The Effect of Social Networks on Student's Academic and Non-Cognitive Behavioral Outcomes: Evidence from Conditional Random Assignment of Friends in School*

April 2014

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Abstract

In this paper, we estimate the influence of social networks on educational attainment and behavioral outcomes of students in school. More specifically, we investigate how separating from pre-existing social networks during the transition from elementary to middle school affect students' academic progress and school and social satisfaction. We use social networks identified by the students themselves in elementary school, as part of a unique aspect of the Tel Aviv school application process which allows sixth-grade students to designate their middle schools of choice and to list up to eight friends with whom they wish to attend that school. The lists create natural "friendship hierarchies" that we exploit in our analysis. We designate the three categories of social networks that stem from these lists as follows: (1) reciprocal friends (students who list one another); and for those whose friendship requests did not match: (2) followers (those who listed fellow students as friends but were not listed as friends by these same fellow students) and (3) non-reciprocal friends (parallel to followers). Our identification strategy is based on a conditional random assignment model: in Tel Aviv middle schools students' are randomly assigned to classes within a given school. Therefore, conditional on the number of friends a student has at her school, the number of friends she attends class with should be random. Our results suggest that the presence of reciprocal friends and followers in class has a positive and significant effect on test scores in English, math, and Hebrew. However, the number of friends in the social network beyond the first circle of reciprocal friends has no effect at all on students. In addition, the presence of non-reciprocal friends in class has a negative effect on a student's learning outcomes. We find that these effects have interesting patterns of heterogeneity by gender, ability and age of students. In addition, we find that these various types of social networks have positive effects on other measures of non-cognitive behavioral outcomes, including social and overall happiness in school and whether one exhibits violent behavior.

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* We thank the Education Department of Tel-Aviv-Yafo Municipality and Yossef Shub, the CEO of Optimal Scheduling Systems, for making the data available for this study. Agnia Galesnik and Elior Cohen provided excellent research assistant. We also benefited from comments from Gigi Foster, Michael Friedman, Analia Schlosser, Tali Regev, Yona Rubinstein, Fabian Waldinger, and from seminar participants at the Hebrew University, Tel Aviv University, University of Warwick, University of Haifa, Ben Gurion University, Bank of Israel, at a conference in the Chinese University of Hong Kong, and at the Economic Workshop in IDC.

I. Introduction

There are many educational programs and practices that separate students from their social network in school or class. For example, school busing programs and policies that enhance school choice in order to increase school productivity (by introducing competition among schools) often detach students from their childhood social network.[1] Other policies that often lead to students being separated from their friends include educational reforms that redesign school zones or catchment areas, programs which expand student access to high-performing schools, or reassigning students when they advance to a higher grade in primary school.[2] Social and welfare programs, such as the US Moving to Opportunity, also detach though voluntarily children from their childhood social environment.[3] The consequences of such social detachment are usually not taken into account in policy making circles[4], even though it is well documented in the sociology and psychology literature that students' social networks are important for their academic performances and overall development (Wentzel 1993, Roseth et al. 2008).[5]

In this paper we investigate the influence of social networks on educational attainment and non-cognitive behavioral outcomes of children in school while carefully addressing the identification and the causal nature of the relationship. Our unique contribution is the analysis of impact of various social networks, while examining as well the narrow and wider circles of these social environments.

[1] Many countries have pursued this type of policy. See for example papers on the U.S. (Cullen et al. 2005), (Angrist et al. 2011); U.K (Gorad 2001); New Zealand (Fiske and Ladd 2000); and Colombia (Angrist et al. 2002).

[2] For example, the Wake County school district has moved up to five percent of the school population in any given year during the 1990s in order to balance schools' racial and income composition (Hoxby and Weingarth 2005).

[3] For an analysis of the Moving to Opportunity Experiment, see Katz et al. 2001, Katz et al, 2007, and Kling et al. 2005.

[4] The recently approved Boston Public School's proposal to reallocate facilities in an effort to expand access to high performing schools has faced strong opposition from parents of children who under the new plan will be detached from their childhood environment [http://www.change.org/petitions/mayor-thomas-menino-stop-bps-superintendent-johnson-s-plan-to-uproot-mission-hill-school-k-8-2].

[5] Many papers emphasize the social difficulties that students face during the transition from elementary school to middle school due to puberty (Wigfield et al. 1991), and changes in social networks of peers, family, and authority figures (Elias et al. 1985, Eccles et al. 1993, Rudolph et al. 2001). This literature stresses the important role of friendships in the adjustment process of students to the new school environment and even suggests that there are long run implications of adjustment difficulties in middle school to latter educational attainments (Wentzel 1998, Wentzel et al. 2004, Nelson and Debacker 2008, Veronneau et al. 2008). Furthermore, friendships ties among children (especially of reciprocal nature) and the related parental networks are also both central dimensions of social capital and its effect on human capital underscoring the importance of the potential negative effect of breaking down social networks of adolescents (Coleman 1988).

We base our analysis on a school choice program that started in Tel- Aviv in 1994 which allowed students who completed primary school to choose their middle school.[6] While much of the literature on school choice compares the benefits that accrue to students who receive their first school choice relative to students who did not, this paper highlights another important and generally overlooked angle of this process: the importance of maintaining one's social network throughout middle school.[7] Our evidence suggests that taking into account the students' social network can create a better assignment of students among and within schools in general and improve the design of school choice programs in particular.

For our research, we take advantage of a unique dataset from a Tel Aviv school choice program that allows us to analyze the students' social networks in elementary schools. These networks are identified by the students themselves as the result of an unusual aspect of the Tel Aviv school application process, which allows sixth-grade students to designate their middle schools of choice and to list up to eight friends with whom they wish to attend that school. The lists create natural "friendship hierarchies" that we exploit in our analysis. We designate the three categories of requited and unrequited networks of friends that stem from these lists as follows: reciprocal friends (students who list one another), and for those whose friendship requests did not match: followers (those who listed fellow students as friends but were not listed as friends by these same fellow students) and non-reciprocal friends (those who were listed by fellow students but did not reciprocate by putting the same students on their own lists).

Using these data, we examine the consequences of the school transition on the size of a student's pre-existing (from elementary school) social networks and the types of friendships. Then, we estimate the effect of the students' new social environment after their assignments in middle schools on their educational attainment and not-cognitive behavioral outcomes. Our identification strategy is a conditional random assignment model: in Tel Aviv middle schools students' are randomly assigned to

[6] See Lavy (2010) for a further analysis of the effect of the Tel Aviv choice program on student achievements and behavioral outcomes.

[7] The optimal design of school choice programs is the focus of much recent research. For example, in a recent serious of studies, Abdulkadiro et al. 2003, 2005, 2011 and Pathak and Sönmez (forthcoming), analyze the optimal design of admission rules in school choice programs where students take into account strategic considerations when submitting their preferences for schools.

classes within a given school; therefore, conditional on the school and on the number of friends a student has at her school, the number of friends she attends class with should be random; since we estimate the impact of friends by type in class, we control for the number of friends by type in school; the school (and in a variation the class) fixed effect enable to eliminate all school (class)-level unobservable and compare the impact of friends in class among students who attend the same class and have the same number of friends in school. To support our identification assumption, we also provide evidence for the practice of random assignment of students to classes within schools and show balancing tests that demonstrate that, conditional on school and on the number of friends in school, student's background characteristics are not correlated with the number of friends in class.

Our results suggest relatively large effect of the various social networks; the presence of reciprocal friends in class has a positive and significant effect on test scores in English, math, and Hebrew: adding one such friend in class raises the student's average test scores by 0.095 standard deviation of the test scores distribution. This relatively large effect is however limited to the first circle of such friends, while any extensions of this social network have no effect on the academic performance of students. The presence of followers also has significant positive effects on student outcomes. Non-reciprocal friends in class have the opposite (negative) effect on a student's learning outcomes. We also find that these effects have interesting patterns of heterogeneity by gender, ability, and student age. In addition, we present in the paper other effects of these various types of social networks on other non-cognitive behavioral measures, including social and overall satisfaction in school, time allocated for studying at home, and whether one exhibits violent behavior. For example, we find that the presence of more reciprocal friends and followers in the classroom reduces fear and intimidation from school violence and bullying, and improves social satisfaction and school satisfaction.

The rest of the paper is organized as follows. In section II, we present a review of the literature. In section III, we present our data. Section IV explains the identification and estimation methodologies. We detail our results in section V and offer conclusions and policy implications in section VI.

II. Literature Review

From childhood to adolescence, social networks play a central role in shaping individuals' attitude toward education (Coleman 1961). The psychology and sociology literature suggests that various kinds of social networks have different impacts on individual behavior.[8] This literature has examined the relationship between friendship networks and children's educational outcomes and social well-being, but it presents evidence that is generally cross-sectional in nature, with little attention paid to a potential correlation between omitted variables related to social networks.

In the economic literature, many papers have studied extensively the effect of social interactions on educational achievements while addressing selection bias problems. However, this literature on social interactions in education focuses mainly on peer effects on educational outcomes rather than actual measures of different types of social networks. Several papers identified peer effects by investigating the implications of random assignments of college students in dormitories or classes on the students' grades (Sacerdote 2001, Zimmerman 2003, De Giorgi et al. (2010)). Alternatively, several studies have examined the effects of small changes in the characteristics of classrooms throughout the years on the average attainments of students in these classrooms (Hanushek et al. 2003, Lavy and Schlosser 2011, Lavy et al. 2012a, Lavy et al. 2012b). Only few papers address the impact of friendships ties on educational outcomes, as we do in this paper. Bramoullé et al. (2009) for example, study the impact of the characteristics and grades of the student's friends on her educational achievements while using the characteristics of friends of friends as instrumental variable. Other closely related studies are Patacchini et al. 2011, and Lin 2010. Lin (2010) implements this method on the Add Health data and finds significant effect of both friends' school grades and friends' characteristics on the student's educational attainments. Patacchini et al. (2011) test the persistency of

[8] Friendships ties among children, especially of reciprocal nature are said to be a source of emotional support (Hartup 1996, Crosnoe et al 2003, Vaquera and Kao 2008); help to deal with problems (Azmitia and Montogomery 1993); and can also function as academic resources (Cauce 1986). The effect of popularity and social status on educational outcomes is more ambiguous. While most of the literature emphasis the fact that centrality in a peer group is usually associated with promoting students' self-esteem, since aggressive children often holds central position within their peer group, it can also promote aggression and decrease children's academic outcomes (Salmivalli et al. 1997). Research examining the different types of rejected children suggests that negative peer experiences may exacerbate academic difficulties by undermining motivation to attend school or by increasing the exposure to other marginalized peers who de-value academic success (Buhs and Ladd 2001).

these effects after more than 10 years and find significant effects of friendships ties formed in grades 10-12 but not for those who were formed in lower grades.

Finally, another form of social network that is addressed in our paper is the broad social network of the students, beyond the first circle of friends.[9] The impact of broader forms of social interactions such as children's social networks is usually associated with the social capital embodied in networks that takes the form of more trust and cooperation among children in the network (Coleman 1988). Empirically, however, this issue had been addressed (to the best of our knowledge) only by Calvo-Amengol et al. (2009) who show that the educational outcomes of students are proportional to their position in the network, given by their Katz-Bonacich centrality measure.

Relative to this literature we make in this paper several important contributions. First, we identify several unique social networks based on types of friendships and estimate their causal effects on student's outcomes. Second, we distinguish between the immediate and the wider definition of the social-network. Third, we estimate the effect of social networks on non-cognitive behavioral outcomes in addition to academic achievements.

III. Data

A. Data Sets

In this paper we use a unique database of friendship networks of students that participated in the Tel Aviv school choice program in 2000-2004. A new school choice program started in Tel Aviv in September 1994. It replaced a busing integration program that assigned some students to schools in the city out of their school district. The choice program allowed students who completed primary school a choice of a middle school. Each student could choose from a set of five schools, three of which were outside his school district. The school choice program opened the possibility for a better match between students and schools, and the system had the potential to increase school productivity by introducing competition among schools.

Within this framework, each student, at the end of sixth grade, was asked to rank their preferred five middle schools, and to list up to eight peers with whom they would like to be assigned in middle school. In case of excess demand for enrollment in one school, students were assigned with

[9] See Jackson (2011) for a recent survey on the theoretical and empirical research on this type of broad social network. The surveyed research focuses on how social networks shape behavior and economic outcomes, in particular the role of social networks in markets and exchange, learning and diffusion, and network games, background on social network characteristics and measurements, models of network formation, models for the statistical analysis of social networks, as well as community detection.

one or more of their nominated friends to a subsequent school, so as to maintain a balanced enrollment across schools based on socio-economic level, educational achievement, gender, and disciplinary record.[10] While the assignments in schools were based on students' school and friend choices, classes were formed randomly.[11] The randomness of class composition results from the fact that students' assignments into class based on ability, family background or any other characteristics of the students are forbidden by law in Israel and this law is strictly enforced. In order to explicitly test for the randomness of class composition in our sample, we performed a series of Pearson Chi-Square (χ^2) that check whether the student's characteristics and the class the student is assigned is statistically independent. Based on 13 middle schools (with two or more classes) and nine characteristics (gender, ethnicity, number of siblings, and level of parents' education) 11 p values were equal of lower than 5% out of 117 p values. Therefore in 9% of the cases we cannot reject that there is non-random assignment. In addition only in one of 13 middle schools, up to three p values were equal or lower than 5%. Overall, we conclude that there is no evidence of systematic formation of classrooms with respect to students' characteristics (see also Lavy (2011) who shows that there is no evidence of systematic non-random formation of classrooms in primary and middles schools in Israel).

The empirical analysis of this paper is based on the Tel Aviv municipality's administrative records of sixth-grade students in schools that participated in the Tel Aviv school choice program, for the years 2000 and 2002 and 2003. The cohort of 2001 is not included in this study because the essential data on school choice and friendships are not available.[12] These records contain an individual identifier, a school and class identifier in the sixth grade and student preferences for middle school enrollment and friend assignments.

[10] Because the system guaranteed that each student would attend school with at least one of his or her nominated friends (if the student nominated eight friends), a strategy that guaranteed getting the first chosen school was to form a group of friends that all chose the same school as first choice but each chose different schools as their other choices. This strategy will work perfectly for all group members if there are only four or five students in the group but it might be less than perfect for some members of the group when the group size is increased beyond five because there are only 14 relevant secondary schools.

[11] Note that on average 93 percent of the students received their first school choice and most of the remaining 7 percent received their second choice. Since most of the students received their first school choice, friends' choice was not a crucial element of the assignment to schools.

[12] We obtained the data from the School Authority of Tel Aviv and the files for the 2001 cohorts were erased from their archive by mistake.

In order to test the effect of the students' separation from pre-existing social networks during the transition from elementary to middle school on their educational and social outcomes, we combine this dataset with data from two additional sources. The first is administrative records from the Israel Ministry of Education for the three cohorts that we study. Each student's record contains their class identifier, school identifier, and demographic information (gender, ethnicity, number of siblings, and level of parents' education). The second source of data is the GEMS records (Growth and Effectiveness Measures for Schools - *Meizav* in Hebrew) collected by the Division of Evaluation and Measurement of the Ministry of Education.[13] This dataset includes test scores of eighth-graders from a series of tests (in math, Hebrew and English) and data from seventh- through eighth-grade students' surveys that include questions addressing various aspects of class environment and student behavior.[14]

The final merged Panel data set includes data from students' social networks in the sixth-grade and their new placement in the eighth-grade, eighth-grade student test scores and questionnaires for 2000-2002, 2002-2004 and 2003-2005, and student characteristics.[15]

Table 1 presents descriptive statistics, for the sample size, number of schools, and number of classes for the Panel data set. We use data for the three sixth grade cohorts: 2000, 2002 and 2003. The school choice program included 42 secular primary schools and 14 secular middle schools[16]. Nearly every primary-school student (about 97 percent) in those schools took part in the program and listed at least one of the two preferences – the preferred school enrollment or peer assignments.[17] The sample included 1018 students from the 2000 cohort, 929 from the 2002 cohort, and 913 in the 2003 cohort. The table indicates that the cohorts are similar across a host of variables: parental education, average family size, and ethnicity.

[13] The GEMS is not administered for school accountability purposes, and only aggregated results at the district level are published. For more information on the GEMS see the Division of Evaluation and Measurement website (in Hebrew): http://cms.education.gov.il/educationcms/units/rama/odotrama/odot.htm.

[14] The GEMS is administered at the midterm of each school year to a representative 1-in-2 sample of all elementary and middle schools in Israel, so that each school participates in GEMS once every two years. The proportion of students tested is above 90 percent, and the rate of questionnaire completion is roughly 91 percent. The raw test scores uses a 1-to-100 scale that we transform into z-scores to facilitate interpretation of the results.

[15] Since every school is sampled once in two years, we observe only half of the sixth- and eighth-grade cohorts in each pair of years.

[16] The number of middle schools presented in the paper refers only to middle schools with GEMS test scores.

[17] If a student listed his or her preferred school but not his or her preferred peers (about 6 percent of the students), we assume that he did not have friends with whom he or she wanted to be with in middle school.

B. Definition and measurement of friendship types

In this study we are able to distinguish between different types of social networks, such as reciprocal friendships versus non-reciprocal. In particular, our database allows us to map students' social networks in elementary schools and in middle schools (according to their sixth grade social networks and after their new assignments).[18] By using the students' friendship preferences we are able to define four different types of students' social networks: (1) reciprocal friends - the nominated friends who reciprocated with friendship nominations; (2) followers - students who nominated individual i but were not reciprocally nominated as friends by i; (3) non-reciprocal friends - students nominated by individual i but who did not reciprocate with friendship nominations of student i and (4) second circle of reciprocal friends- which includes all reciprocal friends of reciprocal friends.

Table 2 lists the descriptive statistics of these social networks at the classroom level (columns 1-3) and at the school level (columns 4-6). The table indicates that on average students have more reciprocal friends than either followers or non-reciprocal friends across almost all groups. For example, the number of reciprocal friends in class is 3.1 in 6th grade while the number of followers is 2.48 and the number of non-reciprocal friends is 2.38. The range of followers is nevertheless wider (from zero to 13 in class in the sixth grade) than the range of reciprocal friends and non-reciprocal friends, since students were allowed to list just up to eight peers. The second circle of reciprocal friends in class includes on average more students (3.6 students in class in the sixth grade) than any other form of first circle friendships, and has also the widest range, from zero to 18 students.

Note that since we observe the students' social networks only in the 6th grade, the table indicates that all types of friendships decline between sixth and eighth grade during the transition from elementary to middle school. For example, the number of reciprocal friends in school drops from 3.5 to 2.7 in the eighth grade and a sharper decline is observed in the count of various friends at the class level. The decline in the number of friends at the school level is due to the fact that the city authority tried to meet students' school preferences, rather than assigning them to school based on friendships' requests. This decline is even sharper at the class level (from 3.1 to 1.5) since classes were formed

[18] It should be noted that our definition of friendships differ from the one usually used in the psychology and sociology literature that relies mainly on more direct questionnaires regarding students' social networks.

randomly. We will rely on this significant variation in number of friendships by types in class, which is random once we control for the number of friendships by type in school, when we estimate the impact of the number of friends by type on students test scores[19].

We also compare social networks according to subgroup in Table A1. For example, the table indicates that girls have larger social networks of all kinds than boys. Younger students have fewer reciprocal friends and followers and more non-reciprocal friends than students who are in the same grade but older. Students of highly educated parents have more reciprocal friends, fewer non-reciprocal friends and considerably more followers than students of low-skilled parents. These patterns are consistent at the class level as well as at the school level.

IV. Identification and Estimation

The main goal of this paper is to estimate the effect of the size of social networks on middle school students' academic progress and non-cognitive behavioral outcomes. Our main identification strategy is based on a conditional random assignment model. Since students are randomly assigned to classes within schools, then conditional school and on the number of friends a student has at her school, the number of friends she attends class with should be random. This motivates the following estimation strategy:

$$y_{icjt} = \alpha + \beta_s + \delta_j + \gamma_t + \beta_n \sum_n FC_{nicjt} + \mu_n \sum_n FS_{nicjt} + u_c + \varepsilon_{icjt}$$

where y_{icjt} denotes the outcome of student *i*, from class/school *c*, subject *j* and year t; β_s is the school fixed effects; δ_j subject fixed effect; γ_t is the year fixed effect; $\sum_n FC_{nicjt}$ are the size of the social network of type n in class, where the types are: first and second circles of reciprocal friends, followers and non-reciprocal friends; and $\sum_n FS_{nicjt}$ are the number of friends of type n in school. The error term in the equation includes a school/class-specific random element, u_c, that allows for any type of correlation within observations of the same school across classes and an individual random element ε_{icjt}. The coefficients of interest are β_n, which capture the effects of the different types of

[19] Note that since the curriculum in middle schools in Israel does not include any elective courses which appear in the study program only in high school, the number of friends that the student has in class is a main channel of influence on his educational and social outcomes, even when the number of friends in school is taken into account.

friendships in class. With students randomly assigned to classes within schools, any additional controls should not affect the plim of the estimate of β_n. However, we also estimate a model that include a class fixed effect β_c instead of a school fixed effect and also student characteristics, X_{icjt} , including the mother's and father's years of schooling, number of siblings, immigration status, and ethnic origin. Controlling for student's background might improve estimation efficiency. We note that the sensitivity of the treatment estimates to these additional controls will provide indirect evidence about whether the size of the different types of social networks is correlated with student's predetermined characteristics which we will also test directly by running standard balancing regressions. The fuller model that we estimate is as follows:

$$y_{icjt} = \alpha + \beta_c + \delta_j + \gamma_t + \lambda X_{icjt} + \beta_n \sum_n FC_{nicjt} + \mu_n \sum_n FS_{nicjt} + u_c + \varepsilon_{icjt}$$

As an alternative specification, we will present also results from a regression that include the sum of the number of friends by type in school as controls, which is less correlated with the coefficients of interest, instead of the number of friends by type in school.

V. Results: Effect of Types of Friendships on Academic Outcomes

A. Main Results

Table 3 reports the estimated effect of social networks, measured by number of friends by type of friendship in class, on pupils' academic success. The test scores in all three subjects (math, English, and Hebrew) are pooled together. We report results for three different specifications: the first specification is a simple OLS regression with subject and year fixed effects; a second specification is based on our conditional random assignment model and it includes as controls middle school fixed effects and the number of friends by type in school; and a third specification includes additionally pupil characteristics and middle school class fixed effects. Each estimate presented in the first three columns comes from a separate regression. We estimate the impact of reciprocal friends (column 1), followers (column 2), and non-reciprocal friends (column 3), on academic outcomes. The next three columns (columns 4-6) show the estimated coefficients from one joint regression that includes the number of reciprocal friends, followers, and non-reciprocal friends in class together.

The simple OLS estimates in columns 1-3 are significant for the three types of friendships, indicating that reciprocal friends and followers have a positive effect on pupil academic performance and non-reciprocal friends has the opposite (negative) effect. The treatment estimates of all three types of friends decline in the conditional random assignment specification. The estimate for reciprocal friends declines marginally while the estimate for followers drop by half but remains statistically significant. The estimate for non-reciprocal friends, on the other hand, becomes not significantly different from zero. We note however that these estimates are robust to adding pupil's characteristic and including class fixed effects instead of school fixed effects to the regression. The estimates of reciprocal friends and followers remain almost identical, while the estimate of non-reciprocal friends is now negative and larger but it is still not significantly different from zero. The fact that the estimates remain stable when adding pupil's characteristic implies that the number of friends by type is not correlated with student's observed characteristics, once we control for the number of friends by type in school and class unobserved characteristics. In columns 4-6 of Table 3 we report estimates from regressions that include all three types of friends jointly in the regression. The table indicates that the estimates for reciprocal friends, followers and non-reciprocal friends in columns 4-6 respectively are only marginally lower than the respective estimates in columns 1-3 despite some degree of collinearity between the three friendship types. Similar to above, the estimates remains similar when adding the number of friends by type in school and school fixed effect and are also robust to pupil's characteristic. The estimates of reciprocal friends declines marginally to 0.095 (se= 0.013) and the estimates of followers drop to 0.033 (se= 0.016). The estimate of non-reciprocal friends remains not significantly different from zero. We view this result as evidence supporting our identification strategy.

In Table 4, we present the results from an alternative specification. The estimates presented are from a joint regression that includes the number of the three types of friendships in class while controlling for the sum of these three types of friendships at school level instead of three separate controls. Similar to Table 3, the first specification is a simple OLS regression with subject and year fixed effects; the second specification is based on our conditional random assignment model and it includes as controls middle school fixed effects and the sum of the number of friends by type in

school; and the third specification includes additionally pupil characteristics and middle school class fixed effects. Adding the sum of these three types of friendships as a control and the school fixed effects changes the estimates less comparing to adding the alternative controls in Table 3. While similarly to the previous case adding pupil characteristics leave the estimates almost unchanged. The estimate of reciprocal friends resemble the estimate in the previous specification 0.085 (se=0.009) and the estimate of followers is higher 0.056 (se=0.014). The estimate of non-reciprocal friends is also negative, as in the previous specification, but it is now statistically significant -0.035 (se=0.015).

These results imply relatively large impact of the social networks, especially that of reciprocal friends, on test scores.[20] For example, an addition of one reciprocal friend raises average test scores by 0.095 standard deviation of the test scores distribution, according to the baseline specification (0.085 according to the alternative specification). Another way of assessing the magnitude of the effect size is by computing the effect of the decline of 1.6 reciprocal friends in the transition from primary to middle school (based on the summary statistics in Table 2). This change led to a decline in the average test scores of 0.15 standard deviation (based on Table 3 estimates).

The treatment estimate of followers is 0.033 standard deviation in the baseline specification and 0.056 standard deviation in the alternative specification. Therefore, the decline of 1.8 in the mean number of followers in middle school relative to primary school lowered the average test scores by a 0.06 standard deviation according to the baseline specification (Table 3), and by a 0.10 standard deviation according to the second.

The impact of non-reciprocal friends is not significant according to the baseline specification, but according to the second, an increase of one non-reciprocal friend will reduce test scores in all three subjects by a 0.035 standard deviation. Therefore, the average 'loss' of 1.72 non-reciprocal friends in middle school relative to primary school increased the average test scores by a 0.04 standard deviation.

[20] Appendix Table A2 tests the effect of the number of friends by type on each subject separately. The results are remarkably similar across subjects. While the subject-specific estimates are naturally less precise than our pooled estimates, each of these three estimates is close to the average estimate obtained in Table 3 (column 4-6, third row) when all the subjects were pooled together.

As an additional way to assess the overall magnitude of these estimates, we simulate how one's academic success would change if the transition to middle school did not entail changing the social networks in class. In other words, we model the dynamics of the circumstances as if students were able to stay with all of their childhood friends. Based on the summary statistics in Table 2, we assume the students would have on average an additional 1.60 reciprocal friends, 1.81 followers and 1.72 non-reciprocal friends. Based on the estimates for the baseline specification with class fixed effects (columns 4-6), this scenario increases their score by 0.211 standard deviations, and by 0.177 standard deviations according to the alternative specification. Alternatively, if we refer only to the impact of reciprocal friends, it would have increased the student's grade by 0.152 of a standard deviation.

Appendix Table A3 reports non-linear effects of the three types of friendships, from a regression that includes dummy variables for the three types of friendships and controls for their respective number in school. The estimates indicate that the effect of friends by type on test scores is partially nonlinear. However, for a small number of friends by type (the dummy for one or two friends by type) the estimates resembles the estimates reported in table 3 (columns 4-6), and leads to a similar impact of maintaining one's social networks from elementary school.

In Table 5, we present results of estimating the equation with an additional treatment: the social network that includes the second circle of reciprocal friends in class. We focus on the second circle of reciprocal friends and not on other types of friendships because the number of first circle reciprocal friends has the largest impact on students' test scores. In addition, the economic literature which addresses broader form of social network of the students, beyond the first circle of friends, focuses mainly on friendships relations that are of reciprocal nature (Calvo-Amengol et al. (2009)). The first column presents the estimates of a regression that includes only the second circle of reciprocal friends in class, controlling for the number of second circle reciprocal friends in school. In columns 2-5 we present estimates in which all types of friendships are included jointly in the regression, controlling for the number of friends by type in school. The estimates presented in the table

are negative but they are small and not significantly different from zero in all specifications.[21] We note that this result differs from that of Calvo-Amengol et al. (2009) which presents evidence on the importance of an individual position in the network, given by his Katz-Bonacich centrality measure, for his educational achievements. Since the effect of the social network measures at the class level is practically zero, in the rest of the paper, we will measure the social network by counting only the first circle of reciprocal friends and not include any other measure of the social network beyond this first circle.

As discussed in Tables 3, 4 and 5, the estimates of all types of social networks are robust to adding pupil's characteristic to the regression, once we control for the number of friends by type in school and add class fixed effects to the regression.[22] The fact that the estimates remains stable when adding pupil's characteristic implies that, conditional on number of friends in school and a school fixed effect, the number of friends of different by types is not correlated with students' observed characteristics. In Table 6, we present additional evidence regarding this important result in the form of "balancing tests" for the number and different types of friends in class. We regresses directly student characteristics on the treatment measures focusing on the following background variables: gender, number of siblings, father's years of education, mother's years of education, new immigrant and four ethnicity indicators (child or parents born in Asia/Africa, Europe/America, Ethnicity Former Soviet Union or in Israel). The estimates presented in the tables are the regression coefficients of each of these student characteristics on the number of friends of a given type in class. We include as controls the number of friends by type in school (same type as in class), and year and middle school class fixed effects. Each column presents estimates for one of the four types of social networks.

[21] Similar results were obtained when addressing the effect of the wide social network of the student which includes all reciprocal friends of reciprocal friends and so on of the student. These results are available from the authors upon request.

[22] Appendix Table A4 tests for the robustness of the effect of the number of friends by type on students' test scores, when including also elementary school fixed effect, or elementary class fixed effect to the regression. The results are remarkably similar to the results in Table 3: For example, the estimates of reciprocal friends, followers and non-reciprocal friends are 0.098, 0.031 and -0.012, respectively, when including class fixed effect in both elementary and middle school (and controlling for the number of friends by type in school). These estimates are very close to the estimates reported in Table 3 which includes class fixed effect only in middle school (columns 4-6 last row).

Overall, the table indicates that there is no evidence of systematic relationship between these characteristics and the change in number of friends of each type. First, there are 36 estimates presented in Table 6 and only 5 are significant or marginally significant. In combination with our Table 3 and 5 results, the overall evidence suggests that there is no systematic imbalance in the relationship between student characteristics and the number of friends by type in class controlling for the number of friends by type in school. Secondly, some of the characteristics switch sign. For example, parental education is positively correlated with reciprocal friends but negatively correlated with followers. We would expect however that these two types of friendship would have the same correlation sign with parental schooling.

B. Heterogeneous Treatment Effects of Friendships on Test Scores

In order to gain more insight on the effects of social networks on students' test scores, in this section, we explore the heterogeneous effects of friendships across different dimensions. In Table 7 we present estimates based on three different stratifications of the full sample. Panel A reports the heterogeneous treatment effects of friendship types by gender and Panel B reports results separately by father's years of schooling (above and below the median – 13 years).[23] Panel C presents evidence separately for young and older children of a given cohort.[24] We report estimates from regressions that includes each friendship type jointly controlling for the number of friends by type in school. The regression includes also students' characteristics, class and year fixed effects.

Interestingly, Panel A suggests that the respective estimates for boys and girls are very similar. The table suggests that while the effect of all friendship types are different across gender, the difference between the estimates are not statistically different: for example, the effect of reciprocal friends is slightly higher for boys than for girls (0.091 (se=0.014) versus 0.079 (se=0.013)) and the effect of followers is lower for boys than for girls (0.048 (se=0.02) versus 0.071 (se=0.019)). The

[23] Students with missing values in parental education (4 percent of the total sample) are excluded from this analysis. The results are not sensitive to the inclusion of these students in the low or high education group. Results based on stratifying the sample by mother's schooling are very similar to those based on father's schooling. These results are available from the authors upon request.

[24] It should be noted that an alternative way to measure heterogeneous effects would have been to use interaction terms for these subgroups. However, in this type of approach, the treatment-interaction terms may pick up variations by gender or parental schooling in the effects of other covariates included in the regressions. For this reason, we choose to stratify our sample, although this means our estimates are based on a smaller sample.

effect of non-reciprocal friends is negative in both groups but is significant only for boys (-0.037 (se=0.022)).

Panel B suggests that the effects of reciprocal friends or followers are larger for the students with high levels of parental education, and that this difference between the estimates is statistically different only in the case of reciprocal friends. For example, the effect of reciprocal friends in the first specification is 0.111 (se=0.013) for students from families with high levels of education and only 0.042 (se=0.012) for students from families with low levels of education. Similarly, the effect of followers upon students from families with high levels of education is slightly higher than the effect on students from families with low levels of education (0.060 (se=0.018) versus 0.045 (se=0.019)). The negative effect of non-reciprocal friends is nevertheless significant only among students from families with low levels of education.

Panel C presents the estimates for the heterogeneity of peer effect by age of pupils. The "young" group includes pupils born in the later part of the cohort year (from July to December) while the "old" group includes pupils born in the earlier part of the cohort year (from January to June). This approach may be uncommon, but we posit that the relative age within a classroom may be significant. Indeed, the table indicates that the positive and significant effect of reciprocal friends in the classroom is higher for the young students, and that the different between the two groups is statistically significant (0.99 (se=0.011) versus 0.054 (se=0.018)). The effects of the other types of friendships are significant in all cases (followers has a positive effect while non-reciprocal friends has the opposite effect) but have similar effects on both groups.[25]

C. Effect of Types of Friendships on Behavioral Outcomes

In this section, we consider the effects of friendship on behavioral outcomes. This analysis is based on the following four questionnaire items[26]: (1) "I was involved in violence (physical fights) in school many times this year"; (2) "Sometimes I'm scared to go to school because there are violent

[25] We also tried a variation in which we divided the "old" into two groups: those born within the cohort year, and those older. However, the results were very similar for these two groups. These results are available from the authors upon request.

[26] In these questions, students are asked about the extent to which they agree with a series of statements by using six-point scale ranging from 1 (strongly agree) to 6 (strongly disagree).

students"; (3) "I feel well-adjusted socially in my class"; (4) "I am satisfied in school". The students also report the time spent (in weekly hours) doing homework in each of the four subjects, and we use the reported total number of weekly hours spent on homework in all subjects as one of our outcomes.

In Table 8 we report estimates of the effect of reciprocal friends and followers on each of the five behavioral outcomes. We report estimates from a regression that includes the three types of friendships jointly in the regression controlling for the number of friends by type in school. The regression includes also students' characteristics, class and year fixed effects. The estimates in Table 8 suggest that the presence of more reciprocal friends in the classroom reduces personal involvement in violence in school (-0.085, se=0.018) and improves school satisfaction (0.033, se=0.019); while the presence of followers improve overall social satisfaction (0.049, se=0.021). The presence of non-reciprocal friends, on the other hand, does not have significant effect on these behavioral outcomes. Note also that all types of friendships do not affect the time dedicated to doing homework.

In Table 9, we examine whether the effects of social networks types on behavioral outcomes vary by gender. The evidence suggests that boys are generally more affected by the number of followers whereas girls are generally more affected by the number of reciprocal friends. For example, the table suggests that followers improve sharply boy's social and school satisfaction. Reciprocal friends, on the other hand, reduce girl's fear of school violence and violent behavior (although it reduces boy's violent behavior as well).

VI. Conclusions

In this paper we study how separating from pre-existing social networks during the transition from elementary to middle school affect students' educational achievement and social well-being. For our research, we are able to take advantage of a unique dataset from a Tel Aviv school choice program that allows us to analyze the students' social networks as they are undergoing a major transition from elementary to middle schools. Our identification strategy relies on a conditional random assignment model: since students' are randomly assigned to classes within a given school, conditional on the number of friends a student has at her school, the number of friends she attends class with should be random. Thus, we estimate the impact of friends by type in class while controlling for the number of

friends by type in school. This strategy allows us to contrast the impact of friends by type among student that have the same number of friends by type in school. We further add school/class fixed effect which enable us to eliminate all school/class-level unobservable.

We make in this study three important contributions. First, we identify several unique social networks, including reciprocal friends, followers, and non-reciprocal friends, and estimate their causal effects on student's outcomes. Second, we distinguish between the immediate and the wider definition of the reciprocal friends, the most studied social network in the literature. Third, we extend the analysis beyond the effect on academic achievements, focusing as well on the effect of social networks on non-cognitive behavioral outcomes of students. Our results suggest non-trivial effects of social networks; the presence of reciprocal friends and followers in class has a positive and significant effect on test scores in English, math and Hebrew, while non-reciprocal friends has an opposite (negative) effect. However, beyond the first circle of reciprocal friends, the effect of the rest of the social network has no effect on students' academic performance. To assess the overall magnitude of the effect size of these estimates we simulate how one's academic success would change if the transition to middle school did not entail changing their social circle. We find that if on average students have the same number of friends at class as they had in primary school it would have increased their score by around 0.2 of a standard deviation. Alternatively, if we refer only to the impact of reciprocal friends, it would have increased the student's grade by 0.152 of a standard deviation. We also found that friendships were generally more important for boys, students with high parental schooling, and young students relative to their age cohort. Our results also suggest that the effects of these various types of friendships are also important for the general well-being of students. The presence of more reciprocal friends and followers in the classroom reduces fear and intimidation from school violence and bullying, and improves social satisfaction and school satisfaction.

The evidence we present is relevant for education policy makers, in particular with regard for the design of school choice program. Since our study addresses the importance of students' social networks on academic achievement and general well-being, the research has the potential to improve the way students are assigned among and within schools, and advance our understanding of the social dynamics implicit in school choice programs.

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Table 1: Summary Statistics of Students' Characteristics by Cohort

	2000	**2002**	**2003**
	(1)	(2)	(3)
Mean Father's Education	13.38	13.42	12.70
	(3.55)	(3.37)	(3.43)
Mean Mother's Education	13.74	13.73	13.08
	(3.10)	(3.11)	(2.99)
Mean Number of Siblings	2.06	2.08	2.28
	(1.18)	(1.03)	(1.11)
Proportion of Asia/Africa Ethnicity	0.13	0.11	0.11
	(0.34)	(0.31)	(0.31)
Proportion of Europe/America Ethnici	0.19	0.20	0.19
	(0.39)	(0.40)	(0.39)
Proportion of Israel Ethnicity	0.57	0.57	0.61
	(0.49)	(0.49)	(0.49)
Number of Students	1018	929	913
Number of Elementry Schools	42	38	37
Number of Elementry Classes	83	73	76
Number of Middle Schools	6	8	7
Number of Middle School Classes	34	32	37

Notes: Each column is based on a different cohort. Standard deviations are reported in parentheses.

Table 2: Descriptive Statistics of the Social Network: Number of Friends by Type in Class and in School

	In Class			In School		
	Mean	Min	Max	Mean	Min	Max
	(1)	(2)	(3)	(4)	(5)	(6)
1. Sixth Grade						
A. Reciprocal friends	3.10	0	8	3.50	0	8
	(2.23)			(2.34)		
B. Followers	2.48	0	13	3.13	0	20
	(2.35)			(2.92)		
C. Non-reciprocal friends	2.38	0	8	2.99	0	8
	(2.14)			(2.30)		
D. Second Circle of Reciprocal Frien	3.60	0	18	4.93	0	26
	(3.11)			(4.01)		
N	8580					
2. Eighth Grade						
A. Reciprocal friends	1.50	0	8	2.72	0	8
	(1.52)			(2.22)		
B. Followers	0.68	0	8	1.96	0	17
	(1.05)			(2.40)		
C. Non-reciprocal friends	0.66	0	7	1.92	0	8
	(1.07)			(1.99)		
D. Second Circle of Reciprocal Frien	1.09	0	9	3.48	0	21
	(1.39)			(3.53)		
N	8580					

Notes: The figures in the table denote the number of friends in each category. Reciprocal friends (group A) includes students who listed one another. Followers (group B) includes students who were listed by fellow students but did not listed them as friends. Non-reciprocal friends (group C) includes students who listed fellow students as friends but were not listed as friends by these same fellow students. Second Circle of reciprocal Friends (group D) includes only the second circle of reciprocal friends. Standard deviations are reported in parentheses.

Table 3: Estimated Effect of Number of Reciprocal Friends, Followers, and Non-Reciprocal Friends on Test Scores in Math, English, and Hebrew

	Treatments incuded separately			Treatments incuded Jointly		
	Reciprocal Friends	Followers	Non-Reciprocal Friends	Reciprocal Friends	Followers	Non-Reciprocal Friends
	(1)	(2)	(3)	(4)	(5)	(6)
OLS	0.118	0.095	-0.034	0.108	0.059	-0.017
	(0.012)	(0.015)	(0.018)	(0.012)	(0.016)	(0.018)
Friends in School and School Fixed Effects	0.109	0.049	-0.002	0.108	0.031	-0.004
	(0.014)	(0.018)	(0.021)	(0.014)	(0.019)	(0.020)
Pupil Characteristics and Class Fixed Effect	0.096	0.050	-0.026	0.095	0.033	-0.022
	(0.012)	(0.016)	(0.020)	(0.013)	(0.016)	(0.020)
N	7787					

Notes: The test scores in all three subjects (math, English, and Hebrew) are pooled together. The first specification is a simple OLS regression with subject and year fixed effects; The second specification includes in addition middle school fixed effects and the number of friends by type in school (Friends in school) as controls; and the third specification includes additionally pupil characteristics (gender, parental education, number of siblings, and dummies for five ethnicity groups) and middle school class fixed effects. The estimates in each row in columns 1-3 are each from a separate regression. The estimates in each row in columns 4-6 are from the same regression. Standard errors are clustered by class and are reported in parentheses.

Table 4: Estimated Effect of Number of Reciprocal Friends, Followers, and Non-Reciprocal Friends on Test Scores from an Alternative Specification

	Reciprocal Friends	Followers	Non-Reciprocal Friends
	(1)	(2)	(3)
OLS	0.108	0.059	-0.017
	(0.012)	(0.016)	(0.018)
Friends in School and School Fixed Effects	0.100	0.059	-0.026
	(0.011)	(0.016)	(0.017)
Pupil Characteristics and Class Fixed Effect	0.085	0.056	-0.035
	(0.009)	(0.014)	(0.015)
N			

Notes: See Table 3. The estimates in each row in columns 1-3 are from the same regression. Friends in school are the control variables for the sum of friends by type in school. Standard errors are clustered by class and are reported in parentheses.

Table 5: Estimated Effect of the Number of Reciprocal Friends, Followers, Non-Reciprocal Friends and Second Circle of Reciprocal Friends on Test Scores in Math, English, and Hebrew

	Treatment incuded separately	Treatments incuded Jointly			
	Second Circle of Reciprocal Friends	Reciprocal Friends	Followers	Non-Reciprocal Friends	Second Circle of Reciprocal Friends
	(1)	(2)	(3)	(4)	(5)
OLS	0.048	0.110	0.062	-0.014	-0.007
	(0.015)	(0.012)	(0.017)	(0.018)	(0.015)
Friends in School and School Fixed Effects	0.009	0.114	0.040	0.004	-0.020
	(0.014)	(0.015)	(0.020)	(0.020)	(0.015)
Pupil Characteristics and Class Fixed Effect	0.008	0.096	0.035	-0.020	-0.005
	(0.013)	(0.013)	(0.018)	(0.020)	(0.015)
N	7787				

Notes: See Table 3. The estimates in each row in the first column are each from a separate regression. The estimates in each row in columns 2-5 are from the same regression. Standard errors are clustered by class and are reported in parentheses.

Table 6: Balancing Estimates of Student Characteristics of the Number of Friends (By Type) in Class

	Reciprocal Friends	Followers	Non Reciprocal Friends	Second Circle of Reciprocal Friends
	(1)	(2)	(3)	(5)
Gender (Boy = 1)	-0.076	-0.078	-0.063	-0.059
	(0.056)	(0.038)	(0.045)	(0.063)
Number of siblings	-0.022	0.003	-0.014	0.004
	(0.021)	(0.012)	(0.016)	(0.030)
Father's years of schooling	0.015	-0.005	0.000	-0.001
	(0.006)	(0.004)	(0.006)	(0.005)
Mother's years of schooling	0.017	-0.005	0.007	0.000
	(0.007)	(0.005)	(0.006)	(0.007)
Ethnicity Asia/Africa	-0.012	-0.019	0.047	0.108
	(0.061)	(0.047)	(0.053)	(0.064)
Ethnicity Europe/America	0.008	-0.004	0.020	-0.016
	(0.042)	(0.039)	(0.048)	(0.052)
Ethnicity Israel	0.015	0.018	-0.056	-0.022
	(0.038)	(0.030)	(0.031)	(0.042)
Ethnicity Former Soviet Union	-0.039	-0.009	0.027	-0.043
	(0.065)	(0.036)	(0.058)	(0.068)
Recent Immigrant	-0.039	-0.018	0.065	-0.038
	(0.059)	(0.036)	(0.058)	(0.062)
N	2858			

Notes: Each regression controls for the number of friends by type in school and includes year fixed effects and class fixed effects. Standard errors are clustered at the class level and reported in parentheses.

Table 7: Estimated Effect of Number of Reciprocal Friends, Followers and Non-Reciprocal Friends in Class on Test Scores, By Sub-Groups

	Reciprocal Friends	Followers	Non-Reciprocal Friends	Reciprocal Friends	Followers	Non-Reciprocal Friends
	(1)	(2)	(3)	(4)	(5)	(6)
A. By Gender		**Boys**			**Girls**	
	0.091	0.048	-0.037	0.079	0.071	-0.026
	(0.014)	(0.020)	(0.022)	(0.013)	(0.019)	(0.020)
N	3991			3796		
B. By Parental Education		**Low Parental Education**			**High Parental Education**	
	0.042	0.045	-0.063	0.111	0.060	-0.020
	(0.012)	(0.019)	(0.023)	(0.013)	(0.018)	(0.018)
N	2787			5000		
C. By Student's Age		**Old**			**Young**	
	0.054	0.048	-0.042	0.099	0.055	-0.034
	(0.018)	(0.025)	(0.027)	(0.011)	(0.017)	(0.019)
N	2963			4824		

Notes: The estimates in each row in columns 1-3 are from the same regression and so are the estimates in each row in columns 4-6. Each regression controls for the number of friends by type in school and includes pupils' characteristics, class and year fixed effects. High parental education is defined as more than 12 years of schooling. The "Young" group includes pupils born in July-December in the cohort year or later. The "Old" group includes pupils born in January-June in the cohort year or earlier. Standard errors are clustered by class and reported in parentheses.

Table 8: Estimated Effect of Reciprocal Friends, Followers and Non-Reciprocal Friends in Class on Behavioral Outcomes

	Reciprocal Friends	Followers	Non-Reciprocal Friends
	(1)	(2)	(3)
A. Involment in school fights			
	-0.085	-0.026	-0.016
	(0.018)	(0.022)	(0.022)
B. Fear from school violence			
	-0.021	-0.013	0.025
	(0.019)	(0.024)	(0.023)
C. Overall social satisfaction in class			
	0.030	0.049	0.017
	(0.020)	(0.021)	(0.020)
D. Overall satisfaction from school			
	0.033	0.023	0.002
	0.019	0.023	0.021
E. Time doing homework			
	0.023	-0.021	0.023
	(0.082)	(0.086)	(0.090)
N	4128		

Notes: The estimates in each row in columns 1-3 are from the same regression. Each regression controls for the number of friends by type in school and includes pupils' characteristics, class and year fixed effects. Standard errors are clustered by class and reported in parentheses.

Table 9: Estimated Effect of Reciprocal Friends and Followers and Non-Reciprocal Friends in Class on Behavioral Outcomes , by Gender

	Reciprocal Friends	Followers	Non-Reciprocal Friends	Reciprocal Friends	Followers	Non-Reciprocal Friends
	(1)	(2)	(3)	(4)	(5)	(6)
		Boy			**Girl**	
A. Involment in school fights						
	-0.128	-0.034	0.045	-0.035	-0.010	-0.084
	(0.032)	(0.043)	(0.041)	(0.018)	(0.021)	(0.024)
B. Fear from school violence						
	-0.012	-0.055	0.046	-0.037	0.039	-0.017
	(0.029)	(0.039)	(0.038)	(0.023)	(0.028)	(0.030)
C. Overall social satisfaction in class						
	0.016	0.082	0.013	0.046	0.013	0.014
	(0.029)	(0.030)	(0.033)	(0.030)	(0.033)	(0.030)
D. Overall satisfaction from school						
	0.023	0.056	-0.022	0.028	-0.023	0.023
	(0.033)	(0.034)	(0.034)	(0.027)	(0.034)	(0.029)
D. Time doing homework						
	-0.005	-0.156	0.120	0.021	0.157	0.043
	(0.106)	(0.145)	(0.145)	(0.129)	(0.126)	(0.119)
N	2074			2054		

Notes: The estimates in each row in columns 1-3 are from the same regression and so are the estimates in each row in columns 4-6. Each regression controls for the number of friends by type in school and includes pupils' characteristics, class and year fixed effects. Standard errors are clustered by class and reported in parentheses.

Table A1: Descriptive Statistics in Sub-Groups of the Panel Sample

	In Class			In School		
	Mean (1)	Min (2)	Max (3)	Mean (4)	Min (5)	Max (6)
1. Boys						
C. Reciprocal friends	2.24 (2.06)	0	8	3.04 2.31	0	8
D. Followers	1.54 (2.04)	0	13	2.48 2.69	0	17
E. Non-reciprocal friends	1.51 (1.90)	0	8	2.44 2.23	0	8
N	8874					
2. Girls						
C. Reciprocal friends	2.36 (2.08)	0	8	3.18 (2.32)	0	8
D. Followers	1.62 2.02	0	13	2.61 (2.79)	0	20
E. Non-reciprocal friends	1.53 (1.89)	0	8	2.47 (2.20)	0	8
N	8274					
3. Young						
C. Reciprocal friends	2.27 (2.05)	0	8	3.04 (2.26)	0	8
D. Followers	1.50 (1.91)	0	13	2.41 (2.57)	0	20
E. Non-reciprocal friends	1.58 (1.94)	0	8	2.55 (2.25)	0	8
N	6468					
4. Old						
C. Reciprocal friends	2.31 (2.09)	0	8	3.15 (2.35)	0	8
D. Followers	1.63 (2.10)	0	13	2.63 (2.83)	0	19
E. Non-reciprocal friends	1.48 (1.86)	0	8	2.39 (2.19)	0	8
N	10746					

Table A1: continued

	In Class			In School		
	Mean (1)	Min (2)	Max (3)	Mean (4)	Min (5)	Max (6)
5. High Parental Education						
C. Reciprocal friends	2.50 (2.10)	0	8	3.36 (2.35)	0	8
D. Followers	1.74 (2.18)	0	13	2.85 (2.99)	0	19
E. Non-reciprocal friends	1.44 (1.85)	0	8	2.40 (2.19)	0	8
N	7044					
6. Low Parental Education						
C. Reciprocal friends	2.16 (2.04)	0	8	2.93 (2.27)	0	8
D. Followers	1.47 (1.91)	0	12	2.33 (2.53)	0	20
E. Non-reciprocal friends	1.57 (1.92)	0	8	2.49 (2.23)	0	8
N	10098					

Notes: The figures in the table denote the number of friends in each category in the panel sample. High parental education is defined as more than 12 years of schooling. The "Young" group is includes pupils born in July-December in the cohort year or later. The "Old" group includes pupils born in January-June in the cohort year or earlier.

Table A2: Estimated Effect of Number of Reciprocal Friends, Followers and Non-Reciprocal Friends in Class on Test Scores, by Subject

	Reciprocal Friends	Followers	Non-Reciprocal Friends
	(1)	(2)	(3)
Math	0.097	0.036	-0.029
	(0.017)	(0.023)	(0.026)
Hebrew	0.110	0.023	-0.037
	(0.016)	(0.022)	(0.022)
English	0.076	0.042	0.003
	(0.015)	(0.017)	(0.024)

Notes: The estimates in each row in columns 1-3 are from the same regression. Each regression controls for the number of friends by type in school and includes pupils' characteristics, class and year fixed effects. Standard errors are clustered by class and reported in parentheses.

Table A3: Non-Linear effect of Reciprocal Friends, Followers and Non-Reciprocal Friends on Test Scores

	Reciprocal Friends	Followers	Non-Reciprocal Friends
	(1)	(2)	(3)
One friend	0.099	0.049	-0.018
	(0.044)	(0.036)	(0.038)
Two friends	0.217	0.108	-0.022
	(0.047)	(0.042)	(0.058)
Three friends	0.336	0.056	-0.025
	(0.060)	(0.082)	(0.087)
Four friends	0.322	0.216	-0.113
	(0.076)	(0.113)	(0.101)
Five friends	0.465	0.110	-0.145
	(0.067)	(0.121)	(0.166)
Six or more friends	0.586	0.001	-0.324
	(0.105)	(0.166)	(0.284)

Notes: The estimates in each row in columns 1-3 are from the same regression. The treatments are dummy variables for each group. Each regression controls for the number of friends by type in school and includes pupils' characteristics, class and year fixed effects. Standard errors are clustered by class and reported in parentheses.

Table A4: Estimated Effect of Number of Reciprocal Friends, Followers, and Non-Reciprocal Friends on Test Scores in Math, English, and Hebrew

	Treatments incuded separately			Treatments incuded Jointly		
	Reciprocal Friends	Followers	Non-Reciprocal Friends	Reciprocal Friends	Followers	Non-Reciprocal Friends
	(1)	(2)	(3)	(4)	(5)	(6)
Elementary School Fixed Effects	0.091	0.047	-0.017	0.089	0.032	-0.013
	0.013	0.016	0.020	0.013	0.016	0.021
Elementary Class Fixed Effects	0.100	0.046	-0.020	0.098	0.031	-0.012
	0.013	0.015	0.021	0.013	0.016	0.021
N	7787					

Notes: See table 3. Each regression controls for the number of friends by type in school and includes pupils' characteristics, middle school class and year fixed effects. Standard errors are clustered by class and are reported in parentheses.