A Dynamic Model of Friendship Choice, Academic Achievement, and Race

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Introduction

Disparities in academic achievement exist across race and ethnicity in the United States. Many argue that these disparities result from an oppositional culture among minority adolescents towards school and academic achievement; high-achieving minority students are rejected by their black and Latino peers because of their achievement and pro-school norms. This rejection causes high-achieving minority students to lower their level of achievement to gain acceptance among their peers. As a consequence, the average level of achievement among blacks and Latinos declines and disparities across race and ethnicity develop and grow. Although several studies attempt to demonstrate the existence of an oppositional culture among minority populations, all of these studies are limited by their cross-sectional approach. To demonstrate causality in the relationship between oppositional culture and low achievement, a dynamic approach is necessary. Using continuous time Markov chain models and data from the National Longitudinal Study of Adolescent Health, this paper shows how changes in academic achievement affect changes in friendship ties. This dynamic approach enables me to observe 1) whether high-achieving black and Latino students have fewer friends than their lower-achieving counterparts, 2) whether high-achieving black and Latino adolescents change their level of achievement over time, and 3) whether their number of friends increases as they decrease their achievement level.

Background

Four studies to date attempt to document the existence of an oppositional culture among minority populations using nationally representative data.[1] . The first two studies find little support for the theory. Using regression analysis and self-reported measures of popularity and academic achievement, both Ainsworth-Darnell and Downey (1998) and Cook and Ludwig (1998) study the relationship between academic achievement and race on the one hand, and popularity on the other. Contrary to the oppositional culture hypothesis, they find that high-achieving black students are as popular as or more popular than both high-achieving whites and lower-achieving blacks. These results, however, cannot differentiate between popularity among blacks, popularity among whites, and popularity among the whole school population. It is consistent with these results that high-achieving blacks may be both popular among white students and socially rejected by their black peers.

To correct for the bias introduced by using self-reported popularity and to differentiate between same-race and cross-race popularity, Fryer and Torelli (2005) use actual friendship nominations to measure adolescents' popularity among students of the same race. Regressing students' academic achievement and race on their same-race popularity, they show that the relationship between popularity and academic achievement is different for different racial groups. Although high-achieving white students are the most popular students among their white peers, high-achieving black students have on average 1.5 fewer same-race friends than high-achieving white students. Middle-achieving black students are the most popular among their same-race peers. Although these results are weakened by the inclusion of school racial and academic composition, the basic finding that high achieving black students are less popular than high achieving white students remains significant. Fryer and Torelli (2005) treat these results as support for the oppositional culture hypothesis.

[1] There are many qualitative analyses documenting this phenomenon as well as quantitative analyses based on regional data but these analyses are small n analyses that cannot be generalized beyond the study population (see for example, Ferguson 2001; Horvat and Lewis 2003; Tyson, Castellino and Darity 2005)

Although Fryer and Torelli (2005) make great strides forward by using friendship nominations rather than self-reported popularity, their approach confounds opportunities for friendships and preferences for friends. As a result, their results can be interpreted in two ways: 1) Low-achieving black students may reject high-achieving black students because they do not approve of their "acting white". The consequence of this rejection is that high-achieving black students are less popular among their black peers. 2) Alternatively, high-achieving black students may reject low-achieving black students, preferring instead to be friends with other high-achieving students. Because fewer black students are high-achieving, high-achieving black students are less likely to be friends with black students. As a result of this preference and the options available for friendships, high-achieving black students are less popular among their black peers. In scenario 2) high-achieving blacks are not burdened by "acting white", instead *they* are rejecting the low-achieving students. Both scenarios are consistent with Fryer and Torelli's results but lead to very different conclusions regarding the potential stigma attached to high achievement among blacks.

Flashman (2008) improves on Fryer and Torelli by studying adolescents' friend preferences. Using discrete choice analysis to separate adolescents' opportunities for choosing friends from their preferences, this paper shows 1) that in schools with large concentrations of black students, all black students prefer lower-achieving black friends compared to black students in schools with small numbers of black students, and 2) that black students in schools with small black populations have the same preferences for achievement as white students. Flashman (2008) is able to account for the potentially different preferences of high and lower-achieving students and therefore improve on Fryer and Torelli's analysis, however, this paper maintains a cross-sectional focus (along with the other papers discussed).

Cross-sectional work cannot document the oppositional culture hypothesis; it can merely confirm that high-achieving black students are less popular among their peers in certain contexts. In order to show support for the hypothesis, we need to also show 1) that high-achieving black students respond to the friend preferences of their peers by changing their academic achievement, and 2) that the formerly high-achieving black students become more popular as a result of their achievement changes.

Research Questions and Hypotheses

This paper extends prior research by modeling the relationship between academic achievement and friendship network change dynamically. Using continuous time Markov chain models (discussed below), this paper asks:

1) Are lower-achieving minority students less likely to extend friendship ties to high-achieving minority students compared to other minority students over time?
2) Are high-achieving minority students consistently less popular than their lower-achieving counterparts and their high-achieving white peers across time?
3) Do high-achieving minority students reduce their level of achievement over time?
4) Does popularity among minority students increase as academic achievement declines?

Answering these questions provides a dynamic look at the relationship between friendship ties and academic achievement among minority students in the US, and a better assessment of the existence of an oppositional culture among minority populations.

Methods

Continuous-time Markov models, as proposed by Snijders (2001), are used to model the dynamics of friend changes among black, Latino, and white adolescents. Network change is divided into three components: an objective function, an endowment function, and a rate function. The objective function describes the actors' preferences for ties and is a function of

the network structure, the respondents' characteristics, the potential friends' characteristics, and the similarity between the two. The objective function is defined as the weighted sum of these effects,

$$f_i(\beta, x) = \sum_{k=1}^{L} \beta_k s_{ik}(x), \quad (1)$$

where β is the estimated effect of the *k*th variable *s* for individual *i*. This function determines whether changes are made by actors and provides a numerical representation of what actors are striving for. The key variables in this analysis are race, academic achievement, and the interaction between them, controlling for network structure, socioeconomic status, and course-taking patterns.

The endowment function allows the process of creating and breaking ties to differ. For example, if high-achieving minority students are ostracized by their peers, it may be more difficult for them to create ties than to break ties. In other words, the effect of being a high-achieving minority student on friendship ties may be different depending on whether a friendship tie is extended or removed. The value of a tie between individual *i* and individual *j* that is lost is represented by the weighted sum of estimated effect γ of the *k*th variable *s* for individual *i*'s tie with individual *j*, or:

$$e_i(\gamma, x, j) = \sum_{k=1}^{K} \gamma_k s_{ijk}(x). \quad (2)$$

The objective and endowment functions are combined to determine a micro-step. When actor *i* makes a tie change, she maximizes the sum of the objective function of the new state (resulting from the new tie), the endowment function, and a random term. If I denote the future network configuration resulting from a change in the tie between actor *i* and actor *j* as $x(i \leftrightarrow j)$ then the probability of the new state $x(i \leftrightarrow j)$ equals the exponentiated sum of the values of the objective function and endowment function for actor *i* choosing actor *j* over the sum of the exponentiated sums of the objective and endowment functions for actor *i* choosing all other actors *h*, or:

$$p_{ij}(\theta, x) = \frac{\exp(r(\theta, i, j, x))}{\sum_{h=1}^{n} \exp(r(\theta, i, h, x))} \quad (3)$$

where

$$r(\theta, i, j, x) = f_i(\beta, x(i \leftrightarrow j)) + e_i(\gamma, x, i, j) \quad (4)$$

These micro-steps are incorporated into a model of network evolution through the rate function. The rate function specifies the amount of time the actor waits until her next opportunity to change her network configuration. A simple specification of the rate function assigns each actor a $1/n$ probability of being chosen to change a tie, where *n* represents the number of actors in the network. This specification treats all actors in the network in the same way. For example, actors with more ties may change their ties more quickly than actors with fewer ties, in part because they have more ties to change. A more realistic rate function depends on the number of ties and can be summarized as

$$\lambda_i(\alpha, x) = \exp(\alpha_1 \textstyle\sum_j x_{ij}), \quad (5)$$

where α_1 is the effect of out-degree (number of ties) on the rate of change in the network

Given that changes in the network are dependent only on the current state, and independent of earlier states, a stationary transition distribution exists and can be represented by function $q_{ij}(x)$, where $q_{ij}(x)$ is defined for the period $(t, t+1)$ by the product of the rate,

objective, and endowment functions. $q_{ij}(x)$ represents the change rates of *x* to $x(i \rightarrow j)$ for all *j* in the network, or

$$q_{ij}(x) = \lim_{dt \downarrow 0} \frac{P\{X(t+dt) = x(i \rightarrow j) | X(t=x)\}}{dt} \quad (6)$$

Parameters are estimated using the SIENA program, version 3.2 (Snijders et al. 2008).

Data

Data for this analysis come from three of the National Longitudinal Study of Adolescent Health (Add Health) saturated sample schools. In 1994-1995, Add Health surveyed 7th through 12th grade students in 144 schools in 80 US communities. The in-school survey provided a census of students within these sampled schools. A subset of students from each school was then surveyed in the wave 1 and wave 2 in-home surveys conducted in the summer and fall of 1995 and 1996. In each wave, students were asked to nominate their five closest male friends and their five closest female friends.[2]

Data requirements for studying friendship ties longitudinally are quite high; I need to observe all students and their friendship ties within a school at multiple time points. In 16 schools, all students participated in all three waves of the study. Two of these schools are large schools containing 1,673 and 757 students respectively. The other 14 schools are quite small (approximately 30 students per grade) and all but one contains few if any black or Latino students. Because this analysis focuses on differences between high and lower-achieving minority students, those schools could not be used in this analysis. As a result, the sample used in this analysis is not a representative sample. Nonetheless, the results can provide suggestive evidence for or against oppositional culture. The three schools used vary in their racial composition and size. Table 1 provides basic descriptive characteristics of each of the schools included in the analysis.

Preliminary Results

Table 2 provides a description of the achievement and number of friends of black and Latino students with GPAs greater than 3.0 in time 1, across schools and within schools. A column including achievement and number of friends for all students is included for comparison. Generally, the GPAs of the high-achieving minority students decline across waves of the survey. The oppositional culture hypothesis would predict a simultaneous increase in their number of friends. Although the number of friends of time 1 high-achievers declines across all schools, the decline is slower than the decline across the entire school populations. In other words, the minority students who are high achievers at time one seem to simultaneously decrease their achievement and lose friends at a *slower* rate than the general population of students. This pattern is consistent with the oppositional culture hypothesis but a crude and poor test of the hypothesis. Preliminary work using the network models discussed above focus only on how academic achievement affects changes in friendship ties. These models control for race, socioeconomic status, grade, course-taking patterns, and network structure. Figures 1 and 2 show the probability that an individual with a given GPA extends a friendship tie to another individual in her school, and how that probability depends on the other's GPA. In these schools, adolescents prefer similarity in GPA and are more likely to extend a tie as the other's GPA approaches theirs. The next step with this model is to include an interaction between race and academic achievement, to determine if black and Latino students have different preferences for achievement in their friends.

[2] In waves 1 and 2 of the in-home survey, only a subset of sampled students was asked to nominate 10 friends. All other students were asked to nominate only their best male friend and their best female friend.

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Tables and Figures

Table 1 Descriptive Characteristics of Sample Schools

	School 1	School 2	School 3
Grades offered	10-12	9-12	k-12
Grade in school	10.90	10.30	9.34
Male	.52	.51	.35
Black	.23	.01	.46
Latino	.40	.02	.09
Mother's ed			
High school	.74	.91	.97
BA/BS	.28	.22	.46
Father's ed			
High school	.73	.92	.94
BA/BS	.28	.30	.54
Professional occ	.47	.49	.73
GPA			
t_1	2.52	2.60	3.39
t_2	2.46	2.54	3.44
t_3	2.63	2.60	3.42
Number of friends			
t_1	3.55	6.69	5.23
t_2	2.73	5.31	3.28
t_3	2.37	4.84	3.93
N			
t_1	1,673	757	108
t_2	1,249	617	92
t_3	850	479	76

Table 2 Average GPA and Number of Friends for All Students and Minority Students with GPAs>3.0

	All Students				T1-High-GPA Black				T1-High GPA Latino			
	All	1	2	3	All	1	2	3	All	1	2	3
GPA												
t_1	2.58	2.52	2.60	3.39	3.36	3.30	--	3.51	3.38	3.38	--	3.41
t_2	2.53	2.46	2.54	3.44	2.96	2.73	--	3.47	2.91	2.88	--	3.70
t_3	2.67	2.63	2.60	3.42	2.99	2.84	--	3.26	2.83	2.80	--	3.60
Number of friends												
t_1	4.56	3.55	6.69	5.23	3.32	2.77	--	4.71	3.24	3.05	--	8.14
t_2	3.44	2.73	5.31	3.28	2.55	1.99	--	3.72	2.92	2.86	--	3.40
t_3	3.14	2.37	4.84	3.93	2.90	2.19	--	4.32	2.66	2.59	--	4.50

Figure 1

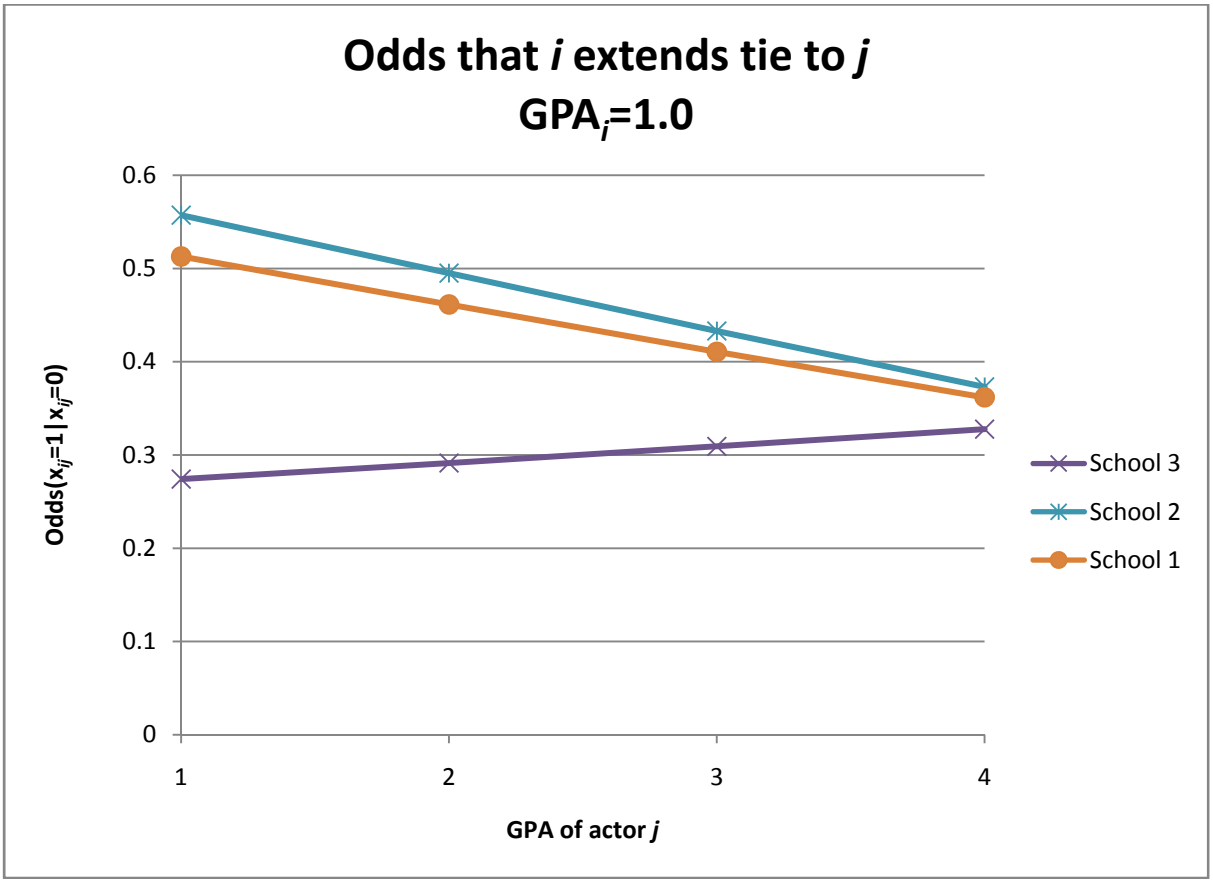

Figure 2