

Friendship Formation by Race and Achievement: Implications on Racial Gaps in Friends and Earnings

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Abstract

This paper investigates adolescent friendship formation, focusing on race and academic achievement. Using dyadic regression and social network data of students from Add Health, we demonstrate that students tend to form friendships within their racial group and with similar GPAs. We further find comparable sensitivities to GPA differences between Black and White student pairs, with less pronounced sensitivities in cross-racial friendships. Through counterfactual analysis using regression coefficients and GPA distributions, we present that fewer friendships observed among high-achieving Black students, in comparison to their White peers, are attributed to the scarcity of high-achieving Black students. Our estimations suggest that this disparity in friendships among high-achieving Black students significantly contributes to the earnings gap between Black and White individuals.

JEL: I21, J15

Keywords: Social Networks, Friendship Formation, Homophily, Racial friends gap, Racial earnings gap

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1 Introduction

Friendship within the school environment is paramount. A growing body of literature underscores the impact of school peers on various aspects, including academic performance, choice of field of study, future earnings, and engagement in risky behavior (Anelli and Peri 2019; Bifulco, Fletcher, and Ross 2011; Calvó-Armengol, Patacchini, and Zenou 2009; Carrell, Hoekstra, and Kuka 2018; Imberman, Kugler, and Sacerdote 2012; Nakajima 2007). Recent works by Chetty et al. (2022a, 2022b) even find that friendship plays a crucial role in shaping economic mobility and inequality, emphasizing connecting with peers from higher socioeconomic backgrounds increases the likelihood of upward mobility.

However, segregation based on socioeconomic status and race acts as a barrier, limiting minority children's access to peers from higher socioeconomic status (Ananat 2011; Angrist and Lang 2004; Cutler and Glaeser 1997). Furthermore, even in areas with less segregation, a noticeable "friending bias" persists, wherein individuals tend to form friendships with others from the same race and socioeconomic class (Chetty et al. 2022b; Currarini, Jackson, and Pin 2010; Mayer and Puller 2008; Mele 2020). This bias contributes to the perpetuation of socioeconomic disparities despite efforts towards desegregation. Consequently, comprehending the factors that matter for friendship formation is crucial in gaining insights into human development, economic mobility, and inequality.

We study the significance of differences in academic achievement (GPA) in the formation of friendships while delving into potential variations across different racial pairs. Specifically, we explore the interactions between differences in academic achievement and the formation of friendships among Black-Black, White-White, and Black-White pairs. To answer the question, we use dyadic regression and the social network data of students from the National Longitudinal Study of Adolescent to Adult Health (Add Health). After generating all possible pairs of students within each school, we examine the friendship patterns based on race and academic achievements.

We find a pronounced homophily in academic achievement, where an increase of one unit in GPA difference between pairs of students corresponds to a 0.164 percentage point decrease in

the likelihood of friendship formation within the school when the overall mean is 0.694 percent. Notably, the relationship between GPA disparity and friendship formation is more prominent among individuals of the same race than those of different racial backgrounds. Specifically, Black-Black and White-White pairs exhibit a decrease in the likelihood of friendship formation by 0.172 and 0.189 percentage points, respectively. In contrast, Black-White pairs are 0.031 percentage points less likely to form friendships with each one-unit increase in GPA difference.

Moreover, our results highlight a strong tendency toward homophily in terms of race, consistent with earlier research (Currarini, Jackson, and Pin 2009; Mele 2020). The probabilities of friendship formation are 1.11 percent for Black-Black pairs and 0.86 percent for White-White pairs. In contrast, the probability of friendship formation is lower, at 0.24 percent, for Black-White pairs. These findings underscore the importance of academic achievement and racial homophily on the formation of friendships within the school context.

One direct implication of our analysis is to investigate whether the influence of peer pressure coming from academic performance on friendship formation varies by race. The phenomenon that high-achieving minority students are ostracized by their social peers, has been extensively discussed in anthropology and sociology literature (Austen-Smith and Fryer Jr 2005; Fordham and Ogbu 1986). In support of the notion, Fryer Jr and Torelli (2010) empirically demonstrate that high-achieving minority students tend to have fewer friends compared to their White peers. However, by conducting counterfactual analysis using the estimated coefficients from our dyadic regression and GPA distributions of Black and White students, we find that the fewer friendships of high-achieving Black students are attributed to limited exposure to high-achieving Black students and strong racial homophily.

Specifically in our counterfactual analysis, we begin by simulating the expected number of high- and low-achieving friends by race and GPA. The simulation results closely resemble the actual data both quantitatively and qualitatively. Using the simulation results, we investigate how the racial friends gap changes for high-achieving students relative to those with the lowest GPA. We first equalize the proportion of Black and White students (level effects), and then equalize the GPA distribution of Black students with that of White students (composition effect). Through our counterfactual analyses incorporating both level and composition effects, we

observe changes in the friendship gap (White - Black) of high-achieving students from 1.05 to 0.07 for high-achieving friends and from -0.26 to -0.15. Thus, under the equal proportion and GPA distribution, the gap in friends for high-achieving students would decrease by 0.87 in total.

Lastly, we assess the extent to which the Black-White earnings gap can be attributed to the difference in the number of friends. Our analysis includes a sample primarily comprising individuals in their early twenties, with an average annual income of \$38,000. After adjusting for demographic factors and individual skills, Black individuals exhibit 25.0% lower yearly earnings compared to White counterparts. Using our estimated reduction in the expected friendship gap in counterfactual scenarios (0.87 friends) and the estimated impact of one more friend on earnings from Lleras-Muney et al. (2020) (5.66 to 11.89% more annual earnings), the wage gap decreases from 25.0% to the range of 20.8 to 16.1%, representing a reduction of the gap by 17% to 36%. Notably, each additional high-achieving friend correlates with a 3.4% increase in earnings, whereas the impact of adding a low-achieving friend is marginal on earnings, which suggests our estimate for a reduced earnings gap might be underestimated.

In this paper, we contribute to strands of the literature in economics. Our paper contributes to the literature on friendship and network formation (Badev 2021; Boardman, Domingue, and Fletcher 2012; Bramoullé, Djebbari, and Fortin 2009; Currarini, Jackson, and Pin 2009; Mayer and Puller 2008; Mele 2017). We use dyadic regression to study friendship formation and explore the potential variations in the implications of GPA differences for both minority and majority-race groups, and friendships within and across race. In the study most closely related to our research, Marmaros and Sacerdote (2006) investigate the email communication patterns of Dartmouth students and find strong homophily based on race and physical proximity, such as sharing a dorm room or living in the same dormitory. Our study expands the literature by examining the interaction between race and ability, utilizing a representative sample of the United States.

We also contribute to the literature on the influence of peer pressure on youth's behavior. Austen-Smith and Fryer Jr (2005) and Eguia (2017) theorize the phenomenon of acting White—high performance Black induces peer group rejection. Empirical evidence presented by Fryer Jr and Torelli (2010) supports it by indicating that high-achieving Black students tend to have

fewer friends compared to their White counterparts. Contrary to this perspective, Andrews and Swinton (2014) find limited evidence supporting the idea that Black students experience more substantial peer rejections than White students based on academic achievement. Recent research in sociology also challenges the oppositional culture framework (Tyson and Lewis 2021), presenting that Black students are equally achievement-oriented as their White students (Diamond and Huguley 2014; Flashman 2012; Hanselman et al. 2014). We contribute to the literature by demonstrating that the seemingly oppositional culture—manifested as a lower number of friends for high-achieving Black students—is specifically observed in Black minority schools and that this phenomenon can be explained by two factors: the racial composition and GPA distribution of Black and White students.

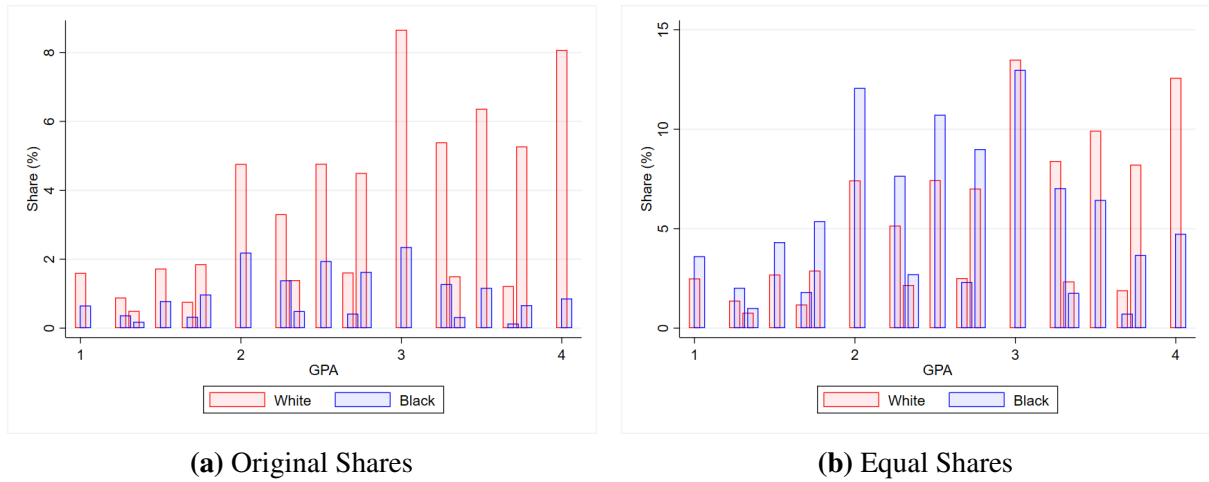
Third, our study contributes to the literature on the racial earnings gap (Altonji and Blank 1999; Bayer and Charles 2018; Brown 1984; Juhn, Murphy, and Pierce 1993; Lang and Lehmann 2012; Neal and Johnson 1996), particularly due to the peers and social network Arrow and Borzekowski (2004), Calvó-Armengol and Jackson (2004), and Holzer (1987). We demonstrate that high-achieving black students tend to have structurally fewer friends due to the smaller proportion in schools, lower average GPA, and homophily in friendship formation. Building upon the findings of Lleras-Muney et al. (2020) regarding the influence of friendship networks on earnings, we highlight the substantial role of racial difference in friendship to the racial earning gap. To our knowledge, this paper is the first to quantify the significance of the racial disparity in friendship networks in secondary schools in understanding earning disparities between racial groups.

The remainder of this paper proceeds as follows. In Section 2, we describe the dataset in detail. Section 3 describes the dyadic regression, and section 3.2 its empirical outcomes. In section 4, we explore the implications on Black and White gaps in friendships and earnings by performing counterfactual exercises using the estimated coefficients and racial compositions. We conclude in section 5.

2 Data

The National Longitudinal Study of Adolescent to Adult Health (hereafter, Add Health) is a nationally representative sample of adolescents in grades 7-12 during the 1994-1995 school year (Wave I). The survey consists of in-school data and in-home survey data. We use the in-school data for our analysis of friendship formation, which consists of a sample of 90,118 students. We restrict our sample to students who reported GPA and demographic variables including race, age, and sex. To understand the Black-White friendship formation difference, we focus on non-Hispanic Black and non-Hispanic White students.¹

Fig. 1. GPA Distribution by Race and Achievements



Notes. The figures illustrate the distributions of average GPA for Black and White students. The red bar indicates the density of the average GPA of White students. The blue bar indicates the density of the average GPA of Black students. We use Black and White students in the in-school data of the National Longitudinal Study of Adolescent to Adult Health. The sub-figure (a) illustrates the average GPA distribution with original Black and White shares. The sub-figure (b) illustrates the average GPA distribution after equalizing Black and White shares.

In panel (a) of Figure 1, we show the GPA distribution based on the original data. We calculate the average GPA based on English, math, history, and science as a measure of achievement. The GPA scale ranges from 1 to 4. We find that White students comprise of the majority of the sample, accounting for 78.9 percent of the total, while Black students constitute 21.1 percent. Moving on to panel (b), we equalize the proportion of Black and White students to facilitate a direct comparison of GPA distributions between the two racial groups. Our findings reveal that Black students have a higher share below a GPA of 3, whereas White students have a

¹ See Table A.1 for summary statistics at the individual level.

higher share above a GPA of 3. Specifically, the average GPA of White students is 2.9, which is higher than that of Black students, which stands at 2.6. White students are more likely to have higher GPAs, while Black students tend to be more concentrated in the middle range of the GPA distribution.

The in-school data collect information on the social network of each participant. The survey asks students to list up to five male and five female friends. In this study, we define friendship as a binary variable, taking one when an individual has been nominated as a friend by another within the same school.²

To analyze the distribution of friendship formation and GPA differences at the pairwise level, we generate all possible pairs of students within each school and match their individual-level characteristics. It is important to note that the pairs are directional. The friendship measure represents a friendship nomination from student i to student j . For instance, student i can nominate student j as a friend, but it does not necessarily mean that the nomination is reciprocated or that student j will nominate student i as a friend.

From the pool of potential pairs of students within each school, we categorize them into four groups based on the racial composition: White-White, Black-Black, White-Black, and Black-White. In total, we have 141 schools, with an average of 395 Black or White students per school. Consequently, the overall number of potential pairs amounts to 36,183,256.

Table 1: Summary, Pairwise Level

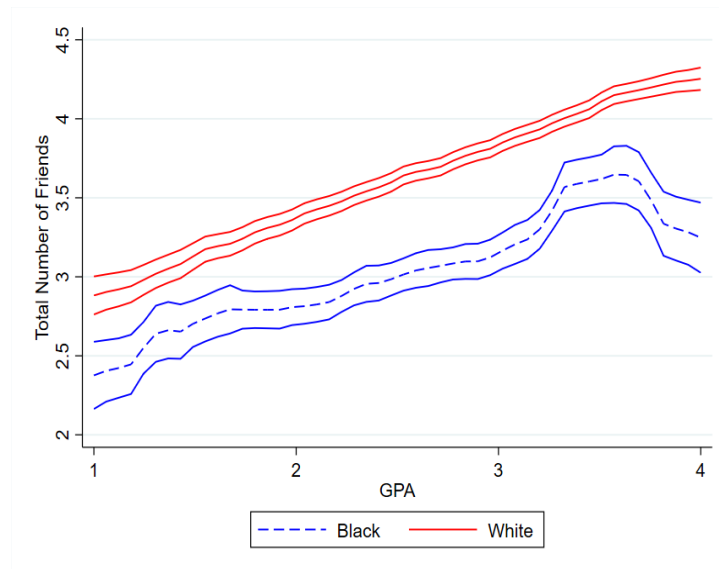
	White→White	Black→Black	White→Black	Black→White	All
Friend (%)	0.567	0.784	0.125	0.103	0.513
GPA difference	0.9	0.8	0.9	0.9	0.9
Share (%)	73.29	9.91	8.40	8.40	100
Observations	26,517,518	3,584,014	3,040,862	3,040,862	36,183,256

Notes. The total number of observations is 36,183,256, which is all potential pairs of students. This is based on the 54,613 non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. Friend(%) measures the shares of friendship formation out of all potential pairs of students. If student i nominates student j as a friend but j does not, we define $i - j$ pair as friends but not the pair $j - i$. GPA difference measures the average difference in GPA between pairs.

² Students can list their friends up to five male friends and five female friends. While a student can list up to ten friends as the “sender”, the friendship measure we utilize is based on the number of “receiving” nominations. For instance, if there are 400 students in a particular school, the maximum number of friendship nominations that one student can receive is 399, as they cannot nominate themselves.

Table 1 provides summary statistics at the pairwise level. Firstly, it reveals that White-White pairs constitute 73.29 percent of all potential pairs among White or Black students. Black-Black pairs account for 9.91 percent, while both White-Black and Black-White pairs represent 8.40 percent each. The average rate of friendship formation across all potential pairs is 0.51 percent. This means that out of all possible pairs of students, 0.51 percent result in the formation of friendships. Interestingly, Black-Black pairs exhibit a higher friendship formation rate at 0.78 percent, while White-White pairs have a slightly lower rate of 0.57 percent. Friendship formation rates between students of different races are lower than those within the same racial group, with rates of 0.10 percent for Black-White pairs and 0.13 percent for White-Black pairs. Lastly, there is no significant difference between groups in terms of GPA differences between pairs. The average GPA difference for all possible Black-Black pairs is 0.8, whereas for the other types of pairs, it is 0.9.

Fig. 2. Number of Friends by GPA



Notes. The figure depicts the locally smoothed means of the number of friends across GPA distribution separately by Black and White students. We use Black and White students in the in-school survey of the National Longitudinal Study of Adolescent to Adult Health.

In Figure 2, we plot the average number of friendships for both Black and White students against GPA distributions. As the GPA increases, the number of friendships for both Black and White students increases. While White students tend to have more friends than Black students across all GPA distributions, the difference is more pronounced in the higher GPA. This is described as White acting in Fryer Jr and Torelli (2010).

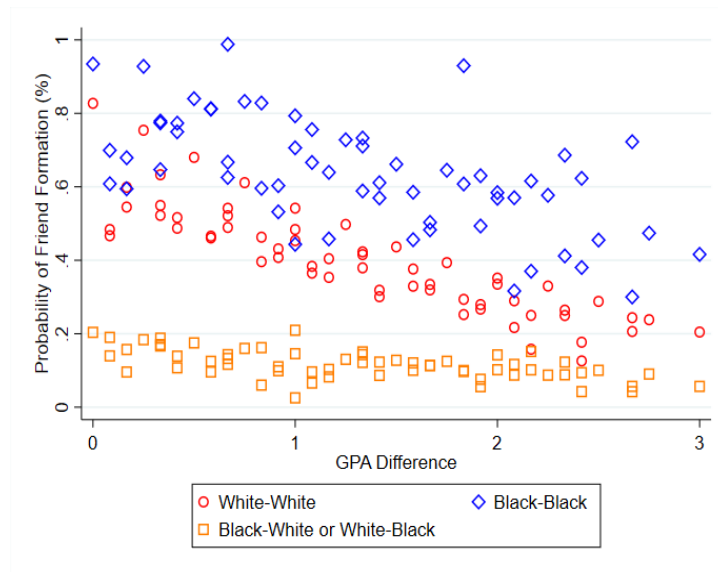
3 Friendship Formation

3.1 Empirical Strategy

We focus on analyzing patterns in the formation of friendships, with a specific emphasis on the role of race, achievement, and the interaction between the two. By studying the interaction, we explore whether the importance of differences in achievements varies based on the race of two students involved in forming a friendship.

In our analysis, we treat each potential dyad of students within each school as an individual observation. This dyadic approach enables us to examine how the probability of forming friendships differs across different racial pairs and how it evolves as the difference in achievements between the students increases.

Fig. 3. Probability of Forming Friendships by GPA difference and race



Notes. The figure illustrates probability of forming friendships based on the GPA difference between pairs, depicted separately for racial combinations. We use Black and White students in the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. Each potential dyad of students in each school is treated as an observation.

In Figure 3, we examine the matching patterns based on race and achievements. The figure illustrates how the proportion of dyads forming friendships varies by the difference in achievements and race pairs (Black-Black, White-White, or Black-White or White-Black).³ A

³ Appendix A.2 provides a comprehensive explanation of our methodology for calculating the likelihood of friendship formation, accompanied by an illustrative example.

few patterns are worth noting. First, same-race pairs are more likely to form friendships. For instance, approximately 0.9 percent of dyads consisting of both Black students with identical GPAs become friends. Similarly, approximately 0.75 percent of dyads composed of both White students with identical GPAs end up as friends. On the other hand, approximately 0.2 percent of dyads consisting of students from different races (Black-White or White-Black) with identical GPAs end up as friends. Secondly, the probability of friendship formation notably declines as the difference in GPA increases. This declining trend is consistent between White-White and Black-Black pairs. In other words, GPA differences in friendship formation matter similarly between White-White and Black-Black pairs of students. Conversely, the difference in GPA has less significance in the formation of friendships across different races compared to the formation within the same race.

We adopt a dyadic regression to estimate the formation of friendships among adolescent students based on race and achievements. We construct a matrix that includes all possible friendship dyads, considering both sender and receiver pairs within each school. For each school, we observe a total of N_s students. This results in a dataset with potential pairs $\sum_{s=1}^{141} N_s \times (N_s - 1)$. The regression equation takes the following form:

$$G_{ij} = \alpha_0 + \beta_0 d_{ij} + \beta_{bb} d_{ij} \times B_i B_j + \beta_{bw} d_{ij} \times B_i W_j + \beta_{wb} d_{ij} \times W_i B_j + \alpha_{bb} B_i B_j + \alpha_{bw} B_i W_j + \alpha_{wb} W_i B_j + X_{ij} \Gamma + \lambda_s + \varepsilon_{ij} \quad (1)$$

where G_{ij} is an indicator variable that takes the value of one if student i designates student j as a friend. The variable d_{ij} represents the difference in achievements (GPA) between students i and j expressed as absolute values. The analysis includes two racial categories: Black and White, denoted by B and W respectively. The directional links between students can be categorized into four types: $B_i B_j$, $B_i W_j$, $W_i B_j$, and $W_i W_j$. For instance, the indicator $B_i W_j$ indicates that student i (the friendship sender) is Black and student j (the friendship receiver) is White. The omitted category in the analysis is White-White pairs of students. The vector X_{ij} incorporates a set of control variables at the dyad-level, such as the difference in ages and gender pairs. Z_i and Z_j includes demographic variables including gender, age, and average GPA of senders and

receivers. We also include school fixed effects, λ_s . We cluster the standard errors at the school level to account for potential dependence within schools.⁴

As Equation (1) excludes White pairs of students, the parameter α_0 represents the baseline probability of friendship formation for White pairs. The remaining parameters in the α group, namely α_{bb} , α_{bw} , and α_{wb} , capture the deviation in the probability of forming friendships for the respective race pairs (Black-Black, Black-White, and White-Black) compared to the baseline probability of White pairs. Regarding the β parameters, β_0 captures the extent to which differences in achievements matter for White students. If β_0 is negative, it means that White students are less likely to list other White students as friends as the difference in achievements increases. β_{bb} captures how much differences in achievements matter differently for Black students listing Black students as friends, compared to White students listing White students. β_{bw} (β_{wb}) captures how much differences in achievements matter differently between Black (White) students listing White (Black) students as a friend and White students listing White students. If the differences in achievements matter less for across-race friendship than within-race friendship, the parameters β_{bw} and β_{wb} will be positive. Additionally, if there is a race asymmetry in how differences in achievement matter for friendship formation, the values of β_{bw} and β_{wb} will differ.

3.2 Results

3.2.1 Friendship Formation by GPA and Race

Table 2 presents the results of the estimation of Equation (1). In column (1), we find that as the difference in achievements (measured by GPA) between two students increases, the likelihood of forming friendships decreases.⁵ Specifically, for each one-unit increase in GPA difference, the likelihood of friendship formation in the school decreases by 0.189 percentage points compared to the overall mean of 0.513 percent. The constant term represents the probability of friendship

⁴ Our regression analysis assumes that each student in the school has an equal probability to encounter and potentially form a friendship with any other student. Under this assumption, the coefficients in the regression model represent the preference parameters associated with the characteristics of both the sender (i) and the receiver (j), as well as the disparities in their characteristics. However, one might have a concern with the assumption of equal probability. To alleviate the concern, we conduct the same analysis among students within the same school club and find consistent results with our baseline results. See Appendix A.5 for more details.

⁵ One might be concerned about endogeneity using GPA as a performance measure affecting friendship since GPA could be affected by the friendship formation. To alleviate the concerns, we alternatively use the mother's education as a measure of achievement and find qualitatively similar results. See Appendix A.3 for more details.

formation when there is no difference in GPA between students. In column (2), we further control for demographic variables, such as the genders and ages of the senders and receivers, as well as dyad-level control variables including the difference in ages and gender pairs, and school fixed effects. The coefficient remains similar. Specifically, the analysis shows that the probability of friendship formation decreases by 0.164 percentage points for each one-unit increase in GPA difference. These findings suggest a negative relationship between the difference in achievements (measured by GPA) and the likelihood of forming friendships, even after considering various controls.

Table 2: Friendship Formation by Race and Achievements

	Dependent variable : <i>i</i> denoting <i>j</i> as a friend (%)				
	(1)	(2)	(3)	(4)	(5)
<i>dGPA</i>	-0.189*** (0.019)	-0.164*** (0.015)	-0.216*** (0.025)	-0.189*** (0.022)	-0.259*** (0.028)
<i>dGPA</i> × <i>BB</i>			0.047 (0.044)	0.017 (0.045)	0.038 (0.049)
<i>dGPA</i> × <i>BW</i>			0.188*** (0.025)	0.158*** (0.022)	0.200*** (0.025)
<i>dGPA</i> × <i>WB</i>			0.182*** (0.024)	0.158*** (0.023)	0.193*** (0.026)
<i>BB</i>			0.168 (0.166)	0.250 (0.171)	
<i>BW</i>			-0.624*** (0.078)	-0.627*** (0.061)	
<i>WB</i>			-0.597*** (0.078)	-0.603*** (0.060)	
Constant	0.674*** (0.060)	0.694*** (0.097)	0.752*** (0.080)	0.862*** (0.129)	0.938*** (0.051)
Observation	36,183,256	36,183,256	36,183,256	36,183,256	36,183,256
Mean	0.513	0.513	0.513	0.513	0.513
Controls		X		X	X
Individual FE					X

Notes. The table presents coefficients and standard errors from estimation of equation (1). Units of observation are directed dyads, based on the non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if student *i* nominated student *j* as a friend. *dGPA* indicates a difference in average GPA between the pairs of students. *B* indicates Black student and *W* indicates White student. *BW* is an indicator that the sender is a Black student and the receiver is a White student. Mean is the average probability of forming friendships. Controls indicates the controlling demographic variables including gender and age of senders and receivers, difference in ages between pairs, and school fixed effects. Individual FE indicates controlling for individual fixed effects of senders and receivers. *** $p < .01$, ** $p < .05$, * $p < .1$

In columns (3) and (4), we examine whether the difference in achievements has a varying association with friendship formation for pairs of Black students, pairs of White students, and pairs of Black and White students. We investigate this association both without additional covariates (column 3) and with the inclusion of other covariates (column 4). The results indicate that regardless of whether the covariates are controlled for or not, the difference in GPA has a similar relationship to friendship formation for pairs of Black students and pairs of White students. When GPA gap increases by 1 for White students, they are 0.189 percentage points less likely to form friendships. Compared to White race pairs, the difference in GPA matters less for Black pairs of students although the coefficient is statistically insignificant. That is, the difference in GPA for Black students is similar to that of White students.⁶

Moreover, we examine the significance of achievement differences across different races in friendship formation, as indicated by the rows of $dGPA \times BW$ and $dGPA \times WB$. The results suggest that the influence of GPA differences on friendship formation is weaker for pairs consisting of individuals from different races compared to pairs within the same race. Specifically, Black-White pairs are 0.031 percentage points less likely to form friendships when the GPA difference increases by 1, and White-Black pairs are 0.032 percentage points less likely.

We find that within-race friendships are more prevalent compared to across-race friendships, which align with the concept of racial segregation (e.g., Currarini, Jackson, and Pin 2009; Marmaros and Sacerdote 2006). Additionally, our analysis reveals that Black pairs of students are more likely to form friendships than White pairs. The baseline probability of forming friendships between Black-Black pairs is approximately 1.11 percent, which is higher than the baseline probability for White-White pairs at 0.86 percent. In contrast, the baseline probability of friendship formation across different races is much lower, ranging from 0.235 to 0.259 percent. The findings highlight the presence of racial homophily in friendship formation, where individuals tend to form friendships more frequently with others of the same race than with individuals of different races.

In column (5), we present the estimation results with individual fixed effects for both

⁶ It is important to note that we compare the racial groups on a percentage points level. Given that Black pairs exhibit a higher baseline probability of friendship formation, comparing percentage points indicates that Black pairs are less concerned about GPA differences. However, we focus on the percentage points level comparison as our primary interest lies in the actual number of friends formed.

friendship senders and receivers. This accounts for the correlation between race and the possibility that certain students may be more likely to consider others as friends, and some students may be more popular within the school. Despite controlling for these fixed effects, the estimated coefficients remain qualitatively similar.

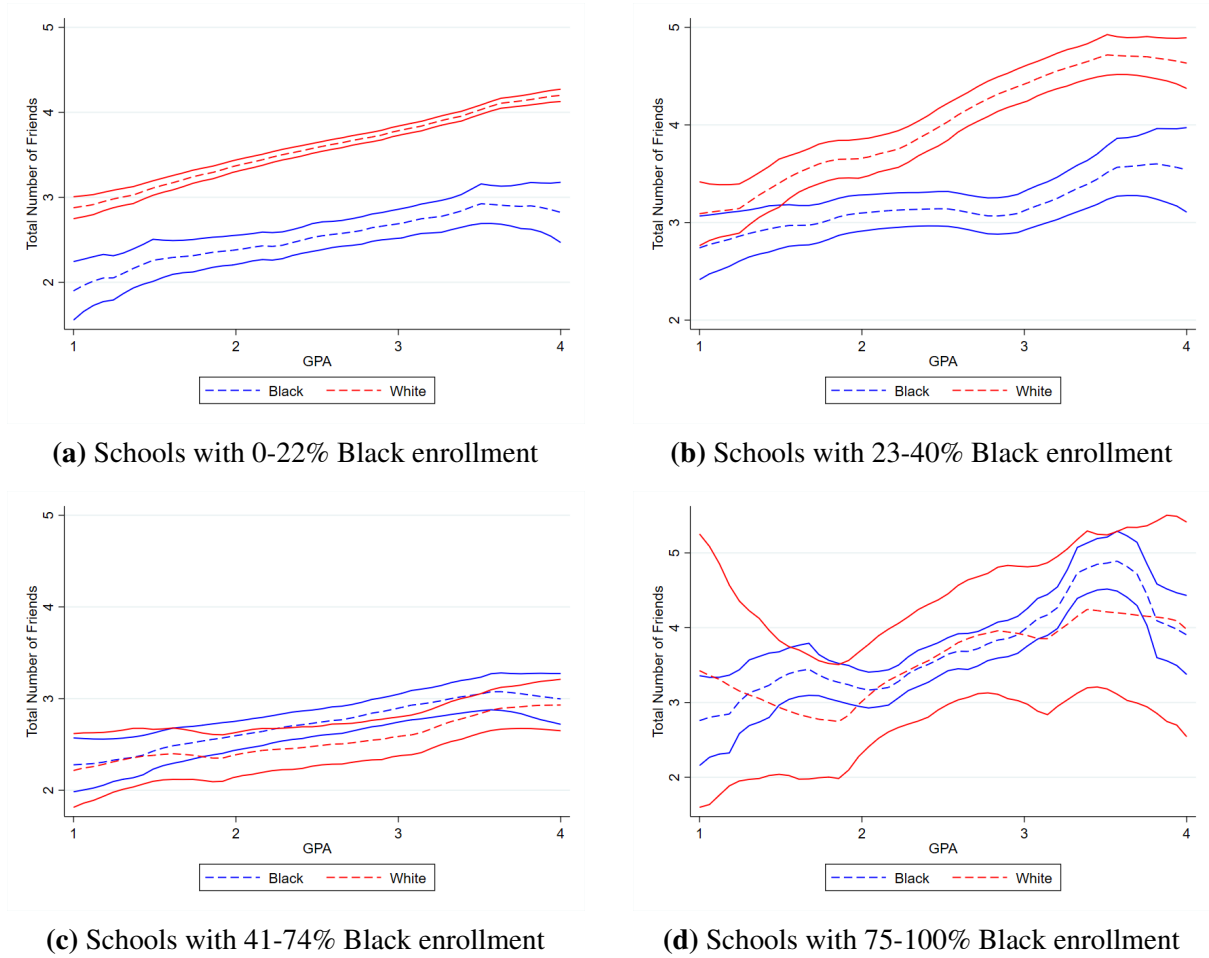
The aforementioned findings are robust across various alternative specifications, as detailed in the Appendix. These alternative specifications include: (i) using the mother’s education as a performance measure (Appendix A.3); (ii) comparing students within the same extracurricular activities (Appendix A.5); (iii) using mutual friendships instead of one side friendship nominations (Appendix B.1); (iv) accounting for asymmetry of GPA between low-high and high-low friendship nominations (Appendix B.2); (v) using semiparametric GPA measures as low and high (Appendix B.3); and (vi) including Hispanic students in the sample (Appendix B.4). Across all these alternative specifications, the main findings regarding the relationship between GPA differences and friendship formation for race pairs remain consistent.

3.2.2 Heterogeneity Across Black Shares in Schools

In this subsection, we explore heterogeneity in friendship formation across schools with different racial compositions. The share of Black students in a school can affect the likelihood of meeting students of the same race (Currarini, Jackson, and Pin 2009). It may also modify the relationship between race and achievement in forming friendships. We divide schools into four groups as each group has the same number of black students: the first, second, third, and fourth groups include schools with Black student shares ranging from 0% to 22%, 23% to 40%, 41% to 74%, and 75% to 100%, respectively.

In Figure 4, we first present the number of friends, categorized by race and the share of Black students. A few patterns are worth noting. High-achieving Black students in Black minority schools (0-40%) tend to have significantly fewer friends than their White peers, whereas this disparity is absent in schools where the Black population is not a minority (41-100%). Low-achieving Black students in Black minority schools also exhibit differences in the number of friends compared to their White counterparts although the difference is smaller than high-achieving students. Moreover, we present the GPA distribution of Black and White students by the proportion of Black students in Figure A.3. While White students tend to cluster above a

Fig. 4. Number of Friends by GPA and Black Students Proportion of Schools



Notes. The figure depicts the locally smoothed means of the number of friends across GPA distribution, categorized by race and the share of Black students. We use Black and White students in the in-school survey of the National Longitudinal Study of Adolescent to Adult Health.

GPA of 3 and Black students are concentrated between 2 and 3, Black minority schools show more pronounced differences in the distribution of GPA.⁷ In essence, the figure suggests that high-achieving Black students tend to have a smaller circle of friends compared to their White peers considering homophily in friendship formation, especially in schools where the proportion of Black students is smaller, particularly at higher GPA.

Table 3: Friendship Formation by Race and Achievements: Across Black Student Proportion

	Dependent variable : Probability of i denoting j as a friend (%)				
	(1) All	(2) 0-22%	(3) 23-40%	(4) 41-74%	(5) 75-100%
$dGPA$	-0.189*** (0.022)	-0.179*** (0.022)	-0.284*** (0.062)	-0.267*** (0.032)	-1.361*** (0.116)
$dGPA \times BB$	0.017 (0.045)	-0.095 (0.075)	0.044 (0.032)	0.187*** (0.032)	1.152*** (0.127)
$dGPA \times BW$	0.158*** (0.022)	0.144*** (0.022)	0.267*** (0.061)	0.239*** (0.040)	1.317*** (0.106)
$dGPA \times WB$	0.158*** (0.023)	0.145*** (0.022)	0.265*** (0.063)	0.245*** (0.034)	1.322*** (0.098)
BB	0.250 (0.171)	1.212*** (0.285)	0.300** (0.128)	-0.513*** (0.122)	-5.207*** (0.186)
BW	-0.627*** (0.061)	-0.474*** (0.048)	-1.000*** (0.208)	-0.983*** (0.144)	-5.927*** (0.223)
WB	-0.603*** (0.060)	-0.448*** (0.047)	-0.987*** (0.213)	-0.952*** (0.128)	-5.838*** (0.259)
Constant	0.862*** (0.129)	0.741*** (0.098)	0.935*** (0.276)	1.701*** (0.244)	6.103*** (0.301)
Observation	36,183,256	26,910,900	4,993,870	2,743,852	1,534,634
Mean	0.513	0.509	0.539	0.400	0.686
Controls	X	X	X	X	X

Notes. The table presents coefficients and standard errors from estimation of equation (1), separately by the share of Black students. Units of observation are directed dyads, based on non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if student i nominated student j as a friend. $dGPA$ indicates a difference in average GPA between the pairs of students. B indicates Black students, and W indicates White students. The schools are divided into four quantile groups as follows: the first quantile (Q1) includes schools with Black student shares ranging from 0% to 22%; the second quantile (Q2) includes schools with Black student shares between 23% and 40%; the third quantile (Q3) includes schools with Black student shares between 41% and 74%; and the fourth quantile (Q4) includes schools with Black student shares between 75% and 100%. *** $p < .01$, ** $p < .05$, * $p < .1$

In Table 3, we estimate Equation (1) separately for students enrolled in schools with different

⁷ Specifically, in schools with Black student shares ranging from 0%-22%, 23%-40%, 41%-74%, and 75%-100%, the gaps in shares with GPA 3-4 between Black and White students are 19%, 19%, 13%, and 1% respectively.

shares of Black students. This analysis enables us to explore how friendship formation patterns vary across different levels by the share of Black students in schools. We present the estimation results starting with all schools in column (1), followed by schools categorized based on different shares of Black students in columns (2) to (5).

Across all types of schools, we observe that the significance of GPA differences is either similar or less pronounced for Black students compared to White students. Specifically, in columns (2) and (3), we find no significant relationship between $dGPA \times BB$ (difference in GPA multiplied by an indicator for Black students) and friendship formation in schools where White students are in the majority. However, positive results are observed for schools with a Black student share exceeding 40%. Notably, we find that the degree of overall racial homophily, denoted as BB , is contingent upon the proportion of Black students. Specifically, as the share of Black students increases, the corresponding coefficient diminishes. This observed trend aligns with the concept of racial homophily. In Table A.5, we find similar results while controlling friendship senders' and friendship receivers' fixed effects.

4 Implications on the Black and White Gaps in Friends and Earnings

In this section, we aim to understand why and how high-achieving Black students have fewer friends than their White counterparts using the estimates obtained from the dyadic regression in Table 2 and the GPA distributions of Black and White students in Figure 1.⁸

We conduct simulations to examine the potential gains in friendship that Black students can achieve when there is a change in the distribution of Black students. To account for the difference in friends, we categorize friends into two groups based on their GPA: those with GPA ranging from 1 to 3 (considered low-achieving friends) and those with GPA ranging from 3 to 4 (considered high-achieving friends). Based on the estimated parameters in Equation (1) and the GPA distributions by race, we calculate the total number of friendships received for student j

⁸ When altering the distribution of GPA for Black and White students, we employ coefficients from the regression for each school. This allows us to isolate the school-specific characteristics in the process.

who is Black and GPA of x using the following equation:

$$\begin{aligned} \sum_{s \in E} N_B^s \times \int_{lb}^{ub} \left[(\alpha_0^s + \alpha_{BB}^s) + (\beta_0^s + \beta_{BB}^s)|x - z| \right] f_B^s dz \\ + \sum_{s \in E} N_W^s \times \int_{lb}^{ub} \left[(\alpha_0^s + \alpha_{BW}^s) + (\beta_0^s + \beta_{BW}^s)|x - z| \right] f_W^s dz \end{aligned} \quad (2)$$

where for each school s , N_B^s is the number of Black students, and N_W^s is the number of White students. $f_B^s(z)$ is the GPA distribution for Black students, and $f_W^s(z)$ is the GPA distribution for White students. α_0^s , α_{BB}^s , α_{WB}^s , β_0^s , β_{BB}^s , and β_{WB}^s are the estimated parameters from Equation (1) that capture the baseline probability of forming friendships and its deviation in the probability, and the interaction between GPA and race for the respective race pair. E represents the set of schools which contains all coefficients of alphas and betas. For low-achieving friends, lb and ub are designated as 1 and 3, respectively, while for high-achieving friends, lb and ub are set to 3 and 4.

The term $(\alpha_0^s + \alpha_{BB}^s) + (\beta_0^s + \beta_{BB}^s)|x - z|$ represents the likelihood of forming friendships between students who are both Black and have a GPA distance of $|x - z|$. This term incorporates the baseline probability of friendship formation for Black students, as well as the influence of the difference in GPA on the likelihood of forming friendships within the same race.

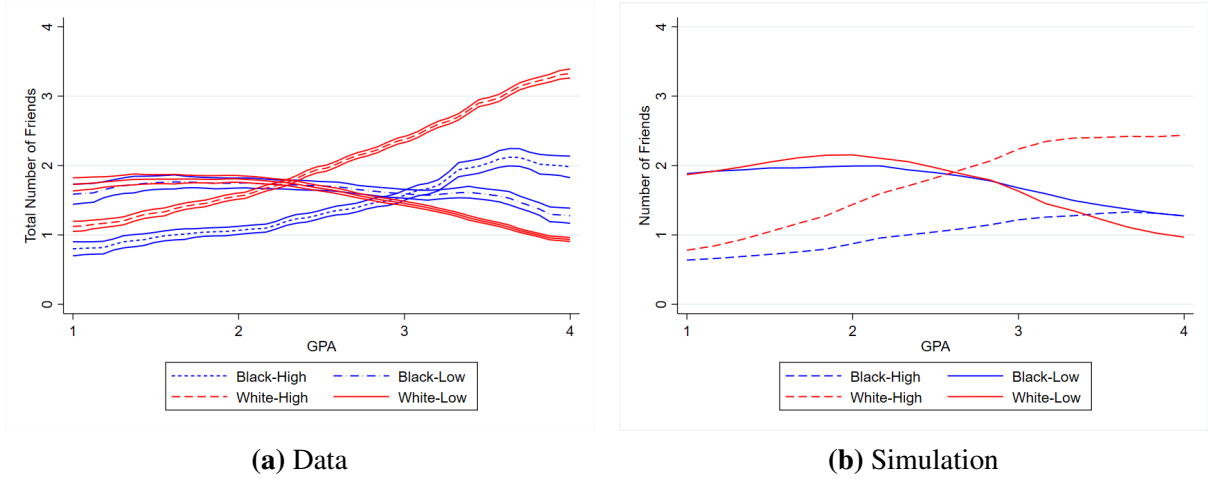
Similarly, the total number of friendships received for student j with a White race and a GPA of x can be calculated as follows:

$$\begin{aligned} \sum_{s \in E} N_W^s \times \int_{lb}^{ub} \left[\alpha_0^s + \beta_0^s|x - z| \right] f_W^s dz \\ + \sum_{s \in E} N_B^s \times \int_{lb}^{ub} \left[(\alpha_0^s + \alpha_{WB}^s) + (\beta_0^s + \beta_{WB}^s)|x - z| \right] f_B^s dz \end{aligned} \quad (3)$$

The term $\alpha_0^s + \beta_0^s|x - z|$ represents the likelihood of forming friendships between students who are both White and have a GPA distance of $|x - z|$, given that they have met each other. This term captures the baseline probability of friendship formation for White students, as well as the influence of the difference in GPA on the likelihood of forming friendships within the same race.

In Figure 5, we present two figures. In panel (a), we present the total number of friends against the receiver's GPA by race and the sender's GPA, where sender's GPA is divided into

Fig. 5. Number of Friends from Data and Simulation



Notes. The sub-figure (a) illustrates the number of friends across GPA distribution separately by race of receiver—Black and White—and achievement of sender—high and low. We define high-achieving students as students with at least a GPA of 3.0. For instance, the dashed blue line indicates the number of high-achieving friends of Black students. The solid red line indicates the number of low-achieving friends of White students. We use Black and White students in the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The sub-figure (b) illustrates the expected number of friends separately for Black and White students by the sender's achievement following Equations (2) and (3).

high (3-4) and low (1-3) types. As the GPA increases, both Black and White students are more likely to receive friendship nominations from high GPA students while the slope is steeper for White students creating a larger gap for students with high GPA. Conversely, they are less likely to receive nominations from low GPA students as the GPA increases, but the change in the difference between Black and White is not as significant as nominations from high GPA students.

Panel (b) displays the results using the simulated data based on Equations (2) and (3). The distribution of the simulated number of friends captures both qualitatively and quantitatively the patterns of the distribution of original data in Panel (a). We also calculate the average number of friends by GPA ranges 1-2, 2-3, and 3-4 for both data and simulation in Appendix A.6. Except for the high-achieving friends of high-achieving students, the difference in the number of friends between our simulation and data is less than 0.3. Although high-achieving students tend to have fewer friends in our simulation, regardless of race, the disparity between Black and White students in the number of high-achieving friends remains consistent between the simulation results and the actual data (1.16 in simulation compared to 1.09 in the data). This alignment is particularly reassuring as we seek to compare friendship patterns between different racial groups.

In the following subsections, using the simulated data we identify the factors contributing to the lower number of friends among high-achieving Black students compared to high-achieving White students by decomposing this into two distinct factors: the population size and the GPA distribution in school.

4.1 Decomposing the Friends Gap: Level and Composition Effects

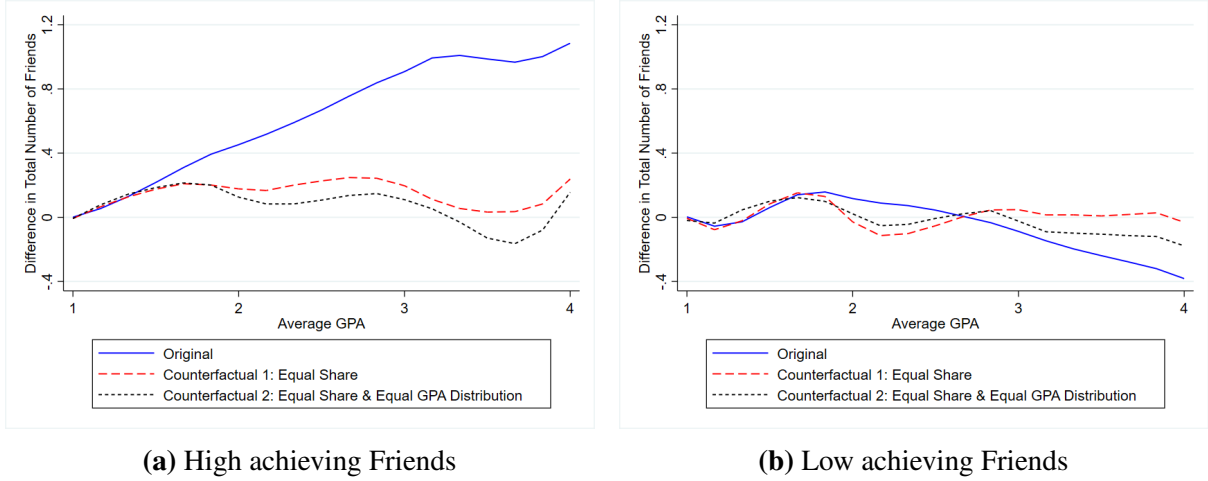
We investigate the influence of changes in both racial composition and GPA distribution on the racial gaps in the number of friends focusing on high-achieving students. To address this, we compare the simulated number of friends before and after the distributional shifts among Black and white students. This analysis involves two steps. First, we equalize the share of Black and White students. Second, in addition to equalization, we substitute the GPA distribution of White students for the GPA distribution of Black students. By examining these steps, we assess the impact of changes in the racial composition of the school and the GPA distribution of Black and White students on their friendship outcomes. Specifically, we use the GPA distributions of Black and White students presented in Figure 1, and the coefficients obtained from Table 2, we apply these values to Equations (2) and (3) to calculate the expected number of friends for Black and White students, respectively. This simulation allows us to examine the differences in expected friendship outcomes between the two racial groups.

In Figure 6, we compare the expected number of high- and low-achieving friends before and after distributional changes.⁹ The solid blue line represents the difference in the simulated number of friends between White and Black students based on Figure 5 (b), which is normalized to have zero at the lowest.¹⁰ It is important to note that the friendship gap is mainly driven by high-achieving peers. This is particularly significant as associations between high-achieving friends and enhanced returns in the labor market have been suggested (Lleras-Muney et al. 2020). High-achieving Black students have fewer high-achieving friends compared to White counterparts,

⁹ We present overall gap including both high- and low-achieving friends in Appendix A.6.

¹⁰ There are two reasons for this normalization. First, there are technical challenges in anticipating overall level changes when shifting compositions. This is because the overall level of racial homophily (represented as the BB coefficient in equation 1) is dependent on the proportion of each race, as we observe in Appendix Table 3, and it is difficult to precisely determine the exact overall homophily level when the proportions are equal. Second, there is almost no gap in the low GPA range, and the gap widens as the GPA increases. This pattern appears even though there is a discrepancy in proportion and GPA distribution. Thus, it is not an extreme assumption of the same number of friends for students with the lowest GPA in our counterfactual.

Fig. 6. Difference in the Number of Expected Friends by GPA: White - Black



Notes. The figure illustrates the difference in the number of expected friends between Black and White students, with standardization of 0 at the lowest GPA level. The expected numbers are computed using equations (2) and (3). Sub-figure (a) and (b) presents the difference in the number of high-achieving and low-achieving friends separately. In the graph, the solid blue line depicts the original difference in the expected number of friends. The dashed red line represents the difference assuming an equal proportion of Black and White students. The short-dashed black line represents the difference assuming both an equal share of Black and White students and an identical GPA distribution for Black and White students.

while they have more low-achieving friends. The red line depicts the difference in the expected number of friends after Black and White student shares are equalized, and the black short dashed line represents the gap after substituting the White GPA distribution for the Black GPA distribution, as well as equal shares.

Equalizing shares of Black and White students in panel (a) narrows the gap in the number of friendship nominations from high performers. Specifically, the gap decreases from 1.05 to 0.16 for students with a 3-4 GPA.¹¹ The reduced amount, which is 0.89, represents the level effect. We then substitute the White GPA distribution for the GPA distribution of Black students. After substituting the White GPA distribution, we find that the gap decreases from 0.16 to 0.07. The reduced amount, which is 0.09, reflects the composition effect. In total, the gap is reduced from 1.05 to 0.07 (a reduction of 93%).

In panel (b) of Figure 6, we compare the difference in the expected number of friendships received from low achievers before and after distributional changes. Compared to nominations from high-achieving peers, the changes are smaller. After equalizing the shares, the gap increases from -0.26 to -0.01 for Black students with a 3-4 GPA. The increased amount, which is 0.25,

¹¹ In appendix Table A.8, we present the expected changes in the number of friends before and after composition changes by GPA.

reflects the level effect. We then compare the difference in the expected number of friendships received from low achievers before and after substituting White GPA distribution for Black GPA distribution. For a Black student with the highest GPA, the gap decreases from -0.01 to -0.15. The reduced amount, which is 0.14, reflects the composition effect.

This analysis provides insights into the potential impact of altering the compositions of Black and White students on the expected number of friends particularly for high-achieving Black students. In this section, We find that high-achieving Black students have fewer friends than White counterparts, and the majority of this friendship gap stems from having fewer high-achieving friends. Through our counterfactual analysis, We further find that more than 90% of the gap can be attributed to compositional changes. This implies that the fewer friends among Black students, particularly high-achievers, are not a result of their personal characteristics or cultures, but rather the circumstances of being a minority in school.

4.2 From the Friends Gap to the Earnings Gap

In the preceding section, we established that the lower number of students among Black students primarily stems from structural factors, notably their status as minorities within educational institutions. In this section, we delve into the labor market consequences of this reduced social connectivity, particularly in relation to the racial wage gap when comparing Black students to their White counterparts.

We conduct a back-of-the-envelope calculation using our estimated reduction in the friendship gap in counterfactual scenarios and the estimated impact of the number of friends on earnings from Lleras-Muney et al. (2020). According to our counterfactual analysis, the friendship gap among high-achieving Black students decreased from 1.05 to 0.07 for high-achieving friends and increased from -0.26 to -0.15 for low-achieving friends.

Using the same data and defining a friend in the same manner, Lleras-Muney et al. (2020) conduct an instrumental variable (IV) analysis to estimate the causal effects of the number of friends. They employ the average absolute difference in age between a student and their peers in the same school and grade as their instrumental variable. They find that having one additional friend increases yearly earnings by 6.50 to 13.67%. Considering that they calculate

the estimate for all friends, we aggregate our estimates for both high- and low-achieving students. According to our counterfactual analysis, the total expected increase in the number of friends for high-achieving Black students is 0.87. Therefore, Black students could potentially earn 5.66% to 11.89% more annually if they had the same number of friends as White students with the same GPA distributions.

In Appendix A.7, we regress log earnings on race and the number of friends to estimate the racial earning gap and the return to the friends in our earnings sample. With basic controls, high-achieving Black students earn 25% less than their White counterparts. The average earnings stand at \$38,200, with respondents predominantly aged between 19 to 25 years old. In our counterfactual scenario, the wage gap decreases from 25.0% to 20.8-16.1%, representing a reduction of the gap by 17% to 36%.¹²

Furthermore, our OLS estimation in Appendix Table A.10 presents significant differences in the returns for high- and low-achieving friends. Notably, having a high-achieving friend is associated with a 3.4% increase in earnings, whereas the impact of having a low-achieving friend is considerably lower and not distinguishable from 0. This suggests that our estimates for the reduction in the wage gap may be underestimated.

5 Conclusion

This paper introduces a novel empirical approach that examines the interaction between race and achievements in understanding the mechanisms of friendship formation. By accounting for individual characteristics correlated with race variables, the study estimates how differences in GPA matter differently among different pairs of races. This approach provides insights into how the role of achievements varies depending on the racial composition of friendships.

Using a representative sample of adolescents in the United States, the study finds that differences in GPA matter similarly between White pairs and Black pairs of students. It further highlights the limited occurrence of friendships across racial lines, where differences in achievements matter less on across-race friendships compared to within-race friendships. The

¹² To alleviate the concerns regarding the difference in returns to the number of friends by race, we conduct a regression that includes interaction terms between Black students and the number of friends. As presented in Appendix Table A.10, the racial difference in return to friendship is not statistically significant.

study also underscores the finding that high-achieving Black students have fewer friends than their White counterparts.

To illustrate the implications of the coefficients obtained from the dyadic regression, we conduct counterfactual exercises. These exercises provide insights into the reasons behind the lower number of friends among high-achieving Black students compared to their White counterparts. The findings indicate that the limited availability of high-achieving Black students, primarily attributed to the smaller proportion and lower average GPA among Black students, is a significant factor contributing to this disparity. Furthermore, we find that the friends lacking among these high-achieving Black students are predominantly high achievers.

Finally, we delve into the labor market consequences stemming from the reduced number of friends experienced by minorities within a school setting. Our analysis reveals that high-achieving friends yield greater returns compared to their low-achieving counterparts. Consequently, we find that the disparity in the number of friends accounts for a 4 percentage point difference in earnings between Black and White individuals.

Overall, the study highlights the importance of exposure to similar types of students in forming friendships. The distribution of student race and achievements within schools notably impacts the number of friends students have. The findings suggest that students are more likely to form friendships with individuals who share similar characteristics, such as race and academic achievements. This emphasizes the role of school composition in shaping friendship networks and highlights the potential implications for social integration and social capital among students.

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ONLINE APPENDIX

Friendship Formation by Race and Achievement: Implications on Racial Gaps in Friends and Earnings

Weonhyeok Chung and Jeonghyeok Kim

Part Appendix

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A Additional Results

A.1 Summary Statistics

Table A.1: Summary, Individual Level

	White	Black	All
GPA	2.9	2.6	2.8
Female (%)	51	55	52
Age	15	15	15
Number of Friends	3.79	3.04	3.64
High Performing ($GPA \geq 3$)	2.38	1.40	2.17
Low Performing ($GPA < 3$)	1.42	1.64	1.47
Share (%)	78.9	21.1	100
Observations	43,086	11,527	54,613

Notes. The total number of observations in friendship sample is 54,613 who reported GPA and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health.

A.2 Calculating Probability of Forming Friends

The distribution of student race and academic achievements (GPA) within schools notably impacts the extent of friendships among students. The following illustration outlines the methodology employed to generate Figure 3 using in-school data.

Consider a school with a total of 15 students. Within this group, there are two high-achieving Black students, three low-achieving Black students, five high-achieving White students, and five low-achieving White students.

Table A.2: Example with Pairs of 15 Students

i and j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	B_H	B_H	B_L	B_L	B_L	W_H	W_H	W_H	W_H	W_H	W_L	W_L	W_L	W_L	W_L
1	B_H	-	1	1	0	0	0	0	0	1	0	0	0	0	1
2	B_H	1	-	0	1	0	1	0	0	0	0	0	0	0	0
3	B_L	1	0	-	1	0	0	0	0	1	0	0	0	0	0
4	B_L	0	0	1	-	0	0	0	0	0	0	0	0	1	0
5	B_L	1	1	1	1	-	0	0	0	1	1	0	1	0	0
6	W_H	0	0	0	0	0	-	1	1	1	0	1	0	0	1
7	W_H	0	0	0	0	0	1	-	1	0	1	0	0	0	0
8	W_H	0	0	0	0	0	1	1	-	0	1	0	0	0	1
9	W_H	0	0	0	0	0	1	0	0	-	1	0	0	0	0
10	W_H	1	1	1	0	1	0	1	1	0	-	1	0	0	1
11	W_L	0	0	0	0	1	1	0	1	1	1	-	1	0	0
12	W_L	0	0	0	0	0	0	0	0	0	0	0	-	1	0
13	W_L	0	0	0	0	0	0	0	0	0	0	1	0	-	1
14	W_L	0	0	0	1	0	0	0	0	0	0	0	0	1	-
15	W_L	1	0	0	0	0	1	0	1	0	1	1	1	0	1

Notes. This is a simple example with Black and White students with either high ability or low ability. Row indicates the students who are listing students and column indicates the students who are listed.

In Table A.2, we present the friendship connections among the 15 students. Each cell indicates whether student i in the row directs student j in the column as a friend. The labels in the table represent the race and achievement of the students, denoted as R_a , where R represents the race and a represents the achievement of the student. For instance, B_H in the first row (student $i = 1$) represents a high-achieving Black student. In the table, we can observe that student 2, who possesses a high-achievement, directs student 7, who possesses a high-achievement.

In Table A.3, we calculate the probabilities of forming friendships based on the data in Table A.2. For instance, let's consider the case of a high-achieving White student as the friendship

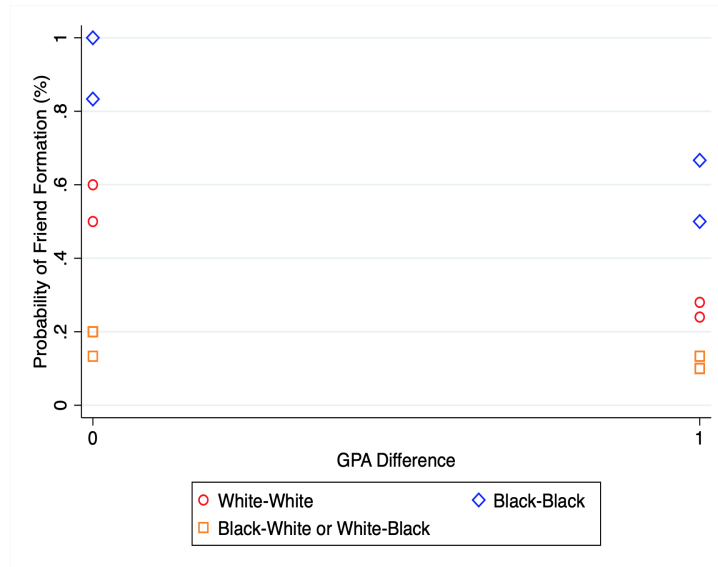
Table A.3: Probability of Forming Friendships (Example)

	B_H	B_L	W_H	W_L
B_H	100%	66.7%	20%	10%
B_L	50%	83.3%	13.3%	20%
W_H	20%	13.3%	60%	24%
W_L	10%	13.3%	28%	50%

Notes. We calculate probabilities of forming friendship for each possible race and achievement from Table (A.2).

sender and a low-achieving Black student as the friendship receiver. In this scenario, there are 15 potential pairs (5 high-achieving White students and 3 low-achieving Black students) that can form a friendship. However, only 2 actual friendships are formed out of these potential pairs. Therefore, the probability of a high-achieving White student directing a low-achieving Black student as a friend is $\frac{2}{15} = 13.3\%$.

Fig. A.1. Probability of Forming Friendships by GPA Difference and Race (Example)



Notes. The figure illustrates average probability of friendship formation by GPA difference and race pairs. This is from the Table A.2. In this figure, GPA difference is 0 when two students are both high type or low type. GPA difference is 1 when two students are different ability type (high-low or low-high types).

Using Table A.2, we plot the relationship between the GPA difference and the probability of friendship formation for each possible pair in Figure A.1. For instance, there are two cases where two Black students have identical GPAs: a high-achieving Black student directing another high-achieving Black student as a friend, and a low-achieving Black student directing another low-achieving Black student as a friend. In the figure, the likelihood of a high-achieving Black

student directing another high-achieving Black student as a friend is 100%, while the likelihood of a low-achieving Black student directing another low-achieving Black student as a friend is 83.3%.

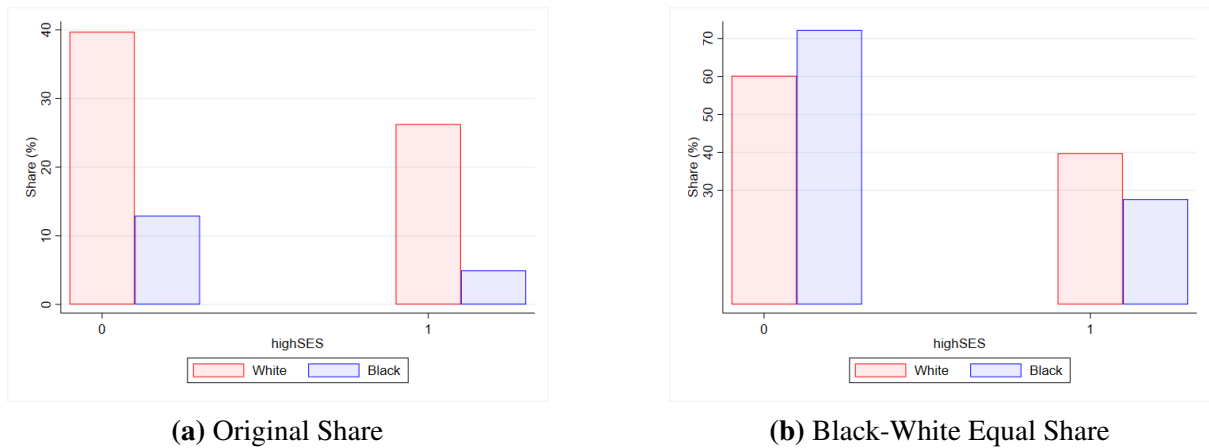
Compared to these same-achieving friend pairs, the likelihood of forming a friendship decreases when students have different GPAs. The likelihood of forming a friendship between Black students with different GPAs is lower than that of the same-ability case. Additionally, the likelihood of forming a friendship for same-race friendships is higher than that of different-race friendships for a given GPA difference.

A.3 Mother's Years of Schooling or SES

In this subsection, we analyze the distribution of socioeconomic status (SES) groups and investigate friendship formation based on race and SES groups. We define socioeconomic status using two indicators of family background: the mother's educational attainment and whether the student lives with both parents. The high SES group includes students whose mothers have attained some college education or higher and who live with both parents. The remaining students are classified into the low SES group. Our definition of the high SES group aligns with the most advantaged group in Lundberg (2013)^{A.1}.

By utilizing SES groups based on family backgrounds, we also address concerns about the reverse causality between GPA and friendship formations. Instead of achievement affecting friendship formation, friendship formation may affect academic achievements. However, the measurement of the SES group is not affected by this issue as the SES group is a predetermined characteristic of students.

Fig. A.2. SES Distribution by Race



Notes. The figures illustrate the distribution of SES for Black and White students. In panel (a), White students are the majority, and Black students are a minority. In panel (b), the shares of Black and White students are equalized. High SES includes students in high maternal education and residence with both parents.

Figure A.2 illustrates the distribution of socioeconomic status (SES) for Black and White students. In panel (a), White students comprise the majority in both SES categories while

^{A.1} Although Lundberg (2013) defines the most advantaged group as students with both biological parents and high maternal education, we use both parents instead as we cannot identify whether both parents of students are biological parents from the in-school data that we use for the analysis.

Black students represent the minority. In panel (b), the distribution of SES for Black and White students is displayed after equalizing the shares of Black and White students. The figure presents that 30 percent of Black students are in the high SES category, whereas 40 percent of White students fall into the high SES category. Consequently, within their respective racial groups, Black students have a smaller pool of potential high SES friends compared to White students.

Table A.4: Forming Friends and Differences in Social Economic Status

	Dependent variable : <i>i</i> denoting <i>j</i> as a friend (%)				
	(1)	(2)	(3)	(4)	(5)
DifferentSES	-0.078*** (0.014)	-0.089*** (0.013)	-0.083*** (0.019)	-0.090*** (0.013)	-0.110*** (0.015)
DifferentSES $\times BB$			-0.022 (0.042)	-0.038** (0.017)	-0.005 (0.032)
DifferentSES $\times BW$			0.074*** (0.020)	0.072*** (0.020)	0.051** (0.025)
DifferentSES $\times WB$			0.063*** (0.021)	0.073*** (0.020)	0.061*** (0.023)
<i>BB</i>			0.211 (0.129)	0.267* (0.145)	1.981*** (0.220)
<i>BW</i>			-0.516*** (0.063)	-0.546*** (0.053)	0.000 (0.000)
<i>WB</i>			-0.495*** (0.063)	-0.525*** (0.053)	0.000 (0.000)
Constant	0.564*** (0.047)	0.705*** (0.103)	0.626*** (0.064)	0.839*** (0.129)	0.878*** (0.043)
Observation	30,156,736	30,156,736	30,156,736	30,156,736	30,156,736
Mean	0.530	0.530	0.530	0.530	0.530
Controls		X		X	X
Individual FE					X

Notes. The table presents coefficients and standard errors from estimation of equation (1). Units of observation are directed dyads, based on the non-Hispanic Black and non-Hispanic White students who reported mothers' education, residency with both parents, and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if student *i* nominated student *j* as a friend. DifferentSES is a binary variable equal to one if both students are in a different SES group. *B* indicates Black student and *W* indicates White student. *BW* is an indicator that the sender is a Black student and the receiver is a White student. Mean is the average probability of forming friendships. Controls indicates controlling for demographic variables including gender and age of senders and receivers, age difference between pairs, and school fixed effects. Individual FE indicates controlling for individual fixed effects of senders and receivers. *** $p < .01$, ** $p < .05$, * $p < .1$

Table A.4 presents estimation results in Equation (1) with and without covariates, using the SES groups instead of GPA. In column (1), when the SES groups differ, the probability of friendship formation between two students in the school decreases by 0.078 percentage points

compared to the overall mean of 0.56 percent. In column (2), when we control for additional characteristics^{A.2}, the coefficient becomes more pronounced. In column (2), the results indicate that when the SES group differs, the probability of friendship formation between two students in the school decreases by 0.089 percentage points. This corresponds to approximately a 12.6 percent decline from the baseline probability of forming friendships, which is 0.705 percent.

In column (3), we find that different SES matters similarly between pairs of White students and pairs of Black students. In column (4), We find similar results to those in column (3) after controlling dyad-level characteristics (age and gender pairs) as well as demographic variables related to the senders' or receivers' genders and ages. In column (5), we control sender fixed effects and receiver fixed effects. Regardless of whether we control for individual fixed effects, we find that the difference in SES matters similarly in friendship formation for Black and White students. The significance of the SES difference is more pronounced for within-race friendships compared to across-race friendships, regardless of the control variables.

^{A.2} We additionally control for dyad-level characteristics (age and gender pairs) and demographic variables related to the senders' or receivers' genders and ages

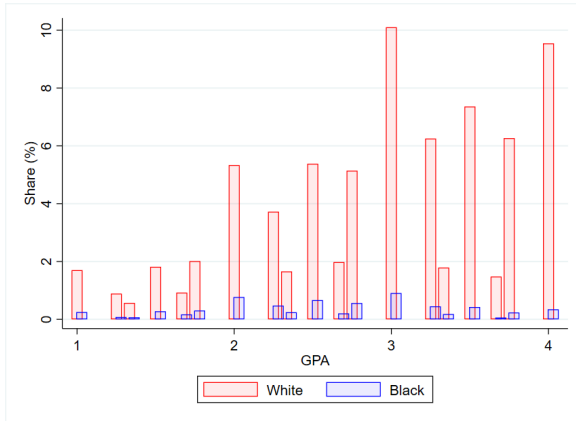
A.4 Different Black Share of Schools

In this subsection, we provide additional information about the characteristics of schools based on the proportion of Black students. Figure A.3 displays two figures, illustrating the distribution of GPAs among Black and White students, both with and without equalizing the shares of each race, across different proportions of Black students. Two notable patterns emerge: i) Black students predominantly cluster in the middle of the GPA distribution, while White students tend to be concentrated at the top of the GPA distribution; ii) the disparity in the proportion of high-performing students between Black and White students is more pronounced in schools with a Black minority.

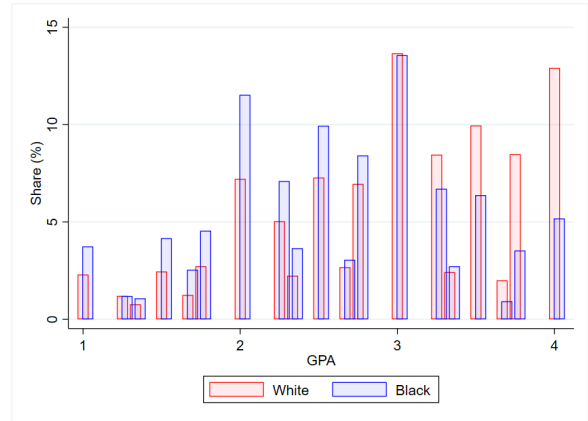
Figures A.4, A.5, and A.6 depict various school characteristics across different proportions of Black students. Black-majority schools are more inclined to be public, located in suburban or rural areas, situated in the South, and characterized by a small to medium size. Conversely, White-majority schools are more likely to be private, located in the Northeast or West, and characterized by a larger size.

Lastly, we provide Table A.5 controlling for sender and receiver fixed effects, which complements Table 3 in the main text.

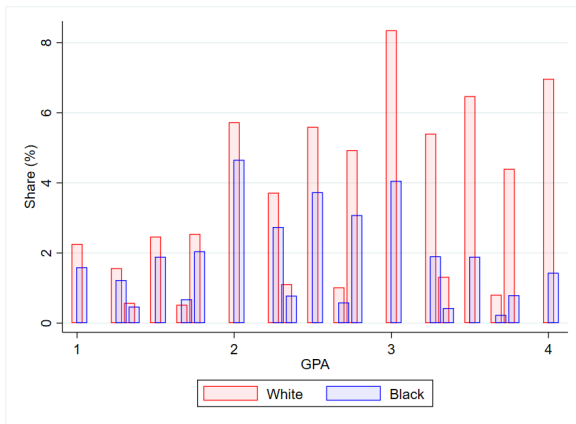
Fig. A.3. GPA Distribution by Average GPA



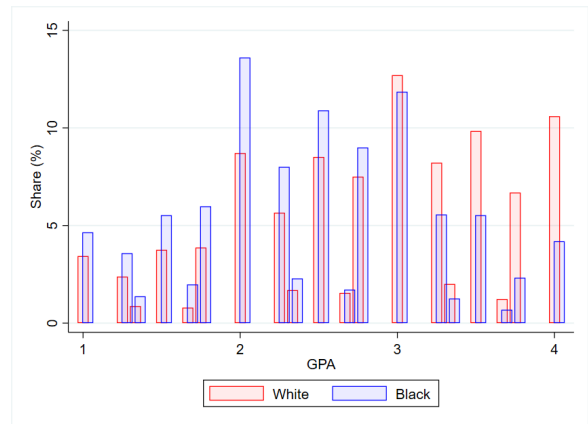
(a) Original Shares (Black 0-22%)



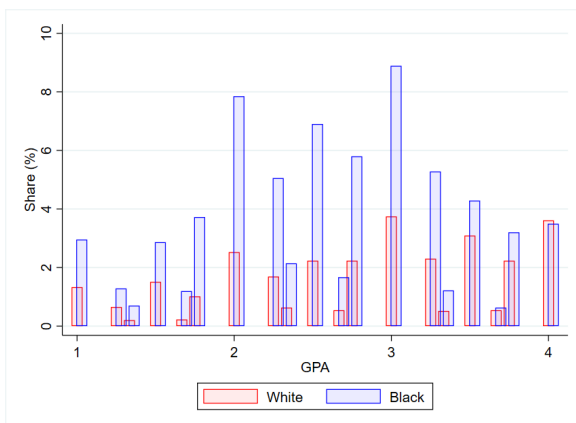
(b) Equal Shares (Black 0-22%)



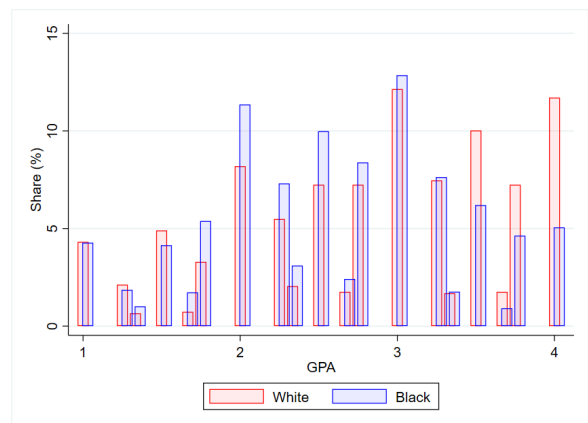
(c) Original Shares (Black 23-40%)



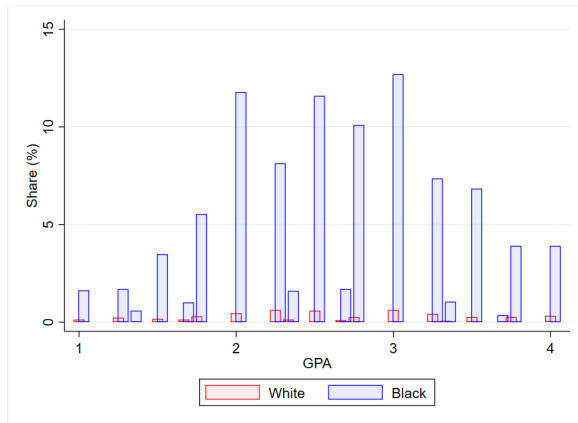
(d) Equal Shares (Black 23-40%)



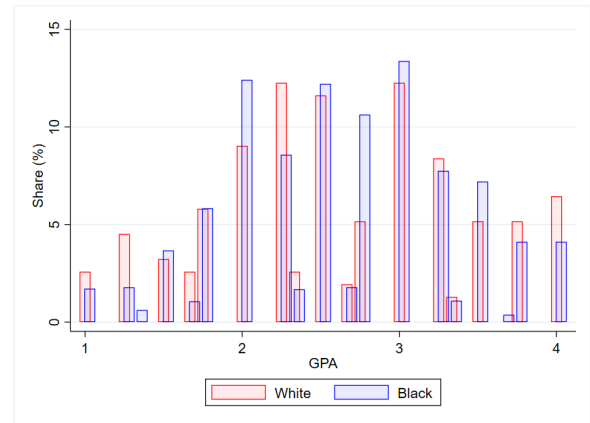
(e) Original Shares (Black 41-74%)



(f) Equal Shares (Black 41-74%)



(g) Original Shares (Black 75-100%)



(h) Equal Shares (Black 75-100%)

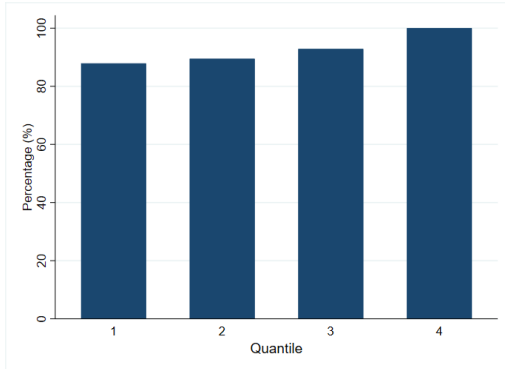
Notes. The figures illustrate the distributions of average GPA for Black and White students, separately by proportion of Black students in school. The red bar indicates the density of the average GPA of White students. The blue bar indicates the density of the average GPA of Black students. We use Black and White students in the in-school data of the National Longitudinal Study of Adolescent to Adult Health. The sub-figures (a), (c), (e), and (g), illustrates the average GPA distribution with original Black and White shares. The sub-figures (b), (d), (f), and (h), illustrates the average GPA distribution after equalizing Black and White shares.

Table A.5: Friendship Formation by Race and Achievements: Across Black Student Proportion: Individual Fixed-Effects

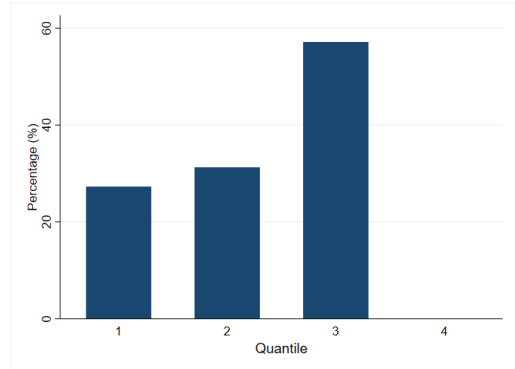
	Dependent variable : Probability of i denoting j as a friend (%)				
	(1)	(2)	(3)	(4)	(5)
$dGPA$	-0.259*** (0.028)	-0.248*** (0.029)	-0.359*** (0.078)	-0.269*** (0.035)	-1.406*** (0.124)
$dGPA \times BB$	0.038 (0.049)	-0.080 (0.075)	0.094** (0.039)	0.146*** (0.031)	1.136*** (0.120)
$dGPA \times BW$	0.200*** (0.025)	0.165*** (0.025)	0.295*** (0.067)	0.221*** (0.039)	1.298*** (0.106)
$dGPA \times WB$	0.193*** (0.026)	0.154*** (0.024)	0.281*** (0.067)	0.229*** (0.037)	1.354*** (0.097)
Constant	0.938*** (0.051)	1.154*** (0.070)	0.870*** (0.056)	0.097 (0.111)	-4.600*** (0.244)
Observation	36,183,256	26,910,900	4,993,870	2,743,852	1,534,634
Mean	0.513	0.509	0.539	0.400	0.681

Notes. The table presents coefficients and standard errors from estimation of equation (1), separately by the share of Black students. Units of observation are directed dyads, based on non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if student i nominated student j as a friend. $dGPA$ indicates a difference in average GPA between the pairs of students. B indicates Black students, and W indicates White students. The schools are divided into four quantile groups as follows: the first quantile (Q1) includes schools with Black student shares ranging from 0% to 22%; the second quantile (Q2) includes schools with Black student shares between 23% and 40%; the third quantile (Q3) includes schools with Black student shares between 41% and 74%; and the fourth (Q4) quantile includes schools with Black student shares between 75% and 100%. *** $p < .01$, ** $p < .05$, * $p < .1$

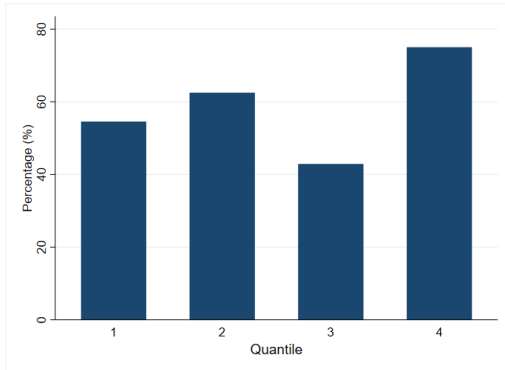
Fig. A.4. Fraction of Schools



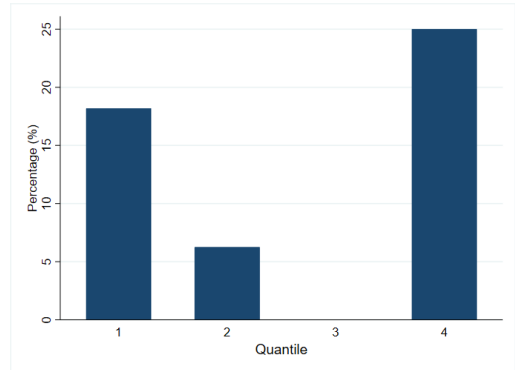
(a) Fraction of Public Schools



(b) Fraction of Urban Schools



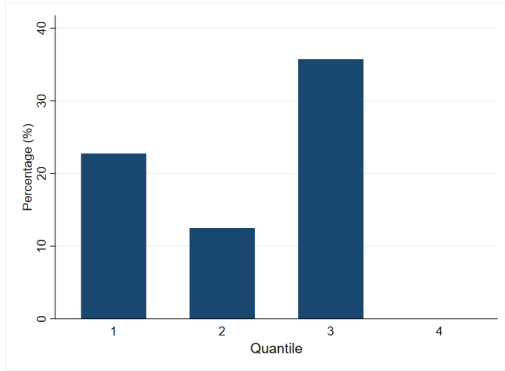
(c) Fraction of Suburban Schools



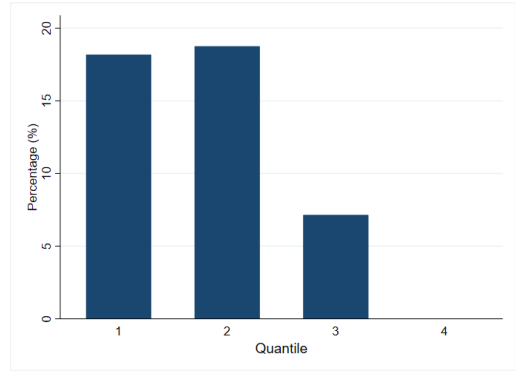
(d) Fraction of Rural Schools

Notes. We sort only black students based on the black share of the schools they are in. We then cut four groups of schools. Q1 indicates the students in the schools with the least share of black students. Q1, Q2, Q3, and Q4 indicate the quantile of students in the black share of schools. Q4 is where the share is the largest. Q1 is a school with a black share between 0% and 22%. Q2 is a school with a black share between 23% and 40%. Q3 is a school with a black share between 41% and 74%. Q4 is a school with a black share between 75% and 100%. The fraction in the figure is the number of schools with the characteristics in the given quantile out of all schools in the given quantile.

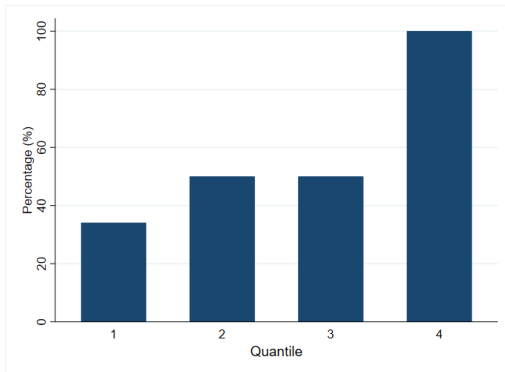
Fig. A.5. Fraction of Schools



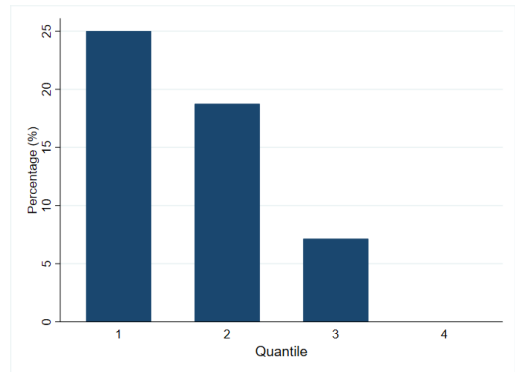
(a) Fraction of Schools in Midwest



(b) Fraction of Schools in Northeast



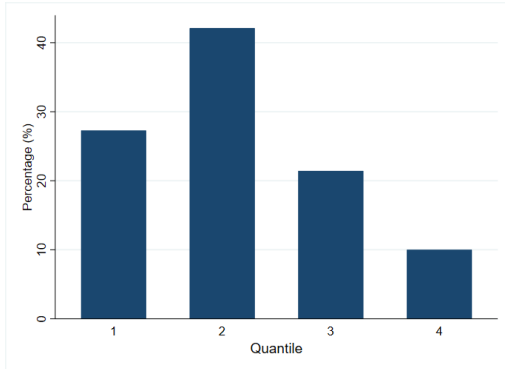
(c) Fraction of Schools in South



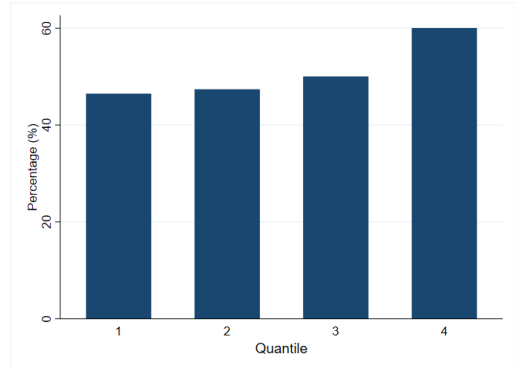
(d) Fraction of Schools in West

Notes. We sort only black students based on the black share of the schools they are in. We then cut four groups of schools. Q1 indicates the students in the schools with the least share of black students. Q1, Q2, Q3, and Q4 indicate the quantile of students in the black share of schools. Q4 is where the share is the largest. Q1 is a school with a black share between 0% and 22%. Q2 is a school with a black share between 23% and 40%. Q3 is a school with a black share between 41% and 74%. Q4 is a school with a black share between 75% and 100%. The fraction in the figure is the number of schools with the characteristics in the given quantile out of all schools in the given quantile.

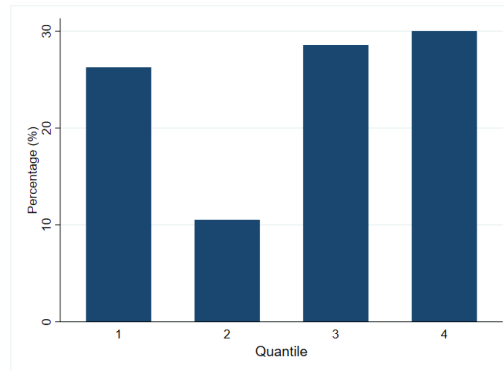
Fig. A.6. Fraction of Schools



(a) Fraction of Large Size School (1,001 to 4,000 students)



(b) Fraction of Medium Size School (401 to 1,000 students)



(c) Fraction of Small Size School (1 to 400 students)

Notes. We sort only black students based on the black share of the schools they are in. We then cut four groups of schools. Q1 indicates the students in the schools with the least share of black students. Q1, Q2, Q3, and Q4 indicate the quantile of students in the black share of schools. Q4 is where the share is the largest. Q1 is a school with a black share between 0% and 22%. Q2 is a school with a black share between 23% and 40%. Q3 is a school with a black share between 41% and 74%. Q4 is a school with a black share between 75% and 100%. The fraction in the figure is the number of schools with the characteristics in the given quantile out of all schools in the given quantile.

A.5 Forming Friendships within School Clubs

In Table A.6, we examine whether the difference in GPA has varying implications for friendship formation when students are members of the same social club or not. The variable *Club* indicates whether the two students are both members of at least one social club. Our findings show that students who share membership in a club are more likely to form friendships compared to those who do not share club membership. Furthermore, we observe that the difference in GPA matters more on friendship formation for student pairs who are part of the same club ($Club \times dGPA$). In other words, even when students belong to the same club, the likelihood of forming friendships diminishes if there are larger differences in their GPAs. These findings address concerns that the formation of friendships is solely influenced by exposure rather than the active choice of students. In addition, we do not find a significant difference between White-White pairs and Black-Black pairs, regardless of their involvement in the social club ($Club \times dGPA \times BB$ and $dGPA \times BB$).

Table A.6: Forming Friends with Extracurricular activities

	Dependent variable : <i>i</i> denoting <i>j</i> as a friend (%)	
	(1)	(2)
<i>Club</i> × <i>dGPA</i>	-0.355*** (0.046)	-0.353*** (0.041)
<i>Club</i> × <i>dGPA</i> × <i>BB</i>	0.103 (0.095)	0.116 (0.085)
<i>Club</i> × <i>dGPA</i> × <i>BW</i>	0.283*** (0.046)	0.288*** (0.044)
<i>Club</i> × <i>dGPA</i> × <i>WB</i>	0.285*** (0.045)	0.290*** (0.042)
<i>Club</i> × <i>BB</i>	-0.123 (0.230)	-0.106 (0.199)
<i>Club</i> × <i>BW</i>	-0.962*** (0.109)	-0.936*** (0.107)
<i>Club</i> × <i>WB</i>	-0.923*** (0.107)	-0.896*** (0.104)
<i>Club</i>	1.242*** (0.110)	1.096*** (0.098)
<i>dGPA</i>	-0.130*** (0.016)	-0.127*** (0.015)
<i>dGPA</i> × <i>BB</i>	0.012 (0.030)	0.002 (0.032)
<i>dGPA</i> × <i>BW</i>	0.113*** (0.016)	0.100*** (0.016)
<i>dGPA</i> × <i>WB</i>	0.108*** (0.016)	0.100*** (0.016)
<i>BB</i>	0.207 (0.125)	0.228 (0.140)
<i>BW</i>	-0.434*** (0.057)	-0.489*** (0.052)
<i>WB</i>	-0.413*** (0.057)	-0.470*** (0.052)
Constant	0.526*** (0.058)	0.592*** (0.125)
Observation	36,183,256	36,183,256
Mean	0.5	0.5
Controls		X

Notes. The table presents coefficients and standard errors from estimation of equation (1). Units of observation are directed dyads, based on the non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if student *i* nominated student *j* as a friend. *dGPA* indicates a difference in average GPA between the pairs of students. *Club* is a binary variable equal to one if both students were in at least one extracurricular activity. *B* indicates Black students, and *W* indicates White students. *** $p < .01$, ** $p < .05$, * $p < .1$

A.6 Additional Simulation Outcomes

Table A.7: Number of friends by Type of Friends and GPA

Data	Black Students			White Students			Difference (White - Black)	
	(1) Low-Perform Friends	(2) High-Perform Friends	(3) Low-Perform Friends	(4) High-Perform Friends	(5) Low-Perform Friends	(6) High-Perform Friends		
Simulation Results								
GPA 1-2	1.71	0.98	1.79	1.37	0.08	0.39		
GPA 2-3	1.66	1.37	1.60	2.10	-0.06	0.73		
GPA 3-4	1.51	1.98	1.10	3.07	-0.41	1.09		
Simulation Results								
GPA 1-2	1.98	0.77	2.08	1.18	0.10	0.41		
GPA 2-3	1.87	1.11	1.87	2.00	0.00	0.89		
GPA 3-4	1.44	1.28	1.15	2.44	-0.29	1.16		
Difference (Data - Simulation)								
GPA 1-2	-0.27	0.21	-0.29	0.19	-0.02	-0.02		
GPA 2-3	-0.21	0.26	-0.27	0.10	-0.06	-0.16		
GPA 3-4	0.07	0.70	-0.05	0.63	-0.12	-0.07		

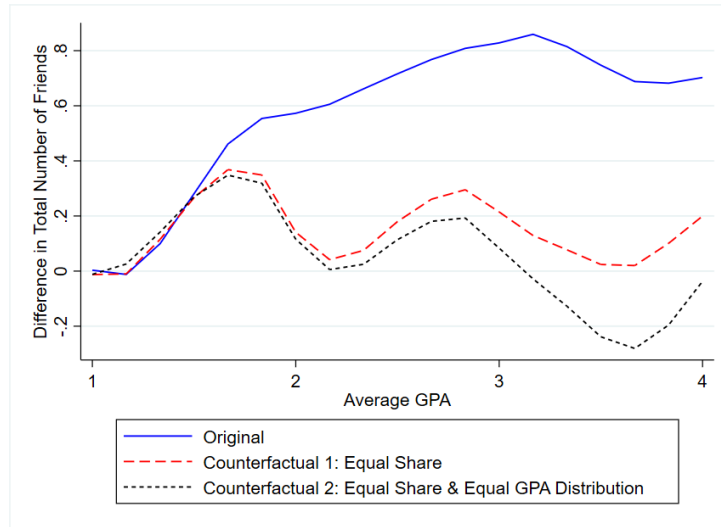
Notes. This table illustrates the number of friends based on the race of receivers and the achievement types of both receivers and senders. Receiver achievement is categorized into GPA ranges 1-2, 2-3, and 3-4, while sender achievement is divided into low (1-3) and high (3-4). The data panel presents the average number of friends in our dataset, while the Simulation Results panel presents the simulated number of friends.

Table A.8: The Difference in the Number of Friends (White - Black) Before and After Composition Changes.

Panel A: High-Performing Friends			
	GPA 1-2	GPA 2-3	GPA 3-4
Simulation	0.31	0.75	1.05
Counterfactual 1: Equal Share	0.17	0.21	0.16
Counterfactual 2: Equal Share & Equal GPA Dist.	0.16	0.11	0.07
Panel B: Low-Performing Friends			
	GPA 1-2	GPA 2-3	GPA 3-4
Simulation	0.08	0.01	-0.26
Counterfactual 1: Equal Share	0.01	-0.01	-0.01
Counterfactual 2: Equal Share & Equal GPA Dist.	0.03	-0.01	-0.15

Notes. The table illustrates the difference in the number of expected friends between Black and White students, with standardization of 0 at the lowest GPA level. The expected numbers are computed using equations (2) and (3). Panel (a) and (b) present the difference in the number of high-performing and low-performing friends separately. In the table, the simulation presents the original difference in the expected number of friends. Counterfactual 1 presents the difference assuming an equal proportion of Black and White students. Counterfactual 2 presents the difference assuming both an equal share of Black and White students and an identical GPA distribution for Black and White students.

Fig. A.7. Difference in Number of Expected Friends by GPA: White - Black



Notes. The figure illustrates the difference in the number of expected friends between Black and White students, with standardization of 0 at the lowest GPA level. The expected numbers are computed using Equations (2) and (3). In the graph, the solid blue line depicts the original difference in the expected number of friends. The dashed red line represents the difference assuming an equal proportion of Black and White students. The short-dashed black line represents the difference assuming both an equal share of Black and White students and an identical GPA distribution for Black and White students.

A.7 Additional Earnings Outcomes

We further restrict our sample for labor market analysis to include individuals who report measures of cognitive skills, social skills, education level, and earnings. Consistent with Lleras-Muney et al. (2020), cognitive skills are assessed using the Add Health Picture Vocabulary Test (AHPVT) score administered in Wave 1, while social skills are gauged through self-reported extroversion levels collected in Wave 2.^{A.3} Earnings are measured as total earnings from wages or salary in the previous year. We utilize earnings data from Waves 3 and 4, corresponding to ages 18-26 and 24-31, respectively. Respondents who responded "do not know" to the earnings question were presented with twelve earnings categories, and we approximate their earnings by using the midpoint of the selected range. On average, individuals in our sample earned approximately \$46,000 in the preceding year. See Table A.1 for summary statistics of both friendship and earnings samples at the individual level.

Connecting students to their earnings and other personal traits, we regress the log hourly wage of individual i in school j in year t on the number of high ($s = h$) and low ($s = l$) achieving friends:

$$\ln(wage)_{ijt} = \gamma_0 + \gamma_b Black_i + \sum_{s \in [h, l]} (\gamma_{sf} NumFriend_{is}) + \iota X_{it} + \delta_j + \eta_t + e_{ijt} \quad (A.1)$$

where *Black* is an indicator denoting high-achieving Black students, and *NumFriend* is the number of friends. We include school fixed effects, δ_j , and year fixed effects, η_t . We also include individual-level controls, X_{it} , indicating age, sex, education, social skill measure, cognitive skill measure, and an indicator function for low GPA and its interaction with black students.

Table A.10 presents the estimation results. In column (1), we find that one additional friend correlates with 2.3% increase in yearly earnings, which is well matched with the estimation results from Lleras-Muney et al. (2020) where they find 2.4% increase. In column (2), we add interaction variable between Black students and the number of friends to see whether the return to additional friends differs by race. We find there is no significant difference between Black and

^{A.3} The survey question is "You are shy?", and the choices are "strongly agree, agree, neither agree nor disagree, disagree, strongly disagree". Individuals choosing last three categories are defined as extrovert. Due to survey design, 26% of individuals in the dataset lack this information. Consequently, we impute this measure and incorporate a dummy variable to indicate its absence.

Table A.9: Summary, Individual Level

Panel A: Friendship Sample			
	White	Black	All
GPA	2.9	2.6	2.8
Female (%)	51	55	52
Age	15	15	15
Number of Friends	3.79	3.04	3.64
High Performing (GPA \geq 3)	2.38	1.40	2.17
Low Performing (GPA<3)	1.42	1.64	1.47
Share (%)	78.9	21.1	100
Observations	43,086	11,527	54,613
Panel B: Earnings Sample			
	White	Black	All
GPA	2.9	2.6	2.9
Female (%)	54	61	55
Age	25	25	25
Number of Friends	4.46	3.38	4.20
High Performing (GPA \geq 3)	2.77	1.63	2.50
Low Performing (GPA<3)	1.69	1.76	1.70
Share (%)	76.0	24.0	100
Observations	8,010	2,534	10,544

Notes. The total number of observations in friendship sample is 10,544 who reported GPA and individual characteristics (age, gender, and race) from the in-school survey, and reported cognitive, social skills, and earnings from the in-home survey of the National Longitudinal Study of Adolescent to Adult Health.

Table A.10: Number of Friends and Racial Earnings Gap

	(1)	(2)	(3)	(4)	(5)
Black	-0.264*** (0.060)	-0.240*** (0.072)	-0.250*** (0.077)	-0.237*** (0.077)	-0.219*** (0.077)
Black \times Low Performing			-0.013 (0.064)	-0.019 (0.065)	-0.034 (0.065)
All Friends	0.023*** (0.003)	0.025*** (0.003)		0.021*** (0.003)	
Black \times Friends		-0.007 (0.009)			
High Performing Friends					0.034*** (0.005)
Low Performing Friends					0.002 (0.006)
Years of Education	0.064*** (0.005)	0.064*** (0.005)	0.060*** (0.005)	0.058*** (0.005)	0.057*** (0.006)
Controls	X	X	X	X	X
Observations	5341	5341	5341	5341	5341

Notes. The table presents estimation results from equation (A.1). In the table, “Controls” stands for the inclusion of fixed effects, including age, survey year, sex, school, social skill measure, cognitive skill measure, and an indicator function for low GPA and its interaction with Black students. We use Black and White students observed both in the in-school and in-home survey of the National Longitudinal Study of Adolescent to Adult Health. Standard errors are clustered at the school level. *** $p < .01$, ** $p < .05$, * $p < .1$

White students while the correlation is smaller for Black students by 0.7%. Moving to column (3), we add the indicator for low-achieving students and its interaction with Black students to see the wage gap for high-achieving students. In column (3), we control for the number of friends and the wage gap reduces to 23.7%. In column (4), as we control for the number of high- and low-achieving friends separately, the earnings gap diminishes to 21.9%. Notably, having a high-achieving friend is associated with a 3.4% increase in earnings, while the impact of having a low-achieving friend is substantially lower and indistinguishable from 0.

A potential concern pertains to the endogeneity of the effects of the number of friends on earnings. It is possible that the number of friends might reflect personal traits such as social skills or a preference for social activities. In such cases, the reduction in the racial earnings gap might not solely be attributed to the differences in the number of friends. However, as demonstrated in the preceding subsection, we have shown that the gap in friendships is not due to personal traits but rather stems from the minority status within the school environment. Moreover, as noted by Lleras-Muney et al. (2020), the OLS estimates of the number of friends may suffer from downward bias, implying that any observed reduction in the earnings gap could be underestimated.

B Robustness Checks

B.1 Mutual Friendship Measures

Table B.1: Forming Friends and Difference in GPA: Mutual Friendship (Both)

	Dependent variable : i denoting j as a friend (%)				
	(1)	(2)	(3)	(4)	(5)
$dGPA$	-0.095*** (0.010)	-0.078*** (0.008)	-0.112*** (0.013)	-0.093*** (0.011)	-0.131*** (0.015)
$dGPA \times BB$			0.036* (0.021)	0.022 (0.022)	0.034 (0.025)
$dGPA \times BW$			0.100*** (0.013)	0.086*** (0.012)	0.104*** (0.013)
$dGPA \times WB$			0.100*** (0.013)	0.086*** (0.012)	0.104*** (0.013)
BB			0.002 (0.065)	0.026 (0.069)	0.928*** (0.108)
BW			-0.295*** (0.035)	-0.296*** (0.029)	0.000 (0.000)
WB			-0.295*** (0.035)	-0.296*** (0.029)	0.000 (0.000)
Constant	0.289*** (0.026)	0.088 (0.054)	0.335*** (0.036)	0.178*** (0.064)	0.373*** (0.021)
Observation	36,183,256	36,183,256	36,183,256	36,183,256	36,183,256
Mean	0.208	0.208	0.208	0.208	0.208
Controls		X		X	X
Individual FE					X

Notes. Units of observation are undirected dyads, based on the 54,850 non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if student i and student j both listed each other as a friend. $dGPA$ indicates a difference in average GPA between the pairs of students. B indicates Black students, and W indicates White students. *** $p < .01$, ** $p < .05$, * $p < .1$

In our dyadic analysis, we measure friendships based on directed numbers, where one student directs another as their friend. However, in Table B.1, we examine the sensitivity of our friendship measure by using a stricter definition of friendship: mutual friendship, where both students mutually direct each other as friends. While this stricter definition results in a smaller probability of forming friendships compared to the baseline measure, our findings are qualitatively unchanged. The difference in GPA matters again similarly between pairs of Black students and pairs of White students ($dGPA \times BB$). Additionally, we find that the difference

in GPA matters less on across-race friendship formations compared to within-race friendships ($dGPA \times BW$ and $dGPA \times WB$).

Table B.2: Forming Friends and Difference in GPA: Mutual Friendship (Either)

	Dependent variable : i denoting j as a friend (%)				
	(1)	(2)	(3)	(4)	(5)
$dGPA$	-0.282*** (0.028)	-0.251*** (0.023)	-0.319*** (0.037)	-0.284*** (0.032)	-0.388*** (0.041)
$dGPA \times BB$			0.058 (0.067)	0.012 (0.069)	0.041 (0.074)
$dGPA \times BW$			0.270*** (0.036)	0.229*** (0.033)	0.289*** (0.038)
$dGPA \times WB$			0.270*** (0.036)	0.229*** (0.033)	0.289*** (0.038)
BB			0.334 (0.267)	0.475* (0.275)	3.574*** (0.398)
BW			-0.926*** (0.122)	-0.935*** (0.093)	0.000 (0.000)
WB			-0.926*** (0.122)	-0.935*** (0.093)	0.000 (0.000)
Constant	1.060*** (0.094)	1.299*** (0.147)	1.168*** (0.125)	1.546*** (0.200)	1.503*** (0.080)
Observation	36,183,256	36,183,256	36,183,256	36,183,256	36,183,256
Mean	0.817	0.817	0.817	0.817	0.817
Controls		X		X	X
Individual FE					X

Notes. Units of observation are undirected dyads, based on the 54,850 non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if at least one of students i and j listed another student as a friend. $dGPA$ indicates a difference in average GPA between the pairs of students. B indicates Black students, and W indicates White students. *** $p < .01$, ** $p < .05$, * $p < .1$

Moreover, we alternatively define the mutual friendship measure, where if at least one student directs the other as a friend, both the $i - j$ and $j - i$ pairs are considered as forming friendships. The results are presented in Table B.2. This looser definition of friendship results in a higher probability of forming friendships compared to my baseline measure. However, our findings are qualitatively unchanged. The difference in GPA matters once again similarly between pairs of Black students and pairs of White students. We find that the difference in GPA matters less on across-race friendship formations compared to within-race friendships

B.2 Asymmetric GPA Effects

In Table B.3, we further examine whether the GPA gap matters differently when students direct a receiver with a higher or lower GPA. The variable *ReceivingHighGPA* indicates that the sender student (i) has a lower GPA than the receiver student (j). The relationship between the GPA gap and friendship formation is weaker when the receiver has a higher GPA ($ReceivingHighGPA \times dGPA$). This suggests that the difference in GPA matters differently when a student directs another student with a higher or lower GPA. However, we do not find a significant difference between White-White pairs and Black-Black pairs, regardless of the direction from lower GPA to higher GPA or higher GPA to lower GPA ($ReceivingHighGPA \times dGPA \times BB$ and $dGPA \times BB$).

Table B.3: Forming Friends and Difference in GPA: Asymmetric GPA

	Dependent variable : <i>i</i> denoting <i>j</i> as a friend (%)	
	(1)	(2)
<i>ReceiverHighGPA</i> \times <i>dGPA</i>	0.032*** (0.006)	0.132*** (0.016)
<i>ReceiverHighGPA</i> \times <i>dGPA</i> \times <i>BB</i>	-0.018 (0.021)	-0.015 (0.020)
<i>ReceiverHighGPA</i> \times <i>dGPA</i> \times <i>BW</i>	-0.040*** (0.009)	-0.046*** (0.014)
<i>ReceiverHighGPA</i> \times <i>dGPA</i> \times <i>WB</i>	0.003 (0.012)	0.006 (0.014)
<i>ReceiverHighGPA</i> \times <i>BB</i>	0.033 (0.025)	0.029 (0.023)
<i>ReceiverHighGPA</i> \times <i>BW</i>	0.021** (0.008)	0.017* (0.010)
<i>ReceiverHighGPA</i> \times <i>WB</i>	0.024** (0.011)	0.031*** (0.011)
<i>ReceiverHighGPA</i>	-0.030*** (0.007)	-0.019*** (0.005)
<i>dGPA</i>	-0.229*** (0.027)	-0.253*** (0.028)
<i>dGPA</i> \times <i>BB</i>	0.054 (0.044)	0.022 (0.045)
<i>dGPA</i> \times <i>BW</i>	0.209*** (0.026)	0.187*** (0.024)
<i>dGPA</i> \times <i>WB</i>	0.186*** (0.026)	0.158*** (0.025)
<i>BB</i>	0.153 (0.164)	0.240 (0.169)
<i>BW</i>	-0.631*** (0.079)	-0.636*** (0.061)
<i>WB</i>	-0.608*** (0.079)	-0.616*** (0.061)
Constant	0.762*** (0.081)	0.868*** (0.129)
Observation	36,519,842	36,183,256
Mean	0.5	0.5
Controls		X

Notes. Units of observation are directed dyads, based on non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if student *i* nominated student *j* as a friend. *dGPA* indicates a difference in average GPA between the pairs of students. *B* indicates Black students, and *W* indicates White students. *** $p < .01$, ** $p < .05$, * $p < .1$

B.3 Semiparametric GPA Measures

We explore whether low and high GPA students exhibit different patterns when they form friendships with low and high GPA peers. we divide students into two GPA groups: low (average GPA 1-3) and high (average GPA 3-4). Then, we examine the difference across races when a student i with a low (or high) GPA forms a friendship with a student j with a low (or high) GPA. The results are presented in Table B.4. First, we observe a higher probability of forming friendships within the same GPA groups than across GPA groups. Particularly, stronger homophily exists among high GPA students. Regardless of whether a student with a low or high GPA forms friendships with a student with a low or high GPA, however, GPA gap matters less or similar to Black-Black pairs compared to White-White pairs. Additionally, we further explore the differences using three levels of GPA: low (average GPA 1-2.5), middle (average GPA 2.5-3.25), and high (average GPA 3.25-4), as shown in Table B.5. Once again, we find that the GPA gap matters similarly or less on friendships for Black-Black pairs compared to White-White pairs.

Table B.4: Forming Friends and Difference in GPA: Semiparametric Low-High

	Dependent variable : <i>i</i> denoting <i>j</i> as a friend (%)	
	(1)	(2)
$GPA_i : low \times GPA_j : high \times BW$	0.060*** (0.022)	0.053** (0.021)
$GPA_i : low \times GPA_j : high \times WB$	0.113*** (0.025)	0.104*** (0.021)
$GPA_i : low \times GPA_j : high \times BB$	0.076 (0.047)	0.069** (0.031)
$GPA_i : high \times GPA_j : low \times BW$	0.115*** (0.024)	0.106*** (0.021)
$GPA_i : high \times GPA_j : low \times WB$	0.060** (0.023)	0.053** (0.023)
$GPA_i : high \times GPA_j : low \times BB$	0.040 (0.045)	0.032 (0.027)
$GPA_i : high \times GPA_j : high \times BW$	-0.214*** (0.075)	-0.221*** (0.055)
$GPA_i : high \times GPA_j : high \times WB$	-0.209*** (0.075)	-0.216*** (0.053)
$GPA_i : high \times GPA_j : high \times BB$	0.174 (0.244)	0.126 (0.192)
$GPA_i : low \times GPA_j : high$	-0.074*** (0.021)	-0.066*** (0.009)
$GPA_i : high \times GPA_j : low$	-0.087*** (0.023)	-0.089*** (0.012)
$GPA_i : high \times GPA_j : high$	0.298*** (0.075)	0.283*** (0.041)
<i>BB</i>	0.214* (0.114)	0.237* (0.129)
<i>BW</i>	-0.452*** (0.057)	-0.499*** (0.052)
<i>WB</i>	-0.429*** (0.057)	-0.473*** (0.052)
Constant	0.548*** (0.058)	0.846*** (0.124)
Observation	36,183,256	36,183,256
Mean	0.5	0.5
Controls	X	X

Notes. Units of observation are directed dyads, based on the 54,850 non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if student *i* nominated student *j* as a friend. *dGPA* indicates a difference in average GPA between the pairs of students. *B* indicates Black students, and *W* indicates White students. *** $p < .01$, ** $p < .05$, * $p < .1$

Table B.5: Forming Friends and Difference in GPA: Semiparametric Low-Middle-High

	Dependent variable : <i>i</i> denoting <i>j</i> as a friend (%)	
	(1)	(2)
$GPA_i : low \times GPA_j : middle \times BW$	0.086*** (0.018)	0.093*** (0.024)
$GPA_i : low \times GPA_j : middle \times WB$	0.093*** (0.017)	0.081*** (0.020)
$GPA_i : low \times GPA_j : middle \times BB$	0.046 (0.044)	0.057 (0.039)
$GPA_i : low \times GPA_j : high \times BW$	0.187*** (0.032)	0.167*** (0.034)
$GPA_i : low \times GPA_j : high \times WB$	0.241*** (0.035)	0.217*** (0.034)
$GPA_i : low \times GPA_j : high \times BB$	0.107** (0.052)	0.099** (0.039)
$GPA_i : middle \times GPA_j : low \times BW$	0.104*** (0.018)	0.090*** (0.024)
$GPA_i : middle \times GPA_j : low \times WB$	0.080*** (0.020)	0.086*** (0.026)
$GPA_i : middle \times GPA_j : low \times BB$	0.076* (0.041)	0.084*** (0.031)
$GPA_i : middle \times GPA_j : middle \times BW$	0.003 (0.031)	0.021 (0.039)
$GPA_i : middle \times GPA_j : middle \times WB$	-0.001 (0.033)	0.018 (0.038)
$GPA_i : middle \times GPA_j : middle \times BB$	0.076 (0.097)	0.094 (0.078)
$GPA_i : middle \times GPA_j : high \times BW$	0.012 (0.047)	-0.008 (0.043)
$GPA_i : middle \times GPA_j : high \times WB$	0.032 (0.048)	0.041 (0.042)
$GPA_i : middle \times GPA_j : high \times BB$	0.230 (0.173)	0.204 (0.139)
$GPA_i : high \times GPA_j : low \times BW$	0.248*** (0.033)	0.224*** (0.033)
$GPA_i : high \times GPA_j : low \times WB$	0.179*** (0.033)	0.160*** (0.035)
$GPA_i : high \times GPA_j : low \times BB$	0.090* (0.051)	0.083** (0.038)
$GPA_i : high \times GPA_j : middle \times BW$	0.068 (0.047)	0.078* (0.040)
$GPA_i : high \times GPA_j : middle \times WB$	0.019 (0.047)	0.001 (0.043)
$GPA_i : high \times GPA_j : middle \times BB$	0.153 (0.151)	0.131 (0.117)

Table B.5: Forming Friends and Difference in GPA: Semiparametric Low-Middle-High (Continued)

	Dependent variable : <i>i</i> denoting <i>j</i> as a friend (%)	
	(1)	(2)
$GPA_i : high \times GPA_j : high \times BW$	-0.207** (0.091)	-0.229*** (0.070)
$GPA_i : high \times GPA_j : high \times WB$	-0.209** (0.090)	-0.229*** (0.066)
$GPA_i : high \times GPA_j : high \times BB$	0.233 (0.305)	0.165 (0.245)
$GPA_i : low \times GPA_j : middle$	-0.085*** (0.015)	-0.067*** (0.009)
$GPA_i : low \times GPA_j : high$	-0.211*** (0.030)	-0.178*** (0.020)
$GPA_i : middle \times GPA_j : low$	-0.098*** (0.017)	-0.087*** (0.011)
$GPA_i : middle \times GPA_j : middle$	0.018 (0.028)	0.031** (0.015)
$GPA_i : middle \times GPA_j : high$	0.013 (0.045)	0.037** (0.016)
$GPA_i : high \times GPA_j : low$	-0.229*** (0.032)	-0.210*** (0.024)
$GPA_i : high \times GPA_j : middle$	-0.005 (0.044)	0.014 (0.015)
$GPA_i : high \times GPA_j : high$	0.307*** (0.090)	0.318*** (0.050)
<i>BB</i>	0.173* (0.101)	0.197* (0.118)
<i>BW</i>	-0.500*** (0.061)	-0.544*** (0.055)
<i>WB</i>	-0.469*** (0.061)	-0.511*** (0.055)
Constant	0.592*** (0.062)	0.877*** (0.124)
Observation	36,183,256	36,183,256
Mean	0.5	0.5
Controls		X

Notes. Units of observation are directed dyads, based on the 54,850 non-Hispanic Black and non-Hispanic White students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. The dependent variable takes on the value of 1 if student *i* nominated student *j* as a friend. *dGPA* indicates a difference in average GPA between the pairs of students. *B* indicates Black students, and *W* indicates White students. Due to the size of table, I do not present variables with *WB* and *BW*. *** $p < .01$, ** $p < .05$, * $p < .1$

B.4 Including Hispanic Students

We examine whether including Hispanic students affects our results. We add Hispanic students to our analysis sample and additional variables indicating Hispanic students to the regression equation 1. The added variables are as follows: $B_i H_j$, $W_i H_j$, $H_i H_j$, $H_i W_j$, $H_i B_j$, $d_{ij} \times B_i H_j$, $d_{ij} \times W_i H_j$, $d_{ij} \times H_i H_j$, $d_{ij} \times H_i W_j$, and $d_{ij} \times H_i B_j$. As presented in Table B.6, including Hispanic students does not significantly affect the results. The difference in GPA matters similarly between pairs of Black students and pairs of White students ($dGPA \times BB$).

Table B.6: Forming Friends and Difference in GPA: Including Hispanic

	Dependent variable : <i>i</i> denoting <i>j</i> as a friend (%)	
	(1)	(2)
<i>dGPA</i>	-0.216*** (0.025)	-0.195*** (0.022)
<i>dGPA</i> × <i>BB</i>	0.047 (0.044)	0.022 (0.045)
<i>dGPA</i> × <i>BW</i>	0.188*** (0.025)	0.163*** (0.023)
<i>dGPA</i> × <i>BH</i>	0.186*** (0.028)	0.158*** (0.026)
<i>dGPA</i> × <i>WB</i>	0.182*** (0.024)	0.160*** (0.023)
<i>dGPA</i> × <i>WH</i>	0.110*** (0.023)	0.104*** (0.020)
<i>dGPA</i> × <i>HH</i>	0.151*** (0.034)	0.117*** (0.034)
<i>dGPA</i> × <i>HW</i>	0.117*** (0.023)	0.107*** (0.019)
<i>dGPA</i> × <i>HB</i>	0.180*** (0.028)	0.152*** (0.025)
<i>BB</i>	0.168 (0.166)	0.234 (0.152)
<i>BW</i>	-0.624*** (0.078)	-0.612*** (0.059)
<i>BH</i>	-0.541*** (0.095)	-0.324*** (0.066)
<i>WB</i>	-0.597*** (0.078)	-0.587*** (0.058)
<i>WH</i>	-0.360*** (0.071)	-0.261*** (0.050)
<i>HH</i>	-0.427*** (0.132)	-0.060 (0.074)
<i>HW</i>	-0.383*** (0.070)	-0.281*** (0.048)
<i>HB</i>	-0.535*** (0.094)	-0.315*** (0.067)
Constant	0.752*** (0.080)	0.876*** (0.092)
Observation	53,008,910	53,008,910
Mean	0.433	0.433
Controls		X

Notes. Units of observation are directed dyads, based on non-Hispanic Black, non-Hispanic White, and Hispanic students who reported GPAs and individual characteristics (age, gender, and race) from the in-school survey of the National Longitudinal Study of Adolescent to Adult Health. *dGPA* indicates a difference in average GPA between the pairs of students. *B* indicates Black students, and *W* indicates White students. *H* indicates Hispanic students. *** $p < .01$, ** $p < .05$, * $p < .1$