Peer effects vs. parental influence in the development of capabilities in adolescence

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Abstract [*]

The past decade has witnessed the surge of a large body of research analyzing critical periods for investment in children's skills. Most of this literature has underscored the importance of parental investments and of preschool education during the early stages of life. Adolescence is another critical period in the formation of skills, where peers have a particularly influential role. In this paper we estimate the role of parents and peers on the development of cognitive and non-cognitive skills using a version of Cunha and Heckman's (2008) technology of skill formation. Identification of peer effects is based on the quasi-random assignment of students across classes, the dissociation of individual and peer outcomes over time, and the use of instrumental variables to account for common shocks. We find that parents continue to exert a positive impact on their kids during adolescence, promoting academic development and life satisfaction. The influence of parents is, however, stronger in outcomes less likely to be observable and penalized by peers (such as life-satisfaction) and much smaller than the effect of peers in those outcomes subject to peer influence (i.e. academic performance).

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1. Introduction

The acquisition of strong cognitive, socio-emotional, and health related capabilities is at the basis of successful economic and social trajectories over the lifetime (Heckman, 2007; Heckman and Kautz, 2012). Childhood and adolescence are critical periods for the development of these skills (Chapko, 2015; Cunha and Heckman, 2008). During childhood, family and school play key roles in the formation of these capabilities, providing care, stimulation, nutrition, and a proper environment. In adolescence, the nature of social exchanges and interactions with the group of peers acquires a more relevant role. The shifting of the relative importance of parents versus peers over the course of adolescence has been documented in the psychology literature (Harris, 2011; Windle, 2000; Wood, Vinson, and Sher, 2001; Trucco et al 2011). Still, a substantial body of literature suggests that in early and even in late adolescence parental factors affect some conducts and attitudes of adolescents (Reifman et al, 1998; Windle, 2000; Wood et al 2004; Barnes et al 2006; Hoffmann and Dufur, 2008; Trucco et al 2011).

To what extent are adolescents' skills shaped by those of their group of peers? Do parents still matter? Does parental monitoring moderate or enhance peer influence? Are non-cognitive skills more likely to be influenced by peers than cognitive ability? What is the relative importance of parental investment? The goal of this paper is to empirically assess the impact of peers, and how it compares with parental investment in the development of skills and capabilities in adolescence. We approach this issue by analyzing students in their natural school setting. Our analysis takes advantage of the exogenous assignment of students across classes within grades in a sample of private secondary schools in Uruguay. The considered schools do not have tracking policies and seek balance of students across classes. As in Hoxby (2000) and Ammermueller

and Pischke (2009), we exploit random variation across small classes in the fraction of students with specific cognitive and non-cognitive capabilities. We address simultaneity of influences by using panel data and instrumental variables to address common shocks.

Using principal component analysis, we construct three latent indicators of cognitive and non-cognitive skills. The first one measures cognitive ability on the basis of a set of academic test results.[1] The other two capture non-cognitive skills by measuring, respectively, the latent predisposition to use substances (based on nine assessments of use of alcohol, tobacco, and marijuana) and latent life satisfaction (based on 10 indicators of satisfaction with different aspects of life). Substance use has been systematically associated with non-cognitive skills and traits such as the levels of socio-emotional regulation and conscientiousness, risk tolerance, and self-control (Heckman, et al., 2006, Wills et al. 2006, Gunnarsson et al 2008, Belcher et al 2014, Jones et al 2015).[2] Life satisfaction, on the other hand, has been shown to depend on non-cognitive attributes such as self-esteem and locus of control (Judge et al 2005, Diener and Diener 2009).

We find statistically significant linear-in-means peer effects in cognitive skills, but not in non-cognitive skills as proxied by latent substance use and life satisfaction. Our findings differ, in this respect, from results in previous literature that find larger effect in social rather than in academic outcomes. A one standard deviation increase in peers' average academic competencies increases individual academic performance by a quarter of a standard deviation. We find no linear-in-means peer effect for substance

[1] Authors such as Welsch et al (2010) have reported strong associations between cognitive skills and academic readiness.

[2] Introverts are less likely to be sensitive to competing rewards, and thus more likely to be pulled in by the effect of a drug. Individuals with negative emotionality respond poorly to stressors and are more likely to suffer from anxiety and depressed moods, which have been associated with the use of substances. Also, individuals with low constraint (low self-control and high impulsivity) are less likely to stop a behavior once started.

use, although there is some suggestive evidence of an influence exerted by those in the lowest and upper percentiles of the latent substance use distribution. On the other hand, we find marginal evidence of parental influence over academic skills (parental investment has a positive influence on academic skills) and, for some specifications, over the latent propensity to use substances (parental investment is negatively related to susbstance use). And we find a quite robust evidence of parental influence over life satisfaction. The influence of parents is smaller than that of peers (0.05 vs. 0.25 standard deviations) when it comes to academic skills, and has a stronger effect on life satisfaction than on academic or substance use latent measures.

The remainder of the paper is organized as follows. Section 2 describes background literature and the paper's significance; data and methodology are described in Section 3; Section 4 shows and analyzes the results; and Section 5 concludes.

2. Background and Significance

The seminal work introduced by Heckman and colleagues set the foundations of a profusive body of research analyzing the critical periods for the development of cognitive and non-cognitive skills throughout the life-cycle (Heckman 2007; Cunha and Heckman, 2008). Cognitive skills are the mental skills that are used in the process of acquiring knowledge and solving problems, including reasoning, memory, visual-spatial skills, and attention. Noncognitive abilities capture competencies such as socio-emotional regulation, self-control, conscientiousness, self-image, locus of control, and the ability to work and interact with others. While much has been written on the effects of cognitive skills on economic and non-economic outcomes (Murnane et al., 1995; Hanushek and Woessman, 2008; Burks et al. 2009; Hanushek and Woessmann, 2012), only recently have noncognitive traits been recognized a role in economics. Research

shows that noncognitive abilities have a strong influence on earnings, employment, labor force experience, college attendance, teenage pregnancy, participation in risky activities, compliance with health protocols, and participation in crime (Bowles and Gintis, 1976; Bowles et al., 2001; Groves, 2005; Segal, 2012; Heckman et al., 2006; Borghans et al., 2008a; Borghans et al. 2008b; Heckman and Kautz, 2012).

Two properties define Heckman's technology of production of capabilities. Self-productivity implies that the capabilities produced at one stage augment those attained at later stages. Dynamic complementarity refers to the fact that capabilities produced at one stage raise the productivity of investment at subsequent stages. Moreover, there are cross-productivity effects across all capabilities: each capability affects the accumulation of the others. These properties provide the theoretical basis for one of the main prescriptions of the model: that investments at earlier stages produce higher social and individual returns. Much of the literature following Heckman and colleagues' work has thus focused on the effects of investments during the first years of the life cycle, and in particular on those of early schooling and parental investment. The evidence suggests that a healthy family environment (Huttenlocher et al., 1991; Bianchi and Robinson 1997; Brody & Ge 2001; Wills and Dishion 2004; Anda et al., 2006; Rutter, 2006; Huttenlocher et al., 2010; Chapko, 2015;) and the quality and quantity of schooling (Cunha et al., 2006; Heckman et al., 2006; Blau and Currie 2006; Currie and Almond, 2011) can contribute substantially to shape cognitive, noncognitive, and health-related outcomes.

During adolescence, peers acquire a critical role in the socialization process, competing with parental influences in the formation of skills and competencies (Windle, 2000; Wood, Vinson, and Sher, 2001; Harris, 2011; Trucco et al 2011). Sacerdote (2011) defines peer influence as "nearly any externality in which peers' backgrounds,

current behavior, or outcomes affect an individual's outcome." Peer influence attains special policy significance when the externality works through peers' current behaviors, as it implies that the individual-level effects of a particular policy will be multiplied by the influential processes that take place between peers. The study of peer effects has received profuse attention in the area of education (Hoxby, 2000; Sacerdote, 2001; Zimmerman, 2003; Angrist and Lang, 2004; Ammermueller and Pischke, 2009; Fletcher, 2012; Imberman et al., 2012; Sojourner, 2012; Jackson 2013; Abdulkadiroglu et al., 2014; Billings et al. 2014). In a summary of this literature, Sacerdote (2011) and Sacerdote (2014) report that half the studies estimating linear-in-means models (models in which the average outcome of peers affects an individual's outcome) show modest to large peer effects, but half do not show statistically significant effects. On the other hand, studies assessing nonlinear effects, are more likely to find positive effects. For example, Hoxby and Weingarth, 2005, find that high achieving students (but not low achieving ones) benefit significantly from the presence of other high achievers.

There is also a large body of literature on peer influence in social outcomes, such as drinking, drug use, and criminal behavior (Gavira and Raphael, 2001; Powell et al., 2005; Duncan et al., 2005; Kremer and Levy, 2008; Lundborg, 2006; Clark and Lohéac, 2007; Trogdon et al., 2008). The evidence tends to suggest larger peer effects when the outcome is social than when it is academic (Sacerdote 2014). In addition, peer effects in social outcomes appear to be stronger in reciprocated friendships than in non-reciprocated pairs (Card and Giuliano 2013). Finally, there is an incipient literature on the transmission of influences in economic parameters and attitudes (Zimmerman et al., 2004; Boisjoly et al., 2006; Ahern et al.; 2014). Within this strand, Balsa et al. (2015), inquire about the endogenous transmission of risk attitudes by studying social spillovers in risk aversion in a school sample. They show that an increase in one standard

deviation in classmates' average risk aversion increases a high school student's risk aversion by between 44% and 64%.

Parents' influences during adolescence, on the other hand, provide youths with the necessary skills to interact in a successful way with others, and to assume adult roles (Marshall and Chassin, 2000). Several studies find a positive association between parental effort and the education attained by children (Brooks, 2003; Pattachini and Zenu, 2011; Dufur et al., 2013), and between parental effort and non-cognitive skills (Griffiths et al. (2011) find that family members play a critical role in supporting help-seeking among people with depression). Parental influences have been broadly conceptualized in terms of parents' behaviors, values, and attitudes. Parental behaviors such as supervising, monitoring, and rule setting are intended to direct the child's behavior towards patterns acceptable to the parent (Barnes et al., 2006). Parental values and attitudes are an indirect means of social modeling (Wood et al., 2001) and may be transmitted tacitly through the setting of limits or by the expression of values.

Given the key role played by peers and parents in the socialization processes during adolescence, considering and comparing both influences may improve our understanding of the process of production of capabilities and skills during this life-stage. The literature has documented that parental influences provide a buffering effect against peers in adolescent alcohol use initiation, delinquency and substance misuse (Wood et al., 2004; Barnes et al., 2006; Hoffmann and Dufur, 2008; Chuang et al., 2009; Trucco et al., 2011). Parental socialization processes contribute to identity development: adolescents whose identity is strongly influenced by their parents may be less susceptible to pressure from peers. Another strand has focused on the interaction of peers and family in the transmission of culture. Bisin and Verdier (2000, 2001) argue that the transmission of traits such as preferences, beliefs, and norms, is the outcome of

socialization efforts inside and outside the family. The relative intensity of the socialization effort exerted by parents depends on the degree of complementarity or substitutability between family and peer efforts, and on the level of heterogeneity between family and peer traits. Focusing on religion, Patacchini and Zenou (2016) analyze the interaction between vertical (parental) and horizontal (peers) transmission of the strength of religion. They find that peers and parents exert a complementary influence on the individual: for religious parents, the higher is the fraction of religious peers of the child, the more parents put effort into transmitting their religiosity, while for non-religious parents, the lower is the fraction of religious peers of the child, the less the parents go to a religious service with their child. In the same line, Olivetti et al. (2013) explore a new mechanism of gender identity formation. They model the utility function of teenagers, and assume that an adult woman's work decisions are influenced not only by her own mother's choices but also by her friends' mothers' choices when she was a teenager, and by the interaction between the two. By using the longitudinal structure of the AddHealth data set, they find that vertical (mother) and horizontal (friends' mothers) channels positively affect woman's working hours in adulthood. Nonetheless, the own mother's effect is larger the more distant she is (regarding working hours) from the friends' mothers. Finally, Battaglini, Benabou and Tirole (2005) propose a model of peer effects in which news from peers' actions (i.e. news on peers' substance use) improve non-cognitive outcomes such as self-control when individuals have a minimum level of self-confidence (which is higher in settings of high family investment), but have the opposite effect when individuals have low levels of self-confidence.

Our analysis adds to the literature by comparing the relative importance of parental monitoring vs. peer influences on the development of capabilities during

adolescence across an array of latent proxies for cognitive and non-cognitive capabilities. By empirically assessing the strength of each influence, our findings allow us to distinguish competencies more susceptible to peer socialization and other competencies more susceptible to parent socialization. We are also able to provide some evidence for the degree of complementarity or substitutability between both types of influences.

3. Data and Methodology

3.1. Data

3.1.1. Data source

The data were originally collected to assess the impact of a web-based substance use preventive program. A randomized controlled trial was conducted to evaluate an Internet and SMS-based intervention that provided adolescents with information about the risks and consequences of substance use. The intervention was somehow effective at improving information but ineffective at changing risky behaviors. In this paper we use detailed data gathered before and after the intervention but we do not exploit the trial per se. [3]

The target population was a sample of students who were in their third and fourth year of secondary school in ten private schools in Montevideo. The majority were between 14 and 16 years old. Compared to the average Uruguayan adolescent, students who attend private secondary schools are of higher socio-economic status. The academic year in Uruguay goes from March to December. Each student was asked to complete two surveys, one in July 2009 and the other in November 2009. The surveys collected a variety of information on socio-demographics, academic performance,

[3] The research proyect underwent review by an Ethics committee at Universidad ORT Uruguay in July 2009. See Balsa, Gandelman and Porzecanski (2010) for a description of the project and Balsa, Gandelman and Lame (2014) for an analysis of participation in the program.

substance use, non-normative behaviors, and perceptions of satisfaction. The surveys were self-administered at school and took around an hour to complete. 1,044 students corresponding to 47 classes responded to the first survey. During the second survey, around 206 interviews had to be conducted on the phone with a scaled down questionnaire due to scheduling problems and 48 students refused to participate. Because our identification strategy relies on comparing classes within schools and grades, we dropped two schools that had only one class per grade.

To assess whether the actual assignment to classes proxies random assignment, we constructed, for several relevant student characteristics, a Pearson chi square test of the difference in the variable mean across classes within grades. As in Ammermueller and Pischke (2009), under the assumption that schools are independent, we can sum up these chi square statistics across schools and construct a balancing test for each characteristic in the sample . Table 1 reports these statistics for age, gender, mother's education, single mother family, intact family, number of siblings, an asset index as an indicator of wealth, and father and mother's working status. For most variables, we find that assignment of students to classes does not depend on these characteristics. At a 5% statistical significance level there are only differences across classes in the number of siblings, and only for 4th graders.

3.1.2. Students' skills

We use principal component techniques to measure latent cognitive and non-cognitive skills at baseline and follow up. This allows us to consider latent tendencies in attitudes and behaviors avoiding the problem of measurement error and family-wise statistical errors. Our proxy for cognitive skills is the first component of a group of academic test results. In Uruguay, all secondary schools have to comply with a common

curriculum mandated by the national public education authority. This implies that all students take the same courses covering a similar content, and are administered subject-specific tests every month or two. Students were asked to report the grade they obtained in the last test they took in Mathematics, History, Literature, and Biology. Grades range from 1 to 12. The minimum passing grade is 6. The average grade is 7.3 with a standard deviation of 1.79 (see Table 2). [4] The principal component analysis of all academic variables at baseline throws a first component that ranges between -4.8 and 3.9 with a mean of 0.07 and a standard deviation of 1.47. The eigenvalue for the first component is 2.3, and the proportion of the variance explained by it is 57%. All four variables have similar loadings on this first factor, which range from 0.49 to 0.53 (see Appendix 1).

We approximate non-cognitive skills using two latent variables. The first one is a measure of the predisposition to use substances, constructed as the first principal component of the following set of variables: a dummy variable indicating any use of alcohol in the past 3 months, a dummy for any use of alcohol in the past 30 days, frequency of alcohol use in the past 3 months and past 30 days, a dummy for any alcohol intoxication in the past 30 days, frequency of intoxication in the past 30 days, a dumy for any use and frequency of use of tobacco in the past 30 days, and a dummy for any use of marijuana in the past 3 months. In our data, sixty eight percent of students report consuming alcohol in the past 3 months and 55.5% in the past 30 days.[5] The prevalence of drinking to intoxication is 19.2%, smoking prevalence is 18.1%, and 11.3% of students report consuming marijuana (see Table 2). The first component for the variables at baseline has an eigenvalue of 4.3 and explains 47.8% of the total

[4] The sample used for the analysis of cognitive skills includes students with non-missing academic test results at baseline and follow up, and non-missing values in all control variables used in the estimation (N=555).

variance. Factor loadings are all positive and range from 0.27 in the case of marijuana use to 0.38 for frequency of alcohol use in the past 30 days (see Appendix 1).

The second latent non-cognitive variable reflects the student's overall level of satisfaction with herself and her environment. It is the first principal component of a set of self-reported indicators that measure if the student is very satisfied with life in general (the average in the sample is 35.0%), her neighborhood (33.2%), neighborhood safety (21.2%), safety at school (38.5%), her education (62. 0%), her friends (75.1%), the relationship with her parents (48.8%), herself (36.3%), her social status (55.7%), and the amount of free time available (25.0 %).[6] The first component for the measures at baseline explains 29.3% of the variance and has an eigenvalue of 2.9. Factor loadings range from 0.22 for the amount of time available, and 0.38 for satisfaction with life in general (see Appendix 1).

Due to non-responses in the 2nd wave and to a shorter telephone interview, that explored mostly substance use behavior, our final sample has 785 observations when dealing with substance use, 603 in the life satisfaction analysis, and 555 when the outcome is academic skills.

3.1.3. Parental investment

Our index of parental investment is a weighted average of seven dummy indicators of parental involvement with the child. These are students' reports of whether the parents, or at least one of them, knows where the child is after school hours or in weekends; is concerned about how the child performs academically at school; shares at least one meal a day with the child; is attentive to the time the child arrives home during

[5] We report substance use descriptive statistics for those students with non-missing values in these variables at baseline and follow-up, and non-missing values in all control variables (N=785).
[6] We report life satisfaction descriptive statistics for those students with non-missing observations on the life satisfaction questions at baseline and follow up and non-missing control variables (N=603).

weekends; is a confident for the child; can keep a peaceful conversation with the child even when disagreeing; and is acquainted to the child's best friends. Table 2 shows that 67.4% of parents know the child whereabouts, 66.8% are concerned about his/her academic performance, 61.7% share at least a meal with the child, 86.1% are attentive to the time the child arrives home, 14.6% are among the first persons with whom the child shares a problem, 68.5% are able to keep peaceful conversations when disagreeing, and 43.9% are acquainted to their child's best friends.[7] The index ranges from 0 to 1, gives higher weight to scarcer parental competences, and has a mean of 0.48 and a standard deviation of 0.21 (see Table 2).[8]

3.1.4. Other control variables

Table 2 shows descriptive statistics for other variables used as controls in the estimation. Individual level variables include student's age, gender, mother's education, family structure (single parent family and number of people in the household), whether the student repeated a grade in the past, the average GPA in the past year, and the age of initiation of alcohol use. We also construct a wealth index on the basis of the availability of durable goods in the household. The index gives higher weight to scarcer goods.[9] The age of the students in the sample ranges from 13.5 to 17.8, with an average

[7] We report descriptive statistics for the parental index and for the other control variables for the sample of students with non-missing observations in all control variables (including the parental index) and non-missing values for the substance use outccomes at baseline and follow up.

[8] Formally, let P_{ij} be a dummy variable taking the value 1 if the parent of child i shows involvement with the child in dimension j. Let μ_j be the sample average of P_{ij} for dimension j. The parental investment index (PI) is defined as: $PI_i = \sum_j \omega_j P_{ij}$ where the weight is $w_j = \frac{1-\mu_j}{\sum_z 1-\mu_z}$. The index ranges from 0 for parents who show no involvement at all with the child (or who show involvement only in those dimensions for which every other parent is also involved) to 1 for parents who show involvement with the child in all assessed dimensions.

[9] The asset index is constructed in the same way as the parental investment index. If D_{ij} is a dummy variable taking the value 1 if the household of student i owns asset j, and λ_j is the sample average of D_{ij} for asset j, the wealth asset index is defined as: $Wealth_i = \sum_j \eta_j D_{ij}$ where the weight $\eta_j = (1-\lambda_j)/\sum_z (1-\lambda_z)$. The index ranges from 0 for a household with no assets (or who owns assets that everybody else owns) to 1 for a household who owns every single available asset.

of 15.3. Fifty-four percent of students are female, mothers' average education is 14.8 years, 21% of students live in a single-mother household, and the average household size is 4.2. Only 1.4% of students report having been retained in a previous grade, the age of initiation of alcohol use is in average 13.7 and the average passing GPA for the previous year is 8.1. The wealth index ranges from 0 to 1 with a mean of 0.48 and a standard deviation of 0.26. In terms of class level characteristics, we consider the average age in the classroom, the fraction of classmates that are female, class size, classmates' mothers' years of education, and the fraction of classmates living in single-mother households. In a robustness analysis we take into account whether there are alcohol problems, use of drugs, or smoking in the family.

3.2. Methodology

3.2.1. Technology of skill formation

We depart from a technology of skill formation similar to that in Cunha and Heckman (2007). We assume there are two types of skills: cognitive and non-cognitive, denoted respectively by θ_{it}^{C} and θ_{it}^{N}, where *i* indexes the individual and *t* denotes time. As in Cunha and Heckman (2007) skills in period t+1 depend linearly on the individual's skills in period t and on parental investments in that period (θ_{it}^{I}). We assume, in addition, that the accumulation of skills in t+1 depends on peers' skills in t (θ_{-it}^{k}). Equation (1) illustrates the technology:

$$\theta_{it+1}^{k} = \gamma_0^{k} + \gamma_1^{k}\theta_{it}^{C} + \gamma_1^{k}\theta_{it}^{N} + \gamma_2^{k}\theta_{-it}^{k} + \gamma_3^{k}\theta_{it}^{I} + \eta_t^{k}, \qquad with\ k = \{C, N\} \qquad (1)$$

The parameters γ_2^k and γ_3^k capture, respectively, peers' influence and parental influence on skill formation.[10]

3.2.2. *Identification of peer effects*

The empirical identification of peer effects faces two critical challenges. First, peer influence is hard to disentangle from self-selection, a phenomenon also known in the literature as correlated effects (Manski, 1993). Peer associations in economic attitudes and behaviors can be explained by selective group formation - that is, the tendency of those with similar preferences, information, and behavior patterns to get together. In the school setting, the selection (or correlated effects) problem stems from the fact that parents choose schools for their children based on their preferences for location, quality, costs, school values, and other school features. Due to this sorting, it is natural to find that students share more characteristics (e.g. religion) within schools than between schools.

A second problem with the identification of social spillovers is the difficulty in isolating the effect of peers' attitudes on the individual from the influence of the individual on his/her peers, known as Manski's reflection problem. A traditional solution in the literature has been to use instrumental variable techniques (Gaviria and Raphael, 2001; Powell et al., 2005; Lundborg, 2006; Clark and Lohéac., 2007; Trogdon, 2008; Fletcher, 2012), where individual-level variables determined ex-ante (such as peers' average family characteristics) instrument for students' current behavior. There are two problems with these instruments. First, they are unable to distinguish contextual from endogenous peer effects. Second, from an empirical point of view, they are usually weak (Angrist, 2014).

[10] An alternative specification for Equation (1) considers θ^C_{-it} as well as θ^N_{-it} as determinants of $\theta^k_{it+1..}$

To avoid confounding peer influence with selection, in this paper we follow Hoxby (2002), Lundborg (2006), and Ammermueller and Pischke (2009) and focus on random variations in attitudes and behaviors across classes within the same grade and school. We exploit the fact that parents of students in our sample are not able to choose the class in which their children will be placed within their age cohort.

The assignment of students across classes in Uruguay is majorly a decision of the school authorities, who seek to balance student characteristics across the different groups. Groups are reorganized every year or every couple of years, depending on the school. While the assignment process is not completely random, it relies on avoiding sorting of equals within classes.[11] Furthermore, once assigned to a class, students are not mixed up with students in other classes. Also, none of the participating schools have tracking rules in the assignment of students. This configuration ensures more frequent and intense interaction among students within a class than between classes. As in Ammermueller and Pischke (2009), the variation in our peer variable most likely reflects the small differences in composition when multiple groups are formed out of a small population (the absence of the law of large numbers).

We avoid the reflection problem by dissociating student i's and his/her peers' outcomes over time: concretely, we identify endogenous effects by studying how peers' capabilities in period t affect a student's capabilities in period t+1, conditional on the student's capabilities in period t. Our approach allows us also to explore the separate role of contextual effects (i.e. the effects of peers' characteristics on i's behavior) by controlling for aggregate peer characteristics in our regressions (e.g. education of peers' parents and peers' family structure). Note that by dissociating behavior over time and

[11] We interviewed principals at each school to understand the nature of students' assignment to classes. While in some schools students are consulted regarding their friendship preferences, the guiding principle for class assignment is randomization with some intervention aimed at avoiding the reinforcement of negative influences, both behavioral and academic, within classes.

controlling for own behavior at baseline, our estimates of peer effects are unlikely to be affected by common shocks.

For simplicity, we work with a linear in means model of peer effects, where the peer measure for student i in a particular class c, is given by the average value of the variable of interest (e.g. grades) in that class c, excluding student *i.*

3.2.3. Empirical model

Using each of the latent measures of skills as outcomes of interest, we estimate the following equation:

$$Y^k_{igct+1} = \gamma^k_0 + \gamma^k_1 Y^k_{igct} + \gamma^k_2 \overline{Y}^k_{-igct} + \gamma^k_3 \theta^I_{igct} + \gamma^k_3 X_{igct} + \gamma^k_4 \overline{X}_{-igct} + \alpha_g + \eta^k_{gct} + \varepsilon_{igct}, \qquad (2)$$

Equation (2) conditions skill *k* of student *i* in school-grade *g*, class *c* and time *t+1* (Y^k_{igct+1}) on the student's skills at *t* (Y^k_{igct}), classmates' average skills at *t* ($\overline{Y}^k_{-igct}$), parental investment at t (θ^I_{igct}), and other individual-level (X_{igct}) and group-level background measures at t ($\overline{X}_{-igct}$). α_g is a vector of school-grade fixed effects. This term allows us to compare students belonging to the same school-grade across exogenously assigned classes that have different peer composition. The error term includes a component that is common to class *c* at school and grade *g*, η_{gct} , and an idiosyncratic individual term ε_{igct}. To accommodate inference to intra-classroom common shocks, we cluster standard errors at the school-grade level.

One limitation of the previous methodology is that the estimation may be inconsistent if skills at t+1 are associated with persistent unobservables that affect also students' and peers' behavior at t. For example, having a good teacher may be associated with good overall performance at time t and at time t+1. The association

between peers' outcomes at t and the individual outcomes at t+1 may capture the common influence of this good teacher if such effect is omitted from the regression. To overcome this problem we instrument peer latent academic skills at t with the average GPA of peers in the previous year, peer latent propensity to use substances at t with peers'average age of initiation of alcohol use, and peer latent life satisfaction with the average number of people in peers' households. These instruments are unlikely to be associated with common shocks, as they were generated in the past, when the students had a different group of peers.

In a robustness analysis we add other skills at baseline as controls (i.e. we control for the full set of cognitive and non-cognitive latent skills at baseline), we use the average for different percentiles in the distribution of peers' skills rather than means to estimate peer effects, and we interact parental effects and peer effects with gender, household education, academic status at baseline, and network centrality. We also explore peer and parental influence on each of the variables used to construct the latent categories in our core analysis.

4. Results

4.1. *Core results*

Table 3 reports the OLS estimations. Each column depicts a regression of a cognitive or non-cognitive latent skill at follow-up (November 2009) on the same skill at baseline (July 2009), the average of peers' skills at baseline, an index of parental investment, individual-level adjustors (age, gender, single mother household, household size, an asset index, prior grade repletion, previous year's GPA, age of initiation of alcohol use), and average peer characteristics at the classroom level (average age, gender, and class size, average household head's education, and average family

structure) at baseline. Each regression adjusts in addition, for school-grade fixed effects. To simplify interpretation and comparison, the student's outcome at t, the peers' mean, and the parental investment measure, as well as the outcomes at follow up, are all standardized with mean 0 and standard deviation equal to 1.

All outcomes at follow up are positively and significantly associated with the outcome at baseline. The persistence is as high as 0.71 in the case of substance use and as low as 0.54 when it comes to academic skills. The OLS findings show suggestive evidence of peer influence in latent academic skills and in the latent predisposition to use substances. A one standard deviation increase in peers' average academic skills at baseline results in a 0.12 standard deviation increase in academic ability at follow up. The effect is statistically significant at the 5% level. The coefficient on the peer group average is 0.14 standard deviations when explaining predisposition to use substances (statistically significant at 1%). There is no statistically significant evidence of peer influence on life satisfaction.

Regarding parental influence, we find a statistically significant association at the 10% level between parental investment and academic skills at t+1 (conditional on own skills at t and other individual, family, and group variables at t): the coefficient is almost half the peer group effect, with a magnitude of 0.059 standard deviations. Parental investment is also associated with life satisfaction: the coefficient on this latent factor is 0.087, significant at the 1% level. Parental investment is not statistically associated, however, to the latent predisposition to use substances.

The instrumental variables (IV) second stage results are depicted in Table 4. All three instruments are statistically significant at explaining each latent skill and show the correct sign (Table A2 in Appendix 2 displays the full set of first-stage estimations).

First, the peer group's average latent academic skills at t is positively associated to the group's average GPA in the past year. Second, the highest the average age of initiation of alcohol use by peers, the lowest the group's latent propensity to use substances at time t. And third, as the average household size of the group of peers increases, the group's average latent life satisfication decreases. The F-statistics for the excluded instrument in each of the first stages are respectively 51.3 in the case of academic skills, 40.4 in the case of the substance use latent measure, and 6.3 for life satisfaction.

The evidence of a peer effect on academic skills detected in the OLS analysis is reinforced by the results of the IV estimation: the IV coefficient on peers' academic skills increases to 0.25 standard deviations in the IV estimation compared to 0.11 in the OLS analysis ($p<0.05$). On the other hand, the peer effect disappears in the case of the substance use regression. The IV coefficient on the group's latent disposition to use substances decreases to 0.023, compared to 0.138 in the OLS estimation, and loses statistical significance. In the case of life satisfaction, the IV coefficient on the peer group average remains small and non-significant.

Parental effects in the IV estimation remain similar, with a coefficient on parental investment of 0.053 standard deviations (statistically significant at 10%) in the academic skills regression, and a coefficient of 0.087 standard deviations ($p<0.01$) in the life satisfaction regression. The parental investment coefficient continues to be small and non-significant in the substance use estimation.

4.2. Robustness of the IV estimates

Columns (1) to (5) in Table5 explore the robustness of the IV results to changes in the set of control variables. The first column runs a regression with a more parsimonious set of controls (only age, gender, household education, and peer group's

average age, gender, and household education, in addition to school-grade fixed effects). The second adds other latent skills at baseline to the core set of controls used in the main IV estimation (we now control for the full set of cognitive and non-cognitive latent skills at baseline, including latent academic skills, latent substance use and latent life satisfaction). The third column adds a set of indicators of parental substance abuse at baseline (smoking, problems of alcoholism, and drug use) to the core set of controls. Column (4) includes both latent skills at baseline and parental substance abuse measures. And the last column adjusts only for school dummies and for a grade dummy (rather than adjusting for the interaction). The coefficient on peers' academic skills at baseline (Panel A) continues to be positive and statistically significant in all but the last specification. In this latter case, the estimation is much less precise, and while the coefficient decreases, it is still of a significant magnitude. Parental investment continues to be marginally significant in most estimations at a value around 0.06 standard deviations.

Results for the substance use analysis (Panel B in Table 5) are also in line with the core IV estimation. The peer effect is non-significant and there is a small negative and marginally significant effect of parental investment. Both in Panel A and B, the coefficient on parental investment achieves marginal statistical significance in some of the specifications, but the magnitude remains small. Finally, Panel C confirms the core results regarding life satisfaction: a student's life satisfaction is unrelated to peer influence and strongly associated with parental investment. The coefficient on the parental index ranges from 0.09 to 0.11 standard deviations.

4.3.Heterogeneity

Next, we explore heterogeneous peer influence in cognitive skills by interacting the peer variable and the parental investment variable with each other, with gender, household education, high achiever academic status, and social network centrality at baseline. No interaction is statistically significant when we run instrumental variables adjusting for the core set of regressors[12], a finding that most probably indicates lack of power given the small number of observations. However, we find a positive and marginally significant ($p<0.10$) interaction between peer influence and parental investment if we control for a more parsimonious set of adjustors (age, gender, mother's education, and peers's age, gender, and family education in addition to the school-grade fixed effects). Results of this exercise are presented in Appendix 3.

4.4.Who is the influential peer?

Finally, we explore which peers are more influential in the formation of academic skills. In each school-grade-class unit we divide the distribution of skills at baseline in three groups: students below the 33rd percentile, students between the 33rd percentile an 66th percentile, and students above the 66th percentile. We then construct average measures of academic skills in each of these terciles and use these measures as replacements for the full group average. Constructing instrumental variables under the same procedure, we run three IV estimations using these measures one at a time for power reasons. Results are shown in Table 6. The three first columns show the OLS results and the other three the IV estimates. Panel A suggests that peers around the median of the distribution (middle tercile) are more likely to be influential academically. The effect is found both in the OLS and IV regressions, and is stronger in the IV estimation, with a coefficient of 0.325 standard deviations. The instrumental

[12] We now use two instruments: the original instrumental variable for average peers' skills plus an interaction of this instrument with the indicator of heterogeneity.

variables regression shows also a statistically significant effect of the skills of peers in the upper tercile of the distribution, but the effect is smaller, nearly half, that of the middle tercile group.

Results for substance use (Panel B) reveal two things. First, the suggestive influence of the group in the middle tercile of the substance use latent measure, as estimated by OLS, disappears once we use instrumental variables. Second, OLS shows also a strong influence of the group in the lowest tercile and a marginally significant effect of those in the upper tercile of the distribution.Nonetheless, the instrumental variables available for these groups are not relevant (the values of the F-statistic for the excluded instruments are between 0.93 and 0.99). Thus, our instrumental variables conclusions of no-peer-effect in the case of substance abuse are valid for those complying with the instrument (those who show an inverse relationship between latent use of alcohol and age of initiation of alcohol use), and these are mostly those with a latent predisposition to use substances around the median. We are unable to dismiss the influence of the lowest tercile or the upper tercile.

Finally, the analysis of latent life satisfaction confirms a lack of evidence for peer effects, neither when running OLS nor when conducting IV estimation. In this latter case, only the instrument for the 3rd tercile is valid, but the peer estimate is insignificant.

5. Discussion and Conclusions

In this paper we aim at measuring the relative influence of peers versus parents in the development of cognitive and non-cognitive capabilities during adolescence. We use a database from a sample of ten private high schools from Uruguay which contains detailed information on various variables that can proxy for these capabilities. Our

model addresses selection by exploiting students' quasi-random assignment to classes within grades. It avoids Manski's (1993) reflection problem by conditioning future behavioral choices on the individual's past choices as well as on peers' past choices. And it addresses endogeneity due to common shocks by using instrumental variables. We measure parental investment by constructing an index that captures several parental nurturing and monitoring behaviors, including being attentive to the child's whereabouts and time of arrival home in the evenings, showing concern about child's academic performance, sharing meals with the child, listening to the child's problems, being well acquainted with the child's best friends, and being able to hold a peaceful conversation upon disagreement.

We find statistically significant linear-in-means peer effects in latent cognitive ability. A one standard deviation increase in peers' academic skills at baseline increase individual skills by 0.25 standard deviations. This effect compares with a positive but smaller (0.05 standard deviations) influence of parental investment. We find some weak evidence of a positive interaction between parental and peer effects: the effect of parental investment increases as the influence of peers becomes stronger. We also find that peers around the median of the distribution exert the strongest influence. Conversely, we do not find enough evidence of peer effects in the latent predisposition to use substances or in life-satisfaction. While OLS estimates suggest positive peer effects in latent substance use predisposition, the linear-in-means effect disappears after using IVs to control for common shocks. Our group of compliers with the instrument (those changing behavior as the instrument changes), is located around the median of the latent substance use distribution. We are unable, however, to find suitable instruments for those in the extremes of the distribution, who show a positive influence on substance use in the OLS estimation. We do find some weak evidence of a

deterrence effect of parental investment on substance use. The effect is quite small: a one standard deviation increase in parental investment decreases substance use by around 0.04 standard deviations. Finally, we find no evidence of peer effects and a strong evidence of parental influence in the determination of life satisfaction. The size of the coefficient of parental investment ranges around 0.10 standard deviations.

Our results indicate that during adolescence peers are a stronger influence than parents in shaping some visible outcomes, such as academic achievement. On the other hand, we find that parents continue to exert an impact on their kids, positively promoting academic development and life satisfaction, and deterring risky behaviors such as substance use. The influence of parents, however, is stronger in outcomes less likely to be observable and penalized by peers (such as life-satisfaction) and much smaller than the effect of peers in those outcomes subject to peer influence. Nonetheless, in such a case, parental and peer effects still have a sort of complementarity as the literature has documentated (Pattachini and Zenou, 2011; and Dufur et al., 2013).

Regarding the life-satisfaction, we can think about it as involved in values and norms that parents transmit to their children. Thus the result of the importance of parental investment on life-satisfaction is in line with the literature on cultural transmition (Bisin and Verdier, 2010) where vertical transmission (parental effect) has a strong evidence.

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Table 1: Pearson $\chi 2$ tests for independence of students' characteristics across classes within school-grades.

Students' characteristics	3rd grade	4th grade	Full sample
Age	27.395	38.148	65.543
Female	8.610	5.927	14.537
Mother´s education	34.875	74.390	109.274
Single mother family	21.761*	17.004	38.765*
Intact family structure	18.298	19.392	37.690
Number of siblings	49,692	82.586**	132.278**
Asset index	8,318	19,566	27,884
Mother works	14.028	19.85	33.878
Father works	10.378	13.849	24.227

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 2: Descriptive Statistics

	N	Mean	Std. dev.	Min	Max
	(1)	(2)	(3)	(4)	(5)
Latent and Measurement Variables					
PC1 Academic Performance	555	0.112	1.405	-3.225	3.925
Math test result	555	7.013	2.897	1	12
History test result	555	7.294	1.945	3	12
Biology test result	555	7.721	2.232	1	12
Literature test result	555	7.708	1.915	1	12
Average test results	555	7.434	1.650	3.500	11.750
PC1 Substance Use	785	0.007	2.005	-1.926	11.358
Used alcohol past 30 days	785	0.555	0.497	0	1
Used alcohol past 3 months	785	0.680	0.467	0	1
Frequency of alcohol use past 30 days	785	1.896	2.643	0	26
Frequency of alcohol use past 3 months	785	5.078	8.523	0	78
Drunk to intoxication past 30 days	785	0.192	0.394	0	1
Frequency drunk to intoxication past 30 days	785	0.355	0.952	0	10
Used tobacco past 30 days	785	0.181	0.385	0	1
Frequency of cigarette use past 30 days	785	1.906	6.108	0	30
Used marijuana past 3 months	785	0.099	0.299	0	1
PC1 Life Satisfaction	603	-0.099	1.674	-2.977	3.595
Very satisfied with life in general	603	0.350	0.477	0	1
Very satisfied with neighborhood	603	0.332	0.471	0	1
Very satisfied with safety in neighborhood	603	0.212	0.409	0	1
Very satisfied with safety at school	603	0.385	0.487	0	1
Very satisfied with education	603	0.620	0.486	0	1
Very satisfied with friends	603	0.751	0.433	0	1
Very satisfied with parents	603	0.488	0.500	0	1
Very satisfied with oneself	603	0.363	0.481	0	1
Very satisfied with social status	603	0.557	0.497	0	1
Very satisfied with free time available	603	0.250	0.434	0	1
Explanatory and control variables					
Parental investment index	785	0.480	0.212	0	1
Parent knows child's whereabouts	785	0.674	0.469	0	1
Parent concerned about child's academic performance	785	0.668	0.471	0	1
Parent and child share at least a meal a day	785	0.617	0.487	0	1
Parent attentive to arrival time	785	0.861	0.346	0	1
Child shares problems with parent	785	0.146	0.354	0	1
Child and parent discuss peacefully	785	0.685	0.465	0	1
Parent knows child's friends well	785	0.439	0.497	0	1
Other controls					
Age	785	15.313	0.608	13.521	17.756
Female	785	0.538	0.499	0	1
Mother’s education (# years)	785	14.812	2.916	3.7	17
Single-mom household	785	0.209	0.407	0	1

Household size	785	4.153	1.063	2.000	10
Repeated a grade	785	0.014	0.118	0	1
Age of initiation of alcohol use	785	13.673	1.557	4	16.271
Average GPA past year	785	8.066	1.620	6	12
Wealth index	785	0.482	0.259	0.036	1
Peers' average age	785	15.339	0.480	14.681	16.063
% of peers female	785	0.515	0.110	0.200	0.800
Class size (# students)	785	23.659	4.993	10	34
Peers' avg household education (# years)	785	14.729	1.339	11.630	16.756
% of peers living in single-mom households	785	0.208	0.099	0	0.421
Alcohol problems in the family	754	0.102	0.303	0	1
Drug consumption in the family	761	0.248	0.432	0	1
Smoking in the family	744	0.274	0.446	0	1
In degree centrality	785	6.289	4.052	0	23
Betweenness centrality	736	28.353	21.074	0	100

Table 3: Peer and parental influence on latent skills. OLS results.

	Academic skills t+1 (1)	Substance Use t+1 (2)	Life Satisfaction t+1 (3)
Individual level skills at t	0.537***	0.711***	0.652***
	(0.035)	(0.041)	(0.040)
Peer group average skills at t	0.118**	0.137***	-0.037
	(0.053)	(0.032)	(0.042)
Parental investment	0.059*	-0.033	0.087***
	(0.031)	(0.023)	(0.032)
Mother's years of Education	0.011	0.008	-0.014
	(0.009)	(0.010)	(0.012)
Age	-0.016	0.004	-0.026
	(0.071)	(0.073)	(0.093)
Female	-0.118**	0.013	-0.083
	(0.055)	(0.056)	(0.059)
Single mother household	-0.008	0.053	0.027
	(0.070)	(0.059)	(0.089)
Wealth index	0.093	0.140	0.068
	(0.100)	(0.096)	(0.114)
Repeated a grade	0.097	0.134	0.307
	(0.221)	(0.160)	(0.215)
Household size	-0.016	0.016	0.010
	(0.022)	(0.030)	(0.034)
Age of initiation of alcohol use	-0.007	-0.014	0.012
	(0.020)	(0.021)	(0.020)
Past year GPA	0.229***	-0.014	-0.000
	(0.024)	(0.016)	(0.020)
Classmates' age	0.165	-0.671**	-0.266
	(0.524)	(0.329)	(0.434)
% of classmates female	-0.088	-0.047	0.451
	(0.342)	(0.316)	(0.384)
Class size	0.008	0.014	-0.005
	(0.010)	(0.011)	(0.008)
Classmates' mothers' yrs of education	-0.036	-0.048	0.026
	(0.060)	(0.056)	(0.047)
% of classmates in single-mother households	-0.075	-0.228	-0.050
	(0.309)	(0.252)	(0.303)
School-grade fixed effects	yes	yes	yes
Constant	1.015	6.295	3.747
	(8.402)	(5.520)	(6.771)
N	555	785	603
N_clust	40	43	40
R2	0.707	0.608	0.479

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Table 4: Peer and parental influence on latent skills. Instrumental variables second stage results.

	Academic skills t+1 (1)	Substance use t+1 (2)	Life satisfaction t+1 (3)
Individual skills at t	0.548***	0.714***	0.651***
	(0.032)	(0.040)	(0.038)
Peer group average skills at t	0.250***	0.023	0.008
	(0.071)	(0.068)	(0.102)
Parental investment	0.053*	-0.035	0.087***
	(0.031)	(0.023)	(0.031)
Instrumental variable	Peers' average GPA past year	Peers' average age of initiation of alcohol use	Peers'average household size
Instrumental variable F-statistic 1st stage	51.3	40.4	6.3
N	555	785	603

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level. Each regression adjusts for individual-level adjustors (age, gender, single mother household, household size, an asset index, prior grade repletion, previous year's GPA, age of initiation of alcohol use), and average peer characteristics at the classroom level (average age, gender, and class size, average household head's education, and average family structure) at baseline. Each regression adjusts in addition, for school-grade fixed effects. To simplify interpretation and comparison, the student's outcome at t, the peers' mean, and the parental investment measure, as well as the outcomes at follow up, are all standardized with mean 0 and standard deviation equal to 1. Period t (baseline) corresponds to July 2009 and period t+1 (follow-up) to November 2009. First stage results are reported in Appendix Table A2.

Table 5: Robustness of the IV estimations to alternative control specifications

Panel A: Academic Test Results

	Academic skills t+1 Parsimonious specification	Academic skills t+1 Controlling for other latent skills at t	Academic skills t+1 Controlling for parental substance abuse at t	Academic skills t+1 Controlling for other latent skills and for parental substance abuse at t	Academic skills t+1 Only observations with non-missing values
	(1)	(2)	(3)	(4)	(5)
Academic skills at t	0.826***	0.537***	0.553***	0.539***	0.544***
	(0.027)	(0.031)	(0.035)	(0.030)	(0.036)
Peers' academic skills at t	0.183**	0.248***	0.259***	0.247***	0.143
	(0.076)	(0.065)	(0.068)	(0.062)	(0.117)
Parental investment at t	0.053**	0.037	0.067**	0.056*	0.060**
	(0.026)	(0.031)	(0.028)	(0.029)	(0.028)

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Panel B: Substance Use

	Substance use t+1 Parsimonious specification	Substance use t+1 Controlling for other latent skills at t	Substance use t+1 Controlling for parental substance abuse at t	Substance use t+1 Controlling for other latent skills and for parental substance abuse at t	Substance use t+1 Only observations with non-missing values
	(1)	(2)	(3)	(4)	(5)
Substance use at t	0.734***	0.735***	0.715***	0.739***	0.710***
	(0.036)	(0.043)	(0.040)	(0.042)	(0.042)
Peers' substance use at t	0.014	0.048	0.003	0.041	-0.022
	(0.068)	(0.074)	(0.070)	(0.079)	(0.078)
Parental investment at t	-0.036*	-0.037	-0.046**	-0.054**	-0.043*
	(0.022)	(0.023)	(0.022)	(0.023)	(0.023)

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Panel C: Life satisfaction

	Life satisfaction t+1 Parsimonious specification	Life satisfaction t+1 Controlling for other latent skills at t	Life satisfaction t+1 Controlling for parental substance abuse at t	Life satisfaction t+1 Controlling for other latent skills and for parental substance abuse at t	Life satisfaction t+1 Only observations with non-missing values
	(1)	(2)	(3)	(4)	(5)
Life satisfaction at t	0.652***	0.652***	0.645***	0.641***	0.653***
	(0.036)	(0.038)	(0.041)	(0.040)	(0.038)
Peers' life satisfaction at t	-0.016	0.031	0.033	0.078	-0.048
	(0.121)	(0.114)	(0.116)	(0.142)	(0.132)
Parental investment at t	0.088***	0.097***	0.102***	0.114***	0.094***
	(0.031)	(0.030)	(0.033)	(0.032)	(0.031)

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Notes to Table 5: Each regression adjusts for individual-level adjustors (age, gender, single mother household, household size, an asset index, prior grade repletion, previous year's GPA, age of initiation of alcohol use), and average peer characteristics at the classroom level (average age, gender, and class size, average household head's education, and average family structure) at baseline. Each regression adjusts in addition, for school-grade fixed effects. To simplify interpretation and comparison, the student's outcome at t, the peers' mean, and the parental investment measure, as well as the outcomes at follow up, are all standardized with mean 0 and standard deviation equal to 1. Period t (baseline) corresponds to July 2009 and period t+1 (follow-up) to November 2009.

Table 6: Peer effects of different terciles of the skills distribution

Panel A: Academic Test Results

	Academic skills t+1 OLS	Academic skills t+1 OLS	Academic skills t+1 OLS	Academic skills t+1 IV	Academic skills t+1 IV	Academic skills t+1 IV
	(1)	(2)	(3)	(4)	(5)	(6)
Academic skills at t	0.528***	0.513***	0.523***	0.515***	0.502***	0.514***
	(0.035)	(0.035)	(0.035)	(0.060)	(0.037)	(0.035)
Lowest tercile's skills at t	-0.009			0.706		
	(0.052)			(1.913)		
Middle tercile's skills at t		0.186***			0.325***	
		(0.055)			(0.118)	
Upper tercile's skills at t			0.059			0.186***
			(0.043)			(0.056)
Parental investment at t	0.065**	0.057*	0.063**	0.053**	0.037	0.067**
	(0.031)	(0.032)	(0.030)	(0.026)	(0.031)	(0.028)
Instrument F-statistic 1st stage				0.15	8.86	30.41

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Panel B: Substance Use

	Substance use t+1 OLS	Substance use t+1 OLS	Substance use t+1 OLS	Substance use t+1 IV	Substance use t+1 IV	Substance use t+1 IV
	(1)	(2)	(3)	(4)	(5)	(6)
Latent substance use at t	0.692***	0.702***	0.707***	0.671***	0.708***	0.721***
	(0.041)	(0.041)	(0.042)	(0.050)	(0.040)	(0.050)
Lowest tercile's substace use at t	0.175***			0.345		
	(0.023)			(0.232)		
Middle tercile's substance use at t		0.138***			0.067	
		(0.049)			(0.068)	
Upper tercile's substance use at t			0.074*			-0.069
			(0.040)			(0.240)
Parental investment at t	-0.031	-0.034	-0.034	-0.026	-0.035	-0.038
	(0.024)	(0.024)	(0.023)	(0.024)	(0.023)	(0.024)
Instrument F-statistic 1st stage				0.99	40.38	0.93

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Panel C: Life satisfaction

	Life satisfaction t+1 OLS (1)	Life satisfaction t+1 OLS (2)	Life satisfaction t+1 OLS (3)	Life satisfaction t+1 IV (4)	Life satisfaction t+1 IV (5)	Life satisfaction t+1 IV (6)
Latent life satisfaction at t	0.655***	0.658***	0.652***	0.668***	0.635***	0.635***
	(0.040)	(0.040)	(0.040)	(0.100)	(0.081)	(0.040)
Lowest tercile's life satisfaction at t	-0.038			-0.182		
	(0.043)			(1.035)		
Middle tercile's life satisfaction at t		-0.044			0.116	
		(0.040)			(0.514)	
Upper tercile's life satisfaction at t			-0.004			0.103
			(0.041)			(0.095)
Parental investment at t	0.088***	0.087***	0.087**	0.091**	0.087***	0.088***
	(0.032)	(0.032)	(0.032)	(0.042)	(0.032)	(0.032)
Instrument F-statistic 1st stage				0.07	0.26	11.76

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Notes to Table 6: Each regression adjusts for individual-level adjustors (age, gender, single mother household, household size, an asset index, prior grade repletion, previous year's GPA, age of initiation of alcohol use), and average peer characteristics at the classroom level (average age, gender, and class size, average household head's education, and average family structure) at baseline. Each regression adjusts in addition, for school-grade fixed effects. To simplify interpretation and comparison, the student's outcome at t, the peers' skill averages in each tercile, and the parental investment measure, as well as the outcomes at follow up, are all standardized with mean 0 and standard deviation equal to 1. Period t (baseline) corresponds to July 2009 and period t+1 (follow-up) to November 2009.

Appendix 1

Table A1: Principal Component Analysis

Panel A. Academic performance

Eigenvalues

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.280	1.604	0.570	0.570
Comp2	0.676	0.110	0.169	0.739
Comp3	0.567	0.090	0.142	0.881
Comp4	0.476	.	0.119	1.000

Eigenvectors

Variable	Comp1	Unexplained
Math test result	0.489	0.456
History test result	0.526	0.370
Biology test result	0.495	0.442
Literature test result	0.490	0.453

Panel B. Substance Use

Eigenvalues

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	4.299	2.981	0.478	0.478
Comp2	1.318	0.323	0.147	0.624
Comp3	0.996	0.211	0.111	0.735
Comp4	0.785	0.133	0.087	0.822
Comp5	0.652	0.333	0.073	0.895
Comp6	0.319	0.050	0.035	0.930
Comp7	0.269	0.060	0.030	0.960
Comp8	0.208	0.055	0.023	0.983
Comp9	0.154		0.017	1.000

Eigenvector

Variable	Comp1	Unexplained
Used alcohol past 30 days	0.364	0.432
Used alcohol past 3 months	0.315	0.574
Frequency of alcohol use 30 days	0.380	0.380
Frequency of alcohol use 3 months	0.350	0.473
Drunk to intoxication past 30 days	0.354	0.460
Used tobacco 30 days	0.331	0.529
Frequency of cigarett use 30 days	0.291	0.637
Used illegal drugs past 3 months	0.271	0.685

Panel C. Life Satisfaction

Eigenvalues

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.925	1.541	0.293	0.293
Comp2	1.384	0.439	0.138	0.431
Comp3	0.946	0.034	0.095	0.526
Comp4	0.912	0.107	0.091	0.617
Comp5	0.805	0.016	0.081	0.697
Comp6	0.789	0.161	0.079	0.776
Comp7	0.628	0.032	0.063	0.839
Comp8	0.596	0.057	0.060	0.898
Comp9	0.539	0.062	0.054	0.952
Comp10	0.477	.	0.048	1.000

Eigenvector

Variable	Comp1	Unexplained
Very satisfied with life in general	0.383	0.571
Very satisfied with neighborhood	0.275	0.779
Very satisfied with safety in neighborhood	0.242	0.829
Very satisfied with safety at school	0.291	0.752
Very satisfied with education	0.326	0.690
Very satisfied with friends	0.281	0.768
Very satisfied with parents	0.375	0.589
Very satisfied with oneself	0.374	0.590
Very satisfied with social status	0.347	0.647
Very satisfied with free time available	0.219	0.860

Appendix 2

Table A2: First stage regressions, instrumental variable estimation

	Academic skills t+1	Substance use t+1	Life satisfaction t+1
	(1)	(2)	(3)
Instrumental variable #	1.336***	-1.123***	-1.492**
	(0.186)	(0.177)	(0.595)
Individual level skills at t	-0.103***	-0.021	-0.024
	(0.019)	(0.028)	(0.033)
Parental investment	0.018*	-0.003	0.008
	(0.010)	(0.013)	(0.017)
Mother's years of Education	0.000	0.008	0.012
	(0.006)	(0.006)	(0.010)
Age	0.010	0.138***	0.156*
	(0.048)	(0.050)	(0.084)
Female	-0.098**	0.036	-0.136*
	(0.042)	(0.049)	(0.071)
Single mother household	0.006	0.003	-0.039
	(0.041)	(0.035)	(0.075)
Wealth index	-0.008	-0.009	-0.063**
	(0.009)	(0.012)	(0.028)
Repeated a grade	0.058	-0.068	-0.056
	(0.061)	(0.069)	(0.062)
Household size	-0.146	-0.261*	0.069
	(0.152)	(0.153)	(0.144)
Age of initiation of alcohol use	0.013	-0.029**	0.015
	(0.008)	(0.011)	(0.014)
Past year GPA	0.021	0.006	0.018
	(0.018)	(0.005)	(0.014)
Classmates' age	-0.037	2.851***	3.178*
	(0.939)	(0.964)	(1.589)
% of classmates female	-2.185**	0.872	-2.414
	(0.839)	(1.039)	(1.461)
Class size	-0.063***	-0.025	-0.076*
	(0.021)	(0.019)	(0.043)
Classmates' mothers' yrs of education	0.062	0.161	0.202
	(0.107)	(0.103)	(0.183)
% of classmates in single-mother households	0.632	0.739	-1.104
	(0.792)	(0.712)	(1.262)
School-grade fixed effects	yes	yes	yes
Constant	-9.568	-31.763*	-43.349*
	(15.370)	(16.527)	(25.081)
N	555	785	603
N_clust	40	43	40
r2	0.884	0.847	0.724

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Appendix 3

Table A3: Heterogeneous peer effects in cognitive outcomes. IV second stage estimation.

	Academic skills t+1 (1)	Academic skills t+1 (2)	Academic skills t+1 (3)	Academic skills t+1 (4)	Academic skills t+1 (5)
Academic skills at t	0.822***	0.827***	0.829***	0.828***	0.824***
	(0.027)	(0.027)	(0.028)	(0.034)	(0.028)
Peers' academic skills at t	0.171**	0.294**	0.311	0.183**	0.129
	(0.076)	(0.130)	(0.293)	(0.076)	(0.104)
Peers' skills x parental investment	0.084*				
	(0.044)				
Peers' skills x female		-0.174			
		(0.136)			
Peers' skills x high household education			-0.008		
			(0.019)		
Peers' skills x high achiever status				0.001	
				(0.230)	
Peers' skills x high popularity					0.066
					(0.112)
Parental investment at t	0.061**	0.048*	0.053**	0.053**	0.047*
	(0.028)	(0.028)	(0.026)	(0.026)	(0.028)
Female	-0.030	-0.056	-0.038	-0.037	-0.021
	(0.059)	(0.059)	(0.059)	(0.059)	(0.061)
High household education	0.015	0.015	0.015	0.015	0.014
	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)
High achiever status at baseline				-0.009	
				(0.097)	
High popularity at baseline					0.012
					(0.069)

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Notes to Appendix Table 3: Each regression adjusts for a parsimonious set of adjustors (age, gender, mother's education, peers' age, gender, and family education, and school-grade fixed effects).