise projects and he attach to the first the effects listed in Section 2.3. It may be that the relevant treatment is not public housing in itself, but some specific characteristics of public housing. Table 1.1 shows that projects are generally almost three times bigger than privately owned buildings. As long as peer effects, role models and the formation of social networks are growing as the size of the reference group increases, we can expect that children in high-rise projects suffer a stronger combination of these factors. The hypothesis is that in small/medium rise projects peer effects are not in place or, if they are, they are smaller. Also, in high-rise projects the chance to face all the disadvantaged categories quoted in Section 2.3 is higher than in small scattered project buildings.

The intriguing theory of Newman (1972) identifies in the lack of a community feeling, widespread in high-rise projects, the root of social problems. There are also high-rise private building, but in these the communal spaces are preserved by the economic resources devoted for their cure. Moreover, he notices that project size affects a social variable such as the crime rate.

However, if low-rise projects are located in the center for physical constraints and high-rise projects in the suburb, the effect of public housing could overlap with the effect of local public goods. Further, projects in cities may represent something different than projects elsewhere. Thus, we also restrict the analysis to projects in the nine biggest cities of the North[17], including city size controls.

To sum up, this approach checks whether there are heterogeneous treatment effects and the hypothesis of joint causal and increasing effects of peers, role models, social networks and the existence of a specific project amenities' effect.

## 1.4 The data

We use the Survey of Households and Income Wealth (SHIW) of the Bank of Italy and the 2001 Census of Population and Buildings data.

[16]For example, households with a disable member have priority in the assignment of flats located at the ground floor. The offer of flats should take into account the size of the households and the dimension of the flat.

[17]Milano, Torino, Genova, Bologna, Venezia, Verona, Trieste, Padova and Brescia.

The SHIW contains information either on (self-assessed) public housing participation[18] either on attained education. It also asks for a self-assessment of the neighborhood where households live (center, suburbs, hills). The Public Use Microdata Census contains information on public housing participation[19] and educational outcomes but it does not display the area of birth of the parents and the exact age of the children. Hence, we had to switch to the original Census data-set, only available at the Italian Statistical Office. This partially constrained our analysis.

We pooled the 1995, 1998, 2000, 2002 and 2004 SHIW waves and it turned out that sample size was still too small. We tried however to perform part of the analysis also with the SHIW data, but we restricted it to two educational outcomes: early school drop-out and years of schooling. We also used the SHIW data to impute parents' income (missing) in the Census. With the original Census we could implement the selection of a proper sample size, free of attrition bias. First, we were able to get a considerable sample of 14 year-old to use grade repetition as an outcome variable. Then, we could get a considerable number of children evading compulsory schooling in order to use evasion as one of the educational outcomes. Also, in the original Census data-set there is information on the number of units per building so that we could apply the difference in difference strategy.

We measure educational attainment by four outcome variables: grade repetition, school evasion, early drop-out and years of education. The questionnaires did not directly ask if the child was held back or skipped school. Notwithstanding, we could recover grade repetition and school evasion by matching age, maximum educational attainment and school enrollment. Grade repetition is a dummy equal to one if the child failed at least once during lower secondary schooling. School evasion is equal to one if the child did not complete lower secondary schooling. Early school evasion takes value one if the child has no more than lower secondary schooling and he is not enrolled in formal education.

In order for the SOUTH instrument to have a meaning and the sample to be homogeneous we restrict the analysis to children having non foreign parents aged 18-25 (18-29 with the SHIW for sample size reasons), born and living in North Italy[20]. As the original Census data-set contains information on the whole Italian population we could refine our

[18]Residence in public housing is defined as when the owner of the rented flat is a Public Housing Agency, the Municipality, the Province or the Region.

[19]Residence in public housing is defined as when the owner of the rented flat is a Public Housing Agency.

[20]Piemonte, Valle d'Aosta, Lombardia, Trentino Alto Adige, Veneto, Friuli Venezia-Giulia, Liguria and Emilia-Romagna.

sample construction. We first selected families with at least one offspring aged 14 or between 18 and 25. Then, we dropped all families living in municipalities where there are no other families in the sample living in public housing and families with overall income above 98.600 euro. Finally, we drew a random sample of families stratified by municipality and residence in public housing. For both the pooled SHIW and the final Census the sample consists of children. With the Census data the analysis is separated for male and female. This was not possible for the SHIW due to the small sample size.

The relevant sample changes according to the outcome variable. For grade repetition we use the sample of 14 year-old, as repetition in primary school is no more allowed in Italy. For school evasion the age range is 18-24, as well as for early school drop-out. For years of education is 24-25 in the Census and 24-29 in the pooled SHIW, as (on average) the minimum expected age to complete tertiary education is 24. We would like to cut the sample below 29 year-old to avoid the selection problem of offspring still living with their parents, but this was only possible with the bigger size of the Census sample.

### 1.4.1 Descriptive statistics

Table 1.1 shows mean values of family characteristics for boys aged 18-24 living in public housing and non, both for the Census and the SHIW data.

Apart from the striking sample size difference of the Census and the SHIW, the two samples are very similar. Descriptive statistics for children of different ages are very similar (not reported). The comparison between columns 1-3 and 2-4 confirms that households living in a project are, on average, disadvantaged on a series of observable characteristics, in particular income, level of education and migrant status. The difference in family income is smaller for the Census, partly because in that sample we exclude families with income above 98.600 euro, partly because income is imputed.

In both data-sets the only difference between the male and female sample is in the educational outcomes, as shown by Table 1.2. Female acquire generally more education and are less likely to fail a grade or skip compulsory schooling. But is the within gender gross educational gap for children living in public housing and non that is worrisome. When considering offspring of low educated households, the difference between the educational outcomes of children living in public housing and non remains high.

Table 1.1 shows that children living in public housing have a proba-

Table 1.1: Variable means (standard deviations) for male aged 18-24 by residence in public housing

| | CENSUS | | SHIW | |
|---|---|---|---|---|
| | ph=0 | ph=1 | ph=0 | ph=1 |
| parents' age at birth | 29.3106 | 28.4881 | 29.1372 | 29.0909 |
| | (5.2545) | (6.2062) | (5.1054) | (5.9427) |
| log family income | 10.4396 | 10.0736 | 10.3177 | 9.2436 |
| | (0.4827) | (0.6240) | (0.8051) | (1.9720) |
| parents' education | 8.7751 | 6.5887 | 9.4404 | 7.4545 |
| | (3.2372) | (2.4676) | (3.5987) | (3.2988) |
| single mum | 0.1029 | 0.2476 | 0.1138 | 0.2364 |
| single dad | 0.0304 | 0.0426 | 0.0202 | 0.0182 |
| n. family members | 3.8040 | 3.8349 | 3.7883 | 3.7818 |
| | (0.9407) | (1.1792) | (0.9143) | (1.1497) |
| n. units in building | 12.8686 | 33.3122 | | |
| | (22.9813) | (36.5389) | | |
| high-rise building | 0.0252 | 0.1034 | | |
| SOUTH | 0.1242 | 0.3539 | 0.1138 | 0.2545 |
| OTHER | 0.1787 | 0.4135 | 0.1691 | 0.2909 |
| N | 346832 | 17306 | 940 | 55 |

Standard deviations for binary variables are omitted. "ph=0" stands for residence outside public housing, "ph=1" for residence in public housing.

bility to repeat a grade two times higher than children living outside . Even if school evasion is very low in the North, it affects kids living in a project around three and a half times more. The percentage of young that ends schooling after primary education is higher for residents in public housing, by 20% and 50% for male and female, respectively. Not surprisingly, young living in a project have about 1.4 for male and 1.6 for female years of education less than the other young with low educated

parents.

Table 1.2: Educational outcomes by gender and residence in public housing, for children with low educated parents

| | CENSUS | | | |
|---|---|---|---|---|
| | male ph=0 | male ph=1 | female ph=0 | female ph=1 |
| failure | 0.2448 | 0.4157 | 0.1364 | 0.2553 |
| N | 6470 | 753 | 5867 | 701 |
| sample | 14 year-old | | | |
| evasion | 0.0171 | 0.0605 | 0.0076 | 0.0281 |
| N | 119370 | 10282 | 106553 | 8724 |
| sample | 18-24 year-old | | | |
| early school leaver | 0.5157 | 0.6649 | 0.2601 | 0.5219 |
| N | 119370 | 10282 | 106553 | 8724 |
| sample | 18-24 year-old | | | |
| years of education | 10.4372 | 9.0519 | 11.4215 | 9.8844 |
| sd | (2.613) | (2.467) | (2.464) | (2.718) |
| N | 49821 | 3902 | 40242 | 2886 |
| sample | 24-25 year-old | | | |

Low educated parents are parents with, on average, less or equal than 6.6 years of education. Standard deviations for binary outcomes are omitted. Census data.

Children with migrant parents differ from those with native parents in some observable characteristics (not reported). Migrant parents have generally less education, among them there are more single mothers, they live more often in big cities and in (private or public) high-rise buildings. The offspring of migrant parents also have a lower educational level.

Concerning the social composition of high-rise and low/medium rise public housing the only difference is in the percentage of migrants and in the concentration in big cities, higher in the first category (not reported). The fact that many migrants live in high-rise building is because they mainly live in big cities, where these building are more common.

## 1.5 Results

### 1.5.1 OLS estimates of the effect of project participation

A simple regression of educational outcomes on participation into public housing suggests a strong, significant and unfavorable correlation, even with a series of meaningful controls. Notably, a similar exercise with US data yields no significant results and public housing is even slightly correlated with a reduction in grade retention (Currie et al., 2000) and an increase in high school completion and years of education (Newman et al., 1999).

Table 1.3 shows that participation in public housing significantly reduces education by 1.2-1.3 years. Table 1.4 shows the coefficients for all educational outcomes: all cases point to a significantly unfavorable and sizeable effect of residence in a project.

We may suspect that participation in public housing is correlated with some unobservables that determine educational outcomes and thus, the coefficient of public housing to be biased. In what follows, we will try to recover the causal effect of public housing with the instrumental variable and the difference in difference approach.

### 1.5.2 2SLS estimates

Table 1.5 shows an example of the first stage of our instrumental variable estimation. The instrument SOUTH is the major determinant of public housing participation together with household's income, both in the Census and the SHIW data. Table 1.6 summarizes the results of the first stage for the two instruments and the different age samples of children. Both SOUTH and OTHER are always highly significant and considerable in magnitude with respect to other family characteristics, at least in the Census[21]. Overall, households with both parents born in the South are more likely to live in a project with respect to households with two, non necessary Southern, interregional migrant parents.

Table 1.5.2 reports the 2SLS results obtained for all outcome variables and with both instruments. All specifications point to an unfavorable effect of residence in public housing on educational attainment. Whereas this effect is always significant with the Census data it is not with the SHIW. Again, this may be due to the high standard errors in the latter.

[21]The lack of significance of the instrument OTHER and the rather weak F-statistics for the instruments with the SHIW data are to be attributed to the high standard errors due to the small sample size.

Table 1.3: OLS for years of education

| | CENSUS | | SHIW |
|---|---|---|---|
| | male | female | all |
| *dependent variable* | *years of education* | | |
| public housing | -1.2142** | -1.3134** | -1.2806** |
| | (0.0349) | (0.0468) | (0.3806) |
| male | | | -0.8661** |
| | | | (0.1518) |
| age | 0.1481** | 0.2373** | 0.0967* |
| | (0.0144) | (0.0171) | (0.0450) |
| parents' age at birth | 0.0429** | 0.0295** | 0.0554** |
| | (0.0016) | (0.0016) | (0.0145) |
| log family income | 0.2028** | 0.2749** | 0.7129** |
| | (0.0235) | (0.0248) | (0.1438) |
| parents' education | 0.3121** | 0.2546** | 0.2939** |
| | (0.0031) | (0.0035) | (0.0248) |
| single mum | -0.5074** | -0.4095** | (0.3339) |
| | (0.0329) | (0.0335) | (0.2630) |
| single dad | -0.8362** | -0.7824** | -0.9963** |
| | (0.0469) | (0.0455) | (0.3664) |
| n. family members | -0.1812** | -0.2224** | 0.0169 |
| | (0.0093) | (0.0103) | (0.0867) |
| constant | 2.6718** | 1.5169** | (0.7860) |
| | (0.4188) | (0.4590) | (1.9007) |
| adjusted R-squared | 0.1851 | 0.1554 | 0.2591 |
| N | 115238 | 96397 | 1419 |
| sample | 24-25 year-old | 24-25 year-old | 24-29 year-old |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Standard errors are clustered by family. Other control variables not shown in the table are dummies for city size and waves' dummies for Shiw. Income values are in 2006 euros, in Census are predicted with Shiw data.

Before discussing more in detail the results, it might be useful to have a look at the choice of our instruments, as these strong findings might cast

some doubts.

Table 1.4: Baseline public housing coefficients

| | CENSUS | | SHIW |
|---|---|---|---|
| | male | female | all |
| ph effect on *failure* | 0.1607** | 0.0920** | |
| se | (0.0118) | (0.0102) | |
| adjusted R-squared | 0.0658 | 0.0357 | |
| N | 43278 | 40572 | |
| ph effect on *evasion* | 0.0276** | 0.0114** | |
| se | (0.0019) | (0.0014) | |
| adjusted R-squared | 0.0170 | 0.0089 | |
| N | 364665 | 332559 | |
| ph effect on *early school leaver* | 0.1922** | 0.2087** | 0.1440** |
| se | (0.0042) | (0.0055) | (0.0528) |
| adjusted R-squared | 0.1398 | 0.1061 | 0.1796 |
| N | 364665 | 332559 | 1919 |
| ph effect on *years of education* | -1.2142** | -1.3134** | -1.2806** |
| se | (0.0349) | (0.0468) | (0.3806) |
| adjusted R-squared | 0.1851 | 0.1554 | 0.2591 |
| N | 115238 | 96397 | 1419 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Control variables are as in Table 1.3. Standard errors are clustered by family. The coefficients reported in the Table correspond to $\delta$ in equation (1.1).

Table 1.5: First stage with SOUTH as IV on sample aged 18-24

| | CENSUS | | SHIW |
|---|---|---|---|
| | male | female | all |
| *dependent variable* | *residence in public housing* | | |
| SOUTH | 0.0613** | 0.0614** | 0.0466** |
| | (0.0011) | (0.0011) | (0.0175) |
| male | | | -0.0071 |
| | | | (0.0102) |
| age | -0.0004* | -0.0014** | -0.0053* |
| | (0.0002) | (0.0002) | (0.0026) |
| parents' age at birth | -0.0006** | -0.0007** | -0.0018 |
| | (0.0001) | (0.0001) | (0.0010) |
| log family income | -0.0340** | -0.0282** | -0.0680** |
| | (0.0010) | (0.0010) | (0.0063) |
| parents' education | -0.0081** | -0.0080** | -0.0038* |
| | (0.0001) | (0.0001) | (0.0016) |
| single mum | 0.0432** | 0.0443** | 0.0349† |
| | (0.0015) | (0.0015) | (0.0183) |
| single dad | 0.0254** | 0.0216** | 0.0094 |
| | (0.0021) | (0.0022) | (0.0391) |
| n. family members | 0.0106** | 0.0102** | 0.0127* |
| | (0.0004) | (0.0004) | (0.0062) |
| constant | 0.4667** | 0.4236** | 0.9130** |
| | (0.0101) | (0.0103) | (0.0962) |
| adjusted R-squared | 0.0577 | 0.0553 | 0.1101 |
| F-test | 1489.3200 | 1299.3900 | 15.8300 |
| N | 364665 | 332559 | 1919 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Other control variables not shown in the table are dummies for city size and waves' dummies for SHIW. Income values are in 2006 euro, in Census are predicted with SHIW data.

Table 1.6: First stage coefficients

| | CENSUS | | SHIW |
|---|---|---|---|
| | male | female | all |
| SOUTH on *ph* | 0.0607** | 0.0583** | |
| se | (0.0031) | (0.0031) | |
| F-statistics | 395.2144 | 348.5689 | |
| sample | 14 year-old | | |
| SOUTH on *ph* | 0.0613** | 0.0614** | 0.0466** |
| se | (0.0011) | (0.0011) | (0.0175) |
| F-statistics | 3384.9124 | 3199.0336 | 7.0800 |
| sample | 18-24 year-old | | |
| SOUTH on *ph* | 0.0654** | 0.0615** | 0.0520* |
| se | (0.0019) | (0.0020) | (0.0207) |
| F-statistics | 1149.2100 | 914.4576 | 6.3200 |
| sample | 24-25 year-old | | 24-29 year-old |
| OTHER on *ph* | 0.0480** | 0.0454** | |
| se | (0.0027) | (0.0027) | |
| F-statistics | 327.6100 | 278.5561 | |
| sample | 14 year-old | | |
| OTHER on *ph* | 0.0458** | 0.0466** | 0.0212 |
| se | (0.0009) | (0.0009) | (0.0147) |
| F-statistics | 2496.0016 | 2462.1444 | 2.0600 |
| sample | 18-24 year-old | | |
| OTHER on *ph* | 0.0466** | 0.0451** | 0.0436** |
| se | (0.0016) | (0.0017) | (0.0168) |
| F-statistics | 804.8569 | 683.2996 | 6.7200 |
| sample | 24-25 year-old | | 24-29 year-old |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Control variables are as in Table 1.5. Reported F-tests are for the instrument. The coefficients in the Table correspond to $\pi$ in equation (1.2).

Table 1.7: 2SLS coefficients

| | CENSUS | | | | SHIW | |
|---|---|---|---|---|---|---|
| | IV:SOUTH male | IV:SOUTH female | IV:OTHER male | IV:OTHER female | IV:SOUTH all | IV:OTHER all |
| ph effect on *failure* | 0.5575** | 0.6019** | 0.6666** | 0.6989** | | |
| se | (0.1237) | -0.0978 | (0.1312) | (0.1120) | | |
| N | 43278 | 40572 | 43278 | 40572 | | |
| ph effect on *evasion* | 0.1126** | 0.0179* | 0.1370** | 0.0430** | | |
| se | (0.0166) | (0.0087) | (0.0180) | (0.0099) | | |
| N | 364665 | 332559 | 364665 | 332559 | | |
| ph effect on *early school leaver* | 1.3827** | 1.1537** | 1.4897** | 1.2416** | 2.1116 | 2.8495 |
| se | (0.0986) | (0.0893) | (0.1051) | (0.0953) | (1.4930) | (2.9896) |
| N | 364665 | 332559 | 364665 | 332559 | 1919 | 1919 |
| ph effect on *years of education* | -7.4458** | -7.3130** | -7.4273** | -7.8012** | -8.4897 | -9.9716 |
| se | (0.5938) | (0.7069) | (0.6495) | (0.7520) | (6.9495) | (7.3909) |
| N | 115238 | 96397 | 115238 | 96397 | 1419 | 1419 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Standard errors are clustered by family in second stage. The coefficients in the Table correspond to $\delta$ in equation (1.3).

**Informal tests on the validity of the instruments**

The 2SLS results rely on the fact that having both parents born in the South or, more in general, migrants is not a determinant of school outcomes, once controlling for observable characteristics. We perform three different informal tests to check the credibility of our results.

The first test is as in (Evans et al., 1995) and consists in estimating a single equation model with both the endogenous variable and the instrument. That is:

$$y_{if} = \mu_1 + \nu_1 X_{if} + \lambda_1 F_{if} + \theta H_{if} + \rho M_{if} + \eta_{if} \tag{1.5}$$

Columns 3 and 6 of Table 1.8 show this test for the instrument SOUTH on the probability to repeat a grade during the last cycle of compulsory schooling. For failure, the SOUTH instrument does not seem to be truly uncorrelated with the unobservables driving the probability to fail a grade. Columns 3, 6 and 9 in Table 1.9 and 1.10 summarize the results for the effect of the instrument on all outcome variables, given participation in public housing. According to this informal test, only in one case the instrument seems to be uncorrelated with the outcome variable: for the probability of not completing compulsory schooling for female[22]. However, if the correct specification of the model is a 2SLS model, then the single-equation model and hence this test is misspecified, but still interesting.

To support and check the reliability of these results we also use a slightly different test. We regress the outcome variables on the instrument, separated for children living in public housing and not living in public housing. That is:

$$y_{if} = \mu_2 + \nu_2 X_{if} + \lambda_2 F_{if} + \psi M_{if} + \omega_{if} \qquad for H_{if} = k \tag{1.6}$$

where $k$ takes value 1 for residents in public housing and 0 for the others.

Columns 1-2 and 4-5 of Table 1.8 show an example. For grade repetition, having both parents from the South seems to matter just for people not living in public housing (but it is likely due to higher standard errors in the public housing sample). In this way, we could avoid the problem of misspecification and the correlation between participation in public housing and households with non-native parents. In other words, this second test gets rid of the spurious effect caught by the coefficient on the "instrument" through participation in a project.

[22]For years of acquired education with SHIW data, the standard errors are too high to exclude this possibility.

Table 1.8: Test for the effect of SOUTH on failure

| | male ph=0 | male ph=1 | male full | female ph=0 | female ph=1 | female full |
|---|---|---|---|---|---|---|
| SOUTH | 0.0304** | -0.0350 | 0.0243** | 0.0339** | -0.0139 | 0.0300** |
| | (0.0066) | (0.0275) | (0.0068) | (0.0051) | (0.0228) | (0.0052) |
| parents' age at birth | -0.0033** | -0.0026 | -0.0032** | -0.0017** | -0.0015 | -0.0016** |
| | (0.0004) | (0.0023) | (0.0004) | (0.0004) | (0.0017) | (0.0003) |
| log family income | -0.0003 | 0.0409 | 0.0031 | -0.0096* | -0.0569* | -0.0133** |
| | (0.0052) | (0.0253) | (0.0052) | (0.0045) | (0.0229) | (0.0046) |
| parents' education | -0.0200** | -0.0265** | -0.0202** | -0.0098** | -0.0237** | -0.0100** |
| | (0.0007) | (0.0050) | (0.0007) | (0.0005) | (0.0047) | (0.0005) |
| single mum | 0.0691** | 0.0736† | 0.0687** | 0.0357** | 0.0462 | 0.0359** |
| | (0.0084) | (0.0381) | (0.0085) | (0.0066) | (0.0332) | (0.0067) |
| single dad | 0.1037** | 0.0862 | 0.1024** | 0.0425** | 0.0585 | 0.0436** |
| | (0.0148) | (0.0742) | (0.0145) | (0.0114) | (0.0733) | (0.0117) |
| n. family members | 0.0214** | 0.0490** | 0.0229** | 0.0127** | 0.0319** | 0.0141** |
| | (0.0021) | (0.0111) | (0.0020) | (0.0018) | (0.0093) | (0.0017) |
| public housing | | | 0.1571** | | | 0.0876** |
| | | | (0.0119) | | | (0.0102) |
| constant | 0.3266** | 0.8437** | 0.3499** | 0.2685** | 0.8755** | 0.3025** |
| | (0.0468) | (0.2352) | (0.0471) | (0.0403) | (0.2186) | (0.0410) |
| adjusted R-squared | 0.0495 | 0.0297 | 0.0663 | 0.0262 | 0.0351 | 0.0369 |
| N | 41494 | 1784 | 43278 | 38909 | 1663 | 40572 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Standard errors are clustered by family. Other control variables not shown in the table are dummies for city size. Census data only. Columns 1-2 and 4-5 correspond to equation (1.6), columns 3 and 6 to equation (1.5).

Table 1.9: Informal tests for SOUTH IV

| | CENSUS | | | | | | SHIW | | |
|---|---|---|---|---|---|---|---|---|---|
| | male ph=0 | male ph=1 | male full | female ph=0 | female ph=1 | female full | all ph=0 | all ph=1 | all full |
| SOUTH on *failure* | 0.0304** | -0.0350 | 0.0243** | 0.0339** | -0.0139 | 0.0300** | | | |
| se | (0.0066) | (0.0275) | (0.0068) | (0.0051) | (0.0228) | (0.0052) | | | |
| N | 41494 | 1784 | 43278 | 38909 | 1663 | 40572 | | | |
| SOUTH on *evasion* | 0.0044** | 0.0099* | 0.0053** | -0.0002 | 0.0039 | 0.0004 | | | |
| se | (0.0008) | (0.0045) | (0.0009) | (0.0005) | (0.0031) | (0.0005) | | | |
| N | 347343 | 17322 | 364665 | 317657 | 14902 | 332559 | | | |
| SOUTH on *early* | 0.0754** | 0.0482** | 0.0737** | 0.0584** | 0.0453** | 0.0586** | 0.1083** | -0.0226 | 0.0920* |
| se | (0.0033) | (0.0091) | (0.0032) | (0.0035) | (0.0124) | (0.0038) | (0.0379) | (0.1177) | (0.0363) |
| N | 347343 | 17322 | 364665 | 317657 | 14902 | 332559 | 1806 | 113 | 1919 |
| SOUTH on *years* | -0.4319** | -0.2153** | -0.4114** | -0.3863** | -0.2067* | -0.3722** | -0.3567 | -0.2013 | -0.3765 |
| se | (0.0257) | (0.0715) | (0.0241) | (0.0289) | (0.0925) | (0.0290) | (0.2731) | (1.2962) | (0.2657) |
| N | 109651 | 5587 | 115238 | 92166 | 4231 | 96397 | 1342 | 77 | 1419 |

Estimation of the coefficients is as in Table 1.8. Columns 1,2,4,5,6 and 8 correspond to the coefficient $\psi$ in equation (1.6), columns 3,6 and 9 to the coefficient $\rho$ in equation (1.5).

Table 1.10: Informal tests for OTHER IV

| | CENSUS | | | | | | SHIW | | |
|---|---|---|---|---|---|---|---|---|---|
| | male ph=0 | male ph=1 | male full | female ph=0 | female ph=1 | female full | all ph=0 | all ph=1 | all full |
| OTHER on *failure* | 0.0295** | -0.0364 | 0.0245** | 0.0316** | -0.0205 | 0.0277** | | | |
| sd | (0.0054) | (0.0261) | (0.0056) | (0.0044) | (0.0222) | (0.0043) | | | |
| N | 41494 | 1784 | 43278 | 38909 | 1663 | 40572 | | | |
| OTHER on *evasion* | 0.0044** | 0.0096* | 0.0050** | 0.0010* | 0.0060* | 0.0015** | | | |
| sd | (0.0006) | (0.0041) | (0.0007) | (0.0004) | (0.0029) | (0.0004) | | | |
| N | 347343 | 17322 | 364665 | 317657 | 14902 | 332559 | | | |
| OTHER on *early* | 0.0607** | 0.0401** | 0.0598** | 0.0482** | 0.0396** | 0.0485** | 0.0686* | -0.0460 | 0.0573* |
| sd | (0.0028) | (0.0088) | (0.0028) | -0.0029 | -0.0112 | (0.0031) | (0.0285) | (0.1116) | (0.0278) |
| N | 347343 | 17322 | 364665 | 317657 | 14902 | 332559 | 1806 | 113 | 1919 |
| OTHER on *years* | -0.3051** | -0.1207 | -0.2919** | -0.3010** | -0.1910* | -0.2945** | -0.3783 | 0.1986 | -0.3804 |
| sd | (0.0226) | (0.0737) | (0.0216) | (0.0238) | (0.0864) | (0.0236) | (0.2390) | (1.1002) | (0.2322) |
| N | 109651 | 5587 | 115238 | 92166 | 4231 | 96397 | 1342 | 77 | 1419 |

Estimation of the coefficients is as in Table 1.8. Columns 1,2,4,5,6 and 8 correspond to the coefficient $\psi$ in equation (1.6), columns 3,6 and 9 to the coefficient $\rho$ in equation (1.5).

Table 1.11: Informal test for the household's discount rate

| *dependent variable* | *discount rate* | |
|---|---|---|
| SOUTH | 0.0091 | |
| | (0.0074) | |
| OTHER | | 0.0039 |
| | | (0.0065) |
| male | 0.0093* | 0.0094* |
| | (0.0046) | (0.0046) |
| age | -0.0005 | -0.0005 |
| | (0.0007) | (0.0007) |
| parents' age at birth | -0.0002 | -0.0002 |
| | (0.0005) | (0.0005) |
| log family income | -0.0068* | -0.0072* |
| | (0.0031) | (0.0031) |
| parents' education | -0.0009 | -0.0009 |
| | (0.0007) | (0.0007) |
| single mum | 0.0129 | 0.0124 |
| | (0.0084) | (0.0084) |
| single dad | -0.0147 | -0.0152 |
| | (0.0140) | (0.0140) |
| n. family members | -0.0057† | -0.0057† |
| | (0.0029) | (0.0029) |
| constant | 0.1800** | 0.1859** |
| | (0.0437) | (0.0433) |
| adjustedR-squared | 0.0448 | 0.0435 |
| N | 846 | 846 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Other control variables not shown in the table are dummies for city size. 2004 wave of SHIW data.

Columns 1-2, 4-5 and 7-8 of Table 1.9 and 1.10 summarize the results. As in the previous informal test, the correlation between the instrument and the unobservables that determine school attainment is negligible only for female school evasion with SOUTH as an instrument. The effect of SOUTH or OTHER on failure goes in opposite directions for the two subsamples of children (living and not living in a project).

On the other hand, an additional test performed with the 2004 SHIW data shows that there is no correlation between the household's head discount rate and the variables SOUTH or OTHER. The discount rate may be an important factor in explaining parents' investments in their children education. We recover the discount rate from a question asking how much the head of the household would have been available to renounce in order to get immediately a premium[23]. We then assign its value to his child and regress it on the same set of control variables as in all other regressions. Table 1.11 shows the results of this test. The estimates are from an OLS regression of the discount rate on the usual control variables, plus those we use as instruments in our 2SLS approach.

To sum up, most 2SLS coefficients are probably biased (upward for grade repetition, school evasion and early school leavers and downward for years of education) by the correlation between the instrument and the unobservable determining the educational outcomes[24]. However, for female school evasion the SOUTH instrument seems to be more credible. In this case, the 2SLS coefficient is significant and bigger than the OLS one, suggesting that OLS underestimates the ghetto effect of public housing. Also, if we believe the bias is reduced for the outcome of grade repetition, we still find an unfavorable and significant effect of public housing.

### 1.5.3 Difference in difference estimates

As a last step to identify the causal effect of a specific type of public housing, Table 1.12 shows the estimates of equation (1.4) for boys. The effect of living in a high-rise project on school attainment is generally unfavorable for boys and also significant for early school drop-out and, at the 10% significance level, for years of education. Table 1.13 summarizes the results with different definitions of high-rise buildings[25] and for both genders. Three facts are worth notice about Table 1.13. First, the effect of project's size seems to be non linear. Second, high-rise projects seem to be more beneficial for girls than for boys. Last, the effect of big projects on school evasion is negative for all gender-size combinations, thought it is only significant for female living in projects with more than 75 units

[23] See Appendix for the derivation.

[24] Another reason could be the imprecision of the imputation of family income. If migrants were discriminated in the labour market, for example on the wage level, the wrong imputed income would distort the effect of being the offspring of a migrant family. Indeed, in Table 1.3 family income has much less explanatory power in the Census than in the SHIW.

[25] High-rise buildings are defined as buildings with more than 20, 50 and 75 units.

and it is generally a small effect. Pherhaps, social control is higher in bigger buildings and, probably, especially for girls. Table 1.15 shows that the number of units in the project has a linear, yet small and rather weak, effect only on grade failure, both for boys and for girls.

Table 1.12: Coefficients of high-rise (20) public housing on male

| *dependent variable* | *fail* | *evasion* | *early leaver* | *years of edu* |
|---|---|---|---|---|
| high-rise (20) ph | 0.0211 | -0.0025 | 0.0210* | -0.1300† |
| | (0.0228) | (0.0041) | (0.0082) | (0.0711) |
| high-rise (20) | 0.0155** | 0.0022** | 0.0109** | -0.0445† |
| | (0.0043) | (0.0006) | (0.0028) | (0.0233) |
| public housing | 0.1454** | 0.0283** | 0.1784** | 0.0000 |
| | (0.0171) | (0.0024) | (0.0056) | (0.0000) |
| age | | 0.0002 | 0.0028** | 0.1479** |
| | | (0.0001) | (0.0004) | (0.0144) |
| parents'age at birth | -0.0032** | -0.0001* | -0.0079** | 0.0428** |
| | (0.0004) | (0.0000) | (0.0002) | (0.0016) |
| log family income | -0.0024 | -0.0073** | -0.0178** | 0.2028** |
| | (0.0052) | (0.0008) | (0.0029) | (0.0235) |
| parents'education | -0.0206** | -0.0022** | -0.0443** | 0.3120** |
| | (0.0007) | (0.0001) | (0.0005) | (0.0031) |
| single mum | 0.0706** | 0.0076** | 0.1015** | -0.5076** |
| | (0.0084) | (0.0010) | (0.0036) | (0.0329) |
| single dad | 0.1054** | 0.0147** | 0.1557** | -0.8367** |
| | (0.0145) | (0.0016) | (0.0047) | (0.0469) |
| n. family members | 0.0234** | 0.0059** | 0.0323** | -0.1817** |
| | (0.0020) | (0.0004) | (0.0010) | (0.0092) |
| constant | 0.3430** | 0.0796** | 0.8648** | 2.6908** |
| | (0.0471) | (0.0079) | (0.0321) | (0.4187) |
| adjustedR-squared | 0.0661 | 0.0170 | 0.1399 | 0.1851 |
| N | 43278 | 364665 | 364665 | 115238 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Standard errors are clustered by family. Other control variables not shown in the table are dummies for city size. Census data only.

By restricting the analysis to the nine biggest cities in the North, living in a high-rise projects significantly and positively increases the probability of failure for female (with the 20 units cut-off) and early school drop-out for male (with the 50 units cut-off). Table 1.14 reports the results.

There is no clear cut evidence of an heterogeneous treatment effect of public housing. However, living in a high-rise project appear to have a more adverse effect on boys than for girls. For female, this effect is particularly strong in big cities on the chance of grade repetition.

Table 1.13: Coefficients of high-rise public housing by high-rise dimension and gender

| | male | | | female | | |
|---|---|---|---|---|---|---|
| dimension high-rise | HR20 | HR50 | HR75 | HR20 | HR50 | HR75 |
| high-rise ph on *failure* | 0.0211 | 0.0100 | 0.0331 | 0.0213 | 0.0208 | 0.0217 |
| se | (0.0228) | (0.0303) | (0.0382) | (0.0209) | (0.0292) | (0.0384) |
| N | 43278 | | (14 year-old) | | 40572 | |
| high-rise ph on *evasion* | -0.0025 | -0.0056 | -0.0134 | -0.0031 | -0.0046 | -0.0085† |
| se | (0.0041) | (0.0052) | (0.0069) | (0.0025) | (0.0036) | (0.0051) |
| N | 362665 | | (18-24 year-old) | | 332559 | |
| high-rise ph on *early leaver* | 0.0210* | 0.0076 | 0.0005 | 0.0076 | -0.0240 | -0.0205 |
| se | (0.0082) | (0.0099) | (0.0115) | (0.0102) | (0.0131) | (0.0139) |
| N | 362665 | | (18-24 year-old) | | 332559 | |
| high-rise ph on *years of education* | -0.1300† | -0.0446 | 0.0068 | -0.0762 | 0.1673 | 0.1991 |
| se | (0.0711) | (0.0960) | (0.1085) | (0.0887) | (0.1081) | (0.1508) |
| N | 115238 | | (24-25 year-old) | | 96397 | |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. "HR20", "HR50" and "HR75" define high-rise buildings with, respectively, more than 20, 50 and 75 units. The coefficients in the Table correspond to $\xi$ in equation(1.4). Census data only.

Table 1.14: Coefficients of high-rise public housing by high-rise dimension and gender, in big cities

| | male | | | female | | |
|---|---|---|---|---|---|---|
| dimension high-rise | HR20 | HR50 | HR75 | HR20 | HR50 | HR75 |
| high-rise ph on *failure* | -0.0606 | 0.0178 | 0.0493 | 0.1292** | 0.0238 | 0.0379 |
| se | (0.0440) | (0.0433) | (0.0481) | (0.0271) | (0.0547) | (0.0515) |
| N | 6739 | | (14 year-old) | | 6427 | |
| high-rise ph on *evasion* | -0.0088 | 0.0029 | 0.0008 | 0.0022 | 0.0074 | 0.0081 |
| se | (0.0093) | (0.0085) | (0.0097) | (0.0050) | (0.0052) | (0.0067) |
| N | 54600 | | (18-24 year-old) | | 50706 | |
| high-rise ph on *early leaver* | 0.0263 | 0.0321* | 0.0072 | -0.0257 | -0.0324 | 0.0051 |
| se | (0.0185) | (0.0142) | (0.0126) | (0.0220) | (0.0203) | (0.0192) |
| N | 54600 | | (18-24 year-old) | | 50706 | |
| high-rise ph on *years of education* | 0.0261 | -0.0013 | 0.0090 | 0.1061 | 0.0838 | 0.0147 |
| se | (0.1790) | (0.1658) | (0.1405) | (0.1349) | (0.1381) | (0.1824) |
| N | 17784 | | (24-25 year-old) | | 15370 | |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. "HR20", "HR50" and "HR75" define high-rise buildings with, respectively, more than 20, 50 and 75 units. The coefficients in the Table correspond to $\xi$ in equation(1.4). Big cities are Milano, Torino, Genova, Bologna, Venezia, Verona, Trieste, Padova and Brescia. City size controls are included. Census data only.

Table 1.15: Coefficients for the number of units of public housing by gender, in big cities

| | male | female |
|---|---|---|
| n. of units of ph on *failure* | 0.0008† | 0.0006† |
| se | (0.0004) | (0.0004) |
| sample | 14 year-old | |
| n. of units of ph on *evasion* | 0.0000 | 0.0001 |
| se | (0.0001) | (0.0001) |
| sample | 18-24 year-old | |
| n. of units of ph on *early school leaver* | 0.0003 | 0.0001 |
| se | (0.0002) | (0.0002) |
| sample | 18-24 year-old | |
| n. of units of ph on *years of education* | -0.0012 | -0.0002 |
| se | (0.0014) | (0.0015) |
| sample | 24-25 year-old | |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. The number of units is a continuos variable. Census data only.

## 1.6 Robustness checks

We adopted several checks to control the reliability of our analysis. First, we support the SHIW analysis with Census data. On the one hand, the Census sample is huge and attrition-free. On the other, household's income is not as precise as in the SHIW, were income is not imputed. Moreover, the findings of the informal tests reported in the previous pages led us to resize our 2SLS results. To address this drawback and to test a different specification of the treatment we also performed a difference in difference estimation.

We added three last checks to this analysis. Firstly, we estimate probit and bivariate probit to assess if our findings are driven by the choice of a linear probability model and we find that this is not the case. The coefficients obtained generally retain the sign and significance as in the linear approximation. Second, we tried a different definition of both instruments. As we suspected that parents married with people from the

same (macro) area might be sistematically different from other parents, we redefine the instruments as having at least one parent (instead of both) born in the South or from another region. Again, we find that this refinement does not really change our findings and it also weakens our first stage estimates. The SHIW data-set provides a self-assessed of the neighborhood of residence. We added this variable[26] in our 2SLS estimation to control whether the effect of public housing could be a spurious effect for (bad) local public goods. The results do not support this confounding effect as the coefficient of public housing does not substantially changes, but the small sample size of the SHIW data and the self-assessment of the neighborhood warn us to be cautious with this conclusion.

## 1.7 Final remarks

A simple analysis provides a clear evidence of an unfavorable correlation between public housing and children's educational outcomes, that is just partially reduced by controlling for some important observable family's characteristics. The analysis also shows the shortcoming of the instrumental variable approach. Our results, as Currie et al. (2000) and Newman et al. (1999) results, might be due to the choice of the instrument. In Currie et al. (2000) the bias is likely towards a positive effect of public housing, as they use the possibilty to apply for an extra bedroom in a project as the instrument. Our instruments likely overestimate the negative effect of living in a project. But we can still say something for some educational outcomes.

More specifically, the SOUTH instrument appears to be exogenous for girls on school evasion and still the effect of public housing remains unfavorable and significant. The instrumented coefficient is more unfavorable than the non instrumented one, showing that, at least for female school evasion, the low performance of these girls is not explained by the sorting of families into public housing. Thus, the 2SLS result for for female school evasion with SOUTH as instrument supports the intuition of a dominant negative ghetto effect. This finding is consistent with the anecdotal and literature evidence on the behavioural problems, rather than the cognitive capabilities, of children living in public housing. Still, we cannot exclude that being an offspring of a migrant family drives the result for the other educational outcomes.

The number of families living in a project seems to worsen the effect of the concentration of truly disadvantaged people in the same environment

[26] We divided neighborhoud in three categories: center, suburb and rural areas.

only in some particular cases, but it does not seem decisive. For boys, the effect is significantly unfavorable on the probability of early school drop-out and on years of education. For girls, the effect shows up in the probability of grade repetition, especially when they live in big cities.

A ghetto effect in the Northern Italian projects (though a stronger proof is needed) might be the result of the restrictiveness of the Italian public housing policy itself. Rigid assignment criteria for a slot into public housing necessarily lead to the concentration of the most disadvantaged families, in a way that may harm the future of its young recipients. Nowadays, the public housing policy in Italy seems to go in the direction of a further concentration of disadvantaged people into projects, with all its possible consequences. Moreover, such a policy is indifferently targeted to families with or without children. And the design of these buildings may not help.

Future research using different identification strategies would allow a better understanding of the relationship between Italian housing projects and socio-educational outcomes and, possibly, the mechanisms it works through. It would also be interesting to shed more light on the relationship between the (persistent) educational disadvantage of interregional migrants' offspring and residence location in Italy.

# Appendix Chapter 1

### Derivation of the discount rate

They notify you a lottery prize equal to the net yearly income of your household. Such prize will be given to you in one year. If you renounce to part of this prize, you will instead withdraw the residual amount immediately.

1) Would you be available to renounce to 5% of this amount in order to get immediately this prize ?
*Yes* → Question 2; *No* → Question 4
2) Would you be available to renounce to 10% of this amount in order to get immediately this prize ?
*Yes* → Question 3; *No* → Stop
3) Would you be available to renounce to 20% of this amount in order to get immediately this prize ?
*Yes* → Stop; *No* → Stop
4) Would you be available to renounce to 3% of this amount in order to get immediately this prize ?
*Yes* → Stop; *No* → Question 5
5) Would you be available to renounce to 2% of this amount in order to get immediately this prize ?
*Yes* → Stop; *No* → Stop

If we define $p$ as the percentage of the prize that the individual is available to loose in order to get the prize immediately and $x$ of the amount of the reward and $\delta$, the choice is given by:

$$x(1-p) = \frac{x}{1+\delta} \tag{1.7}$$

where the left hand side is the net present value of the prize. The discount rate is:

$$\delta = \frac{p}{1-p} \tag{1.8}$$

The choice of conflicting answers is prevented by the sequence of the questions. We used the maximum amount the individual is available to loose to define the chosen $p$.

**The imputation of households' income from SHIW data**

*Data-set used*: 2004 wave of SHIW data.
*Sample*: over 15 year-old living in the North, foreigners are excluded.
*Number of observation*: 3184.
*Dependent variable*: logarithm of individual income.
*Variables included*: gender, age, age square, civil status, civil status interacted with gender, level of education (categorical), occupation and employment status, sector and region of residence.
*Estimation method*: OLS.
*Imputation*: we imputed individual income in the Census with the coefficients obtained as above, we then transformed logarithms in natural values, summed them at the household's level and transformed to logarithm again.

# Chapter 2

# A deeper insight into the ethnic make-up pf schools

## 2.1 Introduction

The "white flight" from predominantly "black" schools is an issue that has attracted the attention of many governments and has also been documented in some studies (Nusche, 2009; Gramberg, 2007). The challenge is to understand what is the effect of migrant students on both native's and minority's achievement and to detect appropriate policies. The literature about the effect of the ethnic composition of classes on pupils' achievement does not provide a clear and easy picture of the issue. However, some general observations can be drawn.

Primarily, it is commonly assumed that part of the effect of the share of ethnic minorities on test scores is driven by the selection and self-selection of students into schools. The pure effect of having schools with more ethnic minorities students is generally found to be negative (Hoxby, 2000; Hanushek *et al.*, 2002), though in some studies it does mot seem to be significant, especially in experimental settings (Card and Rothstein, 2006; Angrist and Lang, 2004). Further, there is a shared evidence that the proportion of ethnic minorities students in a class mainly affects ethnic minority pupils and it has nearly no effect on native children (Hoxby, 2000; Angrist and Lang, 2004; Card and Rothstein, 2006; Gould *et al.*, 2004; Hanushek *et al.*, 2002). In particular, for the US the effect is stronger for the proportion of Afro-Americans on Afro-Americans themselves (Hoxby, 2000). There is no evidence that, if any, the effect of the ethnic share is stronger for language skills than for mathematical abilities.

The fact that different ethnicities have different influences of the eth-

nic majority group and on themselves is somehow puzzling. Why a class with 50% Afro-Americans should perform worse than a class with 50% Hispanic or Asian? Could it be that is not (or not only) the effect of being a Afro-American, having a given culture or having a long past of distress and discrimination, but the fact to study in school and classes in which they constitute the main ethnic minority? What is missing in the existing literature in applied economics of education is a look at how ethnic minorities form the ethnic share. What is done is to study whether the effect of having a class with 50% Afro-Americans has the same effect as having 50% Hispanics, not whether the effect of having 50% students from cultures different from that of the majority group are made up by a single or a dominant ethnicty or by a variety of different ethncities. From minorities analyzed as a "black box" to ethnic specific analysis, the "mixing" of different minority groups is not considered in this type of literature[1]. We want to point out that diversity in the ethnic make-up of a class can play a role in education and other social aspects of the life of young students.

Ethnic diversity can stimulate the creativity of students, can increase the incentive to adopt the instructional language and culture, can reduce the feeling of ethnic identification and the consequences it may generate and may also make the job of teachers more difficult. The contribution of this paper is to investigate whether ethnic diversity matters for school achievement, for who it matters and which can be the mechanisms it may generate. We want to show that apart from the quota of "immigrants" in a class, also the composition of this share matters.

We use a rich data-set about primary school education in the Netherlands, that allows us to exploit the within school time variation in ethnic diversity in order to estimate a causal effect of diversity on test scores. We find ethnic diversity has an overall positive impact on test scores, especially for language skills. This effect is significant for minority students, in particular in the last years of primary education. The positive effect holds for migrant pupils even at considerable high level of minority's share. On the other hand, we find a negative effect of ethnic diversity on the school social environment for the same group of children. So we think that a less favorable social environment may generate some competitive behaviour among pupils. We do not find a strong evidence that an ethnically heterogeneous composition of the classes significantly worsen the relationship between teachers and pupils.

[1]However, the topic of ethnic fragmentation is extensively investigated in the macro and political economy literature and in experimental studies about firms' performance. For a rich review of these other streams of literature, see Alesina and La Ferrara (2005).

The paper is organized as follows. Section 2.2 explains why ethnic diversity can play a role in school achievement, in relation to existing studies about ethnicity and the processes it may generate. Section 2.2.1 describes our measure of ethnic diversity. In Section 2.3 we explain the method used to estimate the causal effect of ethnic diversity on test scores and some refinement of the analysis. Section 3.3 introduces the data about primary school in the Netherlands and some descriptive statistics. Section 3.6 presents the results about ethnic diversity for the linear and the non-linear model. Section 2.6 strengthens our analysis with some robustness checks. Section 2.7 is an attempt to support some explanation about the mechanisms there can be behind the effect of ethnic diversity on test scores. Finally, Section 3.8 draws some conclusive comments.

## 2.2 Ethnic diversity

Ethnic identification and social behaviour is a topic that has long interested scholars. Akerlof and Kranton (2000) introduce the concept of identity in the utility function to explain apparently non-rational economic behaviours. They explicitly associate identity and self-image. In their model identification with the dominant group and its associated prescribed behaviour depends on the extent of the social exclusion imposed by the dominant culture, on the loss in economic returns for individuals of the non-dominant culture for adopting the behaviour prescribed for the dominant group and on the negative externality imposed by the non-dominant group on the peers of their group who choose the activity associated with the dominant culture. Some reasonable values of these factors generate a mixed equilibrium in which some individuals of the non-dominant culture adopt the self-destructive behaviour known as "oppositional identity". In the context of school, diversity can enter the utility function in the process generating the ethnic identification and its associated behaviour. If pupils consider as a reference group only the students of their own ethnicity and not the wider group of non-native pupils and if the negative externality imposed by the reference group is an increasing function of the distribution of their ethnic group in the class, then ethnic diversity can generate equilibria with more non-native pupils adopting the dominant identity and behaviour. With special reference to education, Akerlof and Kranton (2002) describe the utility function of a student as composed by two parts: one follows standard economic theory (ability and effort) and the other follows the concept of identity. The second part of the utility function is maximized by the student by choosing a social category (for instance, "burnout") in order to balance

the social status corresponding to that category with "fitting in", that in turn depends on the characteristics of the student (for instance, ability and look). In this model, ethnic diversity can have a ("positive") effect of the choice of the social category if the weight associated to the identity part of the utility function is a (decreasing) function of diversity.

Fryer and Torelli (2005) demonstrate that there are large racial differences in the relationship between the students' popularity and their academic achievement, corresponding to the notion known as "acting white". Blacks are found to have a considerable more pronounced negative correlation between popularity and achievement than Whites. Interestingly, Fryer and Torelli (2005) find that the "acting white" behaviour is almost non existent in predominantly black schools and in schools where interracial contact is low. They explain this finding with a two-audience signaling model where racial differences in the relationship between social status and academic achievement arise and are exacerbated in environments with more interracial contacts. If ethnic diversity deteriorates somehow the social interaction of pupils, it may have, on the other side, beneficial effects on achievement.

Furthermore, diversity can enrich students. A seminal paper of Lazear (1998) argues that as long as the ethnic minority culture is relevant, not overlapping with that of the majority group and understandable it enriches the majority group and *viceversa*. He argues that diversity may enrich the environment where individuals live and trade and may contribute to greater creativity. By extending the theory of Lazear (1998) to multiple ethnic minority groups we can apply this idea in the context of school achievement.

Bridging the theory of Lazear (1998) and the conclusions of Akerlof and Kranton (2000) and Fryer and Torelli (2005), O'Reilly *et al.* (1997) find that diversity is associated with an increase in conflict and that conflict has a negative impact on firm performance. In particular, they find that ethnic diversity has a positive effect on group performance but this effect occur independent of conflict, not because of it.

From a more pragmatic point of view, the value of assimilation is larger for small ethnic minority groups. As common culture and common language facilitate trade between individuals a small ethnic minority group has a bigger incentive to adopt the majority culture or skills as a mean for interaction (Lazear, 1999), unless different ethnic minority groups form a common ethnic minority culture (probably requiring much more effort and cohesion). In the school context, this incentive could lead to achievement gains as instructional language and culture is set by the majority group and teachers are mostly from the ethnic majority. As long as diversity entails smaller shares of the ethnic groups and a decline

of dominant minority groups, we may expect ethnic diversity to have an effect on school achievement and, in particular, on language scores.

If ethnic diversity may entails benefits, it may also generate some cost. Alesina and La Ferrara (2005) show that the provision of public goods is lower in more fragmented societies, which they explain with a simple model where the utility function depends also on the consumption of a shared public goods and, since different ethnic groups have different preferences over the public good to provide, a higher heterogeneity reduces the utility. Indeed, a different hypothesis about the role ethnic diversity in the context of school might comes from teachers. It can be easier for teachers to deal with an homogeneous ethnic minority group. For instance, teachers can devote some instructional time for the language problems of one particular ethnic minority. The action of teachers can become more problematic if teachers have to target specific instructional time to multiple ethnic groups. Evidence in favor of this consideration is found in Hoxby (2000), where a share of Hispanic between 66% and 100% has a positive effect on their school achievement. We may also think that the cost for teachers of targeting instructional time to specific groups of foreigners is lower the more "relevant", widespread, closer to the native and known is the culture of the minority group at stake.

We have mentioned the effect ethnic diversity might have in the context of school and the mechanisms there could be behind. The primary concern of this work is to investigate whether there exists any effect of ethnic diversity on test scores, as a result of whichever of these mechanisms and in whatsoever combination. Furthermore, as the literature points out that there may exist a relationship between ethnicity and the social environment of students, we explore the issue of the relationship between ethnic diversity and school environment.

For the purpose of this work, we can distinguish three broad and interlinked channels through which ethnic diversity may work: social environment, teacher's attitude and (strategic) individual behaviour (as may be induced by the social environment or directly determined) as residual category. More in detail, we consider whether ethnic diversity have an effect on interest in school, as suggested by Lazear (1998), on self-esteem and social interaction, to be in line with the findings of Akerlof and Kranton (2000), Fryer and Torelli (2005) and O'Reilly *et al.* (1997) and on the relationship between teachers and pupils (as perceived by teachers). However, we do not prove that if ethnic diversity has an impact on some aspects of the school social environment, the effect of ethnic diversity on school achievement is unequivocally and directly determined by these aspects. We can merely exclude or welcome some of the above mentioned hypotheses and leave the issue of whether the effect of ethnic

diversity works *via* some forms of social behaviour or if the effect on social behaviour is determined simultaneously with test scores open for future research.

### 2.2.1 Ethnic diversity index

Non-native (student) population is quite diversified in the Netherlands. Some ethnic minority students are the offspring of the decolonization of Indonesia (and Moluccas islands), Suriname and Dutch Antilles. Some are the offspring of the Mediterranean "guest workers" of the '60s: mainly Turkish and Morocco, but also Italians, Spanish, Portuguese, Greek and from former Jugoslavia. There are also students with Chinese and Vietnam origins and some from countries of a more recent immigration path and offspring of asylum seekers (Zorlu and Hartog, 2001).

We refer to ethnic diversity as an heterogeneous pool of minority students, where ethnicity is defined on the basis of the country of origin. The measure we chose for ethnic diversity is a continuous index that takes into account both the share and the number of ethnic minorities in the non-native group. The measure is an inverted Herfindahl index:

$$D_{gst} = 1 - \sum_{k=1}^{K} m_{kgst}^2 \tag{2.1}$$

$$if\ K = 1 \Rightarrow D = 0$$

$$\lim_{K \to \infty} D = 1$$

where $m$ is the share of ethnic minority $k$ in grade $g$, schools $s$ and year $t$. The more groups and the more dispersed the groups, the higher the index $D$. When $D$ is equal to zero it corresponds to full homogeneity of the ethnic minority group (e.g. there is only one ethnic minority in the non-native group). Higher values of $D$ corresponds to a rise in the number of ethnic groups and to a lower variance of the ethnic groups' shares. More precisely, the Herfindahl index can be decomposed into two effects: the number of the ethnic minority groups and the symmetry of these groups. The symmetry of the ethnic minority groups can be measured as:

$$SYM_{gst} = 1 - [(1 - \frac{1}{K}) - D_{gst}] \tag{2.2}$$

where $(1-1/K)$ is a measure of perfect symmetry for a given number of ethnic minority groups $K$. This index measures the degree of asymmetry among ethnic groups. Higher values of $SYM$ indicates a more equally

distribution of the ethnic minority groups. When the deviation from the situation of perfect symmetry is very large, the index tends to zero.

## 2.3 Empirical strategy

### 2.3.1 Baseline model

The make-up of schools and classes is generally considered to be endogenous. Parents who are very concerned about the schooling of their children tend to choose schools with a small share of immigrants, especially when their children are particularly talented. The rationale behind this choice is that parents look at the average test scores of schools and schools with higher share of immigrants have lower test scores. However, simple averages cannot disentangle compositional and causal effects. The same rationale may hold for the ethnic composition of schools, as more open-minded parents or more able children may choose schools and classes independently of the ethnic make-up (without clustering with relatives and friends) and may opt for ethnically heterogeneous schools and classes. The role of parents and ethnicity in the careful selection of the school for the children in confirmed by Gramberg (2007) for the case of Amsterdam.

In order to eliminate the sorting into classes we consider cohorts and to eliminate the self-selection into schools we adopt a first difference model within the same school. We consider separate learning functions for native and non-native and for each grade. The model is:

$$\overline{y}_{jgst} - \overline{y}_{jgst-1} =$$

$$\alpha_{jgt} - \alpha_{jgt-1} + \beta_{jg}(M_{gst} - M_{gst-1}) + \gamma_{jg}(D_{gst} - D_{gst-1}) + \varepsilon_{jgst} - \varepsilon_{jgst-1} \quad (2.3)$$

$$\forall\ j, g\ \textit{combinations}$$

where $\overline{y}_{jgst}$ is the average test score (in language, mathematics and reading understanding) of ethnic group $j$ (native or non-native), in grade $g$, school $s$ and year $t$; $M$ is the share of non-native children in the cohort, $D$ is the measure of ethnic diversity[2] (common to both the native and non-native groups), $\beta$ and $\gamma$ are ethnic (native and non-native) and grade specific coefficients for the effect of ethnic share and ethnic diversity and $\varepsilon$ is the error term. Error terms are clustered at school and cohort level. Since we consider average values, the model is weighted by the average

[2]For the measure of ethnic diversity we consider all the different ethnicities present in the non-native group, while for the learning function we just distinguish between native and non-native students.

size of each group in the two consecutive cohorts, where larger weights designate more accurately measured observations.

### 2.3.2 Non-linear model

We also consider non-linear effects of ethnic diversity. Indeed, the effect of ethnic diversity can be non-linear in the share of ethnic minorities students. For example ethnic diversity might not matter when the ethnic share is below a certain threshold. We insert the non-linearity at the level of the ethnic share at which the change occurs. We define four intervals, corresponding to the quartile distribution of the share of minority students: below 12%, between 12% and 33%, between 33% and 63% and above 63%. The model is estimated as a variant of equation 2.3, by interacting the term $(D_{gst} - D_{gst-1})$ with an indicator that assigns the share of minority students of the initial cohort $M_{gst-1}$ to one of the four intervals.

### 2.3.3 Robust model

We strengthen our baseline model by performing two additional checks. First, within the same school changes in the index of ethnic diversity from one year to the other can be endogenous. We instrument the ethnic diversity index with the residuals from the grade and school specific trend in the ethnic diversity index, as used in Hoxby (2000) for the share of minorities. The instrument for ethnic diversity $D_{gst}$ is $\Delta\widehat{u}$, where $u$ derives from the following equation:

$$D_{gst} = \alpha_{gs} + \phi_{gs}t + u_{gs} \tag{2.4}$$

$$\forall\ j, g\ \textit{combinations}$$

The identifying assumption is that school/grade time trends in the ethnic diversity $\phi_{gs}$ are well summarized by a linear time trend.

Second, if the share and the mixing of ethnic minorities varies idiosyncratically from one year to the other, also other characteristics may vary and affect pupils' achievement. More precisely, if the change in these (omitted) characteristics is correlated with the change in ethnic diversity, the coefficients of ethnic diversity is biased. For example, a positive change in ethnic diversity could corresponds to a positive change in the level of education of parents. The model is estimated as a variant of equation 2.3, where we add a set of changes in some controls $(Z_{gst} - Z_{gst-1})$ for other possible confounding effects. In particular, we control for changes

in the share of parents with a low level of education, changes in the proportion of male pupils and changes in class size.

### 2.3.4 Mechanisms

In the attempt to investigate the mechanisms driving the effect of ethnic diversity on test scores we also consider the effect of ethnic diversity on some subjective and relational outcomes for teachers and students[3]. Indeed, the coefficient $\gamma$ in equation 2.3 could be enacted through various channels. The model we use is the same as in equation 2.3, where $\overline{y}_{jgst}$ is replaced with the average quality of the relationship between teachers and pupils as perceived by the teacher, the average (self-assessed) school well-being, self-esteem and social interaction of students. We propose to use the last three variables to explain how ethnic diversity can affect the classroom environment and the first to explain if teachers are affected when dealing with an heterogeneous group of minority students. In one set of questions, students are asked to evaluate the general aspect of their classroom, while in the other set of questions teachers are asked to evaluate their relationship with students. We consider the effect of ethnic diversity on individual strategic behaviour as affected by the school environment as a possible residual explanation.

As a cross check of the mechanisms there could be behind ethnic diversity, we also consider a decomposition of ethnic diversity into an effect of the number of ethnic minority groups and of the symmetry of these groups. We estimate these separate effects by decomposing the term $(D_{gst} - D_{gst-1})$ into the change in symmetry of the ethnic minority groups $(SYM_{gst} - SYM_{gst-1})$ and the change in the number of ethnic minority groups $(K_{gst} - K_{gst-1})$.

## 2.4 Data and descriptive statistics

### 2.4.1 The PRIMA data

We use the PRIMA-cohort dataset, a large-scale survey of primary education in the Netherlands. The data were gathered twice a year from 1994 to 2004 in a representative sample of about 450 schools and in a sample of 200 schools containing a relative large number of disadvantaged pupils. The PRIMA data contain information about students in grade 2, 4, 6 and 8 of primary school. For some items the data are not

[3]Lavy and Schlosser (2007) use the same approach to identify the mechanisms working behind gender peer effects.

available for all grades. The data include test scores in language (Dutch), maths and reading understanding, the degree of school well-being, self-confidence and social interaction of pupils, the extent to which teachers feel at ease with pupils and demographic characteristics of the pupils, such as parents' ethnic origin and level of education. In the Appenidx we report the questions reported in Driessen *et al.* (2006), that they used to construct the socio-relational outcomes.

We consider each grade separately and we exploit the longitudinal feature of the data at the school level (not at the student level). We dropped the combinations of school/cohort in which the share of students with missing ethnicity of the parents was above 10%. We selected the remaining combinations of school/cohort that have been observed at least for three subsequent years, in order to render the results comparable with the robust analysis[4]. Indeed, for the instrument presented in Section 2.3.3, we need at least three observations for each school in order to obtain the residuals from a linear time trend. The reading understanding test score was submitted to a random subsample of pupils in grade 6 and 8 and we have these scores only starting from 1998. Similarly, pupils' self-assessments were given to a random subsample of students in grade 6 and 8, only starting from 1998 for the variable "social integration". Also for the variable "teacher relationship with pupils" was drawn a random subsample and only starting from 2000, though for all grades. As a consequence, the sample size for the regressions of each outcome is different. The difference in sample size between native and non-native for the same outcome is due to classes with only "foreign" students.

We assign the ethnicity to the student, based on the ethnic origin of the father or, if missing, that of the mother. We standardize test scores by grade and year, keeping the share of non-native students in the representative sample constant at the level of the first year for which we have the data.

### 2.4.2 Descriptive statistics

Table 2.1 lists the ethnic minority groups present in our sample and their respective share, by grade. In the final sample native students account for about 61% of the total number of students, the four larger ethnic minority groups are students with Surinamese, Turkish, Moroccan and "other countries" origins. Table 2.2 reports the descriptive statistics of the out-

[4]The original and the "selected" samples are not significantly different in terms of test scores and other characteristics. The only difference is that schools with more foreigners are oversampled in the "selected" sample, as explicitly provided for by the PRIMA-cohort survey.

Table 2.1: Shares of ethnic groups, by grade

| | *G2* | *G4* | *G6* | *G8* |
|---|---|---|---|---|
| Dutch | 60,94 | 61,35 | 61,55 | 62,13 |
| | (28353) | (29417) | (26144) | (23861) |
| Surinamese | 3,25 | 4,67 | 4,81 | 5,30 |
| | (1513) | (2237) | (2045) | (2037) |
| Antillean | 1,57 | 1,46 | 1,28 | 1,22 |
| | (732) | (698) | (545) | (468) |
| Moluccan | 0,20 | 0,25 | 0,31 | 0,33 |
| | (93) | (122) | (131) | (127) |
| Turkish | 11,85 | 11,16 | 11,01 | 10,66 |
| | (5513) | (5349) | (4677) | (4093) |
| Moroccan | 10,07 | 10,42 | 10,27 | 9,85 |
| | (4970) | (4995) | (4364) | (3781) |
| Greek | 0,06 | 0,04 | 0,04 | 0,05 |
| | (28) | (19) | (16) | (20) |
| Spanish | 0,17 | 0,16 | 0,16 | 0,22 |
| | (81) | (79) | (68) | (83) |
| Italian | 0,09 | 0,07 | 0,09 | 0,10 |
| | (44) | (32) | (38) | (37) |
| Portuguese | 0,15 | 0,14 | 0,16 | 0,19 |
| | (70) | (66) | (67) | (73) |
| ex Yugoslavian | 0,85 | 0,84 | 0,94 | 0,96 |
| | (395) | (402) | (401) | (370) |
| Chinese | 0,60 | 0,54 | 0,60 | 0,59 |
| | (277) | (261) | (253) | (228) |
| Vietnamese | 0,27 | 0,26 | 0,29 | 0,28 |
| | (126) | (123) | (123) | (109) |
| Other countries | 9,31 | 8,65 | 8,48 | 8,12 |
| | (4333) | (4146) | (3604) | (3118) |
| Total | 100 | 100 | 100 | 100 |
| | (46528) | (47946) | (42476) | (38405) |

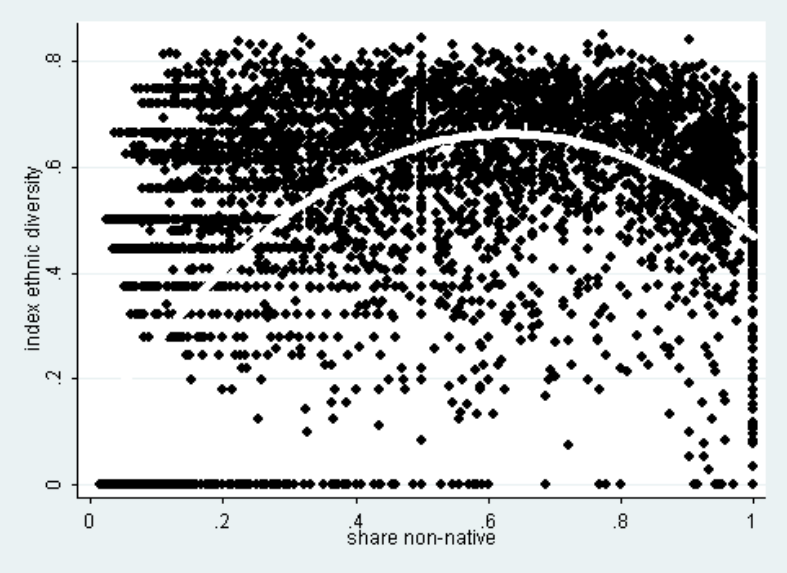
Absolute values in parentheses. The sample includes combinations of school/cohort in which there is at lest one student from an ethnic minority group.

come and explanatory variables, by native status. We only report the descriptive statistics of grade 8, however the tables for the other grades

are very similar. Apart from the native *versus* non-native test scores gap, we notice that minority students have a slightly worse relationship with teachers and self-esteem, a slightly higher level of school well-being and social integration. With respect to demographic characteristics, ethnic minority students are in classes with a slightly higher level of students with a low educational family background and they are in slightly smaller classes. Non-native students are in classes with a slightly higher share of minorities and slightly more ethnically diverse, reasonably due to the presence in our sample of all-minority classes.

Figure 2.1 shows the correlation between ethnic minority share and ethnic diversity. The figure shows that there is considerable independent variation of the two variables, that is cohort/school combinations with the same share of ethnic minority students have different values in the ethnic diversity index.

Figure 2.1: Percentage of ethnic share *versus* ethnic diversity index




However, for our approach we need enough and independent variation in the ethnic diversity index. Table 2.3 shows that there is a considerable amount of within school variation in the ethnic diversity index, that explains about 33% of the total variance. Figure 2.2 plots the within school standard deviation of ethnic diversity: this variation is present at all levels of the share of minority students, though it is higher in schools with a smaller share.

Figure 2.3 shows the correlation between the change in ethnic share

Table 2.2: Descriptive statistics, grade 8

| | *G8, native* | | *G8, ethnic m.* | |
|---|---|---|---|---|
| | mean (sd) | N | mean (sd) | N |
| language | -0,08 | *1404* | -0,63 | *1471* |
| | (0,45) | | (0,63) | |
| math | -0,11 | *1404* | -0,32 | *1471* |
| | (0,54) | | (0,64) | |
| reading | -0,12 | *1005* | -0,44 | *1049* |
| | (0,51) | | (0,57) | |
| rel. with teacher | 3,98 | *686* | 3,95 | *675* |
| | (0,39) | | (0,41) | |
| well-being | 3,75 | *1399* | 3,79 | *1463* |
| | (0,36) | | (0,4) | |
| self-esteem | 3,22 | *1399* | 3,18 | *1463* |
| | (0,3) | | (0,37) | |
| social integration | 4,10 | *1010* | 4,15 | *1053* |
| | (0,32) | | (0,33) | |
| share imm | 0,36 | *1404* | 0,40 | *1471* |
| | (0,28) | | (0,31) | |
| share unknown eth. | 0,01 | *1404* | 0,01 | *1471* |
| | (0,02) | | (0,02) | |
| ethnic diversity | 0,45 | *1404* | 0,46 | *1471* |
| | (0,27) | | (0,27) | |
| cohort size | 25,42 | *1404* | 25,14 | *1471* |
| | (12,15) | | (12,2) | |
| share low fam.backg. | 0,18 | *1398* | 0,21 | *1464* |
| | (0,2) | | (0,23) | |
| share male | 0,50 | *1397* | 0,50 | *1464* |
| | (0,13) | | (0,13) | |

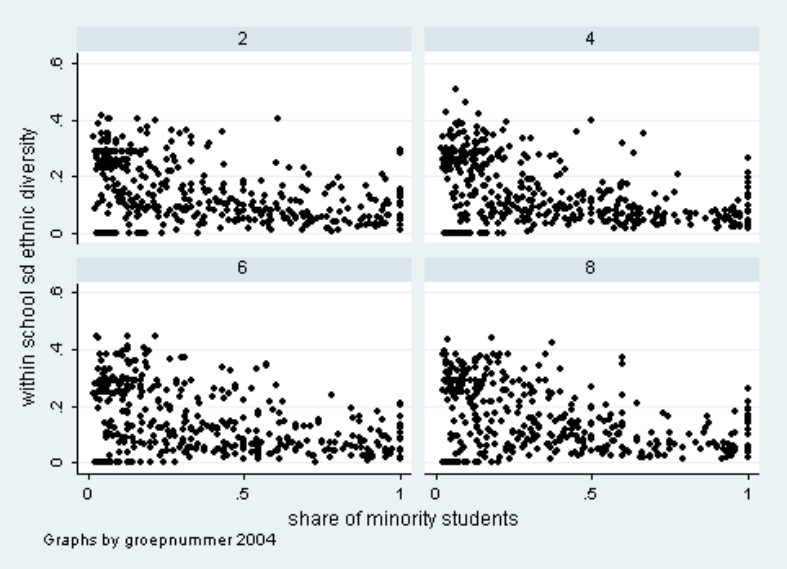
Mean of average values for school/cohort combinations, per group (native and non-native). Standard deviation in parenthesis.

and the change in ethnic diversity and we see there is considerable independent variation, though there is a slight positive correlation between the two measures (0.28).

Table 2.3: Decomposition of variance in the ethnic diversity index

| Grade | | Sum of squares | Share of total | DF |
|---|---|---|---|---|
| | between school | 72.49 | 67% | 398 |
| 2 | within school | 36.42 | 33% | 1141 |
| | total | 108.91 | | 1539 |
| | between school | 87.95 | 68% | 429 |
| 4 | within school | 40.55 | 32% | 1202 |
| | total | 117.10 | | 1606 |
| | between school | 75.30 | 64% | 404 |
| 6 | within school | 41.78 | 36% | 1266 |
| | total | 128.50 | | 1695 |
| | between school | 69.80 | 64% | 387 |
| 8 | within school | 39.74 | 36% | 1111 |
| | total | 109.53 | | 1498 |

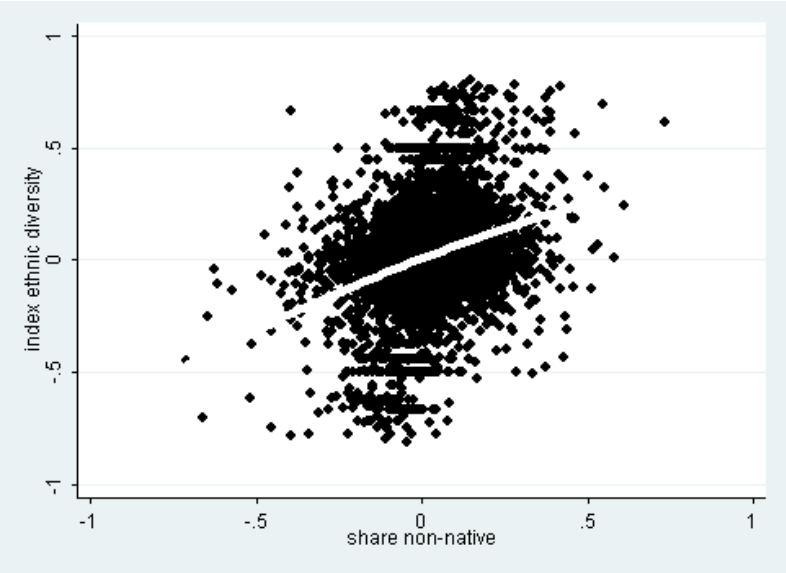
Figure 2.2: Within school standard deviation of the ethnic diversity index




## 2.5 Empirical findings

Table 2.4 and 2.5 show the results for the language test score, for each grade and separated for Dutch and for the ethnic minorities group of students. Ethnic diversity definitively increases language test scores with

Figure 2.3: Change in ethnic share *versus* change in ethnic diversity index




one (non significant) exception, that is for native in grade 4. For all the other grades and for both the groups of native and "immigrants" the coefficient of ethnic diversity is positive and especially significant for the group of non-native. Table 2.6 and 2.7 report the results for math test scores. The effect of ethnic diversity is generally positive, in particular for "immigrants", but the coefficients are not very significant. The only significant finding is for non-native in grade 8, where the effect of ethnic diversity seems to almost counterbalance the negative effect of the ethnic share. For reading understanding (Table 2.8) we get strong and significant results of ethnic diversity on non-natives in both the grades for which this test is available.

Overall, there is no significant effect of ethnic diversity on the test scores of native students. This result is consistent with the evidence brought by the literature about the effect of ethnic share on school achievement, where "foreign" students turn out to be the most affected when a significant effect of ethnic share is found. Here we find that the test scores of native students are poorly sensitive to both the share of minority students and its ethnic composition. On the other hand, the effect of ethnic diversity is always positive and often significant for the ethnic minorities group in all the three subjects. The coefficients are bigger and more significant for the students in higher grades, especially

Table 2.4: Language, grade 2 and 4

| | *G2, native* | *G2, ethnic m.* | *G4, native* | *G4, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | -0.026 | -0.139 | 0.170 | -0.343* |
| | (-0.153) | (-0.804) | (1.074) | (-2.283) |
| | [-0.006] | [-0.031] | [0.038] | [-0.081] |
| Δ eth.diversity | 0.006 | 0.073 | -0.107 | 0.257* |
| | (0.100) | (0.604) | (-1.612) | (2.460) |
| | [0.003] | [0.021] | [-0.061] | [0.080] |
| N | 1025 | 1056 | 1155 | 1193 |

Table 2.5: Language, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | -0.137 | -0.124 | -0.089 | -0.155 |
| | (-0.887) | (-0.947) | (-0.590) | (-1.075) |
| | [-0.034] | [-0.032] | [-0.025] | [-0.039] |
| Δ eth.diversity | 0.087 | 0.332** | 0.023 | 0.289** |
| | (1.556) | (3.735) | (0.462) | (3.117) |
| | [0.057] | [0.130] | [0.017] | [0.106] |
| N | 1096 | 1137 | 986 | 1049 |

Table 2.6: Math, grade 2 and 4

| | *G2, native* | *G2, ethnic m.* | *G4, native* | *G4, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | -0.177 | -0.242 | -0.076 | -0.260 |
| | (-1.062) | (-1.519) | (-0.467) | (-1.545) |
| | [-0.038] | [-0.054] | [-0.017] | [-0.057] |
| Δ eth.diversity | -0.044 | 0.055 | -0.029 | 0.121 |
| | (-0.640) | (0.487) | (-0.441) | (1.103) |
| | [-0.025] | [0.016] | [-0.016] | [0.035] |
| N | 1025 | 1056 | 1155 | 1193 |

in the $8th$ grade and for language skills. Standardized coefficients reported in square brackets show that the positive and significant effect of ethnic diversity counterbalances the negative and rarely significant effect of ethnic share, though a change of one standard deviation in the ethnic share may not be comparable with a one standard deviation change in ethnic diversity. The magnitude of the effect of ethnic diversity is better

Table 2.7: Math, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | -0.158 | -0.187 | -0.037 | -0.293† |
| | (-1.064) | (-1.129) | (-0.235) | (-1.950) |
| | [-0.036] | [-0.039] | [-0.008] | [-0.061] |
| Δ eth.diversity | 0.068 | 0.134 | 0.021 | 0.198† |
| | (1.051) | (1.163) | (0.349) | (1.898) |
| | [0.041] | [0.042] | [0.012] | [0.061] |
| N | 1096 | 1137 | 986 | 1049 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Beta coefficients in square brackets. t-value in round brackets. Standard errors (not reported) are clustered by school.

Table 2.8: Reading understanding, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | 0.019 | -0.132 | 0.214 | -0.131 |
| | (0.078) | (-0.791) | (0.977) | (-0.629) |
| | [0.004] | [-0.030] | [0.051] | [-0.031] |
| Δ eth.diversity | -0.071 | 0.193† | -0.034 | 0.320* |
| | (-0.866) | (1.761) | (-0.484) | (2.513) |
| | [-0.043] | [0.068] | [-0.021] | [0.113] |
| N | 672 | 692 | 618 | 654 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Beta coefficients in square brackets. t-value in round brackets. Standard errors (not reported) are clustered by school.

explained by an example. A one standard deviation change in ethnic diversity (0.27) increases language test score by 10% of the standard deviation (0.63), for $8th$ graders. The gap between native and non-native test scores in grade 8 is 0.55, so an increase in the diversity index of 0.27 points increases the test scores by 0.06 points, reducing the native/non-native gap by 11%. However, a change in the ethnic diversity index of 0.27 points means going, more or less, from two equally distributed minority groups (D=0.5) to four equally distributed groups (D=0.75), that is not a small change.

### 2.5.1 Non linear effects of ethnic diversity

Tables 2.9 to 2.11 illustrate the results for the non-linearities in the ethnic share, respectively for language, reading understanding and math test scores. We only report the results for $6th$ and $8th$ graders. Some cautions in interpreting these results are due, as the number of observations in each cell is rather small.

Table 2.9: Non linear effect in share ethnic m. for language, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| $\Delta$ share imm | -0.137 | -0.113 | -0.087 | -0.158 |
| | (-0.893) | (-0.872) | (-0.583) | (-1.098) |
| | [-0.034] | [-0.030] | [-0.024] | [-0.039] |
| diversity*share1 | 0.056 | 0.040 | 0.039 | 0.158 |
| | (0.790) | (0.226) | (0.634) | (0.825) |
| | [0.028] | [0.007] | [0.022] | [0.026] |
| diversity*share2 | 0.152† | 0.357* | -0.012 | 0.337* |
| | (1.746) | (2.583) | (-0.143) | (2.353) |
| | [0.057] | [0.075] | [-0.005] | [0.068] |
| diversity*share3 | 0.088 | 0.414** | 0.144 | 0.427** |
| | (0.566) | (2.965) | (0.969) | (2.591) |
| | [0.017] | [0.086] | [0.029] | [0.080] |
| diversity*share4 | -0.304 | 0.444* | -0.806 | 0.191 |
| | (-0.592) | (2.318) | (-1.625) | (0.859) |
| | [-0.017] | [0.085] | [-0.057] | [0.034] |
| N | 1096 | 1137 | 986 | 1049 |

Findings are non very straightforward. For all the three subjects, the significance of the non-linear coefficients of ethnic diversity tends to confirm that the heterogeneity of the minority group mainly affects minority students themselves. The sign of the effect of ethnic diversity is mostly positive for most levels of the percentage of minority students. However, if ethnic minorities seem to benefit from ethnic diversity the higher is the share of non-natives, native students seem to be adversely affected by ethnic diversity at high levels of the non-native student population. Indeed, the magnitude of the coefficients in the even columns (minority) of Table 2.9, 2.10 and 2.11 is increasing by going from the top to the bottom of the panel, while in the odd columns (native) the coefficients in some cases turn negative, especially at high level of the ethnic share. An explanation could be that when the share of minority students is

Table 2.10: Non linear effect in share ethnic m. for reading understanding, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| $\Delta$ share imm | 0.024 | -0.155 | 0.212 | -0.102 |
| | (0.101) | (-0.923) | (0.958) | (-0.492) |
| | [0.005] | [-0.036] | [0.050] | [-0.024] |
| diversity*share1 | -0.095 | 0.399† | -0.047 | 0.162 |
| | (-0.942) | (1.657) | (-0.575) | (0.749) |
| | [-0.045] | [0.063] | [-0.023] | [0.027] |
| diversity*share2 | 0.012 | 0.346† | -0.019 | 0.010 |
| | (0.089) | (1.918) | (-0.162) | (0.046) |
| | [0.004] | [0.063] | [-0.007] | [0.002] |
| diversity*share3 | -0.133 | 0.418* | 0.006 | 0.438† |
| | (-0.569) | (2.230) | (0.019) | (1.918) |
| | [-0.023] | [0.072] | [0.001] | [0.078] |
| diversity*share4 | -0.885 | -0.297 | 0.156 | 0.665* |
| | (-1.280) | (-1.303) | (0.211) | (2.300) |
| | [-0.047] | [-0.055] | [0.009] | [0.117] |
| N | 672 | 692 | 618 | 654 |

high, having minorities from many different ethnic groups may require additional efforts for teachers, obtained by removing some attention from native students. Overall, the coefficients for natives are almost never significant, with a (positive) exception for math and language scores when the share of minority is between 12% and 33%.

## 2.6 Robustness checks

Table 2.12 to 2.14 report robust results. We only report results for $6th$ and $8th$ graders.

First, changes in the ethnic composition may be correlated with changes in other observable characteristics of the cohort, like the proportion of children with low family background, the proportion of male and average class size. Even controlling for these characteristics, it does not significantly change the results. Indeed, even columns of Table 2.12, 2.13 and 2.14 confirm the results found with the baseline model, that are actually strenghtened. We also observe that natives are affected by the peers' share of male, while minority students by the peer's share having a low level of parental education. Again, test scores in maths seem less sen-

Table 2.11: Non linear effect in share ethnic m. for math, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| $\Delta$ share imm | -0.146 | -0.191 | -0.036 | -0.275† |
| | (-0.992) | (-1.156) | (-0.229) | (-1.799) |
| | [-0.033] | [-0.040] | [-0.008] | [-0.057] |
| diversity*share1 | 0.051 | -0.170 | 0.057 | 0.101 |
| | (0.616) | (-0.938) | (0.774) | (0.495) |
| | [0.023] | [-0.024] | [0.025] | [0.014] |
| diversity*share2 | 0.167† | 0.227 | -0.016 | 0.011 |
| | (1.875) | (1.329) | (-0.176) | (0.077) |
| | [0.057] | [0.038] | [-0.005] | [0.002] |
| diversity*share3 | -0.228 | 0.400* | -0.124 | 0.364† |
| | (-1.560) | (2.514) | (-0.682) | (1.829) |
| | [-0.040] | [0.067] | [-0.020] | [0.057] |
| diversity*share4 | 0.185 | -0.037 | 0.165 | 0.336 |
| | (0.306) | (-0.114) | (0.304) | (1.324) |
| | [0.010] | [-0.006] | [0.009] | [0.050] |
| N | 1096 | 1137 | 986 | 1049 |

sitive than the two language scores to the characteristics of the peers', including the ethnic make-up.

Moreover, changes in the ethnic composition within schools could follow and endogenous path. Odd columns of Table 2.12, 2.13 and 2.14 report the results using the instrumental variable as in Hoxby (2000). Again, robust analyses tend to confirm the baseline results, indicating that changes in the ethnic diversity index within the same school from one year to the other are not really endogenous. We also perform the same analysis as in equation 2.3 on a restricted sample of schools/cohorts in order to exclude outliers. We selected the combinations school/cohort corresponding to the black mass of figure 2.3, whose change in ethnic share in between $-0.3$ and 0.3, and the change in ethnic diversity is between $-0.3$ and 0.3. The findings (not reported) confirm our previous results, though we find some negative and significant results for grade 2. Results for the other three grades are twice as large (and positive) as in the full sample.

Table 2.12: Robust regressions for language, grade 8

| | *G8, native* | *G8, native* | *G8, ethnic m.* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | 0.005 | -0.102 | -0.039 | -0.161 |
| | (0.030) | (-0.675) | (-0.255) | (-1.105) |
| | [0.001] | [-0.029] | [-0.010] | [-0.040] |
| Δ eth.diversity | 0.016 | 0.040 | 0.271** | 0.330** |
| | (0.321) | (0.725) | (2.850) | (3.081) |
| | [0.012] | [0.030] | [0.100] | [0.121] |
| Δ low fam.back. | -0.225 | | -0.286* | |
| | (-1.565) | | (-2.346) | |
| | [-0.060] | | [-0.084] | |
| Δ share male | -0.302** | | -0.079 | |
| | (-3.487) | | (-0.800) | |
| | [-0.130] | | [-0.028] | |
| Δ cohort size | -0.000 | | -0.000 | |
| | (-0.245) | | (-0.267) | |
| | [-0.009] | | [-0.011] | |
| IV | | x | | x |
| controls | x | | x | |
| N | *986* | | *1049* | |

## 2.7 Mechanisms of ethnic diversity

We find some different results for teacher's related outcomes and pupils' social behaviour. An increase in ethnic diversity rises the proportion of native students who were advised to follow a low level track of secondary education (even by controlling for changes in average test scores). Conversely, an increase in ethnic share reduces the proportion of native students who got a low advice for secondary school (Table 2.15). So, teachers seem to have a positive "bias" towards non-native students when the ethnic minority group is more heterogeneous. Ethnic diversity does seem to make the job of teachers more difficult. In fact, the sign of the coefficients in Table 2.16 and 2.17 is often negative, though not significant. However, the coefficient for 8 graders is not far from being significant. We find no effect of ethnic diversity and ethnic share on the probability of a later drop-out of the student, as perceived by the teacher (Table 2.15).

As shown in Table 2.18 and 2.19, if the ethnic share increases the well-being and self-confidence of pupils, including natives, the effect of

Table 2.13: Robust regressions for reading understanding, grade 8

| | *G8, native* | *G8, native* | *G8, ethnic m.* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | 0.382 | 0.212 | 0.005 | -0.147 |
| | (1.670) | (0.960) | (0.020) | (-0.703) |
| | [0.090] | [0.050] | [0.001] | [-0.035] |
| Δ eth.diversity | -0.052 | -0.032 | 0.303* | 0.411** |
| | (-0.781) | (-0.396) | (2.406) | (2.972) |
| | [-0.033] | [-0.020] | [0.106] | [0.145] |
| Δ low fam.back. | -0.343 | | -0.464** | |
| | (-1.603) | | (-2.784) | |
| | [-0.074] | | [-0.132] | |
| Δ share male | -0.485** | | -0.235 | |
| | (-3.590) | | (-1.585) | |
| | [-0.159] | | [-0.078] | |
| Δ cohort size | 0.003 | | -0.002 | |
| | (1.350) | | (-1.066) | |
| | [0.061] | | [-0.048] | |
| IV | | x | | x |
| controls | x | | x | |
| N | *618* | | *654* | |

ethnic diversity has an opposite sign and, again, is only significant for 8*th* graders. Similarly, for social integration the effect of ethnic diversity is generally negative and only significant for minority 8*th* graders (Table 2.20).

Though the outcome variables we use for the analysis of the mechanisms are very general, we find a striking negative and sometimes significant effect of ethnic diversity. An increase in ethnic diversity reduces (self-reported) well-being, self-confidence and social interaction of both native and minority pupils. As all the three variables have a positive correlation with test scores, it is natural to wonder how a negative effect of ethnic diversity on the social aspects of the pupils' life can translate into a positive effect on test scores, at least for minority students.

Table 2.21 and 2.22 report the results for the decomposition of the effect of ethnic diversity into a "number of ethnicities" part and a "symmetry" part. Both elements seem to be (favorably) important for language and reading understanding test scores (Table 2.21), though it seems difficult to establish which of the two components is more important. For the school well-being the symmetry of the ethnic minority groups seems more

Table 2.14: Robust regressions for math, grade 8

| | *G8, native* | *G8, native* | *G8, ethnic m.* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | 0.021 | -0.029 | -0.183 | -0.300* |
| | (0.118) | (-0.179) | (-1.073) | (-2.002) |
| | [0.005] | [-0.006] | [-0.038] | [-0.063] |
| Δ eth.diversity | 0.013 | 0.009 | 0.200† | 0.251* |
| | (0.207) | (0.132) | (1.891) | (2.027) |
| | [0.007] | [0.005] | [0.061] | [0.077] |
| Δ low fam.back. | -0.089 | | -0.404* | |
| | (-0.471) | | (-2.405) | |
| | [-0.018] | | [-0.100] | |
| Δ share male | -0.115 | | 0.214† | |
| | (-1.177) | | (1.770) | |
| | [-0.039] | | [0.064] | |
| Δ cohort size | 0.001 | | -0.004† | |
| | (0.543) | | (-1.949) | |
| | [0.021] | | [-0.068] | |
| IV | | x | | x |
| controls | x | | x | |
| N | *986* | | *1049* | |

Table 2.15: Teacher advice for a low level secondary school (A) and probability of later drop-out (D), grade 8

| | *G8, native* | *G8, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | -0.187† | 0.150 | -0.013 | 0.016 |
| | (-1.782) | (1.026) | (-0.403) | (0.380) |
| | [-0.122] | [0.067] | [-0.018] | [0.016] |
| Δ eth.diversity | 0.065* | -0.016 | 0.004 | 0.003 |
| | (2.115) | (-0.179) | (0.423) | (0.116) |
| | [0.111] | [-0.011] | [0.015] | [0.005] |
| N | 321 | 341 | 489 | 514 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Beta coefficients in square brackets. t-value in round brackets. Standard errors (not reported) are clustered by school.

important than the number of ethnic groups. Interestingly, the pupils' self-esteem seems to be unfavorably affected by an increasing number of

Table 2.16: Relationship teacher-pupil, grade 2 and 4

| | *G2, native* | *G2, ethnic m.* | *G4, native* | *G4, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | 0.110 | 0.010 | 0.350* | -0.184 |
| | (0.670) | (0.061) | (2.005) | (-1.151) |
| | [0.038] | [0.003] | [0.101] | [-0.058] |
| Δ eth.diversity | -0.001 | -0.007 | -0.074 | 0.086 |
| | (-0.016) | (-0.046) | (-0.967) | (0.497) |
| | [-0.001] | [-0.003] | [-0.054] | [0.032] |
| N | 373 | 361 | 398 | 372 |

Table 2.17: Relationship teacher-pupil, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | -0.015 | 0.196 | 0.277 | -0.365 |
| | (-0.079) | (0.869) | (1.180) | (-1.481) |
| | [-0.004] | [0.051] | [0.069] | [-0.099] |
| Δ eth.diversity | -0.015 | -0.131 | 0.047 | -0.204 |
| | (-0.163) | (-0.760) | (0.496) | (-1.456) |
| | [-0.011] | [-0.049] | [0.031] | [-0.082] |
| N | 377 | 368 | 359 | 341 |

Table 2.18: School well-being, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | 0.014 | 0.319** | 0.182 | -0.130 |
| | (0.097) | (2.737) | (1.466) | (-1.143) |
| | [0.004] | [0.092] | [0.053] | [-0.038] |
| Δ eth.diversity | -0.032 | -0.008 | -0.110* | -0.148 |
| | (-0.631) | (-0.102) | (-2.161) | (-1.644) |
| | [-0.024] | [-0.003] | [-0.084] | [-0.064] |
| N | 1091 | 1132 | 980 | 1038 |

ethnic minorities (Table 2.22).

What can we say now about the mechanisms there can be behind the positive effect of ethnic diversity on test scores? The negative effect of ethnic diversity on socio-relational outcomes may point in favor of an interpretation of the role of ethnic diversity as breaking down the moment of identity formation and all its possible (negative) consequences. The

Table 2.19: School self-confidence, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | 0.165† | 0.245* | 0.265** | 0.142 |
| | (1.650) | (2.527) | (2.630) | (1.364) |
| | [0.064] | [0.086] | [0.105] | [0.051] |
| Δ eth.diversity | -0.012 | -0.011 | -0.036 | -0.136* |
| | (-0.355) | (-0.141) | (-1.065) | (-2.010) |
| | [-0.013] | [-0.006] | [-0.037] | [-0.072] |
| N | 1091 | 1132 | 980 | 1038 |

Table 2.20: Social integration in the class, grade 6 and 8

| | *G6, native* | *G6, ethnic m.* | *G8, native* | *G8, ethnic m.* |
|---|---|---|---|---|
| Δ share imm | -0.316† | -0.054 | -0.146 | -0.185 |
| | (-1.841) | (-0.367) | (-1.011) | (-1.389) |
| | [-0.108] | [-0.016] | [-0.051] | [-0.062] |
| Δ eth.diversity | -0.033 | -0.066 | -0.016 | -0.168† |
| | (-0.594) | (-0.615) | (-0.364) | (-1.876) |
| | [-0.029] | [-0.028] | [-0.015] | [-0.083] |
| N | 680 | 706 | 622 | 658 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Beta coefficients in square brackets. t-value in round brackets. Standard errors (not reported) are clustered by school.

mere fact that ethnic diversity has an effect could suggest that pupils consider the students of their own ethnic group as their reference group, otherwise we should just find an effect of ethnic share. We can say that, overall, ethnic diversity reduces social interaction and identification of pupils that in turn may have a weaker incentive of punishing "acting white" behaviours or "oppositional cultures". We do not find a supporting evidence of the idea that ethnic diversity may enrich the human capital of students. Indeed, we find a negative effect of diversity on well-being (that also includes a question about interest in school). On the other hand, we find that the number of ethnicities (so the number of cultures) does play a role in increasing test scores. Moreover, we do not have test scores in subject such as history or geography, that could better measure this aspect. Hence, we cannot discard the theory of Lazear (1998). With respect to teachers, it seems they are slightly overloaded when they

Table 2.21: Decomposition of ethnic diversity, for the ethnic minority group in grade 8

| | language | math | reading |
|---|---|---|---|
| Δ share imm | -0.126 | -0.285† | -0.084 |
| | (-0.859) | (-1.820) | (-0.388) |
| | [-0.032] | [-0.059] | [-0.020] |
| Δ n.ethnicities | 0.023† | 0.018 | 0.037* |
| | (1.833) | (1.256) | (2.054) |
| | [0.066] | [0.044] | [0.104] |
| Δ symmetry | 0.280† | 0.125 | 0.485* |
| | (1.935) | (0.647) | (2.138) |
| | [0.069] | [0.026] | [0.115] |
| N | 1049 | 1049 | 654 |

Table 2.22: Decomposition of ethnic diversity, for the ethnic minority group in grade 8

| | relation t-p | well-being. | self-esteem. | social inter. |
|---|---|---|---|---|
| Δ share imm | -0.381 | -0.168 | 0.158 | -0.211 |
| | (-1.582) | (-1.449) | (1.479) | (-1.561) |
| | [-0.103] | [-0.050] | [0.057] | [-0.070] |
| Δ n.ethnicities | -0.023 | -0.016 | -0.024* | -0.016 |
| | (-1.386) | (-1.157) | (-2.502) | (-1.497) |
| | [-0.081] | [-0.054] | [-0.098] | [-0.063] |
| Δ symmetry | -0.239 | -0.438* | -0.063 | -0.214 |
| | (-1.132) | (-2.564) | (-0.590) | (-1.375) |
| | [-0.063] | [-0.127] | [-0.022] | [-0.071] |
| N | 341 | 1038 | 1038 | 658 |

teach in too heterogeneous classes, though it does not seem that diversity significantly worsen their relationship with pupils. Though we favor the interpretation according to which ethnic diversity generates a trade-off between (better) achievement and (worse) school social environment, we cannot assert that is the worse social life of students that pushes them to perform better. Indeed, the favorable effect of ethnic diversity on school performance can come through a higher degree of (language) assimilation, made it easier by ethnic diversity. The especially beneficial effect of ethnic diversity on language proficiency may point in favor of this

interpretation.

## 2.8 Final remarks

We have found that ethnic diversity does play a role in the learning function, especially with respect to the acquisition of language skills. The beneficial effect of ethnic diversity on test scores seems to hold even at high levels of non-native's share, for migrant students. The magnitude of the effect of diversity appears to considerably reduce the eventual negative effect of the share of minority students.

Consistently with the literature, we find that ethnicity has an effect mostly for minority students, while natives do not seem to be affected. We may think that natives and minorities base their behaviour as two separate and with different status groups, thus the within group heterogeneity of the minority group does not affect native pupils. We also found that diversity is particularly important for older students. A possible explanation for this finding can be that ethnic identification, competitive behaviour and so on are concepts that young children do not develop yet. Furthermore, it may be that since we use cohort level data the level of interaction and competition within a cohort rather than within a class is stronger for older students. Ethnic diversity may work by implicitly boosting minority students to adopt the dominant culture and by pushing them to be proficient in the dominant language. Another interpretation is that ethnic diversity reduces the scope of ethnic identification and its eventual negative consequences, such as the penalty for "acting white" and probably by inducing some other kinds of behaviours such as competitiveness. Indeed, we observe a trade-off between the effect of ethnic diversity on test scores and on the quality of the school social environment. The relationship between teachers and pupils can be hindered by the heterogeneity of the class, though our data do not really support this evidence.

In conclusion, ethnic diversity could represent a factor to take into account in the policy options fro migrant students, in particular in contexts of free school choice where the "white flight" is difficult to be avoided without contradicting the idea of free school choice itself. However, it seems that ethnic diversity bears a trade-off between achievement and social life. It should be noted that the effect of having low grades in primary school can fade away with age, but there can be more long-lasting behaviours towards school that can be developed during primary school. For example, a child's well-being at school can be a good indicator of how the child will form his idea of going to school. The importance of

these aspects are confirmed by Gibbons and Silva (2009). Hence, in order to corroborate the idea of the beneficial effects of ethnic diversity in school, the importance of social *versus* early academic outcomes for migrant children should be further investigated.

# Appendix Chapter 2

The outcome "school well-being" is based on evaluation of pupils (agree/disagree, 5 options) of the following statements:

- I get well along with teachers
- I think I learn interesting things in school
- I find the school annoying
- I feel at home in school
- I feel comfortable with teachers
- I think the pupils of my class are nice

The outcome "school self-confidence" is based on evaluation of pupils (agree/disagree, 5 options) of the following statements:

- I can learn well
- I am one of the best pupils in the class
- Most of the pupils of the class can learn better than me
- The teacher thinks that I can learn well
- I need little help in the class

The outcome "social integration in the class" is based on evaluation of pupils (agree/disagree, 5 options) of the following statements:

- Most pupils of the class get along better with each other than with me
- I have few friends in this class
- I get well along with my classmates
- I am often teased by the other children of my class
- I think is nice to stay with my classmates
- If I ask my classmates for help, there are enough that can do it

The outcome "teacher-pupil relationship" is based on evaluation of pupils (agree/disagree, 5 options) of the following statements:

- The student feels at ease with me
- The student finds the school unpleasant
- The student has a good relationship with me
- The student would like to reduce the school
- The students has a difficult contact with me
- The student comes to school unwillingly

# Chapter 3

# Promoting scientific faculties: does it work?

## 3.1 Introduction

In the last decade, many developed countries have shown a concern about scientific education. In some cases the absolute number of students enrolled in scientific and technological tracks increased, masking an overall expansion of secondary and tertiary education. The share of students enrolled in science and technology is, perhaps, a more appropriate indicator of the trend, as it normalizes changes in the student population and demographic trends. The evolution of the share of enrolments in scientific and technological studies at secondary and tertiary educational level has been overall decreasing in most of the OECD countries over the last twenty years, though the number of students in Engineering and Computer Science increased . The picture is more serious when considering traditional scientific disciplines such as Mathematics and Physics and PhD programs, in which the decline occurred also in absolute terms (OECD, 2008).

A reversion of this downward trend should be desirable for a variety of reasons. First, R&D may become more difficult over time and a small number of scientist engaged in R&D can hinder economic growth (Segerstrom, 1998). Moreover, investing in studies that "bear" a higher chance of over-education[1] is inefficient. For instance in the Italian context, investing in quantitative fields (including Science) increases not only the participation to the labour market and the employment probability, but also early earnings[2] (Buonanno and Pozzoli, 2007). Furthermore,

[1] See for example Frenette (2004).

[2] However, this results could be due to the relative scarcity of graduated in scientific

Webbink and Oosterbeek (1997) show that there is a unexploited technical potential. That is, there are some types of students that do no choose technical education, but when they do they perform better than others. For example, female students choose less often technical studies, but when they do, they perform better than male. In addition, the choice of the degree (considering that female choose less often scientific studies than male) can explain 13% and up to 36% of the gender wage gap (Machin and Puhani, 2005). Thus, more female in science would translate in a smaller gender gap. After having briefly illustrated the importance of science, it is natural to wonder what drives the choice of the field of study.

The existing literature agrees on the importance of expected earnings in explaining the choice of the field of study. In a simultaneous model of field and length of studies, Beffy *et al.* (2007) find that a 10% increase of expected earnings in a given field results in a significant impact on the allocation of students between fields. Montmarquette *et al.* (2002) define a model in which the utility of choosing major $k$ depends on the characteristics of the individual and his expected income corresponding to major $k$, that in turn depends on his perceived probability of success in major $k$, his expected earnings after graduation for major $k$ and the earnings alternatives. In their model, preferences are an unobserved random component and they also assume that expected earnings are always realized. They find that expected earnings play a crucial role in college major choice, though the importance of earnings is lower for female and for non-whites. In another work Boudabart and Montmarquette (2007) introduce a weight for expected income as a function of student characteristics, such as family background, and the probability of job-education skill match. They find a correlation between male choosing science and a vocation for high income and for the acquisition of skills, while for female choosing science they do not find such a correlation. Berger (1988) stresses the importance of the streams of future earnings *versus* early income (at the time of the choice) as driving the students' choice of college majors. Freeman *et al.* (2008) introduce the role of the knowledge content of job. That is, the choice to undertake a specific major may be affected by the importance of the competencies provided by that major in the labour market, that may vary over years. They find that women, when choosing majors, are more responsive to this aspect, while men are more responsive to changes in the wage return of the knowledge content in a field. The different behaviour of male and

fields (Ballarino and Bratti, 2006) and to the signal for high ability and flexibility attached to Italian scientific graduates (Convert, 2005).

female is a constant feature in the literature about the choice of college major[3], but this difference does not seem to be addressed at the level of policy design. On the other hand, Arcidiacono (2004) argues that the large exogenous monetary premiums for attending science (and business courses) cannot explain the ability sorting across majors, due instead to differing preferences for majors across abilities.

However, a non-decreasing payoff of science cannot explain why scientific fields of study are chosen less often today than in past years. We agree with Convert (2005) that this apparently puzzling fact can be explained by a general (among the developed countries) expansion and democratization of the education system, where the students more "adverse" to science or less informed about studying science, like female and students with low family background, have entered higher education. At this point, a more general question arises: how can policy affect the choice of the field of study?

Some governments have attempted to attract more students in scientific tracks. The policy instruments that have been used fall under two categories: reduction of tuition fees and promotion of science studies. The first tool merely reduces the direct cost of investments in scientific education, as it is commonly assumed that the non-monetary costs of studying science are higher than those of studying, for instance, humanities. The second kind of intervention may play a role in the formation of the expectations about the probability of finding a (proper) job and about earnings after majoring in science and it may increase the non pecuniary returns of studying science, by stimulating the interest in scientific subjects. Moreover, promotion activities may help students to familiarize themselves with scientific subjects and, as a possible consequence, they may upgrade their perception of the probability of success in science majors.

Italy is not an exception of the general trend of declining majoring in science. In the next years there will be a generational turnover of high school teachers and, in particular, new teachers of science are needed. Moreover, the contribution of the private sector to the founding of research, a crucial aspect for science, is 40% with respect to an Euroepan average of 53.4% (Ministero della Pubblica Istruzione , 2007). The performance of 15 year-old Italian students in science, reported by the survey OCSE-PISA 2006, are not conforting. Aware of this situation, in 2005 the Ministry of Education and Research, the National Employers Organization (*Confindustria*) and the Universities launched a program to boost enrolment in scientific bachelors and to increase the number of graduates

[3]See for example Zafar (2009).

in science. With respect to the first aim, the content of this policy was to promote scientific studies to high school students.

This paper analyzes the impact of the sponsoring policy on enrolments in Chemistry, Physics, Mathematics and Materials Science[4] to see whether it has been effective and, more in detail, for whom it worked and in which fields. We match the records of the students enrolled in the two main public universities of Milan with the records of the secondary schools that participated to the program. We use an "exposure" approach to identify the "intention" effect of the treatment. We find that the "Progetto Lauree Scientifiche" increased the probability to choose a scientific bachelor, on average, by about 1.5%. The effect is not limited to the selected disciplines and there are positive cross effects of treatment's subject for Mathematics and Physics. When considering a differential effect of the policy for male and female, we find that for male students the policy was even more successfull, with a shift in the probability of enrolment in science equal to 3.5 percentage points, while for female it seems the policy had no effect.

The remainder of the paper is organized as follows. Section 3.2 discusses the content and the functioning of the policy. Section 3.3 presents the available data. Section 3.4 explains the "exposure" approach proposed to evaluate the effect of the policy. Section 3.5 reports the descriptive statistics of our sample. Section 3.6 presents our findings and Sections 3.7 adds some robustness checks. Finally, Section 3.8 draws some conclusive remarks.

## 3.2 The PLS policy

The "Progetto Lauree Scientifiche" (PLS) is a policy launched in 2005 by an agreement between the Ministry of Education and Research, the National Employers Organization and the National Committee of Science and Technological Universities to increase the enrolments and the number of graduates in Chemistry, Physics, Mathematics and Materials Science. The distinguishing characteristic of this project, with respect to previous interventions, is the considerable amount of its founding and its coverage of the national territory: 11 millions euro invested and more than 30 universities involved[5]. The program includes different interventions: 4 about the sponsoring of science to students and the training of teachers, at secondary school level, 3 concern university education, stage and post-graduate studies, 1 for scholarships and other activities at ter-

[4]Materials Science is a course of study in chemistry and physics of materials.

[5]Only two regions were not involved in the program: Valle d'Aosta and Molise.

tiary level (Ministero della Pubblica Istruzione , 2007). The first block of interventions aimed at increasing enrolments in scientific bachelors and was intended for high school students, while the other blocks aimed at increasing the number of graduates in science and were intended for university students.

The present analysis focuses on what we think is the most innovative content of this policy: the activities to promote scientific studies to secondary school students. The project was initially introduced for two years: 2005 and 2006. The content of this sponsoring policy is summarized by an evocative sentence: *"We need to change the idea that Math is boring, Physics difficult and Chemistry dangerous"* (page 10 of Ministero della Pubblica Istruzione (2007)). The activities to promote scientific studies to high school students aim, on the one hand, at stimulating the interest in subjects that are commonly deemed to be boring and, on the other, they aim at filling the gap between the perception of the professions one can undertake after these studies and the variety of the applications they can have (both in terms of the width of labour opportunities and the social utility of these studies). In practice, the project organized lab activities stimulating an active participation of students and experiments to show the links between science and everyday life. A second, but not minor, pillar upon which the project is focused is the involvement of secondary school teachers to stimulate the interest of their students in science, realized through training and support for lab activities provided by university professors and researchers.

The target of the policy were students of the last three years of the secondary cycle of education. 50.000 students, 20.000 teachers and 2.000 high schools[6] participated to these activities on the entire national territory (Ministero della Pubblica Istruzione , 2007). The PLS deliberately intended to attract students according to their interest. The rationale of the policy was to boost an underlying propensity or ability for scientific studies and not to create it. The explicit aim was to increase the matriculations in the bachelors of Chemistry, Physics, Mathematics and Materials Science.

Originally, all secondary schools received an official communication about the PLS policy, but few of them were actually involved in this way. In most of the cases the universities that organized these activities relied on e-mails, personal contacts with teachers and principals and on a teacher-to-teacher advertising. Once the organizers of the activities had a reference person in a school, through one or more teachers or the principal, the participation could occur with one or more classes or

[6]Schools are counted twice if they participated to two activities.

with small groups of students, depending on the type of the activity. The teacher of reference was not necessarily the teacher of the students involved, as the program was limited to the last three years of the high school. Furthermore, many activities were mainly targeted to the last or before last year students of high school and could take place in the first or the second semester of the school year. From direct interviews that we made to the organizers of the activities, it often happened that the decision of a school to participate with the $4^{th}$ or $5^{th}$ grade depended on the collocation of the activity in the first or second semester. In the second semester many $5^{th}$ grades were busy to prepare their final exam. Students could participate in one or more activities, in one or more of the four subjects. Finally, the program organized a survey of the participants to assess their evaluation of the activities.

The PLS policy may have affected three aspects regarding the choice of the field of study. First, practical examples of professions linked with the every day life may have "corrected" the labour market expectations related to graduates in science. Second, the proposal of non-standard activities may have increased the non-pecuniary returns of studying science. Finally, the time spent following the PLS activities may have helped students to familiarize themselves with scientific subjects and increased students' expectations of success in studying science. While the first aspect may, according to the literature, affect mostly male students, the second aspect could be more important for female students.

## 3.3 Data

We anticipate the section about the data as data availability has constrained the empirical strategy. Thus, we explain which data we have and in the next section, given the data, which strategy we use. We had access to the data of the students' enrolments in the two public universities of Milan: Università degli Studi di Milano and Università degli Studi Milano-Bicocca, containing the records of the high school attended by the student and its address, the year of the enrolment, the year, age and mark of the final high school diploma, the type of school, gender, family income bracket and the chosen bachelor. The data cover four school years: from 2004 to 2007[7].

A second data-set contains the information of the high schools participating to the program, with the address of the school, the subject of the program in which the school was involved, the year of involvement and the grades involved or the grade that individual students attended when

[7]These years correspond to school year 2004/2005 to 2007/2008.

participating. This dataset corresponds to the questionnaires submitted to the participants of the PLS after they completed the activities. About the questionnaires the program defined three cases: for some activities the questionnaires had to be filled in by individual students, for others they had to be filled in at the class level, whereas for some activities (especially for the more general ones, such as the showing of movies about science, museums' visits and so on) the program did not ask to fill any questionnaire. Some information about school participation were missing. I collected the remaining information through direct contacts with the professors who organized these activities. I then matched these two data-set by the address of the secondary school.

It was non possible to link the information about program's participation at the individual level, even for the questionnaires filled by the students, as the data-set about program's participation does not contain and individual identifier. Since the corrections we made on the two datasets and the recovering of the missing information were considerably time consuming, we restricted the analysis to the students enrolled in the two universities of Milan, having attended a high school in the province of Milan.

It is worth noticing that among the students having attended the secondary school in the province of Milan and among those that decide to continue to study at tertiary level, about 90% enrol at a university in the same region and among them 93% enrol at a university in the province of Milan[8]. However, Milan has several universities: the Catholic University (15.6%[9]), the *IULM* (2.8%), the Bocconi University (7.2%), the *Politecnico* (21.4%) and few medical and art institutions (2.2%). The Catholic University of Milan does not offer bachelors in science, that are instead offered at a campus located in a city located 85 km away from Milan[10]. Similarly, the *IULM*, the Bocconi University and the *Politecnico* do not offer bachelors in science, though the *Politecnico* offers "competing" scientific bachelors such as Engineering. The Statale and Bicocca Universities enrol about 51% of all the students enrolled in one the universities of Milan, including those who do not provide courses in science and including students from other provinces, regions and countries[11]. Furthermore, the activities of the PLS program were organized by the two University for which we have the data. It might be

[8]See www.anagrafe.miur.it.

[9]The total is the overall number of students enrolled in one of the universities of Milan, including students from other provinces, regions and countries. See www.sistemauni.it.

[10]Brescia

[11]See www.sistemauni.it.

that the policy pushed some students to undertake a scientific bachelor at a university for which we do not have the data, for instance at the University of Pavia. For the facts listed above we think that the two public universities of Milan constitute a natural outcome for most of the students for which the policy could have had an effect. In any case, this aspect should not invalidate our analysis, at the most it could make it weaker.

The final dataset contains the records of students coming from 320 different secondary schools, out of which 56 were involved in the program. The participating schools sent 14172 students from 2004 to 2007. From this matched sample I exclude the (few) schools that do not have a stable number of students enrolled in the two universities over the four year period 2004-2007. I also drop the students with a gap year between the diploma and the first year of matriculation. The final sample includes 6333 observations for post-policy years (2006 and 2007). The schools can have participated to the PLS in 2005 and/or 2006, with the $5^{th}$ or the $4^{th}$ grade. In these schools 46% of the students were exposed to the activities organized by the PLS program since its inception, corresponding to 3371 individuals for the school year 2006 and 2007.

From the data about project's participation for which the number of participants is available[12], we know that, approximately, an average of 16 students participated for each high school's cohort. We also know that in our final data about university's enrolments, each high school (of the province of Milan) sent, on average, 64 students (living in the province of Milan) per year. If all the participants to the PLS enroled in the two public universities of Milan, then 25% of the "exposed" cohorts were actually treated[13].

## 3.4 Empirical strategy

The aim of the analysis is to estimate the effect of the PLS advertising policy on the enrolment of students in the targeted scientific bachelors. As this policy was not designed to be a randomized experiment, the effect of the participation to the PLS may be confounded by several factors. First, the schools involved may be the schools that better prepare students for scientific faculties. Second, the students who participated to the program could be the students most interested in science. Third,

[12]The number of participants is not available for all the PLS activities and, in any case, for the individual questionnaires it just corresponds to the number of participants who actually answered to the questionnaire.

[13]However, we do not know who they are.

the classes that participated can have, for instance, better teachers of scientific subjects. Last, a school may have participated with some classes of the $4^{th}$ grade cohort because there were not similar students in the $5^{th}$ grade cohort.

In order to avoid the confounding effect of schools' self-selection, we only consider the secondary schools involved in the sponsoring policy, where we can find both the students who participated to the policy and the students who did not. The results are limited to the effect of the policy for the schools that chose to participate. While to avoid the confounding effect of students' and classes' self-selection and, also, for the constraints imposed by the data[14], we adopt an "exposure" approach[15]. That is, we assign the treatment to the whole cohort of a school where one or more classes or some students of the same cohort were involved in the program. In this way the treatment effect is comparable to an intention to treat effect. Usually, the intention to treat effect is used in randomized trials when non compliance may be non random[16]. In this case we use the intention to treat because actual treatment is likely endogenous and, however, we do not have information on actual participants. If we had information on actual participant we could have only used it to estimate an upper bound of the treatment. In order to be eligible for the treatment the student should have been in school $S$ in grade $g$ in year $t$. The actual treatment effect corresponds to the treatment coefficient divided by the proportion of students for each cohort in each school that actually participated in the program. The intention to treat coefficient is a lower bound of the actual treatment effect.

The identification of the treatment effect together with school-specific effects and a time trend is allowed by the within school year and/or grade variation of the exposure to the treatment. The causal interpretation of the treatment effect relies on the assumption that cohorts within a school have the same unobservable and the only observable difference is having been exposed to the policy or not. We partially relax this assumption in Section 3.7.

The basic idea of this approach is that the cohort's composition of students and teachers within a school should be more stable and less selective than the within school class' variation or the within class students' variation, in terms of motivation toward science. For example,

[14]We cannot link the (in any case, incomplete) individual data about PLS' participation to the university administrative data.

[15]The "exposure" approach is generally used when a given policy has an effect spread over a certain subpopulation, identified, for instance, by the date and region of birth. For an application see Bratti *et al.* (2008) and Oppedisano (2008).

[16]See for example Angrist and Lavy (2002).

science's teachers can teach in more cohorts in the same school and the potential manipulation of students allocation may occur when forming classes and not for the cohorts, that are determined by the age of the students. However, it could still be possible that a cohort in the same school is systematically different from another cohort in the same school and that this difference drives the participation (of a portion of these cohorts) into the program. The resulting model is:

$$y*_{ics} \,|(U=1) = \alpha + \beta C_c + \gamma S_s + \xi X_{ics} + \delta treat_{cs} + \varepsilon_{ics} \tag{3.1}$$

$$y_{ics} = \begin{cases} 1 & \text{if } y*_{ics} > 0 \\ 0 & \text{if } y*_{ics} \leq 0 \end{cases}$$

$$\varepsilon \sim (0, \pi^2/3)$$

where $y*_{ics}$ is the latent propensity to attend a scientific faculty of the $i^{th}$ student in the $c^{th}$ cohort in the $s^{th}$ school, $C_c$ is a dummy for the cohort to capture the trend, $S_s$ is the pre-policy rate of enrolment in scientific bachelor for each school, $X$ is a vector of students' characteristics (gender, final grade of diploma, having repeated one or two grades during high school, family income bracket). The variable $treat_{cs}$ is defined as belonging to a high school's cohort in which some classes or some students participated to one or more activities organized by the PLS. These students are not necessarily actual participants but, among them, some actually participated. Thus, the coefficient $\delta$ is an intention to treat effect and the average treatment effect for the treated in the participating schools.

Just to give an example, let's say that school B was involved in the project in 2005 with one class in the $4^{th}$ grade cohort. A student in the $4^{th}$ grade in 2005 can enrol at the university in 2007. We define as treated all the students from that cohort of school B. If school C participated to the program in 2006 with some students of the $4^{th}$ grade, school C is included in the analysis and its students enrolled at the university in year 2006 and 2007 are included in the control group. Indeed, "exposed" students of school C can enrol at the university at the earliest in 2008, but our data include only enrolments in 2006 and 2007. The Table below illustrates the mechanism of the treatment's assignment:

| *year and class PLS* | → | *year enrol.* | school A | school B | school C |
|---|---|---|---|---|---|
| 2005 V | → | **2006** | **T** | **C** | **C** |
| 2005 IV (2006 V) | → | **2007** | **C** | **T** | **C** |
| 2006 IV | → | 2008 | C | C | T |

As we consider only the participating schools and we do not assign the treatment at the individual or class level, we do not have to deal with possible unobservable and confounding factors such as $\eta_s$, $\upsilon_i$ and $\nu_g$, respectively at school, individual and class level. The outcome $y_{ics}$ is a binary variable for whether or not the student attends a bachelor in Chemistry, Physics, Mathematics or Materials Sciences. We have to condition on $U$ (equal to one if the student is enrolled at the university) as we do not have data about the students of the $s^{th}$ high school that do not enrol at the university. Hence, with this model we cannot disentangle the effect of the treatment on the probability to go to the university to follow a scientific track from the effect on the probability to choose a scientific track, once chosen to go to the university (independently from the policy). The coefficient $\delta$ includes both mechanisms. Finally, since the error terms may be correlated within school and cohort and the coefficient of interest is defined at this level, we cluster by school and cohort to capture common unobservable shocks to students in the same school and cohort. We allow for an unrestricted correlation structure.

## 3.5 Descriptive statistics

Figure 3.1 shows the trend of the share of the enrolments at the two universities of Milan in Chemistry, Physics, Mathematics and Materials Sciences from 2004 to 2007, separately for the schools participating to the PLS and those who did not. The vertical line corresponds to the year in which the policy may have started to have an effect on these enrolments. The positive change in the trend at the point the policy was introduced for the group of the schools involved is clearcut, especially in the first year of its implementation.

Figure 3.2 shows the same picture, but with the absolute number of the enrolments in the four sciences rather than the share on the total number of enrolments. The difference in the trends for the two groups of schools is slightly more pronounced than in Figure 3.1. The participating schools had already a larger share and number of students enrolled in science before the policy was introduced, but the steep increase after 2005 is considerable. In the first year after the introduction of the policy the effect seems to be driven by Physics, while in the second year by Chemistry. Indeed, in 2006 there are 13% of students that were exposed to a treatment in Physics, while only 6% the following year. The opposite is true for Chemistry: 5% of treated in 2006 and 42% in 2007.

Figure 3.3 shows the trend in science's enrolments for male and female, in non participating and participating schools. If for female the

Figure 3.1: Trend of the share of enrolments in science, by school participation to PLS

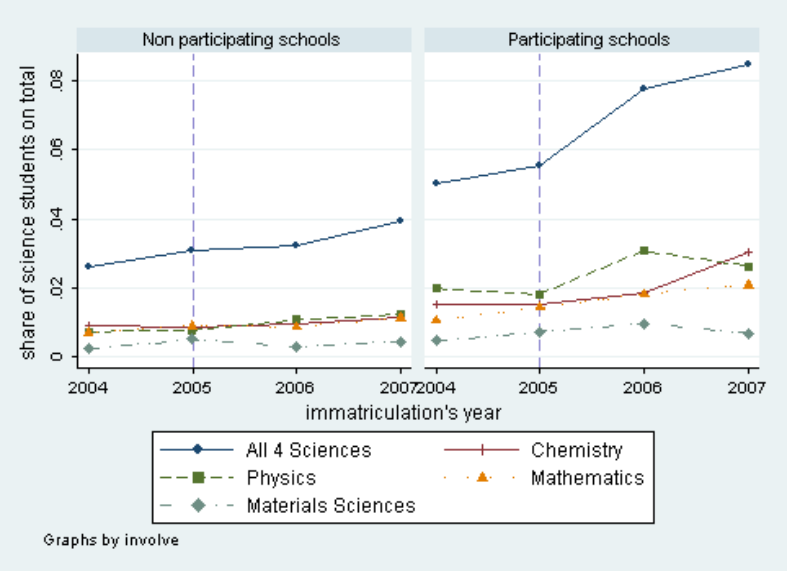
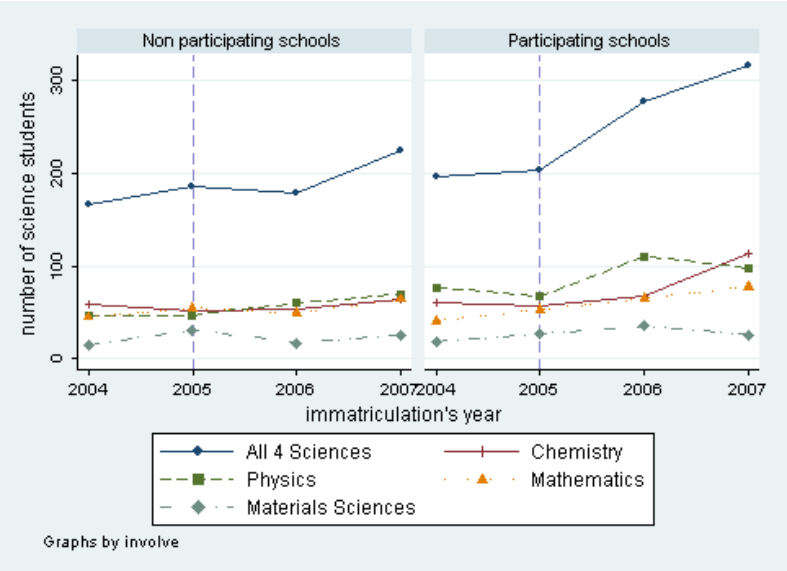



Figure 3.2: Trend of the number of enrolments in science, by school participation to PLS



increase in enrolments for the participating schools seems to happen only in the first year after the introduction of the policy, for male the increase is notable and constant over the following two years. Figure 3.4 shows the difference between the share of students immatriculated in science between the cohorts exposed and not exposed to the treatment, only for the participating schools. Figure 3.4 seems to confirm that the gain from being exposed to the policy is higher for male than for female.

Figure 3.3: Trend of the number of enrolments in science, by school participation and gender

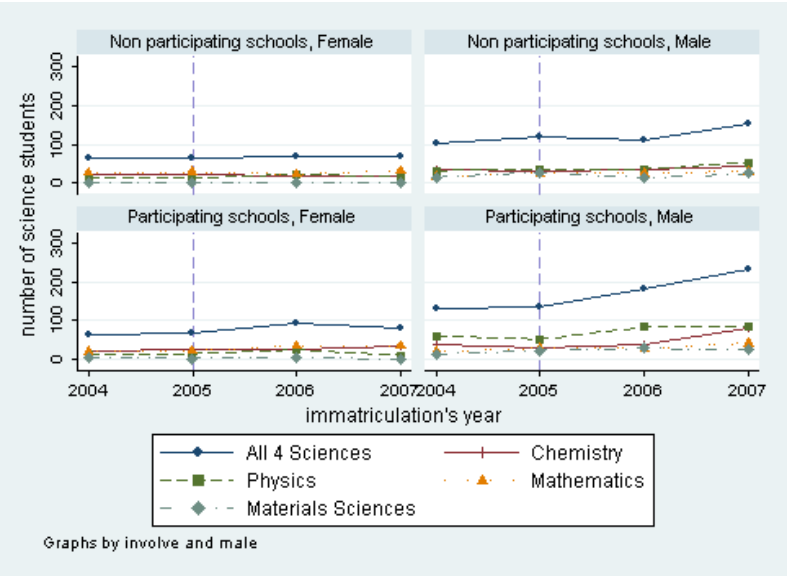



Table 3.1 and 3.2 report the descriptive statistics of the sample of participating schools, by treatment status. Table 3.1 reports mean values using students as unit of measurement, while Table 3.2 is calculated using cohorts as unit of measurement. When we assign equal weight to each cohort, the only significant difference between treated and controls is the year of enrolment. On the other hand, if we assign a weight to the cohorts proportional to their number of students we find that the treated and control students differ in the pre-policy share of enrolments in science and in the share of male of the high school of provenience. However, the share of male is not a pre-treatment variable. Thus, the descriptive characteristics reported in Table 3.1 and 3.2 do not seem to seriously invalidate our cohort approach, where we would basically like to have the treated and non treated cohorts as similar as possible.

Figure 3.4: Gap in the share of enrolments in science between treated and control group, by gender

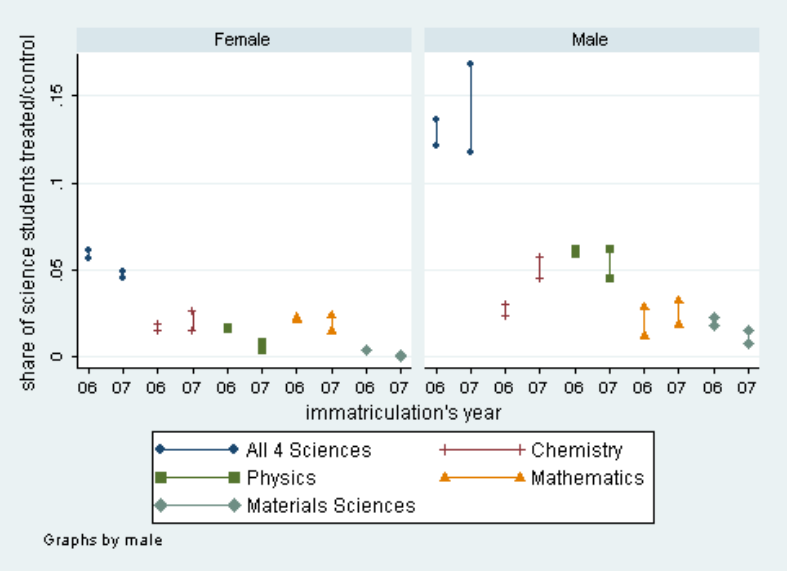



Table 3.1: Descriptive statistics (with students as unit of observation)

| | control group | treated group | difference |
|---|---|---|---|
| *Science* | 0.080 | 0.105 | -0.025** |
| | (0.005) | (0.005) | (0.007) |
| Pre-policy share science | 0.052 | 0.057 | -0.005** |
| | (0.001) | (0.001) | (0.001) |
| Enrolment 2007 | 0.346 | 0.671 | -0.325** |
| | (0.001) | (0.001) | (0.012) |
| Male | 0.434 | 0.487 | -0.053** |
| | (0.009) | (0.009) | (0.013) |
| Mark diploma | 0.031 | -0.012 | 0.042 |
| | (0.018) | (0.018) | (0.025) |
| Fail | 0.136 | 0.147 | -0.011 |
| | (0.006) | (0.006) | (0.009) |
| N | 3102 | 3231 | 6333 |

## 3.6 Empirical findings

Table 3.3 reports the estimation of equation 3.1. In order to interpret the results in terms of probabilities we also report the corresponding marginal

Table 3.2: Descriptive statistics (with cohorts as unit of observation)

| | control cohorts | treated cohorts | difference |
|---|---|---|---|
| *Science* | 0.080 | 0.106 | -0.026 |
| | (0.011) | (0.010) | (0.015) |
| Pre-policy share science | 0.058 | 0.057 | -0.002 |
| | (0.005) | (0.004) | (0.007) |
| Enrolment 2007 | 0.348 | 0.691 | -0.343** |
| | (0.058) | (0.063) | (0.086) |
| Male | 0.524 | 0.550 | -0.027 |
| | (0.033) | (0.031) | (0.046) |
| Mark diploma | -0.044 | -0.014 | 0.030 |
| | (0.040) | (0.049) | (0.063) |
| Fail | 0.172 | 0.171 | -0.000 |
| | (0.019) | (0.015) | (0.025) |
| N | 69 | 55 | 124 |

effects. The attended high school's pre-policy share of students enrolled in a scientific track is the major determinant of the choice of a scientific bachelor. Male students are 8% more likely to choose a scientific track and the higher the mark of the diploma, the higher this chance. On the other side, students who failed a grade during secondary school are less likely to choose science at the university. There is no significant trend in the enrolment of science between 2006 and 2007, that we can interpret as a stable (perceived) labour market rewards for choosing a scientific track. Introducing a control for family income does not change the results. The possibility to participate to the PLS project significantly increases by 1.4% the probability to enrol in scientific faculties. By using a liner probability model the effect raises to 1.9%. Thus, for the cohorts who had the chance to participate, the treatment shifts upward the probability to enrol in science. We gather all four scientific bachelors in one dummy for science studies or "other studies". We have to remember that only a small fraction of the cohorts defined as treated have been actually treated. For this reason we expect the actual (individual) effect of the PLS policy to be higher than that found here.

As the figures reported in this paper suggest, it is worthwhile to investigate whether the effect of the treatment is the same for male and female. By calculating a proper interaction effect between treatment and gender[17], we indeed find that the positive effect of the policy is driven

[17]In a non linear model framework, this interaction effect corresponds to the cross

Table 3.3: Main effect of the participation to the PLS program

| | Logit | Marginal effects | OLS |
|---|---|---|---|
| Pre-policy share science | 9.4269** | 0.5536** | 0.7770** |
| | (1.5574) | (0.0920) | (0.1334) |
| Enrolment 2007 | -0.0144 | -0.0008 | 0.0016 |
| | (0.1244) | (0.0073) | (0.0092) |
| Male | 1.2758** | 0.0816** | 0.0981** |
| | (0.0939) | (0.0076) | (0.0094) |
| Mark diploma | 0.7687** | 0.0451** | 0.0641** |
| | (0.0548) | (0.0031) | (0.0059) |
| Failure | -0.4173* | -0.0216* | -0.0230* |
| | (0.2071) | (0.0096) | (0.0101) |
| Treatment | 0.2450* | 0.0144* | 0.0186* |
| | (0.1235) | (0.0073) | (0.0092) |
| N | 6333 | 6333 | 6333 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Standard errors are clustered by school and cohort. Marginal effects calculated at mean values.

by male students. Th effect of treatment for male is 3.5% higher than for female with a z-value of 2.1 and this effect dominates for most of the values of the other control variables. Figure 5 shows this result.

The treatment includes activities in Chemistry, Physics, Mathematics or Materials Sciences. We expect an effect of the subject-specific treatment on the choice of the same subject as the activity attended, but we do not exclude that it can have an effect on the other three scientific subjects. Table 3.4 shows the cross treatment effect for each of the four scientific subjects. We restrict the analysis to the students who participated in the activities in only one subject, to avoid the correlation between participations in different subject-specific activities. As expected, the effect are found on the diagonal. However, we cannot give a causal interpretation of these coefficients, as it can be that cohorts more inclined towards one subject chose to participate (even the small fraction) to the activities in that specific subject. Interestingly, there are cross effects for Mathematics and Physics. Participating in activities about Physics has a positive effect on choosing Mathematics and *viceversa*.

derivative of the bachelor choice equation with respect to gender and treatment and not to the single derivative with respect to the interaction gender and treatment. For the calculation we used the Stata command inteff (Ai and Norton, 2003).

Figure 3.5: PLS treatment effect heterogenous by gender

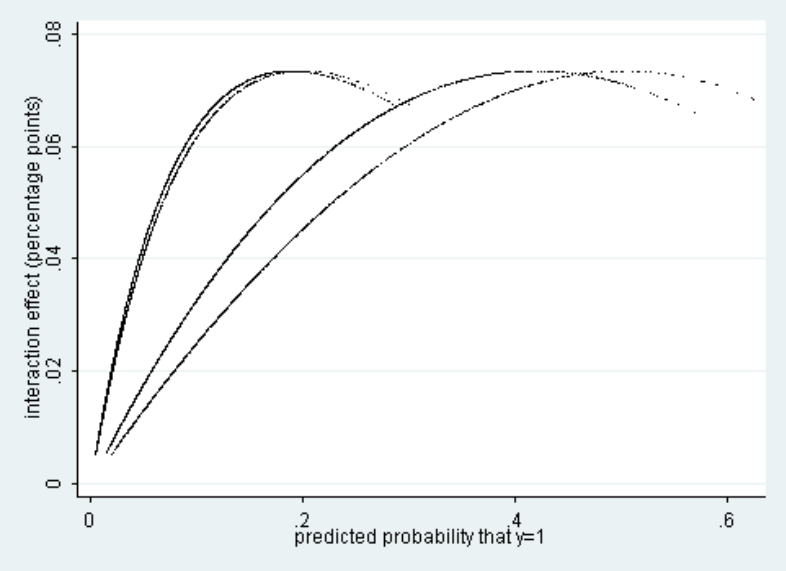



Table 3.4: Cross subject-specific treatment effects on each subject

| | *Chemistry* | *Physics* | *Math* | *Mat Sc* |
|---|---|---|---|---|
| Chemistry treatment | 0.4874† | -0.3253 | 0.0166 | 0.2392 |
| | (0.2767) | (0.4579) | (0.2848) | (0.3994) |
| Physics treatment | -0.0632 | 0.5620* | 1.1245** | -1.2700 |
| | (0.2617) | (0.2585) | (0.2728) | (0.9217) |
| Mathematics treatment | -0.1178 | 0.5449* | 0.6292* | -0.5599 |
| | (0.2105) | (0.2592) | (0.2522) | (0.7159) |
| Materials Sc. treatment | -0.1281 | 0.0044 | -0.0837 | 0.8906* |
| | (0.3458) | (0.2440) | (0.3626) | (0.3635) |
| N | 5697 | 5697 | 5697 | 5697 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Control variables for each estimation not reported in the table are as in Table 3.3. Standard errors are clustered by school and cohort.

In addition, the policy was intended to promote the four mentioned scientific subjects, but there can have been supplementary effects. First, if the policy diverted potential students from other scientific fields not included in the policy's target, it could not be considered as a full success. As already mentioned, the policy can act in two ways: by redistribut-

ing students across faculties and by increasing the number of students that choose to purse their studies at the university to follow a scientific track. The first mechanism can, in turn, works by redistributing students from overcrowded tracks or from other scientific and reasonably non rival tracks, according to the philosophy of the policy. Last, the policy can have a positive effect on other bachelors. Table 3.5 shows that the policy does not appear to have diverted students from other scientific and quantitative bachelors. Moreover, there is a strong positive and significant effect of the treatment on Pharmacy, reasonably due to the fact that this faculty also includes a course of study in Chemistry and Pharmaceutical Technologies.

Table 3.5: PLS treatment effect on other bachelors

| | treatment |
|---|---|
| Biotechnology | 0.0047 |
| | (0.1621) |
| Biology | 0.1471 |
| | (0.1348) |
| Pharmacy | 0.3393* |
| | (0.1341) |
| Environmental Sciences | -0.2718 |
| | (0.4076) |
| Geology | 0.5024 |
| | (0.3405) |
| Economics | -0.2000 |
| | (0.1706) |
| Medicine | 0.2028 |
| | (0.2554) |
| Statistics | -0.2987 |
| | (0.3143) |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Standard errors are clustered by school and cohort.

This result, together with the increase in the absolute number of male enrolments from the participating schools, might point in favor of the mechanism of the policy as boosting students to go to the university in order to attend a bachelor in science.

## 3.7 Robustness checks

The treated and untreated groups differ in some (omitted) characteristics that could bias the result about project's participation. In fact, the cohort's composition in each school may reflect the learning environment of the students of our sample, through peers' effect or as a result of common shocks as in a case where teachers are assigned to cohorts according to the characteristics of the students. In other words, the difference in some observable characteristics between treated and untreated cohorts can have an effect itself on the choice of scientific bachelors and not merely through the treatment status. In order to check this possibility we perform an estimation including controls for cohort's average characteristics in each school[18]. Results are reported in the first column of Table 3.6. Column 2 reports the marginal effects. Cohort's average characteristics do play a role in the choice of college major, especially the share of grade repeaters and the proportion of male. Conditional on the average characteristics, the treatment coefficient is slightly reduced to 1.3% as well as the corresponding standard error. Unfortunately, we do not have pre-treatment characteristics. Therefore, the selection of cohorts into treatment may have not been based on these characteristics and they could not represent the actual learning environment of the student. They could be, instead, an effect of the treatment on university's enrolment. In particular, we cannot exclude that project's participation had an effect on male university's enrolment. In column 3 and 4 of Table 3.6 we report the results by replacing the share of male for the school/cohort combination that the student belongs to with the average share of male in the same school for the two cohorts preeceding the introduction of the policy. With this latter specification the treatment coefficient is confirmed to increase by around 1.4-1.5% the probability to choose a scientific bachelor, with a confidence level within 5%.

As explained in Section 3.2 the PLS policy provided also training courses for secondary school teachers. We know the year of participation, the school of the teachers involved and that they were teachers of the last three grades of the high school. We cannot identify the effect of teacher training as all cohorts of students in our data, coming from the schools where these teachers were working would be defined as treated. In other words, teacher training is introduced as a school level control. As a robustness check we insert in our specification a control for teacher training for the students that could have had these teachers. If we cannot

[18]Average characteristics are calculated excluding the $i^{th}$ observation for each observation.

Table 3.6: Estimation with cohort's average characteristics

| | Logit | Mfx | Logit | Mfx |
|---|---|---|---|---|
| Pre-policy share science | 7.4287** | 0.4242** | 7.9608** | 0.4579** |
| | (1.6249) | (0.0926) | (1.6281) | (0.0928) |
| Enrolment 2007 | -0.0137 | -0.0008 | -0.0135 | -0.0008 |
| | (0.1090) | (0.0062) | (0.1107) | (0.0064) |
| Male | 1.2142** | 0.0751** | 1.2234** | 0.0763** |
| | (0.1032) | (0.0074) | (0.1047) | (0.0076) |
| Mark diploma | 0.7706** | 0.0440** | 0.7705** | 0.0443** |
| | (0.0549) | (0.0029) | (0.0547) | (0.0029) |
| Fail | -0.3845 | -0.0195* | -0.3838 | -0.0196* |
| | (0.2078) | (0.0095) | (0.2075) | (0.0096) |
| Cohort's share male | 1.3889** | 0.0793** | | |
| | (0.3310) | (0.0185) | | |
| Cohort's share male (pre) | | | 1.1639** | 0.0669** |
| | | | (0.3129) | (0.0181) |
| Cohort's av mark diploma | 0.1023 | 0.0058 | 0.0978 | 0.0056 |
| | (0.2570) | (0.0147) | (0.2656) | (0.0153) |
| Cohort's share fail | -3.0149** | -0.1722** | -2.7224** | -0.1566** |
| | (0.7445) | (0.0414) | (0.6889) | (0.0397) |
| Treatment | 0.2244* | 0.0128* | 0.2539* | 0.0146* |
| | (0.1102) | (0.0063) | (0.1123) | (0.0065) |
| N | 6333 | 6333 | 6333 | 6333 |

Legend: † p<0.10 ∗ p<0.05 ∗∗ p<0.01. Standard errors are clustered by school and cohort. Marginal effects in columns 2 and 4 are calculated at mean values.

interpret the effect of teacher training on student enrolment in science, the omission of this variable could distort our results. For instance, if the students that are classified in the control group are the students of the teachers that received the training, the coefficient of the treatment for the students' activities could be underestimated. This more precise specification strengthens our results: conditional on teachers' training, the treatment increases by 1.5% the probability to choose a scientific bachelor, with a confidence level of 4.4% (regression not reported).

## 3.8 Final remarks

The intuition of the PLS policy seems right: policy interventions should be made before the choice of the field is made by the students. Contrary to interventions such as the reduction of tuition fees in science that, in Italy for example, act *ex-post*. The policy succeeded in increasing enrolments in Chemistry, Physics, Mathematics, Materials Sciences and, unintentionally, in Pharmacy. Participating in activities in one subject is correlated with the probability of enrolling in a bachelor in that subject but not exclusively, as in the case of the students participating in the activities of Physics and Mathematics. For these subjects, the PLS project seems to boost a general attitude towards a scientific approach, rather than a specific interest in the selected disciplines.

Nonetheless, a more accurate insight into the effect of the policy leads to a somehow different conclusion. The policy was very effective for male students, but there seems to be no effect for female students. Having participating to the treatment raises the probability to enrol in a scientific track by 3.5 percentage points for male with respect to female and this result holds for most of the values of the other characteristics of the student. If we follow the existing literature on the choice of college major, as depending on expected income, being a function of the probability to find a (proper) job and of expected earnings, and on a non-pecuniary utility of studying science, we believe that the PLS policy was more effective in tackling the first issue. Indeed, if male react more than female to changes in expected income and treated male benefit the most from the policy, we can imagine that these activities helped students in correcting their labour market expectations for graduating in science.

Overall, our results are robust to different specifications and poorly sensitive to controls for additional factors such as cohorts' average characteristics and teacher training activities. The effect of the treatment on the probability to choose a scientific bachelor ranges from 1.3% to

1.8%. It is worthwhile noticing that the effect that we identify with the cohort approach is an intention to treat effect. Consequently, we expect the actual (individual) effect of participating to the PLS activities to be somehow higher and the higher, the lower the proportion of students actually treated on the size of the same cohort enrolled at the university. For instance, if this proportion were 20% of the cohorts classified as treated, the actual policy effect could go up to 17.5% for male. From the analysis we can also deduce that the policy worked through pushing students that would have not chosen to pursue their studies at the university to follow a scientific track, rather than by redistributing students across bachelors. Indeed, we do not find a negative effect of the PLS policy on the enrolments in other bachelors and the data show an increase in the absolute number of the students of science.

The overall cost of the 7 projects organized by the universities of Milan (2 for Chemistry, 2 for Physics, 2 for Mathematics and 1 for Materials Science) was 717838 euro, including the activities to train high school teachers. A 1.5% effect of the policy[19] for our sample of treated schools/cohorts including 3371 students means that 51 students chose a scientific bachelor thanks to the policy. Thus, the (maximum) cost to have one student more studying science is about 14000 euro[20]. An extension of this research could be to estimate the benefit of having one student more studying science.

The limitation of our study is the short sight of our evaluation, due to the fact that the "Progetto Lauree Scientifiche" is a policy introduced very recently. We do not know if what we identify as a success will become a later drop-out from science bachelors and/or if it translates in a lower academic performance of the students boosted to study science.
It would be interesting to compare these findings with other studies on the effect of policies sponsoring scientific majors, especially for policies designed to be a randomized experiment. Our results, supported by the existing literature, would suggest to pay more attention to gender differences in the choice of college major when designing policies to sponsor scientific studies.

[19]We are just considering the effect of the sponsoring activities for high school students and not the effect of teacher training (as we do not know the magnitude of this effect).

[20]This per capita estimation is valid only if the effect of teacher training on the students' choice of scientific bachelor is zero, otherwise this amount is an overestimation of the costs.

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