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EdWorkingPaper No. 26-1459

A Dynamic Model of the Economic Returns to Adolescent Social Skills

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VERSION: April 2026

Suggested citation: Weingarten, Zach, Jere Behrman, and Andrew Postlewaite. (2026). A Dynamic Model of the Economic Returns to Adolescent Social Skills. (EdWorkingPaper: 26-1459). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/bzec-e178

A Dynamic Model of the Economic Returns to Adolescent Social Skills*

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April 20, 2026

Abstract

Social-skill formation during adolescence depends on peer environments, but those environments are equilibrium outcomes shaped by individual choices. To account for this endogeneity, we develop and estimate a dynamic model in which parents invest in adolescents, adolescents choose whether to participate in social activities (athletics and extracurricular clubs), and these choices jointly determine the neighborhood peer environment that influences the accumulation of social skills, cognitive skills, and mental health. The model matches empirical patterns of skill accumulation, parental investment, and activity participation among U.S. adolescents, and links terminal adolescent skill stocks to adult educational attainment and labor-market outcomes. In policy counterfactuals, subsidizing parental investment generates large gains in college completion and earnings, and subsidizing club participation generates larger long-run gains than subsidizing athletic participation. We also find that a counterfactual that eliminates peer effects reduces athletic and club participation by 15 and 9 percentage points, terminal adolescent social and cognitive skills by 0.05–0.08 standard deviations, college completion by 3%, and adult income by nearly 1%.

Keywords: social skills, skill formation, peer effects, parental investments, adolescent development, athletics, clubs

JEL Codes: I24, J24

*We thank Hanming Fang and Dan Silverman for early discussions of the topic of this paper. We also thank Francesco Agostinelli for helpful feedback. We have benefited from helpful comments from Refine.

1 Introduction

Social skills—the ability to communicate, cooperate, and form productive relationships—have become an increasingly central component of labor-market success. Since 1980, employment and wage growth in the United States have concentrated in occupations requiring interpersonal interactions, and social skills appear to complement cognitive ability in generating substantial earnings premia (Deming, 2017). At the same time, the social environments in which these skills are formed have been contracting. Time spent in face-to-face social interaction among adolescents has fallen sharply over recent decades (Twenge, Spitzberg and Campbell, 2019), and the U.S. Surgeon General has identified loneliness among young Americans as a national public-health crisis.[1]

If peer environments are an important input into social-skill formation and social skills have important impacts on later labor-market and other outcomes, these trends may have first-order economic implications. Yet identifying the consequences of deteriorating adolescent social lives—and evaluating the scope for policy to counteract them—requires confronting a fundamental challenge: social interactions are jointly determined. Peer environments shape individual skills and behaviors, but they are also the equilibrium outcome of those same individual choices. A credible account of the formation of social skills therefore requires a framework that allows for dynamic feedback between behaviors, social environments, and subsequent human-capital accumulation.

In this paper, we build on the framework of Cunha, Heckman and Schennach (2010) and Agostinelli et al. (2026) to develop and estimate a dynamic model of adolescent skill formation in which social environments and individual behaviors are jointly determined over time.[2] In the model, parents choose investments during their children's adolescence, adolescents decide whether to participate in common social activities—namely, athletics and extracurricular clubs—and these choices shape the peer context that influences the accumulation of social skills, cognitive skills, and mental health. At the end of adolescence, young adults make schooling decisions as a function of their terminal adolescent skill stocks, which in turn shape employment and earnings. The model links individual choices and neighborhood-wide participation rates in equilibrium, which allows us to quantify how changes in adolescent social environments propagate into skill accumulation, schooling, and earnings.

We conduct motivating descriptive analyses and estimate the model using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), which follows individuals from adolescence

[1] The full 2023 report from the U.S. Surgeon General can be found here.

[2] Adolescence is a critical period in life-cycle models of skill development, and it may exhibit important dynamic complementarities with earlier and later periods (Cunha and Heckman, 2007; Cunha, Heckman and Schennach, 2010; Black et al., 2021, 2022).

into adulthood and links adolescent environments and behaviors to later educational attainment and labor-market outcomes. Beyond its panel structure, which is well-suited for studying the evolution of skills across adolescence, Add Health contains rich measures of adolescents' social integration and their local peer environments. We measure social skills using a summary index constructed from survey items that capture perceived social acceptance and peer support, including self-reported number of friends, whether respondents feel close to people at school, whether they feel socially accepted, and whether they believe their friends care about them.[3] We proxy the adolescent social environment using peers' participation in extracurricular group-based activities within each respondent's local community. In particular, we construct leave-one-out participation shares in athletics and clubs, so that an individual's own choices do not mechanically enter the measure of peer behavior. Together, these features allow us to track the joint evolution of social skills, activity choices, and local participation rates during adolescence, and to connect these objects to education and earnings in adulthood.

Our descriptive analyses reveal four empirical facts that motivate the model's key mechanisms. First, parental investment is associated positively with adolescents' social skills with a magnitude comparable to its association with cognitive skills, suggesting that parents treat social skills as a productive input and place similar weight on social and cognitive dimensions of human capital. These positive associations with baseline endowments are consistent with two canonical models of parental investment. In the "wealth model," parents care only about the distribution of wealth among children and invest more in children with higher endowments whenever the return to investment exceeds the market interest rate, adjusting transfers otherwise (Becker and Tomes, 1976; Becker, 1993; Behrman, Pollak and Taubman, 1995). In the "separable earnings transfers" (SET) model, parents have preferences over the distribution of human-capital outcomes—such as earnings—that are separable from their preferences over other outcomes, and sufficiently low inequality aversion leads them to reinforce rather than compensate for endowment differentials (Behrman, Pollak and Taubman, 1982). In both of these models, if child endowments are complementary with parental investments in producing desirable outcomes, higher child endowments are associated with higher parental investments.

Second, adolescents' athletic and club participation decisions are tightly linked to those of their peers. Youth are more likely to participate in athletics or extracurricular clubs when those activities are prevalent in their neighborhood. A 1 percentage point increase in peer athletics (clubs) take-up is correlated with a 0.6 (0.9) percentage point increase in an adolescent's own probability of participating in athletics (clubs). We also find sizable cross-activity correlations, which indicate meaningful substitution between athletics

[3] In the empirical section (Section 2.3), we provide full details on item construction and index formation.

and clubs. A 1 percentage point increase in the local peer club share predicts a 0.07 percentage point decline in own-athletics participation, and a 1 percentage point increase in the local peer athletics share predicts a 0.09 percentage point decline in own-club participation. Together, these correlations are consistent with activity-specific social influences, in which prevailing local activity patterns raise the relative social cost of participating in the less-common activity.

Third, the social activities that we study differ in their productivity for skill formation. Athletics are especially effective for the accumulation of social skills, while clubs generate broader gains spanning both social and cognitive skills. This heterogeneity implies that shifts in participation between athletics and clubs change not only the level of adolescent social interaction, but also the composition of skill accumulation, which is central for evaluating policies that seek to induce changes in activity choices.

Fourth, social skills are predictive of later educational attainment, which in turn is strongly related to employment and income. A one standard deviation increase in social skills is associated with 0.06 additional years of completed schooling, even conditional on cognitive skills and other observed background characteristics. This relationship motivates our focus on how social skills evolve over adolescence and on whether policies implemented in adolescence can generate longer-run returns through educational and labor-market outcomes.

Motivated by these empirical patterns, we develop a finite-horizon dynamic model of adolescent skill formation across three skill dimensions—social skills, cognitive skills, and mental health—in which parents choose investments and adolescents choose whether to participate in athletics and extracurricular clubs each period. In line with Agostinelli et al. (2026), the timing follows a Stackelberg structure, with parents moving first and adolescents responding. Parents value their children's evolving stocks of skills and choose investments to increase their children's future human capital. Adolescents' participation decisions depend on the local social environment. Adolescents incur social costs when their activity choices diverge from prevailing local participation patterns, so local social context enters preferences and generates endogenous social interactions in both activities. Athletics and clubs enter the technology of skill formation with activity- and skill-specific productivities, so the two activities can differentially shape the accumulation of social skills, cognitive skills, and mental health. Parental investments affect skill accumulation directly and also shift participation incentives by changing their children's propensities to be involved in either athletics or clubs. Through these linkages, local participation rates influence skill accumulation both through adolescents' best responses and through parents' investment incentives given the anticipated participation responses.

We estimate the model by simulated method of moments using three main sources of variation that mirror the descriptive evidence. Identification comes from within-neighborhood relationships between skills, parental investment, and activity participation, from cross-neighborhood differences in participation rates that shift the social environment, and from the link between terminal adolescent skill stocks and adult schooling and labor-market outcomes. We show that the estimated model replicates the broad empirical patterns in the data, including the strength of within-activity peer correlations together with cross-activity substitution and the differential associations between athletics and clubs participation and subsequent skill growth. It also matches the joint distributions of adolescent choices and skill stocks and their relationships to adult education and labor-market outcomes, providing a credible platform for the policy experiments that follow.

In general, models with social interactions can generate multiple equilibria (Brock and Durlauf, 2001). Our equilibrium is characterized by a fixed point in which neighborhood participation rates coincide with the aggregation of individual choices. In estimation, we impose rational expectations and interpret the neighborhood participation rates observed in Add Health as equilibrium outcomes. We then impose the equilibrium restriction by targeting neighborhood participation shares as moments in the estimation procedure. In counterfactual policy experiments, peer club and athletic participation shares are equilibrium objects that adjust endogenously, so each policy is evaluated at its policy-consistent fixed point. Under our estimated parameters, the equilibrium mapping is a contraction, which implies a unique fixed point in each policy environment and ensures that counterfactual outcomes are uniquely defined.

The estimated model highlights three forces that guide the counterfactual analysis. First, adolescents respond strongly to local participation patterns. Higher peer participation in an activity raises the utility of joining that activity, while cross-activity spillovers discourage choices that depart from prevailing local patterns. As a result, peer environments shift participation across athletics and clubs, rather than simply increasing extracurricular participation overall. Second, athletics and clubs play distinct roles in skill production, which makes it important to treat them separately in the model. Athletics are especially productive for social-skill accumulation, whereas clubs generate broader gains, especially for cognitive skills. Third, these differences matter for long-run outcomes because adolescent skill stocks lower the cost of acquiring additional schooling, and schooling is a key determinant of longer-run labor-market outcomes, such as employment and earnings. Together, estimates imply that changes in local adolescent social environments can generate persistent effects by changing both the level and composition of skill accumulation, leading to substantial heterogeneity in educational attainment, employment, and income.

We use the estimated model to evaluate six counterfactual policies. We find large long-run effects arising from interventions that subsidize parental investment. In particular, a parental investment subsidy that reduces the baseline cost of investment by 50 percent raises mean investment during adolescence by 15% and increases terminal adolescent social, cognitive, and mental health skills by 0.06, 0.10, and 0.07 standard deviations, respectively. These skill gains translate into a 5% increase in college completion, a 9% increase in post-baccalaureate attainment, a 0.15% increase in employment, and a 1.22% increase in income. Turning to participation subsidies, we find that subsidizing club participation generates larger long-run gains than subsidizing athletics. The key mechanism is that clubs raise cognitive skills more than they raise social skills, and cognitive skills have a stronger effect on schooling and labor-market outcomes in our estimates.

The estimates also imply that moving adolescents from low- to high-club-participation neighborhoods can reduce skill accumulation and attainment on net. This result reflects equilibrium feedback. An inflow of low-participation adolescents depresses club participation in the receiving community and offsets the gains from greater exposure to clubs.

Finally, we use the model to quantify the importance of peer interactions in amplifying differences in adolescent participation and human-capital accumulation. Eliminating peer-share terms from activity utility reduces participation in both athletics and clubs by 14.5 and 9 percentage points, respectively, and lowers terminal adolescent social, cognitive, and mental health skills by 0.08, 0.05, and 0.04 standard deviations. These skill losses translate into a 2.6% decline in college completion, an 8% decline in post-baccalaureate attainment, a 0.17% decline in employment, and a 0.65% decline in income. This exercise captures the overall importance of the peer-interaction channel—combining its direct effect on participation incentives and the equilibrium feedback operating through peer shares—and shows that social interactions are quantitatively important during adolescence, particularly for the accumulation of social skills. In light of recent concerns about declining adolescent social interaction, the estimates suggest that weaker peer reinforcement of extracurricular participation may generate persistent long-run economic losses.

Related literature. Our paper relates to several strands of the economics literature on child development and social interactions. First we contribute to the large literature on child development and skill formation initiated by Cunha and Heckman (2007, 2008) and Cunha, Heckman and Schennach (2010), and extended by Agostinelli and Wiswall (2025), as well as other structural studies of parental time allocation and investment timing (Todd and Wolpin, 2003, 2007; Del Boca, Flinn and Wiswall, 2014; Fiorini and Keane, 2014; Caucutt and Lochner, 2020; Caucutt et al., 2026). A central departure is that adolescents in our model make choices in a social equilibrium rather than in isolation.

A smaller theoretical literature treats children as active agents through parent–child incentive problems

(Weinberg, 2001), parental choices over supervised learning (Lizzeri and Siniscalchi, 2008), or parent–child interactions in the formation of non-cognitive skills (Seror, 2022). These models typically abstract from an equilibrium peer environment. More closely related in structure, Del Boca, Monfardini and Nicoletti (2017) and Del Boca et al. (2019) estimate models in which adolescents allocate time to skill-building activities alongside parental investments, with parents as Stackelberg leaders and children as followers. Adolescents are active co-producers of their own human capital in these settings, but their choices do not respond to, or jointly determine, the broader social environment.

The closest work to ours is Agostinelli et al. (2026), which we build on in several important respects. Like us, they develop and estimate a structural model in which parents invest in adolescent children, peer environments are equilibrium outcomes rather than fixed parameters, and parents move as Stackelberg leaders relative to adolescents. We follow their framework in treating neighborhood peer environments as endogenous fixed points that adjust in response to policy interventions, and their use of Add Health provides a methodological template for our own empirical approach. Our model departs from theirs along several dimensions that are central to our research questions. Whereas Agostinelli et al. (2026) study parental intervention in adolescent peer-group *formation*—with adolescents choosing whom to befriend—we model adolescents choosing whether to participate in specific social activities, namely athletics and extracurricular clubs, that differ in their productivity for social- and cognitive-skill accumulation. This activity-choice margin generates neighborhood participation rates as equilibrium objects, rather than network links, and it allows us to study how substitution *across* activities—and the distinct skill returns they generate—shapes long-run educational attainment and earnings. In this sense, our framework is more narrowly focused on observed extracurricular choices as the mechanism through which peer environments form and influence human capital, rather than on the endogenous formation of friendship ties themselves.

Our paper also relates to the large literature on peer effects in education. A central challenge in identifying peer effects, as emphasized by Manski (1993), is that peers' outcomes and an individual's outcomes are jointly determined. This concern has motivated a broad quasi-experimental literature using random peer assignment (Sacerdote, 2001; Zimmerman, 2003) and network-based identification strategies (Bramoullé, Djebbari and Fortin, 2009; Calvó-Armengol, Patacchini and Zenou, 2009). A growing body of work using these designs documents that peer exposure shapes not only contemporaneous outcomes but also long-run educational attainment and earnings (Carrell and Hoekstra, 2010; Bifulco, Fletcher and Ross, 2011; Carrell, Hoekstra and Kuka, 2018; Chetty et al., 2022; Feng, Kim and Yang, 2026). Our approach differs from this literature in treating the peer environment not as a fixed parameter identified from exogenous variation, but as an equilibrium object that responds endogenously to individual choices and policy interventions.

This equilibrium force arises naturally in our framework and shapes several of our policy counterfactuals, including the finding that moving adolescents to higher-participation neighborhoods can be partially offset by the inflow's effect on local participation decisions.

The social-pressure mechanism at the center of our model is further motivated by the economics of identity and social norms (Akerlof and Kranton, 2000; Bursztyn, González and Yanagizawa-Drott, 2020), as well as by Bursztyn and Jensen (2015) and Bursztyn, Egorov and Jensen (2019), who show that adolescents suppress human-capital investments when those investments conflict with prevailing peer norms. In our model, adolescents incur utility costs from deviating from neighborhood participation rates, and our estimates indicate that these costs are significant drivers of individuals' activity choices.

Lastly, our paper relates to a broad interdisciplinary literature on the importance of social skills and social connection. In economics, a large body of work shows that non-cognitive and interpersonal skills shape schooling choices, wages, and labor-market advancement, and that the returns to non-cognitive skills are substantial and often complementary to cognitive skills (Kuhn and Weinberger, 2005; Heckman, Stixrud and Urzua, 2006; Almlund et al., 2011; Lindqvist and Vestman, 2011; Deming, 2017). Our contribution is to model the formation of social skills during adolescence separately from cognitive skills and other non-cognitive skills, particularly mental health, rather than take these skill distributions as given, and to link the long-run returns documented in this literature to the adolescent choices and peer environments that generate them.[4] More broadly, evidence in psychology (Cacioppo, Hawkley and Thisted, 2010) and sociology (Umberson and Montez, 2010) shows that adolescent social connection matters for later-life well-being well beyond earnings, with social isolation and loneliness linked to premature mortality (Holt-Lunstad et al., 2015). Together, these findings underscore the importance of understanding the economic determinants of adolescent social participation and the scope for policy to support it.

The rest of the paper is organized as follows. Section 2 describes the data and presents motivating descriptive results that guide the development of our structural model. Section 3 outlines the model. Section 4 describes the estimation strategy and presents the estimation results. Section 5 provides an overview of the counterfactual policy experiments and presents their results. Finally, Section 6 concludes.

[4] Because athletics is a central margin in our model and counterfactual analysis, our paper also speaks to evidence on the returns to school-based sports participation (Barron, Ewing and Waddell, 2000; Stevenson, 2010).

2 Data and Empirical Results

2.1 The National Longitudinal Study of Adolescent to Adult Health

Our analysis uses data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), a nationally representative survey that follows a cohort of adolescents from middle and high school into adulthood. Add Health began with a school-based survey of students in grades 7 through 12 in 1994–1995 and then conducted repeated in-home interviews that tracked respondents over time. The baseline data provide rich information on adolescents' demographic characteristics, schooling experiences, and social environment, together with detailed measures of family background and parental resources from a companion parent interview. We use Waves I–IV of Add Health, which consist of an initial in-home interview in adolescence (Wave I, 1994–1995) and three follow-up interviews in adolescence (Wave II, 1996) and then young adulthood (Wave III, 2001–2002; and Wave IV, 2008–2009).

Add Health provides a convenient setting for studying the evolution of adolescent skills in response to parental inputs and social conditions because it measures key dimensions of skill repeatedly during adolescence and early adulthood. We focus on a triplet of skill types that are central to our framework. The first is cognitive skills, measured using respondents' self-reported grades in core academic subjects. The second is mental health, which we measure inversely using 19 items on depressive symptoms. The third is social skills, which we measure using four items available across waves that capture the respondent's perceived social integration and peer support. Specifically, we use whether the respondent feels close to people at school, how much the respondent feels that friends care about them, whether the respondent feels socially accepted, and the respondent's self-reported number of friends (up to ten). For each skill, we aggregate the relevant items into a single index using Bartlett factor scores constructed separately by wave.[5] We use the same approach to construct a latent factor for parental investment from ten binary survey items on whether the respondent's mother engaged in specific activities with the respondent in the past month.[6]

For our purposes, a further advantage of Add Health is that it allows us to proxy adolescents' local social environments using peers' participation in multiple extracurricular activities. In Wave I, respondents report involvement in a wide range of sports and school clubs, which allows us to construct indicators for participation in athletics and in extracurricular clubs. Although Add Health does not release residential locations in the public-use files, it does provide a de-identified community identifier that groups respon-

[5] We follow the latent-factor approach in Heckman, Pinto and Savelyev (2013).

[6] These items capture both time investments, such as going shopping or to the movies, and emotionally substantive investments, such as talking about schoolwork or grades.

dents attending the same high school and its feeder schools, which corresponds closely to the grade 7 to 12 school catchment structure. We treat this community identifier as our neighborhood unit and use it to construct neighborhood-level peer participation rates in athletics and extracurricular clubs. To measure each adolescent's peer environment, we use leave-one-out neighborhood shares so that an individual's own choices do not mechanically enter the peer measures. These leave-one-out participation rates summarize the social environment to which adolescents are exposed within their school community.

Finally, Add Health follows respondents into young adulthood and thus provides rich measures of longer-run socioeconomic outcomes. In Waves III and IV, which correspond to ages 18–26 and 24–32, respondents report educational attainment, labor-market outcomes, and income, along with information on family formation and continued athletic participation. These measures allow us to relate the evolution of skills—especially social skills—during adolescence to subsequent economic outcomes in adulthood.

2.2 Analysis Sample

Unlike prior work using Add Health friendship nominations to study peer effects (e.g., Mele, 2020; Boucher et al., 2023; Agostinelli et al., 2026), our empirical approach does not restrict attention to reciprocated links. Because reciprocated links can be constructed only from the in-school friendship roster, they are most commonly exploited in the "saturated" school sample, which considerably reduces the available sample size. We instead study peer effects at the neighborhood level, without imposing a mutual-consent model of friendship ties. Accordingly, we use the respondent's self-reported number of friends from the core Wave I survey as an imperfect indicator of social connectedness—one of several noisy measures of latent social skills—which allows us to retain a substantially larger set of observations.

We impose two main sample restrictions. First, because we measure social environments using the local (neighborhood-wide) shares of peers participating in athletics and extracurricular clubs, we restrict attention to neighborhoods with at least 10 seventh-grade respondents.[7] Second, we retain only individuals with non-missing Wave I measures required to construct latent factors for cognitive skills, mental health, social skills, and parental investment. After applying these restrictions, the analytic sample comprises 17,114 Wave I respondents (from 20,779 initial respondents in our baseline file).

Table 1 reports summary statistics for the analytic sample and for subsamples defined by athletics and extracurricular club participation. Several patterns emerge. First, activity choices differ sharply by gender. Club participation is disproportionately female, whereas participation in sports without clubs is

[7] We require a sizable sample of seventh graders in each neighborhood because this cohort forms the population of interest when we estimate neighborhood-level initial conditions for the distribution of skills in the structural model.

Table 1: Descriptive Statistics

	Analysis Sample (1)	No Sports, No Clubs (2)	No Sports, Clubs (3)	Sports, No Clubs (4)	Sports, Clubs (5)
Panel A: Child Characteristics					
Female	0.511	0.604	0.686	0.331	0.480
	(0.500)	(0.489)	(0.464)	(0.471)	(0.500)
White	0.615	0.607	0.599	0.619	0.651
	(0.487)	(0.488)	(0.490)	(0.486)	(0.477)
Black	0.228	0.225	0.255	0.228	0.205
	(0.419)	(0.418)	(0.436)	(0.419)	(0.403)
Non-White, Non-Black	0.157	0.168	0.145	0.154	0.144
	(0.364)	(0.374)	(0.352)	(0.361)	(0.351)
Age	15.58	15.89	15.63	15.34	14.99
	(1.733)	(1.715)	(1.708)	(1.708)	(1.648)
GPA	2.761	2.645	2.962	2.737	3.024
	(0.746)	(0.746)	(0.710)	(0.738)	(0.699)
Number of Friends	2.998	3.157	2.323	3.307	2.307
	(2.548)	(2.626)	(1.891)	(2.781)	(1.866)
Mental Health	0.043	−0.097	0.041	0.168	0.202
	(1.022)	(1.079)	(1.017)	(0.945)	(0.961)
Panel B: Mother Characteristics					
Household Income ($1,000's)	45.39	41.19	48.07	46.73	52.98
	(50.72)	(42.84)	(54.53)	(52.97)	(62.24)
College-Educated	0.227	0.183	0.284	0.220	0.333
	(0.419)	(0.387)	(0.451)	(0.415)	(0.471)
Investment	0.021	−0.126	0.118	0.061	0.335
	(1.286)	(1.259)	(1.240)	(1.298)	(1.328)
Observations	17,114	7,183 (42%)	2,369 (14%)	5,680 (33%)	1,882 (11%)

NOTES: This table reports summary statistics for selected Add Health subsamples. The analysis sample (Column (1)) includes respondents who completed the Wave I in-home interview, have non-missing baseline measures of skills and parental investment, and reside in a neighborhood containing at least ten Wave I seventh graders. Columns (2)–(5) split the analysis sample by whether the respondent participates in sports and/or extracurricular clubs. All characteristics are measured in Wave I. "GPA" is the average of self-reported grades in four core subjects. "Number of Friends" is the total number of self-reported friends (maximum 10). "Mental Health" is the baseline stock, measured as the negative of a latent factor constructed from items on depressive symptoms. "Investment" is baseline parental investment, measured as a latent factor constructed from binary items on the respondent's mother's emotional and time investments. Observations report the maximum sample size available in each subsample. Some variables (e.g., maternal college education) have fewer observations.

disproportionately male. Second, academic performance is higher among club participants. Mean GPA is highest for respondents who participate in both sports and clubs and lowest for those who participate in neither. Third, reported friendships vary systematically with activity choice. Respondents participating in sports without clubs report the largest number of friends, whereas those participating in clubs report fewer friends on average.[8] Finally, baseline mental health and parental investment are positively associated with extracurricular participation, with the highest levels observed among respondents who participate in both

[8] We report summary statistics for the full collection of measures used to construct our latent factor for social skills in Table A1.

sports and clubs. Maternal socioeconomic status covaries with activity choices as well. Household income and maternal-college education are higher in groups with extracurricular club participation.

2.3 Empirical Results

We study the dynamic interplay between parents, children, and peers, and how their endogenous decisions interact over adolescence. Our central objective is to assess whether social skills shape human-capital accumulation during adolescence and, in turn, translate into economic returns in adulthood. To discipline the structural model of child development in Section 3, we first document a set of reduced-form empirical facts. In particular, we focus on four key relationships: (1) whether parents' investments in their children are associated with their children's social skills; (2) whether adolescent choices regarding athletic and club participation are associated with their social environments, as captured by contemporaneous peer participation in activities; (3) are adolescents' participation in athletics and extracurricular clubs associated with the evolution of cognitive skills, mental health, and social skills; and (4) how terminal adolescent skills predict long-run outcomes, including educational attainment and earnings. Of course these reduced-form relations do not capture causality, but they are suggestive for the specification of our structural model.

2.3.1 The Association Between Parental Investments and Children's Baseline Social Skills

Table 2 reports correlational evidence on how parental investments vary with children's baseline skills. We estimate a sequence of linear specifications that regress baseline parental investment (measured in Wave I of Add Health) on their children's baseline social skills, cognitive skills, and mental health. We focus on Column (5), which includes demographic, age, and maternal controls and adds neighborhood indicators. By comparing families within the same neighborhood in Wave I, these indicators absorb neighborhood-level factors common to residents (e.g., local resources and social context) that may jointly shape parental resources and children's baseline skills, reducing concerns that cross-neighborhood differences confound the estimated relationships between investment and skills.[9]

Across specifications, parental investment is positively associated with both social and cognitive skills, with very similar magnitudes. In Column (5), a one standard deviation increase in an adolescent's social skills is associated with a 0.118 standard deviation increase in parental investment, compared to 0.094 for

[9] These regressions are descriptive and do not rule out selection into neighborhoods or within-neighborhood sorting on unobserved factors correlated with both investment and baseline skills. Again, we do not interpret these estimates causally and instead use them to discipline the structure of the parental investment rule in the subsequent structural model.

Table 2: Empirical Results for Parental Investment

	(1)	(2)	(3)	(4)	(5)	(6)
Social Skills	0.103	0.097	0.096	0.096	0.096	—
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	
Cognitive Skills	0.132	0.110	0.109	0.101	0.101	0.108
	(0.008)	(0.008)	(0.008)	(0.009)	(0.011)	(0.010)
Mental Health	−0.035	−0.009	−0.012	−0.015	−0.012	0.034
	(0.010)	(0.011)	(0.011)	(0.011)	(0.017)	(0.015)
Female		0.320	0.315	0.310	0.311	0.332
		(0.020)	(0.020)	(0.020)	(0.019)	(0.019)
Black		0.052	0.051	0.023	0.071	0.062
		(0.024)	(0.024)	(0.025)	(0.056)	(0.053)
Non-White, Non-Black		−0.137	−0.128	−0.113	−0.120	−0.114
		(0.027)	(0.027)	(0.027)	(0.039)	(0.038)
Age			0.326	0.300	0.302	0.298
			(0.003)	(0.095)	(0.114)	(0.112)
Age^2			−0.011	−0.010	−0.010	−0.010
			(0.003)	(0.003)	(0.004)	(0.004)
Outcome Mean	0.021	0.021	0.021	0.021	0.021	0.021
Std. Dev.	1.285	1.285	1.285	1.285	1.285	1.285
R^2	0.033	0.050	0.051	0.060	0.075	0.063
Observations	17,108	17,108	17,108	17,108	17,108	17,108
Maternal Controls	✗	✗	✗	✓	✓	✓
Neighborhood FE	✗	✗	✗	✗	✓	✓

Notes: This table reports OLS estimates from regressions of baseline parental investment on baseline child skills. The dependent variable is a latent parental investment measure. The key regressors are social skills, cognitive skills, and mental health, all measured in Wave I of Add Health. Columns progressively add controls. 'Maternal Controls" include indicators for whether the adolescent's mother is college-educated and married. "Neighborhood FE" include indicators for the adolescent's neighborhood. Standard errors clustered at the neighborhood level are reported in parentheses.

a one standard deviation increase in cognitive skills.[10] These relationships are stable across progressive control sets.[11] Column (6) reports estimates from a version of the fully specified model that omits social skills entirely, which is closer in spirit to the canonical framework in Cunha, Heckman and Schennach (2010). Relative to Column (5), omitting social skills slightly increases the estimated association between cognitive skills and parental investment (from 0.101 to 0.108) and reverses the sign of the mental health coefficient, which becomes positive and statistically significant. Together, these results suggest that including social skills in this framework is not innocuous for predicting how parental investments in their

[10] We transform the coefficient $\hat{\beta}$ into standard deviation measures through $\tilde{\beta} = \hat{\beta} \times \text{SD}(\theta^k)/\text{SD}(I)$, for skill k. In Wave I of Add Health, the standard deviations of measures of social skills, cognitive skills, and mental health are, respectively, 1.56, 1.20, and 1.02.

[11] The positive association between social skills and parental investment, and the similarity in magnitude relative to cognitive skills, is robust to demographic heterogeneity, as shown in Table A2. The only exception is the male subsample, where the correlational evidence suggests compensatory behavior in response to lower mental health, and we find no statistically significant association with mental health otherwise.

children's human capital are associated with the children's baseline human capital.

This pattern is consistent with a skill-formation framework featuring self-productivity and dynamic complementarity, in which higher baseline skills can raise the perceived marginal returns to subsequent investments and lead parents to allocate more inputs to more-advantaged children (Cunha and Heckman, 2007; Cunha, Heckman and Schennach, 2010). Related evidence likewise mostly finds that parental investments vary systematically with children's initial conditions in ways that can amplify early gaps though some studies report compensating behaviors.[12] The results are robust across multiple alternative specifications, including an alternative social-skills latent factor that excludes self-reported number of friends from the set of noisy measures (Table A3) and a within-family design that probes the role of unobserved household-level heterogeneity (Table A4).

2.3.2 Associations between Adolescents' Behaviors and Social Environments

We next study adolescents' endogenous choices to participate in social activities. In our framework, participation decisions may respond both to parental influence and to peer influence. Beyond the role of parental investment, an adolescent may be more likely to participate in an activity when that activity is common among local peers. Motivated by evidence that adolescents respond to peer pressure and local norms when making visible choices (Bursztyn and Jensen, 2015), we summarize the local social environment using neighborhood-level participation rates in extracurricular activities.

Let $a_{i,t} \in \{0,1\}$ and $e_{i,t} \in \{0,1\}$ denote adolescent i's participation in athletics and extracurricular clubs, respectively, in period t. Let $j(i)$ denote i's neighborhood and let $\mathcal{N}_j$ denote the set of adolescents observed in neighborhood j, with $n_j \equiv |\mathcal{N}_j|$. We construct leave-one-out neighborhood participation shares for each activity. Define the neighborhood totals as

$$A_{j,t} = \sum_{i' \in \mathcal{N}_j} a_{i',t}, \qquad E_{j,t} = \sum_{i' \in \mathcal{N}_j} e_{i',t}. \tag{1}$$

[12] A number of studies report parental reinforcing behaviors in the U.S. and other countries (Behrman, Pollak and Taubman, 1982; Behrman and Taubman, 1986; Abufhele, Behrman and Bravo, 2017; Behrman, Pollak and Taubman, 1986; Behrman, Rosenzweig and Taubman, 1994; Datar, Kilburn and Loughran, 2010; Del Boca et al., 2019; Pitt, Rosenzweig and Hassan, 1990; Rosenzweig and Zhang, 2009; Rosales-Rueda, 2014; Del Boca, Monfardini and Nicoletti, 2017; Yi et al., 2015; Macedo et al., 2026). To our knowledge, only two studies report compensating investments favoring less-well endowed children for any parental investments or in any circumstances: Yi et al. (2015) for health investments but not for educational investments in response to early-life health shocks in China and Behrman (1988) for nutritional investments in rural Indian children in the surplus season when food is relatively abundant but not in the lean season.

Table 3: Empirical Results for Adolescents' Activity Choices

	Athletics	Extracurricular Clubs
Peer Share – Athletics	0.585	−0.094
	(0.060)	(0.053)
Peer Share – Clubs	−0.065	0.860
	(0.038)	(0.032)
Social Skills	0.029	−0.001
	(0.002)	(0.002)
Cognitive Skills	0.023	0.053
	(0.003)	(0.003)
Mental Health	0.005	0.003
	(0.004)	(0.003)
Parental Investment	0.033	0.017
	(0.003)	(0.003)
Female	−0.252	0.059
	(0.009)	(0.008)
Black	0.019	0.002
	(0.009)	(0.008)
Non-White, Non-Black	0.016	0.009
	(0.010)	(0.009)
Height	0.008	0.001
	(0.001)	(0.001)
Age	0.028	0.074
	(0.035)	(0.030)
Age^2	−0.003	−0.003
	(0.001)	(0.001)
Outcome Mean	0.442	0.248
Std. Dev.	0.497	0.432
R^2	0.129	0.079
Observations	16,958	16,958

NOTES: This table reports OLS estimates from regressions of the indicated activity participation outcome (athletics or extracurricular clubs) on neighborhood peer participation rates and baseline covariates. Each specification controls for leave-one-out neighborhood shares of peers participating in athletics and in extracurricular clubs, baseline skills, parental investment, race, gender, and age and its square. Robust standard errors are reported in parentheses.

The *leave-one-out peer shares* faced by adolescent i are

$$\bar{a}_{j,i,t} \equiv \frac{A_{j(i),t} - a_{i,t}}{n_{j(i)} - 1}, \qquad \bar{e}_{j,i,t} \equiv \frac{E_{j(i),t} - e_{i,t}}{n_{j(i)} - 1}. \tag{2}$$

Given that we restrict our analysis sample to neighborhoods with at least ten 7th graders, these objects are fairly well-defined for every neighborhood. Intuitively, $\bar{a}_{j,i,t}$ is the fraction of *other* adolescents in the neighborhood j who participate in athletics, and $\bar{e}_{j,i,t}$ is defined analogously for clubs.

With these objects in hand, we examine how the adolescents' own activity choices are correlated with the local peer environment, holding fixed baseline skills, parental investment, demographics, age and height, following evidence from Persico, Postlewaite and Silverman (2004) on the returns to height. Table 3 reports these estimates.[13] The results show strong within-activity comovement and suggest substitution across activities. A 1 percentage point (pp) increase in the neighborhood peer share participating in athletics is associated with a 0.585 pp increase in an adolescent's own probability of participating in athletics. In contrast, higher peer club participation is associated with lower athletic participation. A 1 pp increase in the peer club share predicts a 0.065 pp (p-value ≈ 0.09) decline in own athletics participation.

The same pattern appears for clubs. A 1 pp increase in the peer share participating in extracurricular clubs is associated with a 0.860 pp increase in an adolescent's own probability of club participation. Higher peer athletics participation is in turn associated with lower club participation. In particular, a 1 pp increase in the peer athletics share predicts a 0.094 pp (p-value ≈ 0.08) decline in own club participation. As emphasized above, these relationships are correlational and may reflect sorting into neighborhoods and peer groups, but they provide disciplined evidence that local participation patterns are strongly related to adolescents' activity choices.

These social interactions also motivate the need for a structural model. The peer shares in Table 3 are inherently contemporaneous objects. An adolescent's participation decision is measured in the same period as the participation rates of their peers, and those peer rates are themselves generated by the choices of adolescents facing the same environment. As a result, reduced-form estimates cannot be given a causal interpretation without additional assumptions, and they do not directly deliver meaningful counterfactual predictions.

Looking ahead, our structural model addresses these limitations by treating neighborhood participation rates as endogenous equilibrium objects. In each neighborhood, peer shares are pinned down by a fixed point between individual best responses and the implied aggregate participation rates. This equilibrium perspective allows peer environments to adjust under counterfactual policies, such as changes in parental investment incentives or in the costs and benefits of participation. It therefore provides a coherent framework for mapping primitives and policy changes into equilibrium activity choices, endogenous peer behaviors, the evolution of skills, and adult economic returns.

2.3.3 The Productivity of Social Skills and Social Activities

Next, we investigate the dynamic returns to social skills in an environment where both parental and peer-related factors are endogenous. To discipline the intuition behind our skill formation technology, we begin

[13] Although not the focus of this section, we note that baseline skills and parental investment meaningfully impact the decision to participate in athletics and clubs. Height is also a strong predictor for one's decision to participate in athletics.

with a reduced-form specification relating next-period skills (measured in Wave II of Add Health) to contemporaneous inputs measured at baseline (Wave I). The included baseline inputs consist of skill stocks (social skills, cognitive skills, and mental health) and three key environmental inputs: parental investment, athletics participation, and extracurricular club participation. Add Health's panel structure provides a natural mapping from skills today to skills tomorrow, because Wave II re-interviews the same adolescents approximately one year after Wave I.

Table 4 reports the results.[14] For each skill dimension $k \in \{S, C, H\}$, we regress the Wave II stock of skill k on baseline (Wave I) skill stocks and baseline inputs. We report two specifications. The first imposes additivity in inputs. The second allows for flexible input complementarity by including pairwise interactions among the three baseline skill stocks and interactions between each baseline skill and each environmental input (parental investment, athletics participation, and extracurricular club participation). To allow for differences in skill evolution between younger and older adolescents, we further interact each baseline skill and each environmental input with an indicator for being in grades 7 or 8 (junior high). All specifications include neighborhood fixed effects, and standard errors are clustered at the neighborhood level.

We do not include leave-one-out peer participation shares in these regressions. Peer participation rates and own participation are measured in the same period and are jointly determined, as suggested by Table 3. Including peer shares would introduce a contemporaneous equilibrium object on the right-hand side, complicating interpretation without additional assumptions. Instead, we treat peer environments as operating through adolescents' own activity decisions. In the structural model, neighborhood participation rates shift the utility of participation and thereby affect skill accumulation through the induced changes in $(a_{i,t}, e_{i,t})$.

The first row of Table 4 highlights substantial persistence in social skills across adolescence. In the social-skill equation, the coefficient estimate on baseline social skills is large (0.459 in column (1)), indicating that differences in baseline social skills remain an important component of social-skill dispersion one year later. Baseline social skills are also positively associated with subsequent mental health (0.044 in column (5)), even after controlling for baseline cognitive skills, baseline mental health, and included environmental input. In contrast, baseline social skills have little association with future cognitive skills conditional on the other baseline skill stocks and inputs. Together, these patterns motivate treating social skills as a core state variable in the model, both because they persist over time and because they are systematically related to subsequent outcomes beyond what is captured by cognitive skills and mental health

[14] Table A7 additionally presents the coefficient estimates on many of the omitted interaction terms.

Table 4: Evolution of Skills Across Adolescence

	Future Social Skills		Future Cognitive Skills		Future Mental Health	
	(1)	(2)	(3)	(4)	(5)	(6)
Social Skills	0.459	0.456	0.006	0.006	0.044	0.044
	(0.011)	(0.011)	(0.008)	(0.009)	(0.006)	(0.006)
Cognitive Skills	0.043	0.043	0.568	0.569	0.051	0.053
	(0.016)	(0.016)	(0.019)	(0.017)	(0.010)	(0.010)
Mental Health	0.159	0.160	0.046	0.052	0.524	0.528
	(0.015)	(0.015)	(0.012)	(0.012)	(0.014)	(0.013)
Athletics	0.151	0.150	0.033	0.033	−0.004	−0.004
	(0.030)	(0.029)	(0.022)	(0.021)	(0.022)	(0.022)
Extracurricular Clubs	0.097	0.096	0.094	0.093	0.024	0.022
	(0.037)	(0.037)	(0.027)	(0.027)	(0.028)	(0.028)
Parental Investment	0.035	0.033	0.032	0.033	0.026	0.025
	(0.013)	(0.013)	(0.009)	(0.009)	(0.007)	(0.008)
Junior High	0.050	0.040	−0.208	−0.217	−0.071	−0.067
	(0.067)	(0.068)	(0.059)	(0.060)	(0.037)	(0.034)
Junior High × Social Skills	−0.073	−0.078	−0.010	−0.013	−0.025	−0.026
	(0.018)	(0.019)	(0.014)	(0.014)	(0.011)	(0.012)
Junior High × Cognitive Skills	0.030	0.026	0.074	0.063	0.009	0.006
	(0.026)	(0.028)	(0.022)	(0.022)	(0.013)	(0.014)
Junior High × Mental Health	0.046	0.050	0.043	0.039	0.018	0.019
	(0.036)	(0.039)	(0.019)	(0.020)	(0.020)	(0.019)
Junior High × Athletics	−0.073	−0.077	0.029	0.026	0.003	0.003
	(0.057)	(0.057)	(0.042)	(0.042)	(0.029)	(0.029)
Junior High × Clubs	−0.042	−0.045	−0.028	−0.029	−0.034	−0.032
	(0.071)	(0.071)	(0.037)	(0.036)	(0.037)	(0.037)
Junior High × Parental Investment	−0.015	−0.016	−0.025	−0.028	−0.028	−0.023
	(0.023)	(0.026)	(0.014)	(0.015)	(0.011)	(0.013)
Female	0.030	0.029	0.149	0.144	−0.164	−0.164
	(0.028)	(0.029)	(0.020)	(0.020)	(0.023)	(0.023)
Black	−0.004	−0.001	−0.102	−0.097	−0.040	−0.040
	(0.049)	(0.049)	(0.039)	(0.039)	(0.031)	(0.030)
Non-White, Non-Black	0.002	0.005	0.047	0.051	−0.074	−0.072
	(0.040)	(0.041)	(0.027)	(0.028)	(0.024)	(0.023)
Age	−0.344	−0.365	−0.599	−0.602	−0.327	−0.325
	(0.162)	(0.162)	(0.136)	(0.136)	(0.082)	(0.082)
Age^2	0.011	0.012	0.019	0.019	0.010	0.010
	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)
Outcome Mean	0.046	0.046	0.023	0.023	0.035	0.035
Std. Dev.	1.564	1.564	1.202	1.202	1.036	1.036
R^2	0.272	0.274	0.453	0.455	0.358	0.360
Observations	11,396	11,396	11,160	11,160	12,352	12,352
Input Complementarity	✗	✓	✗	✓	✗	✓

Notes: This table reports OLS estimates from regressions of the next-period stock of skill $\theta^k_{i,t+1}$, for $k \in \{S, C, H\}$, on the current stocks of all three skills, contemporaneous activity participation (athletics and extracurricular clubs), and parental investment. "Current" skills and inputs are measured in Wave I of Add Health, and "future" skills are measured in Wave II. "Junior High" is an indicator for whether the adolescent is in 7th or 8th grade in Wave I. Columns labeled "Input Complementarity" additionally include interaction terms among the three skills and between each skill and each investment/input (athletics, clubs, and parental investment). All specifications control for neighborhood fixed effects. Standard errors clustered at the neighborhood level are reported in parentheses.

alone.

The coefficient estimates on athletics and extracurricular clubs indicate that adolescents' activity choices are associated with subsequent skill accumulation, particularly for social skills.[15] Athletic participation is positively related to future social skills (0.151 in column (1)), while its association with future cognitive skills is small (0.033 in column (3)) and its association with future mental health is close to zero (−0.004 in column (5)). Club participation is likewise positively related to future social skills (0.097 in column (1)) and future cognitive skills (0.094 in column (3)), with a smaller association with future mental health (0.024 in column (5)). Parental investment is also positively related to subsequent skill growth across all dimensions. The magnitudes motivate modeling athletics and clubs as separate endogenous inputs into skill formation, alongside parental investment.

When comparing the additive specification with the interaction specification, the estimated coefficients on baseline skill stocks and environmental inputs are very similar (columns (1) versus (2), (3) versus (4), and (5) versus (6)). This stability suggests that the average associations between baseline inputs and next-period skills are not sensitive to allowing for flexible input complementarity. We use these reduced-form patterns to discipline the structure of the technology in the model.

2.3.4 Terminal Adolescent Skills and Long-Run Outcomes

Lastly, we document how adolescents' accumulated human capital at the end of our short-run adolescent panel is related to economically relevant outcomes later in life. Using skill stocks measured in Wave II as proxies for terminal adolescent adolescent skills, we estimate reduced-form associations between social skills, cognitive skills, and mental health and a set of adult outcomes observed in Waves III and IV. Each specification conditions on race, gender, and a quadratic in age. We additionally include an indicator for being in junior high in Wave II (grade 8) and allow the associations between terminal adolescent skills and outcomes to differ by junior-high status via interactions with each terminal adolescent skill.

[15] As a robustness check, we re-estimate this specification including an indicator for attendance at a "small" school, defined using the coarse Add Health school-size categories. We classify as small any school with 775 or fewer students, which comprises roughly one-third of the sample. The motivation is that school-sponsored teams may be more capacity-constrained in smaller schools, so participation may be both harder to obtain and more consequential. We find no evidence that the relationship between activities and subsequent skill production differs between small and large schools.

Table 5: The Impact of Terminal Adolescent Skills on Long-Run Outcomes

	College Graduation (1)	Schooling Attainment (2)	Working in Adulthood (3)	Log Income (4)	Top Quartile Prestige Occupation (5)	Supervisory Role at Work (6)
Social Skills	0.006	0.036	0.010	0.056	0.009	0.010
	(0.003)	(0.013)	(0.004)	(0.027)	(0.004)	(0.005)
Cognitive Skills	0.170	0.652	0.023	0.167	0.085	0.015
	(0.004)	(0.016)	(0.004)	(0.033)	(0.006)	(0.006)
Mental Health	0.147	0.151	0.021	0.138	0.007	0.003
	(0.005)	(0.021)	(0.006)	(0.044)	(0.007)	(0.008)
Junior High	−0.071	−0.710	−0.062	−0.470	−0.054	0.007
	(0.017)	(0.061)	(0.020)	(0.135)	(0.022)	(0.026)
Junior High × Social Skills	−0.004	0.012	0.001	0.055	−0.001	0.020
	(0.008)	(0.026)	(0.009)	(0.061)	(0.010)	(0.011)
Junior High × Cognitive Skills	−0.014	−0.319	0.009	0.044	−0.032	0.004
	(0.008)	(0.031)	(0.011)	(0.072)	(0.011)	(0.014)
Junior High × Mental Health	−0.011	0.016	0.014	0.029	0.034	−0.043
	(0.014)	(0.047)	(0.015)	(0.106)	(0.015)	(0.020)
Female	0.025	0.101	−0.114	−1.088	0.055	−0.093
	(0.009)	(0.034)	(0.009)	(0.066)	(0.012)	(0.013)
Black	0.003	−0.008	−0.011	0.063	−0.010	−0.026
	(0.011)	(0.043)	(0.012)	(0.080)	(0.014)	(0.016)
Non-White, Non-Black	−0.004	0.061	0.013	0.098	0.007	−0.015
	(0.013)	(0.049)	(0.014)	(0.102)	(0.017)	(0.019)
Age	−0.031	0.355	−0.011	−0.619	0.128	0.023
	(0.060)	(0.229)	(0.067)	(0.444)	(0.076)	(0.089)
Age^2	0.001	−0.004	0.000	0.020	−0.004	−0.000
	(0.002)	(0.008)	(0.002)	(0.014)	(0.002)	(0.003)
Outcome Mean	0.336	13.26	0.796	9.338	0.275	0.364
Std. Dev.	0.472	1.820	0.403	2.832	0.447	0.481
R^2	0.203	0.264	0.037	0.050	0.077	0.026
Observations	9,072	8,867	7,465	7,110	5,649	5,648

NOTES: This table presents regression results with various adult outcomes as the dependent variable and terminal adolescent skill levels as the independent variables of interest. "Junior High" is an indicator for whether the adolescent was in grade 8 in Wave II. "College Graduation" is an indicator for whether the respondent has graduated from college in Wave IV. "Schooling Attainment" is measured in Wave III, while the remaining outcomes are measured in Wave IV. "Log Income" does not condition on working status, but is transformed as $\ln(1 + \text{income})$. "Top Quartile Prestige Score" is an indicator for whether the individual works in the top 25% most prestigious jobs, as measured by the NORC prestige score. "Supervisory Role" is an indicator for whether the individual works at a job where they supervise at least one other worker. The last two specifications control for log income, with the final specification additionally controlling for occupational prestige score. Robust standard errors are presented in parentheses.

Table 5 reports the results.[16] In the discussion that follows, we transform each of the reported coeffi-

[16] Table A12 reports associations between terminal adolescent skills and additional outcomes. Social skills are positively associated with high-school graduation (0.2 percentage points, though imprecisely estimated), adult athletics participation (1.4 percentage points), and the probability of ever being married (0.6 percentage points), and are negatively associated with holding a bottom-quartile prestige occupation (−0.8 percentage points). The association between social skills and top-decile occupational prestige is small and statistically indistinguishable from zero, suggesting that the positive gradient in occupational standing documented in Table 5 is concentrated in the middle and upper-middle of the prestige distribution rather than the very top. Cognitive skills, by contrast, are strongly predictive of both avoiding bottom-quartile occupations (−6.0 percentage points) and attaining top-decile occupations (5.8 percentage points), consistent with cognitive skills being the dominant skill dimension for sorting into the most prestigious professional and technical roles.

cients $\hat{\beta}$ into units of standard deviation $\tilde{\beta}$ via $\tilde{\beta} = \hat{\beta} \times \text{SD}(\theta^k)$, where $\text{SD}(\theta^k)$ is the standard deviation of skill k in Wave II of Add Health. Social skills are positively associated with several adult outcomes, though the magnitudes are modest relative to those of cognitive skills, particularly for educational attainment. A one standard deviation increase in Wave II social skills is associated with a 0.9 percentage point increase in the probability of college graduation (column (1)) and 0.055 additional years of completed schooling (column (2)). Social skills are also positively associated with labor-market outcomes: a 1.5 percentage point increase in the probability of working in adulthood (column (3)), an 8.6 log-point increase in income (column (4)), a 1.4 percentage point increase in the probability of holding a prestigious occupation (column (5)), and a 1.5 percentage point increase in the probability of holding a supervisory role at work (column (6)).[17] The last two specifications additionally condition on log income, and column (6) further conditions on occupational prestige. In these models, the coefficient on social skills should be interpreted as a conditional association: among individuals with similar earnings (and, in column (6), similar occupational standing), those with higher adolescent social skills are more likely to report holding a supervisory role. Because income and occupational prestige are themselves plausibly influenced by social skills and may share unobserved determinants with supervisory status, these conditional patterns do not isolate a "direct productivity" channel and should not be interpreted causally.

Cognitive skills and mental health are also strongly related to long-run outcomes. Cognitive skills are tightly linked to educational attainment, with a 0.782-year increase in completed schooling per one standard deviation increase in Wave II cognitive skills (column (2)) and a 20.4 percentage point increase in the probability of college graduation (column (1)). Cognitive skills are also positively associated with log income (0.2, column (4)) and are especially predictive of occupational prestige, with a 10.2 percentage point increase in the probability of working in a top-quartile prestige occupation (column (5)). A one standard deviation increase in mental health is likewise positively associated with college graduation (0.153), completed schooling (0.157), employment (0.022), and log income (0.144), though its associations with occupational prestige and supervisory status are small and imprecisely estimated (columns (5) and (6)). The junior high interactions allow these relationships to vary across adolescents at different points in the grade distribution at Wave II; the interaction terms are generally modest, suggesting that the broad patterns are not driven by differences in the maturity of skill measurement across grades.

[17] We construct the occupational prestige score by matching the SOC occupation code recorded in Add Health Wave IV to the corresponding GSS/NORC occupational prestige score. Specifically, we match each SOC occupation label to the occupational titles used in the GSS/NORC classification scheme. The NORC prestige score is a widely used index that ranks occupations on a 0–100 scale based on survey respondents' assessments of the social standing of each occupation (Nakao and Treas, 1992). Scores reflect the general prestige accorded to an occupation rather than its wage or educational requirements per se, though these are correlated. For reference, aerospace engineers have a prestige score of 75, whereas parking enforcement officers have a score of 27.

We reiterate that these estimates are descriptive and should not be interpreted causally. Nonetheless, they establish that variation in adolescent human capital—including social skills—is systematically linked to later-life educational and labor-market outcomes, across dimensions ranging from years of schooling and college completion to earnings, occupational standing, and workplace authority. This pattern motivates modeling social skills as a key state variable whose evolution is shaped by endogenous parental investment and adolescent activity choices, and motivates the structural framework that follows, which maps adolescent skill accumulation into adult educational decisions and economic outcomes.

3 A Dynamic Model of Adolescent Development with Social Interactions

This section develops a finite-horizon model of adolescent skill formation across three dimensions—social skills, cognitive skills, and mental health. Each period, parents choose investments in their adolescent children and these children choose extracurricular activities. The economy consists of a set of neighborhoods populated by households, each comprising one adolescent child and one parent. A key feature is that adolescents incur social costs when their activity choices deviate from neighborhood participation patterns. These social costs generate endogenous social interactions in athletics and extracurricular clubs.

The model links parents and their adolescent children through a Stackelberg sequence: in each period, parents choose investments first; adolescents then choose whether to participate in athletics and extracurricular clubs. We follow Agostinelli et al. (2026) in adopting this Stackelberg structure and in treating neighborhood peer environments as equilibrium objects that are consistent with individual choices in each period, rather than as fixed parameters. Our departure is that the peer environment is determined by adolescents' choices over activity participation—athletics and extracurricular clubs—rather than by their choices over friendships. Neighborhood culture affects skill accumulation directly by shifting adolescents' activity choices and indirectly by changing parents' incentives to invest through the anticipated activity responses.

3.1 Initial Conditions

We begin by specifying baseline skills at the start of adolescence. Allowing initial endowments to vary across neighborhoods provides a parsimonious way to capture persistent differences in early-life environments that are difficult to observe directly, and that jointly shape subsequent parental investments, adolescents' activity choices, and the comovement of skills across dimensions.

Let i denote an adolescent child and t denote time, with $t = 0$ the initial period. Each adolescent child resides in neighborhood $j \in \mathcal{J}$ and is endowed with a vector of latent skills $\boldsymbol{\theta}_{i,0}^{j} \equiv \left(\theta_{i,0}^{S,j}, \theta_{i,0}^{C,j}, \theta_{i,0}^{H,j}\right)'$, where $\theta_{i,0}^{S,j}$ denotes social skills, $\theta_{i,0}^{C,j}$ denotes cognitive skills, and $\theta_{i,0}^{H,j}$ denotes mental health. Let $\ln \boldsymbol{\theta}_{i,0}^{j}$ denote the elementwise logarithm. We assume

$$\ln \boldsymbol{\theta}_{i,0}^{j} \sim \mathcal{N}\left(\boldsymbol{\mu}^{j}, \boldsymbol{\Sigma}^{j}\right), \tag{3}$$

where $\boldsymbol{\mu}^{j} \in \mathbb{R}^{3}$ is the neighborhood-specific mean vector and $\boldsymbol{\Sigma}^{j} \in \mathbb{R}^{3\times 3}$ is the corresponding variance-covariance matrix across skill types in neighborhood j.[18]

3.2 Technology of Skill Formation

We next specify how skills evolve over time as a function of current-skill stocks, parental investment, and the adolescent child's contemporaneous activity choices. For the remainder of the model exposition, we suppress neighborhood subscripts in the state variables and parameters, with neighborhood heterogeneity entering only through initial conditions in Equation 3 and through neighborhood participation rates in the adolescent child's problem.

Let $\boldsymbol{\theta}_{i,t} \equiv \left(\theta_{i,t}^{S}, \theta_{i,t}^{C}, \theta_{i,t}^{H}\right)'$ denote the vector of current-skill stocks in period t. In period t, parents choose a continuous investment level $I_{i,t}$ and adolescent children choose athletics participation $a_{i,t} \in \{0, 1\}$ and extracurricular club participation $e_{i,t} \in \{0, 1\}$. Adolescents may choose both activities.

We assume a nested-CES technology with two bundles: a *skill bundle* that aggregates current skill stocks and an *input bundle* that aggregates parental investment and activity choices.[19] Define the skill bundle for skill $k \in \{S, C, H\}$ as

$$\mathcal{K}_{i,t}^{k} = \left[\alpha_{k,S}\left(\theta_{i,t}^{S}\right)^{\rho_K} + \alpha_{k,C}\left(\theta_{i,t}^{C}\right)^{\rho_K} + \alpha_{k,H}\left(\theta_{i,t}^{H}\right)^{\rho_K}\right]^{1/\rho_K}, \tag{4}$$

and the input bundle as

$$\mathcal{I}_{i,t}^{k} = \left[\alpha_{k,I}\left(I_{i,t}\right)^{\rho_I} + \alpha_{k,a}\left(a_{i,t}\right)^{\rho_I} + \alpha_{k,e}\left(e_{i,t}\right)^{\rho_I}\right]^{1/\rho_I}. \tag{5}$$

Given that $a_{i,t}, e_{i,t} \in \{0, 1\}$, we have $(a_{i,t})^{\rho_I} = a_{i,t}$ and $(e_{i,t})^{\rho_I} = e_{i,t}$ for any $\rho_I > 0$ (with the Cobb-Douglas case obtained as the limit $\rho_I \to 0$). We therefore restrict the input-bundle curvature parameter to

[18] The latent factors estimated from Add Health map to the log skill levels detailed in the model.

[19] In simulations, we restrict $I_{i,t} \in [\underline{\mathrm{I}}, 1]$ for a small $\underline{\mathrm{I}} > 0$ to ensure the CES production function is well-defined for all admissible curvature parameters.

$\rho_I > 0$, ensuring the bundle is well-defined with binary activity choices and consistent with the empirical evidence in Section 2.3.

Define the skill-specific Total Factor Productivity (TFP) term $A_k(t) \equiv \exp(\gamma_{k,0} + \gamma_{k,1} t)$. The next-period stock of skill k is produced according to

$$\theta_{i,t+1}^k = A_k(t) \left[\alpha_{k,O} \left(\mathcal{K}_{i,t}^k \right)^{\rho_O} + (1 - \alpha_{k,O}) \left(\mathcal{I}_{i,t}^k \right)^{\rho_O} \right]^{1/\rho_O}, \tag{6}$$

where $\alpha_{k,O} \in (0,1)$ governs the relative importance of the skill bundle and the input bundle. The TFP includes a skill-specific level shifter ($\gamma_{k,0}$) and a separate component that captures deterministic growth (or decline) in productivity over time ($\gamma_{k,1}$).

The curvature parameters ρ_K and ρ_I govern the elasticity of substitution within the skill and input bundles, respectively, while ρ_O governs substitutability between bundles. Larger values of ρ imply inputs are more easily substituted; smaller values imply stronger complementarity. In particular, $\rho = 1$ yields linear aggregation (perfect substitutes) and $\rho \to -\infty$ approaches Leontief aggregation (perfect complements).

3.3 The Parent's Problem

Parents value their adolescent children's contemporaneous skill stocks but incur costs of investment. In each period, the parent chooses $I_{i,t}$ taking the technology as given and anticipating the adolescent's subsequent activity choice probabilities (derived in Section 3.4).

Parental period utility is

$$u^P(\boldsymbol{\theta}_{i,t}, I_{i,t}) = \psi_S \ln \theta_{i,t}^S + \psi_C \ln \theta_{i,t}^C + \psi_H \ln \theta_{i,t}^H - (\psi_{I,0} + \psi_{I,1} x_i^f + \psi_{I,2} x_i^B + \psi_{I,3} x_i^{\text{NWNB}}) I_{i,t} - \frac{\psi_{I,4}}{2} (I_{i,t})^2, \tag{7}$$

where x_i^f indicates female, x_i^B indicates Black, and x_i^{NWNB} indicates non-White and non-Black. The parameters ψ_S, ψ_C, ψ_H govern parental valuations of each skill, and the remaining terms govern the marginal disutility and curvature of investment costs.

Let $\mathbf{P}_{j,t}(\cdot \mid I_{i,t})$ denote the vector of multinomial logit choice probabilities over $(a,e) \in \{0,1\}^2$ implied by the adolescent children's optimization problem (Equation 11). In other words, for each (a,e), $\mathbf{P}_{j,t}(a, e \mid I_{i,t}) = \Pr(a_{i,t} = a, e_{i,t} = e \mid I_{i,t}, j)$. The parent's Bellman equation is

$$V_t^P(\boldsymbol{\theta}_{i,t}) = \max_{I_{i,t} \geq 0} \left\{ u^P(\boldsymbol{\theta}_{i,t}, I_{i,t}) + \beta \, \mathbb{E}\left[V_{t+1}^P(\boldsymbol{\theta}_{i,t+1}) \mid \boldsymbol{\theta}_{i,t}, I_{i,t} \right] \right\}, \tag{8}$$

where $\beta \in (0,1)$ is the discount factor and the expectation is taken over the adolescent's idiosyncratic taste shocks, with $\boldsymbol{\theta}_{i,t+1}$ determined by Equation 6 and evaluated at $(I_{i,t}, a_{i,t}, e_{i,t})$.

3.4 The Adolescent Child's Problem

After observing parental investment, the adolescent chooses whether to participate in athletics and extracurricular clubs. Utility depends on local peer culture in the sense that deviating from prevailing neighborhood participation patterns is socially costly. The peer environment is summarized by leave-one-out neighborhood participation shares, which enter the adolescent's utility.

Let j denote adolescent i's neighborhood. Define $\bar{a}_{j,t}$ and $\bar{e}_{j,t}$ as the leave-one-out shares of other adolescents in neighborhood j who participate in athletics and extracurricular clubs, respectively.[20] Given $(I_{i,t}, j)$, adolescent i chooses $(a_{i,t}, e_{i,t}) \in \{0,1\} \times \{0,1\}$. Period utility is written as

$$\begin{aligned} u_{i,t}(a_{i,t}, e_{i,t};\, I_{i,t}, j) = {} & \delta_{i,a}\, a_{i,t} + \delta_{i,e}\, e_{i,t} + \lambda_a\, a_{i,t}\bar{a}_{j,t} + \lambda_e\, e_{i,t}\bar{e}_{j,t} \\ & - \lambda_{a,e}\, a_{i,t}\bar{e}_{j,t} - \lambda_{e,a}\, e_{i,t}\bar{a}_{j,t} + (\phi_a\, a_{i,t} + \phi_e\, e_{i,t})\, I_{i,t} + \sigma\, \varepsilon_{i,t}(a_{i,t}, e_{i,t})\,, \end{aligned} \tag{9}$$

where $\lambda_a > 0$ and $\lambda_e > 0$ capture same-activity social interactions. The cross terms $\lambda_{a,e}$ and $\lambda_{e,a}$ allow peer culture in one activity to affect the desirability of the other, allowing for spillovers in social contexts. In particular, when $\lambda_{a,e} > 0$, higher club participation among peers lowers the utility of athletics; when $\lambda_{e,a} > 0$, higher athletic participation among peers lowers the utility of clubs. The parameters ϕ_a and ϕ_e allow parental investment to shift the relative desirability of athletics and clubs. Conceptually, parents with high levels of investment may provide resources that allow the take-up of athletics or clubs to be comparatively easier. The shocks $\varepsilon_{i,t}(a, e)$ are i.i.d. Type I Extreme Value across the four bundles and $\sigma > 0$ is a scale parameter.

Taste heterogeneity is allowed to vary at the margins of skill level, gender, and race, which enters through $\delta_{i,a}$ and $\delta_{i,e}$,

$$\delta_{i,z} = \delta_{z,0} + \delta_{z,1} \ln \theta^S_{i,t} + \delta_{z,2} \ln \theta^C_{i,t} + \delta_{z,3} \ln \theta^H_{i,t} + \delta_{z,4} x^f_i + \delta_{z,5} x^B_i + \delta_{z,6} x^{\mathrm{NWNB}}_i, \tag{10}$$

for $z \in \{a, e\}$. The baseline taste parameters $\delta_{a,0}$ and $\delta_{e,0}$ correspond to White male adolescents with average skill levels, no parental investment, and zero-peer take-up of the given activity.

Let $\tilde{u}_{i,t}(a, e; I_{i,t}, j)$ denote the deterministic component of Equation 9 (excluding $\sigma\varepsilon_{i,t}(a, e)$). Under

[20] Conceptually, $\bar{a}_{j,t}$ and $\bar{e}_{j,t}$ exclude adolescent i from the neighborhood averages, as in Section 2.3. In Section 4, we show that in our computational exercises the leave-one-out shares coincide with the neighborhood-wide shares.

the Type I Extreme Value assumption, the adolescent's myopic choice probabilities are multinomial logit,

$$\Pr(a_{i,t} = a,\, e_{i,t} = e \,|\, I_{i,t}, j) = \frac{\exp(\tilde{u}_{i,t}(a, e; I_{i,t}, j)/\sigma)}{\sum_{(a',e')\in\{0,1\}^2} \exp(\tilde{u}_{i,t}(a', e'; I_{i,t}, j)/\sigma)}. \tag{11}$$

These conditional choice probabilities enter the parent's problem through the expectation in Equation 8. In equilibrium, neighborhood participation rates $(\bar{a}_{j,t}, \bar{e}_{j,t})$ are consistent with the aggregation of individual choices implied by Equation 11.

3.5 Terminal Payoffs and the Adolescent's Education Problem

We close the model with terminal payoffs that deliver a finite-horizon dynamic program and permit backward induction. Let T denote the terminal adolescent period of skill accumulation and define $\boldsymbol{\theta}_{i,T} \equiv (\theta^S_{i,T}, \theta^C_{i,T}, \theta^H_{i,T})'$ as the terminal adolescent stock of skills at the end of adolescence.

3.5.1 Parent Terminal Payoff

Parents derive terminal utility from the adolescent's terminal adolescent skill levels. We impose that terminal adolescent preferences match flow preferences and write

$$V^P_T(\boldsymbol{\theta}_{i,T}) = \psi_S \,\ln \theta^S_{i,T} + \psi_C \,\ln \theta^C_{i,T} + \psi_H \,\ln \theta^H_{i,T}. \tag{12}$$

As in Del Boca, Flinn and Wiswall (2014), this assumes that parents value the skills their adolescent children carry into adulthood but do not directly value adult choices. Parents choose investments for $t = 0, 1, \ldots, T-1$, after which the adolescent enters adulthood with skill vector $\boldsymbol{\theta}_{i,T}$.

3.5.2 Schooling Choices in Adulthood

After terminal adolescent skills are realized, the adolescent makes an educational choice that trades-off expected labor-market payoffs against the cost of schooling. Let $s_i \in \mathcal{S}$ denote completed educational attainment, where $\mathcal{S}$ is a finite set of discrete categories. In our application, $\mathcal{S} = \{0, 1, 2, 3\}$, where $s = 0$ denotes no-college experience, $s = 1$ denotes some (incomplete college experience, $s = 2$ denotes college completion, and $s = 3$ denotes educational attainment beyond college.

We model adult labor-market outcomes using a two-part structure that features an employment margin and an earnings margin, conditional on working. Let $W_i(s) \in \{0, 1\}$ denote employment under schooling choice s, and let $y_i(s) > 0$ denote income, conditional on working. The adolescent chooses s_i^* satisfying

$$s_i^* \in \underset{s \in \mathcal{S}}{\operatorname{argmax}} \left\{ v_i(s) + \varepsilon_i(s) \right\}, \tag{13}$$

where $\{\varepsilon_i(s)\}_{s \in \mathcal{S}}$ are i.i.d. Type I Extreme Value shocks.

The deterministic component captures expected log income net of schooling costs. Under the two-part structure, define the *unnormalized* deterministic value as

$$\bar{v}_i(s) = p_i(s; x_i) \cdot \ell_i(s; x_i) - \kappa(s; \ln \boldsymbol{\theta}_{i,T}), \tag{14}$$

with

$$p_i(s; x_i) \equiv \Pr(W_i(s) = 1 \mid x_i), \quad \ell_i(s; x_i) \equiv \mathbb{E}[\ln y_i(s) \mid W_i(s) = 1, x_i],$$

so that $p_i(s; x_i) \cdot \ell_i(s; x_i) = \mathbb{E}[W_i(s) \cdot \ln y_i(s) \mid x_i]$ is expected log income and $\kappa(s; \ln \boldsymbol{\theta}_{i,T})$ is a schooling cost that depends on the schooling level and terminal skills. We impose the standard location normalization by working with values relative to the outside option:

$$v_i(s) \equiv \bar{v}_i(s) - \bar{v}_i(0), \tag{15}$$

so that $v_i(0) = 0$.

Given the discrete nature of schooling, we use schooling indicators to capture the marginal effects of each level on both employment and log earnings. Let $\mathbb{1}\{s = r\}$ denote an indicator for schooling level $r \in \{1, 2, 3\}$, with $s = 0$ omitted. We parameterize the probability of working using a logit index:

$$p_i(s; x_i) = \Lambda\Big(\pi_0 + \pi_1 \mathbb{1}\{s = 1\} + \pi_2 \mathbb{1}\{s = 2\} + \pi_3 \mathbb{1}\{s = 3\} + \pi_4 x_i^f + \pi_5 x_i^B + \pi_6 x_i^{\text{NWNB}}\Big), \tag{16}$$

where $\Lambda(z) \equiv \exp(z)/(1 + \exp(z))$. Expected log earnings conditional on working is

$$\ell_i(s; x_i) = \zeta_0 + \zeta_1 \mathbb{1}\{s = 1\} + \zeta_2 \mathbb{1}\{s = 2\} + \zeta_3 \mathbb{1}\{s = 3\} + \zeta_4 x_i^f + \zeta_5 x_i^B + \zeta_6 x_i^{\text{NWNB}}. \tag{17}$$

Schooling costs vary with terminal skills:

$$\kappa(s; \ln \boldsymbol{\theta}_{i,T}) = \sum_{r=1}^{s} \Big(\kappa_{r,0} - \kappa_{r,S} \ln \theta_{i,T}^S - \kappa_{r,C} \ln \theta_{i,T}^C - \kappa_{r,H} \ln \theta_{i,T}^H\Big), \quad s \in \{1, 2, 3\}, \tag{18}$$

with $\kappa(0; \ln \boldsymbol{\theta}_{i,T}) \equiv 0$. When $\kappa_{r,S}, \kappa_{r,C}, \kappa_{r,H} > 0$, higher skills reduce the marginal costs of progressing through schooling, capturing selection into higher education on the basis of human capital (e.g., higher cognitive skills can reduce the difficulty of completing college and higher social skills can reduce adjustment costs in a new environment).

4 Estimation Strategy and Results

4.1 Initial Conditions and Additional Parameterizations

Rather than estimate the initial skill distribution jointly with the structural parameters, we discipline initial conditions using the data. Let $\mathcal{N}_{j,0}$ denote the set of seventh-grade adolescents observed in neighborhood j in Wave I of Add Health, with $n_{j,0} \equiv |\mathcal{N}_{j,0}|$. Define the baseline log-skill vector

$$\ln \boldsymbol{\theta}_{i,0} \equiv \left(\ln \theta_{i,0}^{S},\, \ln \theta_{i,0}^{C},\, \ln \theta_{i,0}^{H}\right)'.$$

We set the neighborhood-specific mean vector and variance-covariance matrix equal to their empirical counterparts:

$$\widehat{\boldsymbol{\mu}}^{j} = \frac{1}{n_{j,0}} \sum_{i \in \mathcal{N}_{j,0}} \ln \boldsymbol{\theta}_{i,0}, \qquad \widehat{\boldsymbol{\Sigma}}^{j} = \frac{1}{n_{j,0} - 1} \sum_{i \in \mathcal{N}_{j,0}} \left(\ln \boldsymbol{\theta}_{i,0} - \widehat{\boldsymbol{\mu}}^{j}\right)\left(\ln \boldsymbol{\theta}_{i,0} - \widehat{\boldsymbol{\mu}}^{j}\right)'. \tag{19}$$

Writing $\widehat{\boldsymbol{\mu}}^{j} = (\widehat{\mu}_{S}^{j}, \widehat{\mu}_{C}^{j}, \widehat{\mu}_{H}^{j})'$, the associated variance-covariance matrix is

$$\widehat{\boldsymbol{\Sigma}}^{j} = \begin{pmatrix} \widehat{\sigma}_{SS}^{j} & \widehat{\sigma}_{SC}^{j} & \widehat{\sigma}_{SH}^{j} \\ \widehat{\sigma}_{CS}^{j} & \widehat{\sigma}_{CC}^{j} & \widehat{\sigma}_{CH}^{j} \\ \widehat{\sigma}_{HS}^{j} & \widehat{\sigma}_{HC}^{j} & \widehat{\sigma}_{HH}^{j} \end{pmatrix}, \tag{20}$$

where for $X, Y \in \{S, C, H\}$,

$$\widehat{\sigma}_{XY}^{j} \equiv \frac{1}{n_{j,0} - 1} \sum_{i \in \mathcal{N}_{j,0}} \left(\ln \theta_{i,0}^{X} - \widehat{\mu}_{X}^{j}\right)\left(\ln \theta_{i,0}^{Y} - \widehat{\mu}_{Y}^{j}\right).$$

We treat $\left(\widehat{\boldsymbol{\mu}}^{j}, \widehat{\boldsymbol{\Sigma}}^{j}\right)$ as fixed inputs to the model. When simulating the economy for neighborhood j, we draw initial skills $\ln \boldsymbol{\theta}_{i,0}$ from $\mathcal{N}\left(\widehat{\boldsymbol{\mu}}^{j}, \widehat{\boldsymbol{\Sigma}}^{j}\right)$. This approach allows neighborhoods to differ in baseline skill endowments and in the correlation structure across skill dimensions, while imposing a common subsequent law of motion for skills across neighborhoods.

To separately identify the skill-specific productivity shifters $A_k(t) = \exp(\gamma_{k,0} + \gamma_{k,1} t)$ from the scale of the CES nests, we impose within-nest share normalizations for each skill $k \in \{S, C, H\}$:

$$\alpha_{k,S} + \alpha_{k,C} + \alpha_{k,H} = 1, \qquad \alpha_{k,I} + \alpha_{k,a} + \alpha_{k,e} = 1, \tag{21}$$

with $\alpha_{k,\cdot} \geq 0$. We additionally restrict the outer weight $\alpha_{k,O} \in (0,1)$ for each k. These normalizations pin down the relative contribution of inputs within each nest, while the level and trend of $A_k(t)$ absorb skill-specific scale and time variation in skill accumulation. Finally, we set the discount factor to $\beta = 0.96$.

4.2 Identification

We identify the model from three main sources of variation: (i) within-neighborhood relationships between skills, parental investment, and activity participation, (ii) cross-neighborhood variation in participation rates that shifts the social environment, and (iii) the connection between terminal skills and adult schooling and labor-market outcomes.

Our analysis treats neighborhood (school) assignment as predetermined and does not model residential mobility or endogenous school choice. This is a deliberate scope choice: incorporating a housing market and the joint determination of peer environments and family location decisions would substantially expand the model and is not required for our primary objective, which is to quantify the roles of endogenous social interactions conditional on the observed sorting of families into neighborhoods. Furthermore, Add Health data do not include information related to either the neighborhood or school selection process. Consequently, the counterfactual exercises based on our estimated model should be interpreted as within-neighborhood equilibrium responses holding the cross-neighborhood assignment fixed (except for policy experiments where we explicit reassign adolescents to counterfactual neighborhoods). If, in reality, families choose neighborhoods partly to access particular peer environments or activity cultures, then a full general-equilibrium response could attenuate or reallocate the effects reported here. We therefore view our counterfactuals as informative about the importance of the peer-interaction channel given prevailing sorting patterns, rather than as predictions of the long-run housing-market equilibrium.

Consistent with this focus, the targeted moments are based on regressions that include neighborhood fixed effects and rich controls. Many specifications also include an indicator for being in junior high to absorb broad-level differences and common shifts between middle school and high school. This is particularly important for panel moments that discipline the evolution of skills and choices over adolescence, as it allows the model to match systematic changes over time without attributing them to other mechanisms, such as self-productivity, cross-skill spillovers, or the effects of investment and activities.

Peer effects enter through neighborhood participation shares in athletics ($\bar{a}_{j,t}$) and extracurricular clubs ($\bar{e}_{j,t}$), so the model can, in principle, admit multiple equilibria. To obtain a well-defined mapping from parameters to observables in estimation, we impose rational expectations and treat the realized neighborhood participation rates in Add Health as the equilibrium selected in the data. Adolescents are assumed to anticipate correctly the period- and neighborhood-specific participation rates and to take them as given when making participation decisions.

Operationally, estimation is therefore disciplined by a fixed-point restriction. For any candidate parameter vector, the model implies individual participation choices that aggregate to neighborhood participation shares. Rational expectations requires that these model-implied shares coincide with the shares agents anticipate. We enforce this restriction by targeting neighborhood participation shares as moments in the method-of-simulated-moments procedure (see Section 4.3). Matching these moments aligns beliefs and behavior at the neighborhood level and ensures that the model is estimated at the equilibrium observed in the data. In counterfactual experiments, peer shares are endogenous and are solved as equilibrium objects using a fixed-point algorithm. We discuss the equilibrium computation and the possibility of multiple equilibria in Section 5.

4.3 Targeted Moments

Our model contains 79 parameters to be estimated: 21 parameters governing the technology of skill formation (7 per skill across $k \in \{S, C, H\}$), 3 curvature parameters shared across skills, 8 parameters governing parental preferences, 21 parameters governing adolescents' activity utilities, and 26 parameters governing the adult schooling problem. We estimate these parameters by matching a targeted set of 274 empirical moments computed from Add Health to the corresponding moments computed from simulated data generated by the model. In the following, we describe the targeted moments and the parameter blocks they primarily discipline.

1. *The technology of skill formation.* We target coefficients from reduced-form regressions that relate next-period skill stocks to baseline skills and baseline inputs. For each $k \in \{S, C, H\}$ we estimate:

    (a) *Additive skill evolution regressions:* regress $\ln \theta^k_{i,t+1}$ on $(\ln \theta^S_{i,t}, \ln \theta^C_{i,t}, \ln \theta^H_{i,t})$, parental investment $I_{i,t}$, athletics $a_{i,t}$, clubs $e_{i,t}$, a junior high indicator, and controls (female, Black, non-White, non-Black, age, and age^2), with neighborhood fixed effects. We target the 7 coefficients on baseline skills, baseline inputs, and the junior high indicator.

    (b) *Input-complementarity regressions:* augment the above specification with interactions among baseline skills, interactions between investment and each baseline skill, and interactions between investment and each activity, with the same controls and neighborhood fixed effects. We target the first 15 coefficients (the 7 main effects above plus the 8 interaction terms).

2. *Parental preferences and investment behavior.* We target the first 6 coefficients from regressions of parental investment on baseline skills $(\ln \theta^S_{i,t}, \ln \theta^C_{i,t}, \ln \theta^H_{i,t})$ and demographics (female, Black, and non-White, non-Black), with age controls and neighborhood fixed effects.

3. *Adolescents' activity choices and social interactions.* We target:

   (a) *neighborhood participation rates:* the share of individuals within each neighborhood who participate in athletics and clubs in the initial period (7th grade).

   (b) *Choice regressions:* the first 9 coefficients from regressions of $a_{i,t}$ and $e_{i,t}$ on neighborhood peer shares $(\bar{a}_{j,t}, \bar{e}_{j,t})$, baseline skills, parental investment, and demographics (female, Black, non-White, non-Black), with age controls and neighborhood fixed effects.[21]

4. *Adult outcomes and schooling choices.* We target:

   (a) *Schooling choice shares:* the empirical distribution of schooling attainment, $\Pr(s = r)$ for each $r \in \{1, 2, 3\}$, overall and by female, Black, and non-White, non-Black status (12 moments total).

   (b) *Employment by schooling:* 6 coefficients from a linear probability model of employment on schooling indicators $(s = 1, 2, 3)$ and demographics (female, Black, non-White, non-Black).

   (c) *Schooling attainment by terminal skills:* 18 coefficients from three linear probability models of $\mathbb{1}\{s = r\}$ for $r \in \{1, 2, 3\}$ on terminal skills $(\ln \theta^S_T, \ln \theta^C_T, \ln \theta^H_T)$ and demographic controls (female, Black, non-White, non-Black), yielding 6 coefficients per schooling level.

   (d) *Earnings conditional on positive log earnings:* 6 coefficients from an OLS regression of log earnings on schooling indicators $(s = 1, 2, 3)$ and demographics (female, Black, non-White, non-Black), estimated on the subsample with positive log earnings.

Denote by $\mathbf{\Omega}$ the vector of all model parameters to be estimated. Let M denote the vector of empirical moments computed from Add Health data, and let $M(\mathbf{\Omega})$ denote the corresponding moments computed

[21] In simulated data, neighborhoods are large, so the leave-one-out neighborhood participation share is numerically indistinguishable from the full-neighborhood share. We therefore treat these objects interchangeably when forming the activity-choice moments, which also reduces computational burden because neighborhood shares can be computed once per neighborhood without affecting the resulting moments in large simulated samples.

from simulated data generated by the model under parameter vector $\mathbf{\Omega}$. Our SMM estimates $\widehat{\mathbf{\Omega}}$ solve

$$\widehat{\mathbf{\Omega}} \in \underset{\mathbf{\Omega}}{\operatorname{argmin}} \left[M - M(\mathbf{\Omega})\right]' \left[M - M(\mathbf{\Omega})\right], \tag{22}$$

where we set the weighting matrix to the identity matrix for computational convenience.

4.4 Estimation Results

Table 6 reports the estimated parameters governing adolescent skill formation, parental preferences, and adolescents' activity choices. Table 7 reports parameters governing adult labor-market outcomes and schooling decisions. We organize the discussion around the model's central economic mechanisms.

4.4.1 The Technology of Skill Formation

Panel A of Table 6 reports the estimated parameters of the adolescent skill formation technology for social skills, cognitive skills, and mental health. The estimates indicate meaningful heterogeneity across skill dimensions in both persistence and the productivity of contemporaneous environments, including parental investment and activity participation.

Baseline skill stocks are important determinants of subsequent accumulation. The estimated outer-nest weights on the skill bundle are sizable for each dimension, ranging from 0.633 for social skills to 0.714 for mental health, implying that lagged skills account for a large share of next-period variation relative to environmental inputs. Within the skill bundle, the estimates imply strong self-productivity across all dimensions. The own-skill elasticities are 0.627 for social skills, 0.823 for cognitive skills, and 0.824 for mental health, indicating substantial persistence in adolescent skill dynamics. Cross-skill effects are present but smaller in magnitude. For example, cognitive skills contribute meaningfully to subsequent social skills ($\alpha_{S,C} = 0.117$), while social skills contribute little to subsequent cognitive skills ($\alpha_{C,S} = 0.018$). For mental health, we find that both cognitive and social skills are important inputs ($\alpha_{H,C} = 0.228$; $\alpha_{H,S} = 0.084$), though persistence remains the dominant force.

We find that contemporaneous and endogenous environmental inputs are quantitatively important, with their relevance differing by skill. Parental investment is productive in all three technologies and is especially important for cognitive skills and mental health. The estimated investment elasticities are 0.239 for social skills, 0.584 for cognitive skills, and 0.824 for mental health. In contrast, athletics participation is most productive for social-skill accumulation ($\alpha_{S,a} = 0.577$), plays a secondary role for cognitive skills ($\alpha_{C,a} = 0.138$), and contributes little to mental-health accumulation ($\alpha_{H,a} = 0.037$). This pattern is

Table 6: Parameter Estimates – Adolescence

Panel A: Technology of Skill Formation				
Social Skills	Social Skill ($\alpha_{S,S}$)	Cognitive Skill ($\alpha_{S,C}$)	Investment ($\alpha_{S,I}$)	Athletics ($\alpha_{S,a}$)
	0.627	0.117	0.239	0.577
	(0.006)	(0.006)	(0.016)	(0.017)
	Skill Bundle ($\alpha_{S,O}$)	TFP Constant ($\gamma_{S,0}$)	TFP Trend ($\gamma_{S,1}$)	
	0.633	0.015	0.001	
	(0.011)	(0.015)	(0.014)	
Cognitive Skills	Social Skill ($\alpha_{C,S}$)	Cognitive Skill ($\alpha_{C,C}$)	Investment ($\alpha_{C,I}$)	Athletics ($\alpha_{C,a}$)
	0.018	0.823	0.584	0.138
	(0.004)	(0.005)	(0.018)	(0.014)
	Skill Bundle ($\alpha_{C,O}$)	TFP Constant ($\gamma_{C,0}$)	TFP Trend ($\gamma_{C,1}$)	
	0.643	0.042	0.027	
	(0.008)	(0.008)	(0.004)	
Mental Health	Social Skill ($\alpha_{H,S}$)	Cognitive Skill ($\alpha_{H,C}$)	Investment ($\alpha_{H,I}$)	Athletics ($\alpha_{H,a}$)
	0.084	0.228	0.824	0.037
	(0.005)	(0.005)	(0.031)	(0.023)
	Skill Bundle ($\alpha_{H,O}$)	TFP Constant ($\gamma_{H,0}$)	TFP Trend ($\gamma_{H,1}$)	
	0.714	0.303	0.121	
	(0.012)	(0.055)	(0.018)	
Curvature Parameters	Skill Bundle (ρ_K)	Input Bundle (ρ_I)	Outer Nest (ρ_O)	
	−0.062	0.919	1.187	
	(0.025)	(0.036)	(0.034)	
Panel B: Preference Parameters				
Parent Utility	Social Skill (ψ_S)	Cognitive Skill (ψ_C)	Mental Health (ψ_H)	Baseline Investment ($\psi_{I,0}$)
	1.489	1.058	0.144	0.585
	(0.195)	(0.153)	(0.079)	(0.035)
	× Female ($\psi_{I,1}$)	× Black ($\psi_{I,2}$)	× NWNB ($\psi_{I,3}$)	Quadratic ($\psi_{I,4}$)
	−0.499	−0.105	0.216	0.160
	(0.034)	(0.023)	(0.021)	(0.057)
Adolescent Utility	Baseline Athletics ($\delta_{a,0}$)	× Social Skills ($\delta_{a,1}$)	× Cognitive Skills ($\delta_{a,2}$)	× Mental Health ($\delta_{a,3}$)
	−0.117	0.074	0.235	0.008
	(0.009)	(0.002)	(0.003)	(0.005)
	× Female ($\delta_{a,4}$)	× Black ($\delta_{a,5}$)	× NWNB ($\delta_{a,6}$)	
	−0.766	0.299	0.439	
	(0.010)	(0.008)	(0.012)	
	Baseline Clubs ($\delta_{e,0}$)	× Social Skills ($\delta_{e,1}$)	× Cognitive Skills ($\delta_{e,2}$)	× Mental Health ($\delta_{e,3}$)
	−1.225	0.006	0.201	0.008
	(0.009)	(0.005)	(0.004)	(0.005)
	× Female ($\delta_{e,4}$)	× Black ($\delta_{e,5}$)	× NWNB ($\delta_{e,6}$)	
	0.203	−0.628	0.223	
	(0.006)	(0.013)	(0.010)	
	Athletic Peers (λ_a)	Club Peers (λ_e)	Cross-Athletics ($\lambda_{a,e}$)	Cross-Clubs ($\lambda_{e,a}$)
	1.128	1.958	0.904	0.404
	(0.011)	(0.019)	(0.013)	(0.011)
	Investment × Athletics (ϕ_a)	Investment × Clubs (ϕ_e)	T1EV Scale (σ)	
	0.112	0.099	0.750	
	(0.009)	(0.004)	(0.005)	

Notes: This table reports simulated-method-of-moments (SMM) parameter estimates for the portion of the model related to adolescent skill development. Standard errors are reported in parentheses and are computed using the delta method, based on the estimated Jacobian of the moment conditions with respect to the parameters. S, C, and H denote social skills, cognitive skills, and mental health, respectively. I denotes parental investment, a athletics participation, and e clubs participation. "NWNB" indicates non-White, non-Black.

consistent with a model in which activities operate primarily through the social dimension of adolescent development, while parental investments are central for cognitive and mental-health accumulation.

Lastly, the curvature estimates imply meaningful but incomplete substitutability across inputs. The curvature within the skill bundle is very close to Cobb-Douglas ($\rho_K = -0.062$), indicating limited scope for offsetting among the components of the skill bundle and reinforcing the role of persistence in shaping adolescent skill trajectories. The estimated curvature within the input bundle is below one ($\rho_I = 0.919$), implying partial substitutability across environmental inputs, rather than perfect offsetting. Finally, the outer-nest curvature is larger ($\rho_O = 1.187$), indicating greater substitutability between current-skill stocks and contemporaneous environments. As a result, increases in one input can mitigate declines in another, but do not fully undo them. For example, higher parental investment can partially substitute for reductions in activity participation in the production of social skills, but it cannot fully replicate the contribution of athletics when participation declines.

4.4.2 Parental Response to Social Skills

Panel B of Table 6 implies that parents place substantial value on social skills relative to the other skill dimensions. The estimated preference weight on social skills is 1.489, exceeding the weight on cognitive skills (1.058), while the weight on mental health is small (0.144) in the flow-utility specification. Combined with the skill formation technology in Panel A, these preferences generate strong incentives to invest in ways that raise both social skills and cognitive skills over adolescence.

Panel B also indicates systematic heterogeneity in the marginal cost of investment by observable characteristics. The linear cost shifters differ by gender and race, with a negative coefficient on female ($\psi_{I,1} = -0.499$) and smaller effect for Black adolescents ($\psi_{I,2} = -0.105$) and non-White, non-Black adolescents ($\psi_{I,3} = 0.216$). In addition, the quadratic term is positive ($\psi_{I,4} = 0.160$), implying increasing marginal costs at higher investment levels. Together, these features help the model match both the level and dispersion of investment as well as the demographic gradients documented in Table 2.

4.4.3 Peer Environments and Activity Choices

The estimated peer interaction parameters imply that neighborhood participation patterns shape activity choices through strong social incentives to conform. Same-activity peer effects are large for both athletics and clubs, with stronger effect for clubs ($\lambda_e = 1.958$) relative to athletics ($\lambda_a = 1.128$). As a result, higher neighborhood participation substantially increases the relative attractiveness of choosing the corresponding activity. The cross terms are positive but enter the utility index with the opposite sign, so they imply negative cross-activity peer effects. Increases in neighborhood athletics participation reduce the relative attractiveness of clubs, and increases in neighborhood clubs participation reduce the relative attractiveness of athletics. This pattern generates a tradeoff across activities that varies with local peer culture, and it helps the model match the negative correlation between athletics and clubs participation across neighborhoods documented in Table 3. Concretely, the estimated cross-peer parameters ($\lambda_{a,e} = 0.904$; $\lambda_{e,a} = 0.404$) imply that peer environments amplify specialization. As one activity becomes more prevalent locally, adolescents are more likely to sort into that activity and away from the alternative.

Baseline preference heterogeneity interacts with these peer effects to generate the main cross-sectional patterns in participation. At the baseline, clubs are less attractive than athletics ($\delta_{e,0} = -1.225$ versus $\delta_{a,0} = -0.117$), but the skill interactions imply systematic sorting by adolescent endowments. For athletics, the payoff increases with both social skills and cognitive skills ($\delta_{a,1} = 0.074$; $\delta_{a,2} = 0.235$), while for clubs the payoff is primarily increasing in cognitive skills ($\delta_{e,2} = 0.201$), with little sensitivity to social skills or mental health. Demographic shifters further contribute to persistent differences in baseline tastes—girls have substantially lower baseline utility for athletics ($\delta_{a,4} = -0.766$) and higher baseline utility for clubs ($\delta_{e,4} = 0.203$). With strong same-activity peer effects, these taste differences translate into larger gender gaps in neighborhoods where the corresponding activity is more prevalent, since the social return to matching local patterns is higher.

Finally, parental investment complements activity participation in preferences, reinforcing the link between family resources and adolescents' time allocation. The estimated interaction terms are positive for both activities ($\phi_a = 0.112$; $\phi_e = 0.099$), implying that higher investment raises the marginal utility of participation. This complementarity strengthens the model's ability to match joint patterns in investment and participation across neighborhoods and demographic groups.

4.4.4 Adolescent Terminal Skills and Economic Returns

Adolescent terminal skills affect schooling choices through costs. Panels A and B of Table 7 show that, conditional on education and demographics, adult labor-market outcomes are driven primarily by educational categories and demographic shifters. Relative to the omitted category of no college, higher schooling is associated with higher expected log earnings and, on average, higher employment propensities, while women have lower employment and lower earnings conditional on education. Differences by race are modest relative to the educational gradients.

Panel A indicates that employment varies by schooling and demographics. Relative to the baseline, the schooling-level indicators each positively increase the likelihood of employment. Gender differences

Table 7: Parameter Estimates – Adulthood

Panel A: Probability of Working			
Baseline (π_0)	Some College (π_1)	College (π_2)	Beyond College (π_3)
1.036	1.056	0.967	1.038
(0.105)	(0.096)	(0.110)	(0.099)
Female (π_4)	Black (π_5)	NWNB (π_6)	
−0.514	0.111	0.041	
(0.086)	(0.086)	(0.038)	
Panel B: Expected Log Income			
Baseline (ζ_0)	Some College (ζ_1)	College (ζ_2)	Beyond College (ζ_3)
10.27	0.175	0.558	0.651
(2.119)	(0.007)	(0.007)	(0.007)
Female (ζ_4)	Black (ζ_5)	NWNB (ζ_6)	
−0.346	−0.172	0.077	
(0.007)	(0.007)	(0.007)	
Panel C: Schooling Costs			
Some College ($\kappa_{1,0}$)	× Social Skills ($\kappa_{1,S}$)	× Cognitive Skills ($\kappa_{1,C}$)	× Mental Health ($\kappa_{1,H}$)
1.262	0.502	−0.108	0.293
(0.427)	(0.171)	(0.061)	(0.070)
College ($\kappa_{2,0}$)	× Social Skills ($\kappa_{2,S}$)	× Cognitive Skills ($\kappa_{2,C}$)	× Mental Health ($\kappa_{2,H}$)
1.301	0.143	0.652	−0.005
(0.244)	(0.046)	(0.113)	(0.108)
Beyond College ($\kappa_{3,0}$)	× Social Skills ($\kappa_{3,S}$)	× Cognitive Skills ($\kappa_{3,C}$)	× Mental Health ($\kappa_{3,H}$)
0.596	0.104	0.381	−0.156
(0.105)	(0.083)	(0.113)	(0.082)

NOTES: This table reports simulated-method-of-moments (SMM)-parameter estimates for the adulthood module of the model. Panel A reports coefficient estimates in the index for the probability of working. Panel B reports coefficient estimates in the expected log income equation. Panel C reports schooling cost parameters by educational level. Standard errors are reported in parentheses and are computed using the delta method, based on the estimated Jacobian of the moment conditions with respect to the parameters. S, C, and H denote social skills, cognitive skills, and mental health, respectively; educational categories are relative to the omitted baseline category (no-college experience).

are substantial, with females having a lower likelihood of employment ($\pi_4 = -0.514$). The model does not detect statistically significant employment differences on the basis of race.

Panel B shows that earnings rise sharply with educational attainment. Expected log income increases with each schooling category relative to no college, with each educational level exhibiting a greater total return. Conditional on educational level, women earn less on average ($\zeta_4 = -0.346$). Our model predicts that Black adults also earn less on average ($\zeta_5 = -0.172$).

Consistent with our reduced-form evidence, we model adolescent terminal skills as impacting adult outcomes only through the schooling decision itself. Panel C shows that adolescent terminal skills shift schooling costs in systematic ways. Higher cognitive skills are associated with higher costs at the "some college" level, which rationalizes why adults with higher cognitive skills are less likely to obtain only some-college education. Conversely, higher cognitive skills substantially reduce the costs associated with completing college and going beyond college. Social skills reduce the cost of each educational level, with significantly lower effects at higher-education levels. We do not find that mental health significantly changes the average costs of educational attainment at any educational level.

Taken together, the estimates underscore the importance of educational completion margins for long-run outcomes and the role of skills in generating sizable economic returns. Relative to no college, completing college and obtaining education beyond college are associated with substantially larger gains in expected earnings than partial-college attainment. Moreover, because schooling costs depend on adolescent terminal skills, the model implies sorting across educational levels by skill profiles rather than by a single index of skill. In particular, adolescents with higher cognitive skills face relatively higher costs of stopping before completing college, but substantially lower costs of completing college and progressing to education beyond college. This cost structure pushes high-cognitive-skill individuals away from partial attainment and toward completion. Social skills reduce the cost of post-secondary attainment at each margin, with effects that attenuate at higher educational levels, reinforcing a broad pattern in which higher social skills shift the distribution of schooling upward.

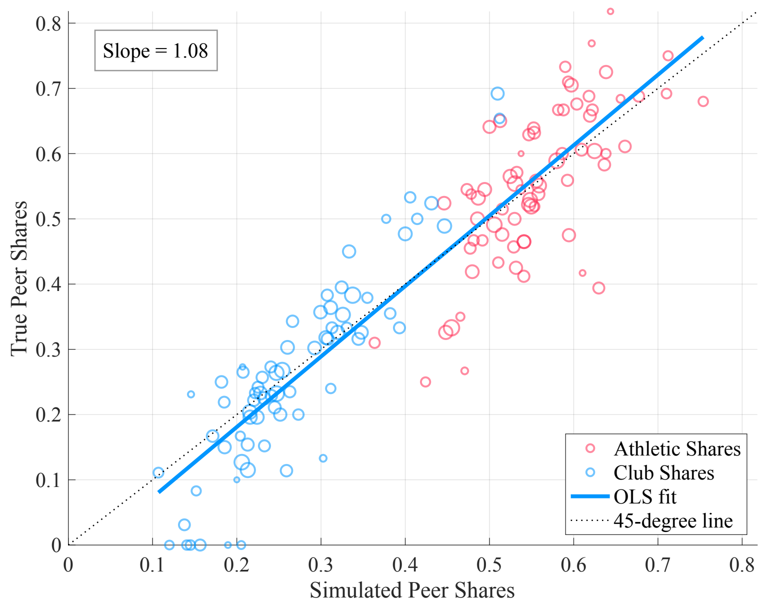
4.5 Model Fit

We assess model fit by comparing the empirical moments targeted in estimation to their model-implied counterparts. Figure 1 compares neighborhood-level participation shares in athletics and extracurricular clubs in Add Health to those generated by the model. The model reproduces the cross-neighborhood distribution closely. Regressing observed neighborhood shares on simulated shares yields an OLS slope of 1.08, and the correlation between observed and simulated neighborhood shares is 0.91. Although not targeted, the model closely reproduces population-wide average athletic participation rates (55% in data versus 56% in simulation) and club participation rates (26% in data versus 27% in simulation).

Table A13–Table A20 report fit for the remaining targeted moments, including reduced-form coefficients from the skill-formation regressions, activity-choice regressions, education moments, and labor-market regressions. Overall, the model matches several key reduced-form patterns in the Add Health analytic sample, supporting its use as a baseline for counterfactual policy analysis.

For adolescent skill formation, the model reproduces the prominence of self-productivity in each skill and captures several cross-skill relationships qualitatively (Table A13–Table A15). At the same time, it overstates the reduced-form role of investment in the cognitive and mental health technologies and overstates the contribution of cognitive skills to mental-health accumulation. In the social-skills technology, the flexible specification with a large degree of complementarity between inputs understates the reduced-form contributions of athletics and clubs, and it does not match the positive reduced-form association

Figure 1: Model Fit – Neighborhood-Level Participation in Athletics and Clubs



Notes: This figure compares the 142 neighborhood-level peer-share moments in Add Health to their simulated counterparts using the estimated parameter vector. Hollow red circles correspond to athletic peer-share moments and hollow blue circles correspond to club peer-share moments. The solid line is the OLS best-fit line from regressing true moments on simulated moments, and the dotted 45-degree line indicates perfect fit. Observations are weighted by neighborhood size, which is reflected in the relative size of each circle.

between investment and subsequent social skills.

In examining parental investment behavior (Table A16), the model matches the demographic patterns in investment well, but it does not reproduce the positive within-neighborhood association between investment and contemporaneous skills observed in the data. In the data, investment is increasing in both social and cognitive skills, whereas the model-implied investment regressions yield negative coefficients on these skill measures.

For adolescents' activity choices, the model captures the strong role of peer environments in both activities (Table A17). In particular, the effect of athletic peer culture on athletic participation is closely matched (0.595 in the data versus 0.639 in the model), and the model captures the strong effect of club peer culture on club participation, though it understates the magnitude (0.862 versus 0.723). The model also matches the negative effect of athletic peer culture on club participation (−0.093 versus −0.143); however, it does not reproduce the large negative effect of club peer culture on athletic participation. In the data, higher club participation among peers lowers athletic participation (−0.064), while the model implies a near-zero coefficient (−0.003). Still, the model generally captures the asymmetry in cross-activity spillovers.

In adulthood, the model matches the share with some college experience closely, while slightly understating the fraction with no-college experience and slightly overstating the fractions with college completion and education beyond college relative to the data (Table A18). For employment, the fit is strongest for college attainment, while the model overstates the estimated employment premium for some college and beyond-college attainment (Table A20). For earnings, the educational coefficients are closely matched across schooling categories.

5 Counterfactual Policy Experiments

With the model estimated and closely exhibiting the same trends in the Add Health data, we are ready to conduct counterfactual experiments indexed by a policy environment τ. We interpret τ as the policy regime in place and allow parental investment and adolescents' activity choices to depend on τ, writing $I_{i,t}(\tau)$, $a_{i,t}(\tau)$, and $e_{i,t}(\tau)$. Payoffs feature social interactions through neighborhood peer-share terms $\bar{a}_{j,t}$ and $\bar{e}_{j,t}$, which are functions of the underlying individual choices. Therefore, peer shares are equilibrium objects—rather than primitives—meaning that any policy-induced change in $\{a_{i,t}(\tau), e_{i,t}(\tau)\}$ changes the implied peer shares $\{\bar{a}_{j,t}(\tau), \bar{e}_{j,t}(\tau)\}$, which in turn affects individual best responses.

For each counterfactual τ, we use a fixed-point algorithm to compute the τ-consistent equilibrium neighborhood shares $\{\bar{a}_{j,0}(\tau)^*, \bar{e}_{j,0}(\tau)^*\}_{j\in\mathcal{J}}$. Starting from an initial guess for peer shares, the algorithm iterates between solving individuals' optimal choices given the current peer shares and updating peer shares by aggregating the resulting choices, until the distance between successive iterates falls below a tolerance.[22]

In general, peer-effects models may generate multiple equilibria, which can make counterfactual comparisons sensitive to equilibrium selection. Following the logic of Brock and Durlauf (2001), Appendix B establishes that, under our estimated parameters, the mapping from neighborhood-peer shares into themselves is a contraction. Consequently, for each τ, the model admits a unique fixed point and the iterative procedure converges globally, ensuring that counterfactual outcomes are uniquely defined.

5.1 Higher Baseline Tastes for Athletics

In our first counterfactual ($\tau = 1$), we consider a policy environment that increases adolescents' baseline taste for participating in athletics. A natural analogue is an intervention that makes athletics more

[22] To significantly reduce computation, we compute the fixed point only for the initial period and then impose the baseline law of motion for aggregate participation in subsequent periods. Concretely, let $g^a_{t,t+1} \equiv \bar{a}_{t+1}/\bar{a}_t$ denote the baseline proportional change in aggregate athletic participation between t and $t+1$ (and similarly for clubs). In each counterfactual, we set $\bar{a}_{t+1}(\tau) = g^a_{t,t+1}\,\bar{a}_t(\tau)$ and $\bar{e}_{t+1}(\tau) = g^e_{t,t+1}\,\bar{e}_t(\tau)$ for $t \geq 1$. This allows the level of participation to change based on counterfactual policies in place, but imposes that the decline in participation as a function of age is itself policy-invariant.

attractive on average (for example, by improving the quality of athletics programming or reducing non-pecuniary barriers to participation), holding fixed the structure of social interactions.

In the model, we implement this policy as an increase in the baseline taste for athletics, $\delta_{a,0}$, which enters the utility for all adolescents if they choose athletics. Formally, we establish $\delta_{a,0}(1) = |\delta_{a,0}|$, which transforms the minor distaste that White male adolescents have for athletics (when no peers participate in athletics) into a minor taste for athletics. We leave all other preference parameters in the adolescent's activity problem fixed. We then re-solve the model under $\tau = 1$, allowing parental investment and adolescents' activity choices to adjust to the policy-induced change in the direct utility of athletics.

5.2 Higher Baseline Tastes for Clubs

Our second counterfactual ($\tau = 2$) is analogous to $\tau = 1$, but targets clubs rather than athletics. We interpret this as a policy that increases the attractiveness of club participation, such as improving access to clubs, reducing non-pecuniary barriers to joining, or strengthening the culture of club involvement prior to the start of our model horizon. To make $\tau = 1$ and $\tau = 2$ comparable in magnitude, we impose the same additive shift in baseline utility across the two counterfactuals, but assign the shift to alternative activities. Specifically, we increase the baseline clubs taste parameter, $\delta_{e,0}$, by twice the absolute value of the baseline athletics taste parameter: $\delta_{e,0}(2) = \delta_{e,0} + 2 \times |\delta_{a,0}|$. As before, we leave all other preference parameters in the adolescent's activity problem fixed and re-solve the model under $\tau = 2$, allowing parental investment and adolescents' activity choices to adjust endogenously.

5.3 Parental Investment Subsidy

In our third counterfactual ($\tau = 3$), we study a parental investment subsidy that lowers the baseline cost of investing in adolescent children. This counterfactual captures policies that reduce out-of-pocket costs of investments in adolescent children, such as subsidies or vouchers for tutoring, academic enrichment, test preparation, or extracurricular fees. In the model, we implement the subsidy by decreasing the baseline investment cost component, $\psi_{I,0}$ (common across households), by 50%: $\psi_{I,0}(3) = 0.5 \times \psi_{I,0}$. All other parameters in the parental investment problem remain fixed, including observed heterogeneity in investment costs. Thus, the policy preserves demographic differences in parenting choices while uniformly lowering the cost of investment for all households.

5.4 Exogenous Increase in Baseline Social Skills

In our fourth counterfactual ($\tau = 4$), we consider a policy environment that exogenously increases adolescents' baseline social skills at the start of adolescence. This counterfactual is motivated by interventions that operate prior to the start of our model horizon, such as early-childhood social-emotional learning programs, mentoring and social-support initiatives in elementary school, or community-based programs that strengthen interpersonal skills and perceived-peer support. In contrast to the preceding counterfactuals, which shift incentives for investment or participation, this exercise directly shifts a core state variable at baseline.

In the model, baseline social skills enter through the neighborhood-specific initial condition distribution in Equation 3. We implement the policy as an additive shift to the log of baseline social skills for every adolescent in every neighborhood, $\ln \theta^S_{i,0}(4) = \ln \theta^S_{i,0} + 0.1$, so that baseline social skills increase by approximately 10% of a standard deviation. We leave baseline cognitive skills and baseline mental health unchanged.

We consider two versions of $\tau = 4$. In the first, we isolate the purely mechanical implications of higher baseline social skills by holding fixed the full profile of parental investment decisions and adolescent activity choices at their baseline equilibrium levels (and therefore holding fixed any equilibrium objects pinned down by those choices). In the second, we allow both parents and adolescents to endogenously respond to the higher baseline social skills by re-solving the model under $\tau = 4$, permitting investment, activity choices, and the associated equilibrium objects to adjust.

5.5 Neighborhood Reassignment to High-Club Peer Environments

In our fifth counterfactual ($\tau = 5$), we alter adolescents' peer environments by reassigning adolescent children from low-club neighborhoods to high-club neighborhoods at the start of adolescence. This exercise is best interpreted as a stylized "re-zoning" or "busing" thought experiment in which adolescents who would have attended low-club-participation schools are instead assigned to schools in the highest-club-participation neighborhoods, holding fixed individual endowments and the structural environment.

Let $\bar{e}^*_{j,1}$ denote the baseline equilibrium club participation share in neighborhood j in period 1. Define the set of "sending" neighborhoods as the bottom decile,

$$\mathcal{S}_{10} \equiv \left\{ j \in \mathcal{J} : \bar{e}^*_{j,1} \leq q_{0.10}\left(\{\bar{e}^*_{k,1}\}_{k \in \mathcal{J}} \right) \right\},$$

and the set of "receiving" neighborhoods as the top decile,

$$\mathcal{R}_{10} \equiv \left\{ j \in \mathcal{J} : \bar{e}^*_{j,1} \geq q_{0.90}\left(\{\bar{e}^*_{k,1}\}_{k \in \mathcal{J}}\right) \right\}.$$

Let $j(i)$ denote individual i's baseline neighborhood at the start of adolescence. We implement the policy by reassigning every adolescent child with $j(i) \in \mathcal{S}_{10}$ to a new neighborhood $\tilde{j}(i) \in \mathcal{R}_{10}$ drawn at random, with probabilities proportional to baseline neighborhood size, i.e., $\Pr(\tilde{j}(i) = r) \propto N_r$ for $r \in \mathcal{R}_{10}$. We leave all individual baseline endowments and structural parameters unchanged.

The reassignment counterfactual is intentionally stylized. It is designed to isolate the causal role of exposure to a different peer environment by changing peer-participation shares for a targeted group while holding fixed other neighborhood-level features. We do not interpret this experiment as a literal policy forecast, because a full-scale reassignment would likely trigger additional margins not modeled here, including endogenous residential sorting, institutional responses (e.g., changes in activity supply), and congestion/capacity constraints in clubs and teams. Instead, the reassignment exercise should be read as a partial equilibrium "exposure" experiment in the sense that it quantifies the magnitude of peer-environment effects, holding constant the broader equilibrium that would operate through residential sorting.

5.6 Eliminating Peer Effects

In our final counterfactual ($\tau = 6$), we shut off peer effects in adolescents' activity decisions in order to isolate the role of social interactions in shaping participation and downstream outcomes. This counterfactual can be interpreted as a limiting benchmark in which adolescents no longer respond to neighborhood participation patterns.

In the model, peer effects enter the adolescent's activity problem through the neighborhood peer share terms $\bar{a}_{j,t}$ and $\bar{e}_{j,t}$. We implement $\tau = 6$ by setting all coefficients multiplying these peer share terms equal to zero. Concretely, we set the peer-effect parameters to zero for both athletics and clubs,

$$\lambda_a(6) = 0; \quad \lambda_e(6) = 0; \quad \lambda_{a,e}(6) = 0; \quad \lambda_{e,a}(6) = 0,$$

so that utility from activity participation no longer depends on $\bar{a}_{j,t}$ or $\bar{e}_{j,t}$ at any t. We leave all other preference parameters and the parental investment problem unchanged.

Unlike the preceding counterfactuals, $\tau = 6$ does not require solving for an equilibrium fixed point in peer shares: once peer effects are eliminated, individual best responses are independent of the peer-share objects, and any initial peer-share profile is consistent with the resulting choices. We interpret the difference between the baseline outcomes and the $\tau = 6$ outcomes as the component of model-implied policy effects that is attributable to endogenous social interactions.

5.7 Results

Table 8 reports the effects of each counterfactual policy relative to the baseline equilibrium. Panel A summarizes short-run changes in endogenous inputs, Panel B reports impacts on adolescent terminal skills, and Panels C and D report long-run outcomes in educational attainment and the labor market. Across policies, we find substantial heterogeneity in effectiveness, with meaningful downstream consequences driven by peer interactions during adolescence.

Increasing the baseline taste for athletics ($\tau = 1$) raises athletic participation by 10.64 percentage points and reduces extracurricular club participation by 2.40 percentage points. Because these activities substitute with parental investment in the model, mean-parental investment falls slightly (by 0.41%). Together, these responses increase adolescent terminal social skills by 0.04 standard deviations on average, with smaller gains in cognitive skills and mental health (0.01 standard deviations each). In adulthood, these skill gains translate into higher educational attainment: the share completing college rises by 1.00% and the share completing post-baccalaureate degrees rises by 1.16%, alongside a 0.20% increase in income.

A policy that similarly increases tastes for extracurricular clubs ($\tau = 2$) generates even larger gains. Club participation rises by 15.09 percentage points, while athletic participation falls by 6.08 percentage points, with little change in parental investment (a 0.10% decline). Relative to increases in athletic participation, the expansion of clubs primarily raises adolescent terminal cognitive skills (0.03 standard deviations), alongside smaller improvements in social skills (0.01) and mental health (0.02). Because cognitive skills more strongly reduce the effective costs of progressing through each educational level, these improvements translate into larger attainment gains than under $\tau = 1$. In particular, the share completing college rises by 1.27% and the share going beyond college rises by 2.70%, accompanied by a 0.34% increase in adult income.

We find large improvements from a policy that directly increases parental investment, consistent with Fiorini and Keane (2014). In column (3), a parental investment subsidy that reduces the baseline fixed cost of investment by 50% ($\tau = 3$) increases the mean investment by 15.19% during adolescence. This increase in investment substantially improves adolescent terminal skill stocks, with gains of 0.06 standard deviations in social skills, 0.10 in cognitive skills, and 0.07 in mental health. These skill improvements translate into broad increases in educational attainment, including a 7.21% decline in the share with no college, a 5.15% increase in the share completing college, and an 8.89% increase in the share completing

Table 8: Results of Counterfactual Policy Experiments

	Athletics Subsidy (1)	Clubs Subsidy (2)	Investment Subsidy (3)	Increased Social Skill Endowment [No Endogeneity] (4)	Increased Social Skill Endowment [With Endogeneity] (5)	Move from Bottom Decile to Top Decile† (6)	Shut Down Peer Effects (7)
Panel A: Endogenous Inputs							
Δ Athletics (p.p.)	+10.64	−6.08	+0.39	—	+0.63	−0.12	−14.56
Δ Clubs (p.p.)	−2.40	+15.09	−0.38	—	−0.63	−2.00	−9.34
%Δ Investment	−0.41	−0.10	+15.19	—	−0.53	+0.14	−0.53
Panel B: Terminal Skills							
Δ Social Skills (σ)	+0.04	+0.01	+0.06	+0.01	+0.01	−0.00	−0.08
Δ Cognitive Skills (σ)	+0.01	+0.03	+0.10	+0.00	+0.00	−0.01	−0.05
Δ Mental Health (σ)	+0.01	+0.02	+0.07	+0.01	+0.00	−0.00	−0.04
Panel C: Educational Attainment							
%Δ No College	−2.34	−1.42	−7.21	−0.61	−0.58	+0.51	+0.92
%Δ Some College	−0.19	−1.02	−3.13	−0.14	+0.06	+0.00	−0.08
%Δ College	+1.00	+1.27	+5.15	+0.38	+0.15	+0.54	−2.59
%Δ Beyond College	+1.16	+2.70	+8.89	+0.42	+0.07	−1.28	−7.97
Panel D: Labor Market Outcomes							
%Δ Employment	+0.03	+0.01	+0.15	+0.02	+0.01	−0.02	−0.17
%Δ Income	+0.20	+0.34	+1.22	+0.07	+0.02	−0.01	−0.65

Notes: This table reports model-implied changes in outcomes under counterfactual=policy environments relative to the baseline equilibrium. Columns correspond to: (1) higher baseline taste for athletics, implemented by setting the baseline athletics taste parameter to $\delta_{a,0}(1) = |\delta_{a,0}|$ (all other adolescent preference parameters unchanged); (2) higher baseline taste for clubs, implemented by shifting the baseline clubs taste parameter by the same additive utility change as in (1), i.e., $\delta_{e,0}(2) = \delta_{e,0} + 2|\delta_{a,0}|$; (3) a parental investment subsidy that lowers the baseline investment cost component by 50%, $\psi_{I,0}(3) = 0.5\,\psi_{I,0}$, holding fixed all other parameters (including observed heterogeneity in investment costs); (4) an exogenous increase in baseline social skills at the start of adolescence, implemented as $\ln\theta^S_{i,0}(4) = \ln\theta^S_{i,0} + 0.1$, with parental investment, adolescent activity choices, and equilibrium objects held fixed at baseline levels (no endogenous response); (5) the same baseline social skill increase as in (4), but with parental investment, adolescent activity choices, and equilibrium peer shares re-solved (endogenous response); (6) reassignment at $t = 1$ of adolescents from bottom-decile baseline club-participation neighborhoods to top-decile neighborhoods, with destination neighborhoods drawn with probabilities proportional to baseline neighborhood size, and a fixed point computed only for peer shares in receiving neighborhoods; and (7) elimination of peer effects in adolescent activity utility by setting all coefficients on neighborhood peer-share terms to zero, so that activity choices no longer depend on $\bar{a}_{j,t}$ or $\bar{e}_{j,t}$. Panel A reports changes in initial participation rates in athletics and clubs (percentage points) and percent changes in mean parental investment. Panel B reports changes in adolescent terminal skill levels in standard deviation units. Panels C and D report percent changes in educational attainment shares and adult labor-market outcomes (employment and income). †Results are reported only for the subset of movers and receivers.

post-baccalaureate degrees. Consistent with these gains, labor-market outcomes improve by more than under any other policy considered: employment increases by 0.15% and income increases by 1.22%.

We next consider policies that operate through initial conditions and social interactions. Columns (4) and (5) report the effects of an exogenous increase in baseline social skills at the start of adolescence ($\tau = 4$). In column (4), we hold fixed parental investment, adolescent activity choices, and equilibrium objects at their baseline levels to isolate the purely mechanical effect of higher initial social skills. Under this "no-endogeneity" exercise, adolescent terminal social skills increase by 0.01 standard deviations (with a similarly sized increase in mental health). These improvements generate modest long-run gains, with the share completing college rising by 0.38% and the share completing post-baccalaureate degrees rising by 0.42%, along with a 0.07% increase in income.

In column (5), we instead allow parents and adolescents to respond endogenously to this baseline increase in social skills by re-solving the model. The qualitative effects are similar but smaller. In response to higher initial social skills, adolescents slightly increase athletic participation (0.63 percentage points) and reduce club participation (0.63 percentage points), while mean parental investment declines by 0.53%. These behavioral adjustments partially offset the direct gains from the endowment shift, so adolescent terminal skills increase only slightly (0.01 standard deviations in social skills and approximately zero in cognitive skills and mental health). As a result, long-run changes in attainment and labor-market outcomes are attenuated relative to column (4)—college completion rises by 0.15%, post-baccalaureate completion rises by 0.07%, and income increases by only 0.02%.

In column (6), we examine a neighborhood reassignment thought experiment ($\tau = 5$) that moves adolescents from bottom-decile club-participation neighborhoods to top-decile neighborhoods at the start of adolescence, holding fixed individual endowments and structural parameters. Because this counterfactual is partial equilibrium and only peer-share objects in *receiving* neighborhoods are updated, we report effects only for the receiving neighborhoods. We find that exposure to low-participation peers dominates the positive gains that may occur from newfound exposure to high-participation peers. On average, athletic participation declines slightly (0.12 percentage points) and club participation falls by 2 percentage points, with essentially no change in parental investment (a 0.14% increase). Consistent with these modest input changes, adolescent terminal skills and long-run outcomes are essentially unchanged. In particular, adolescent terminal cognitive skills fall by 0.01 standard deviations (with near-zero changes in social skills and mental health) and educational attainment declines slightly—college completion rises by 0.54% while post-baccalaureate completion falls by 1.28%. Lastly, income is essentially flat (a 0.01% decline) for movers and receivers.

Finally, column (7) shuts down peer effects in the adolescent activity problem ($\tau = 6$) by setting all coefficients on neighborhood peer-share terms in activity utility to zero. This counterfactual therefore removes both (i) the *direct* contribution of peer-dependent utility to participation incentives in the baseline equilibrium and (ii) the *equilibrium feedback* channel through which changes in individual choices shift neighborhood peer shares and, in turn, others' incentives to participate. We find that peer-dependent utility is a major contributor to adolescents' activity choices and long-run outcomes. Eliminating peer effects substantially reduces participation in both activities, with athletic participation falling by 14.56 percentage points and club participation falling by 9.34 percentage points, alongside a 0.53% decline in parental investment. These changes translate into sizable skill losses by the end of adolescence (0.08 standard deviations in social skills, 0.05 in cognitive skills, and 0.04 in mental health) and declines in long-run attainment and earnings: college completion falls by 2.59% and post-baccalaureate completion falls by 7.97%, with income declining by 0.65%. Taken together, these results quantify the overall importance of peer-dependent utility for participation in athletics and clubs and downstream human-capital accumulation. They should be interpreted as a "peer-channel" contribution rather than a pure social-multiplier estimate, since shutting down peer terms changes the level of participation incentives as well as the strength of equilibrium feedback.

6 Conclusion

This paper develops and estimates a dynamic model of adolescent skill formation in which peer environments are equilibrium outcomes of individual behaviors. Parents invest in adolescent children, adolescents choose whether to participate in athletics and extracurricular clubs, and these choices jointly determine local participation rates that shape the evolution of social skills, cognitive skills, and mental health. By treating peer environments as endogenous, the framework delivers policy counterfactuals evaluated at policy-consistent fixed points, rather than holding peer effects fixed by assumption.

Our estimates reveal several substantive findings. Parents treat social skills as a productive component of their adolescent children's human capital, investing more in adolescents with higher social endowments in a manner comparable to their response to cognitive skills. Peer environments exert strong influence over adolescents' activity choices, with same-activity peer participation raising the attractiveness of a given activity and cross-activity spillovers generating meaningful substitution between athletics and clubs. These mechanisms imply that changes in adolescent social environments generate persistent effects on adult educational attainment and income, that subsidizing parental investment produces large long-run gains, and that policies targeting adolescents' club activity participation may yield larger gains than those targeting adolescents' athletic participation. Our decomposition further reveals that the erosion of social interactions would meaningfully reduce extracurricular engagement, compress adolescent terminal skill stocks, and lower educational attainment and adult income.

Several limitations point to promising directions for future work. Our model takes neighborhood assignment as given and abstracts from residential sorting, so counterfactuals should be interpreted as within-neighborhood equilibrium responses rather than predictions of the broader general equilibrium operating through housing markets and institutional adjustments. We also model a single cohort and do not capture how participation in social activities evolves across cohorts, which may be central to understanding secular trends in youth social engagement. Future work could incorporate digital media and online interaction, which have reshaped the opportunity cost of face-to-face participation and likely interact with the social pressure mechanisms at the center of our framework.

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Online Appendix

A Additional Tables

Table A1: Measures of Social Skills—Summary Statistics

	Analysis Sample (1)	No Sports, No Clubs (2)	No Sports, Clubs (3)	Sports, No Clubs (4)	Sports, Clubs (5)
Feel close to people at school	3.729 (0.978)	3.612 (1.019)	3.718 (0.975)	3.821 (0.928)	3.910 (0.911)
How much friends care about you	4.253 (0.775)	4.223 (0.795)	4.317 (0.745)	4.243 (0.774)	4.318 (0.734)
Feel socially accepted	4.109 (0.731)	4.023 (0.739)	4.033 (0.769)	4.212 (0.695)	4.219 (0.705)
Number of Friends	2.998 (2.548)	3.157 (2.626)	2.323 (1.891)	3.307 (2.781)	2.307 (1.866)
Observations	17,114	7,183 (42%)	2,369 (14%)	5,680 (33%)	1,882 (11%)

NOTES: This table reports summary statistics for the measures used to construct our latent measure of social skills, for selected Add Health subsamples. The analysis sample (Column (1)) includes respondents who completed the Wave I in-home interview, have non-missing baseline measures of skills and parental investment, and reside in a neighborhood containing at least ten Wave I seventh graders. Columns (2)–(5) split the analysis sample by whether the respondent participates in sports and/or extracurricular clubs. All characteristics are measured in Wave I.

Table A2: Empirical Results for Parental Investment by Demographic Group

	Female (1)	Male (2)	White (3)	Black (4)	Non-White, Non-Black (5)
Social Skills	0.081	0.113	0.111	0.074	0.072
	(0.011)	(0.010)	(0.009)	(0.013)	(0.015)
Cognitive Skills	0.101	0.101	0.118	0.072	0.075
	(0.013)	(0.014)	(0.012)	(0.021)	(0.020)
Mental Health	0.014	−0.054	−0.018	−0.044	0.049
	(0.022)	(0.016)	(0.016)	(0.022)	(0.038)
Observations	8,751	8,357	10,517	3,897	2,694
Demographic Controls	✓	✓	✓	✓	✓
Age Controls	✓	✓	✓	✓	✓
Maternal Controls	✓	✓	✓	✓	✓
Neighborhood FE	✓	✓	✓	✓	✓

NOTES: This table reports OLS estimates from regressions of baseline parental investment on baseline child skills for the indicated subsamples of the analytic sample. The dependent variable is the Wave I latent parental investment measure. The key regressors are Wave I latent factors for social skills, cognitive skills, and mental health. "Demographic Controls" include race and gender indicators and are omitted when the subsample is split on that dimension. "Age Controls" include age and age squared. "Maternal Controls" include indicators for whether the adolescent's mother is college-educated and married. "Neighborhood FE" include neighborhood indicators. Standard errors clustered at the neighborhood level are reported in parentheses.

Table A3: Parental Investment using Alternative Social-Skill Definition

	(1)	(2)	(3)	(4)	(5)
Social Skills	0.100	0.094	0.093	0.093	0.094
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Cognitive Skills	0.132	0.109	0.109	0.101	0.101
	(0.008)	(0.008)	(0.008)	(0.009)	(0.010)
Mental Health	−0.036	−0.010	−0.013	−0.015	−0.013
	(0.010)	(0.011)	(0.011)	(0.011)	(0.017)
Outcome Mean	0.021	0.021	0.021	0.021	0.021
Std. Dev.	1.285	1.285	1.285	1.285	1.285
R^2	0.032	0.050	0.051	0.060	0.075
Observations	17,108	17,108	17,108	17,108	17,108
Demographic Controls	✗	✓	✓	✓	✓
Age Controls	✗	✗	✓	✓	✓
Maternal Controls	✗	✗	✗	✓	✓
Neighborhood FE	✗	✗	✗	✗	✓

NOTES: This table reports OLS estimates from regressions of baseline parental investment on baseline child skills. The dependent variable is a latent parental investment measure. The key regressors are social skills (which are constructed without using self-reported number of friends in the latent factor model), cognitive skills, and mental health, all measured in Wave I of Add Health. Columns progressively add controls. 'Maternal Controls" include indicators for whether the adolescent's mother is college-educated and married. "Neighborhood FE" include indicators for the adolescent's neighborhood. Standard errors clustered at the neighborhood level are reported in parentheses.

Table A4: Empirical Results for Within-Family Parental Investment

	(1)	(2)	(3)
Social Skills	0.080	0.076	0.079
	(0.023)	(0.023)	(0.023)
Cognitive Skills	0.125	0.108	0.109
	(0.034)	(0.023)	(0.034)
Mental Health	−0.017	−0.002	0.002
	(0.038)	(0.038)	(0.038)
Female		0.198	0.198
		(0.075)	(0.075)
Age			0.284
			(0.310)
Age^2			−0.007
			(0.010)
Outcome Mean	0.023	0.023	0.023
Std. Dev.	1.251	1.251	1.251
R^2	0.027	0.033	0.042
Observations	2,563	2,563	2,563

Notes: This table reports OLS estimates from within-family fixed effects regressions of baseline parental investment on baseline child skills. We focus on full sibling pairs, which eliminates the role of child race and maternal demographics. The dependent variable is a latent parental investment measure. The key regressors are social skills, cognitive skills, and mental health, all measured in Wave I of Add Health. Columns progressively add controls. Standard errors clustered at the family level are reported in parentheses.

Table A5: Empirical Results for Adolescents' Athletics Choices by Demographic Group

	Female (1)	Male (2)	White (3)	Black (4)	Non-White, Non-Black (5)
Peer Share – Athletics	0.619	0.561	0.664	0.423	0.337
	(0.082)	(0.089)	(0.070)	(0.148)	(0.192)
Peer Share – Clubs	−0.031	−0.094	−0.041	−0.039	−0.073
	(0.052)	(0.057)	(0.048)	(0.078)	(0.116)
Social Skills	0.029	0.026	0.032	0.017	0.030
	(0.003)	(0.004)	(0.003)	(0.005)	(0.006)
Cognitive Skills	0.026	0.021	0.031	0.002	0.018
	(0.004)	(0.005)	(0.004)	(0.007)	(0.008)
Mental Health	−0.004	0.021	0.005	0.004	0.005
	(0.005)	(0.006)	(0.005)	(0.007)	(0.009)
Parental Investment	0.026	0.041	0.031	0.036	0.029
	(0.004)	(0.004)	(0.004)	(0.006)	(0.008)
Height	0.008	0.006	0.009	0.007	0.005
	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)
Observations	8,663	8,295	10,451	3,846	2,661

NOTES: This table reports OLS estimates from regressions of an indicator for Wave I athletics participation on leave-one-out neighborhood peer participation shares (athletics and extracurricular clubs) and baseline covariates for the stated demographic group. Each specification controls for baseline skills (Wave I latent factors), baseline parental investment (Wave I latent factor), height, age and age squared, and neighborhood fixed effects. Race and gender indicators are included when they are not used to define the subsample. Standard errors clustered at the neighborhood level are reported in parentheses.

Table A6: Empirical Results for Adolescents' Clubs Choices by Demographic Group

	Female (1)	Male (2)	White (3)	Black (4)	Non-White, Non-Black (5)
Peer Share – Athletics	−0.064	−0.128	−0.110	−0.140	0.127
	(0.076)	(0.072)	(0.061)	(0.142)	(0.161)
Peer Share – Clubs	1.072	0.634	0.905	0.785	0.739
	(0.046)	(0.043)	(0.039)	(0.069)	(0.098)
Social Skills	−0.000	0.000	−0.001	0.007	−0.011
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)
Cognitive Skills	0.054	0.052	0.055	0.050	0.048
	(0.004)	(0.004)	(0.003)	(0.007)	(0.007)
Mental Health	0.003	0.002	0.008	−0.008	0.001
	(0.005)	(0.005)	(0.004)	(0.007)	(0.008)
Parental Investment	0.018	0.017	0.017	0.022	0.013
	(0.004)	(0.004)	(0.003)	(0.005)	(0.007)
Height	0.003	0.000	0.002	−0.002	0.002
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Observations	8,663	8,295	10,451	3,846	2,661

Notes: This table reports OLS estimates from regressions of an indicator for Wave I extracurricular club participation on leave-one-out neighborhood peer participation shares (athletics and extracurricular clubs) and baseline covariates for the stated demographic group. Each specification controls for baseline skills (Wave I latent factors), baseline parental investment (Wave I latent factor), height, age and age squared, and neighborhood fixed effects. Race and gender indicators are included when they are not used to define the subsample. Standard errors clustered at the neighborhood level are reported in parentheses.

Table A7: Additional Coefficients for the Evolution of Skills Across Adolescence

	Future Social Skills		Future Cognitive Skills		Future Mental Health	
	(1)	(2)	(3)	(4)	(5)	(6)
Social Skills	0.459	0.460	0.006	0.006	0.044	0.044
	(0.011)	(0.011)	(0.008)	(0.009)	(0.006)	(0.006)
Cognitive Skills	0.043	0.043	0.568	0.519	0.051	0.053
	(0.016)	(0.016)	(0.019)	(0.017)	(0.010)	(0.013)
Mental Health	0.159	0.160	0.046	0.052	0.524	0.527
	(0.015)	(0.015)	(0.012)	(0.012)	(0.014)	(0.013)
Athletics	0.151	0.150	0.033	0.033	−0.004	−0.004
	(0.030)	(0.029)	(0.022)	(0.021)	(0.022)	(0.022)
Extracurricular Clubs	0.097	0.096	0.094	0.093	0.024	0.022
	(0.037)	(0.037)	(0.027)	(0.027)	(0.028)	(0.028)
Parental Investment	0.035	0.033	0.032	0.033	0.026	0.025
	(0.013)	(0.013)	(0.009)	(0.009)	(0.007)	(0.008)
Athletics × Clubs		0.068		−0.015		0.007
		(0.052)		(0.031)		(0.040)
Social × Cognitive		0.035		−0.001		0.007
		(0.011)		(0.008)		(0.006)
Social × Mental		0.004		0.009		−0.003
		(0.010)		(0.006)		(0.006)
Cognitive × Mental		−0.003		0.036		0.019
		(0.016)		(0.011)		(0.007)
Investment × Social		0.003		−0.004		0.000
		(0.008)		(0.005)		(0.005)
Investment × Cognitive		0.009		−0.008		0.005
		(0.009)		(0.006)		(0.008)
Investment × Mental		−0.031		0.010		−0.017
		(0.013)		(0.008)		(0.009)
Observations	11,396	11,396	11,160	11,160	12,352	12,352
Input Complementarity	✗	✓	✗	✓	✗	✓

Notes: This table reports OLS estimates from regressions of the next-period stock of skill $\theta^k_{i,t+1}$, for $k \in \{S, C, H\}$, on current skill stocks and contemporaneous inputs. "Current" skills and inputs are measured in Wave I of Add Health, and "future" skills are measured in Wave II. Columns labeled "Input Complementarity" additionally include the interaction terms shown (among skills and between each skill and each input). All specifications control for race, gender, age and age squared, and neighborhood fixed effects. Standard errors clustered at the neighborhood level are reported in parentheses.

Table A8: Evolution of Skills Across Adolescence with School Size Interactions

	Future Social Skills		Future Cognitive Skills		Future Mental Health	
	(1)	(2)	(3)	(4)	(5)	(6)
Social Skills	0.459	0.460	0.006	0.006	0.044	0.044
	(0.011)	(0.011)	(0.008)	(0.009)	(0.006)	(0.006)
Cognitive Skills	0.043	0.041	0.568	0.569	0.051	0.052
	(0.016)	(0.015)	(0.019)	(0.019)	(0.010)	(0.010)
Mental Health	0.159	0.154	0.046	0.044	0.524	0.524
	(0.015)	(0.015)	(0.012)	(0.012)	(0.014)	(0.014)
Athletics	0.151	0.112	0.033	0.037	−0.004	−0.022
	(0.030)	(0.033)	(0.022)	(0.026)	(0.022)	(0.024)
Clubs	0.097	0.101	0.094	0.101	0.024	−0.004
	(0.037)	(0.048)	(0.027)	(0.036)	(0.028)	(0.035)
Parental Investment	0.035	0.033	0.032	0.033	0.026	0.025
	(0.013)	(0.013)	(0.009)	(0.009)	(0.007)	(0.008)
Small School		0.068		0.243		0.178
		(0.052)		(0.033)		(0.027)
Athletics × Small School		0.107		−0.032		0.043
		(0.073)		(0.045)		(0.053)
Clubs × Small School		−0.015		−0.027		0.081
		(0.078)		(0.054)		(0.055)
Observations	11,396	11,205	11,160	10,976	12,352	12,131

NOTES: This table reports OLS estimates from regressions of the next-period stock of skill $\theta^k_{i,t+1}$, for $k \in \{S, C, H\}$, on current skill stocks and contemporaneous inputs. "Current" skills and inputs are measured in Wave I of Add Health, and "future" skills are measured in Wave II. "Small School" is an indicator for whether the adolescent attends a school with 775 or fewer total students. All specifications control for junior high indicators and their interactions, race, gender, age and age squared, and neighborhood fixed effects. Standard errors clustered at the neighborhood level are reported in parentheses.

Table A9: Reduced-Form Evolution of Social Skills by Demographic Group

	Female (1)	Male (2)	White (3)	Black (4)	Non-White, Non-Black (5)
Social Skills	0.433	0.436	0.456	0.385	0.421
	(0.013)	(0.013)	(0.011)	(0.020)	(0.029)
Cognitive Skills	0.079	0.025	0.048	0.063	0.079
	(0.016)	(0.019)	(0.016)	(0.031)	(0.025)
Mental Health	0.145	0.215	0.180	0.163	0.151
	(0.018)	(0.023)	(0.020)	(0.033)	(0.032)
Parental Investment	0.029	0.032	0.031	0.001	0.064
	(0.013)	(0.016)	(0.012)	(0.025)	(0.029)
Athletics	0.117	0.129	0.098	0.196	0.105
	(0.040)	(0.041)	(0.033)	(0.067)	(0.082)
Extracurricular Clubs	0.057	0.159	0.055	0.114	0.213
	(0.048)	(0.063)	(0.042)	(0.095)	(0.093)
Observations	5,965	5,431	7,170	2,498	1,728

Notes: This table reports OLS estimates from regressions of Wave II social skills on Wave I skill stocks (social skills, cognitive skills, and mental health), Wave I parental investment, and Wave I activity participation (athletics and extracurricular clubs) for the stated demographic group. Each specification controls for age and age squared and neighborhood fixed effects. Race and gender indicators are included when they are not used to define the subsample. Standard errors clustered at the neighborhood level are reported in parentheses.

Table A10: Reduced-Form Evolution of Cognitive Skills by Demographic Group

	Female (1)	Male (2)	White (3)	Black (4)	Non-White, Non-Black (5)
Social Skills	0.002	0.002	−0.001	0.008	0.011
	(0.009)	(0.009)	(0.008)	(0.014)	(0.015)
Cognitive Skills	0.599	0.591	0.613	0.530	0.594
	(0.020)	(0.015)	(0.014)	(0.026)	(0.032)
Mental Health	0.066	0.053	0.066	0.083	0.007
	(0.015)	(0.020)	(0.014)	(0.021)	(0.022)
Parental Investment	0.034	0.013	0.037	0.000	0.027
	(0.009)	(0.010)	(0.008)	(0.013)	(0.024)
Athletics	0.070	0.044	0.044	0.067	0.004
	(0.032)	(0.031)	(0.028)	(0.052)	(0.064)
Extracurricular Clubs	0.072	0.059	0.055	0.109	0.194
	(0.033)	(0.046)	(0.030)	(0.045)	(0.070)
Observations	5,830	5,330	7,010	2,464	1,686

NOTES: This table reports OLS estimates from regressions of Wave II cognitive skills on Wave I skill stocks (social skills, cognitive skills, and mental health), Wave I parental investment, and Wave I activity participation (athletics and extracurricular clubs) for the stated demographic group. Each specification controls for age and age squared and neighborhood fixed effects. Race and gender indicators are included when they are not used to define the subsample. Standard errors clustered at the neighborhood level are reported in parentheses.

Table A11: Reduced-Form Evolution of Mental Health by Demographic Group

	Female (1)	Male (2)	White (3)	Black (4)	Non-White, Non-Black (5)
Social Skills	0.037	0.035	0.035	0.031	0.053
	(0.008)	(0.007)	(0.006)	(0.011)	(0.012)
Cognitive Skills	0.068	0.042	0.067	0.038	0.037
	(0.014)	(0.009)	(0.010)	(0.022)	(0.017)
Mental Health	0.531	0.523	0.531	0.503	0.548
	(0.016)	(0.015)	(0.014)	(0.024)	(0.031)
Parental Investment	0.024	0.007	0.018	0.005	0.033
	(0.009)	(0.008)	(0.007)	(0.013)	(0.015)
Athletics	−0.014	0.009	−0.016	0.055	−0.020
	(0.027)	(0.024)	(0.025)	(0.047)	(0.033)
Extracurricular Clubs	0.032	−0.003	0.006	0.058	−0.036
	(0.032)	(0.039)	(0.028)	(0.056)	(0.100)
Observations	6,406	5,946	7,749	2,711	1,892

NOTES: This table reports OLS estimates from regressions of Wave II mental health on Wave I skill stocks (social skills, cognitive skills, and mental health), Wave I parental investment, and Wave I activity participation (athletics and extracurricular clubs) for the stated demographic group. Each specification controls for age and age squared and neighborhood fixed effects. Race and gender indicators are included when they are not used to define the subsample. Standard errors clustered at the neighborhood level are reported in parentheses.

Table A12: The Impact of Terminal Adolescent Skills on Additional Long-Run Outcomes

	High School Graduation (1)	Athletics in Adulthood (2)	Ever Married (3)	Bottom Quartile Prestige Occupation (4)	Top Decile Prestige Occupation (5)
Social Skills	0.002	0.014	0.006	−0.008	−0.000
	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)
Cognitive Skills	0.041	0.007	0.007	−0.060	0.058
	(0.003)	(0.003)	(0.005)	(0.004)	(0.004)
Mental Health	0.014	−0.009	0.013	−0.007	0.010
	(0.004)	(0.004)	(0.006)	(0.007)	(0.005)
Junior High	−0.106	0.006	−0.001	0.069	−0.022
	(0.014)	(0.014)	(0.020)	(0.025)	(0.015)
Junior High × Social Skills	0.008	0.001	0.004	0.000	0.002
	(0.006)	(0.006)	(0.009)	(0.011)	(0.007)
Junior High × Cognitive Skills	0.026	−0.003	−0.030	−0.009	−0.022
	(0.008)	(0.007)	(0.011)	(0.013)	(0.008)
Junior High × Mental Health	0.028	0.009	0.002	−0.010	0.011
	(0.011)	(0.010)	(0.015)	(0.019)	(0.010)
Female	0.001	−0.197	0.093	−0.076	0.016
	(0.006)	(0.007)	(0.010)	(0.012)	(0.009)
Black	0.004	0.066	−0.229	0.036	−0.006
	(0.007)	(0.009)	(0.012)	(0.015)	(0.010)
Non-White, Non-Black	−0.017	0.043	−0.078	−0.025	−0.011
	(0.008)	(0.010)	(0.015)	(0.016)	(0.012)
Age	−0.177	−0.020	0.124	−0.013	0.017
	(0.042)	(0.052)	(0.071)	(0.084)	(0.056)
Age^2	0.006	0.000	−0.002	0.000	−0.000
	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)
Outcome Mean	0.923	0.125	0.481	0.257	0.119
Std. Dev.	0.266	0.330	0.500	0.437	0.324
R^2	0.076	0.094	0.074	0.062	0.053
Observations	8,866	8,633	9,066	5,649	5,649

NOTES: This table presents regression results with additional adult outcomes as the dependent variable and terminal adolescent skill levels as the independent variables of interest. "Junior High" is an indicator for whether the adolescent was in grade 8 in Wave II. "High School Graduation" is an indicator for whether the respondent has graduated high school in Wave III. "Athletics in Adulthood" is measured in Wave III. The final three outcomes are measured in Wave IV. "Bottom Quartile Prestige Occupation" is an indicator for whether an individual's occupation is in the bottom 25% of occupations as ranked by their NORC prestige score. "Top Decile Prestige Occupation" is a similar indicator for whether the individual's occupation is in the top 10%, based on their NORC prestige score.

Table A13: Model Fit — Social Skills Technology

	Data (1)	Model (2)	Data (3)	Model (4)
Social Skills	0.435	0.492	0.433	0.505
Cognitive Skills	0.054	0.104	0.052	0.090
Mental Health	0.174	0.223	0.175	0.175
Investment	0.030	0.034	0.024	−0.034
Athletics	0.125	0.188	0.123	0.102
Extracurricular Clubs	0.086	0.059	0.090	0.032
Junior High	−0.002	−0.016	−0.007	−0.018
Social × Cognitive			0.027	0.007
Social × Mental			0.005	0.056
Cognitive × Mental			0.000	0.005
Investment × Cognitive			0.004	0.004
Investment × Mental			−0.019	0.018
Investment × Social			0.005	−0.040
Investment × Athletics			0.021	0.126
Investment × Clubs			−0.017	0.040

Notes: This table compares OLS regression coefficients related to the technology of skill formation for social skills in Add Health (columns labeled "Data") to those simulated using the estimated model parameters. Columns (1) and (2) compare the simplest technology of skill formation that omits input complementarity, whereas Columns (3) and (4) allow for flexible input complementarity.

Table A14: Model Fit — Cognitive Skills Technology

	Data (1)	Model (2)	Data (3)	Model (4)
Social Skills	0.003	0.018	0.002	0.017
Cognitive Skills	0.595	0.624	0.592	0.704
Mental Health	0.060	0.153	0.066	0.074
Investment	0.022	0.057	0.026	0.094
Athletics	0.044	0.042	0.043	0.021
Extracurricular Clubs	0.084	0.082	0.083	0.045
Junior High	−0.192	−0.025	−0.194	−0.024
Social × Cognitive			0.001	0.001
Social × Mental			0.011	−0.001
Cognitive × Mental			0.042	0.067
Investment × Cognitive			0.001	−0.132
Investment × Mental			0.003	0.038
Investment × Social			−0.004	0.004
Investment × Athletics			−0.003	0.030
Investment × Clubs			−0.006	0.055

NOTES: This table compares OLS regression coefficients related to the technology of skill formation for cognitive skills in Add Health (columns labeled "Data") to those simulated using the estimated model parameters. Columns (1) and (2) compare the simplest technology of skill formation that omits input complementarity, whereas Columns (3) and (4) allow for flexible input complementarity.

Table A15: Model Fit — Mental Health Technology

	Data (1)	Model (2)	Data (3)	Model (4)
Social Skills	0.036	0.074	0.036	0.061
Cognitive Skills	0.055	0.195	0.054	0.165
Mental Health	0.530	0.560	0.532	0.571
Investment	0.016	0.023	0.021	0.137
Athletics	−0.003	0.007	−0.003	0.002
Extracurricular Clubs	0.014	0.023	0.012	0.006
Junior High	−0.078	−0.012	−0.079	−0.015
Social × Cognitive			0.003	−0.002
Social × Mental			0.001	0.028
Cognitive × Mental			0.013	0.052
Investment × Cognitive			0.001	0.002
Investment × Mental			−0.013	−0.059
Investment × Social			−0.003	0.000
Investment × Athletics			−0.012	0.006
Investment × Clubs			0.008	0.025

NOTES: This table compares OLS regression coefficients related to the technology of skill formation for mental health in Add Health (columns labeled "Data") to those simulated using the estimated model parameters. Columns (1) and (2) compare the simplest technology of skill formation that omits input complementarity, whereas Columns (3) and (4) allow for flexible input complementarity.

Table A16: Model Fit — Parental Investment Behavior

	Data (1)	Model (2)
Social Skills	0.096	−0.033
Cognitive Skills	0.109	−0.094
Mental Health	−0.012	−0.095
Female	0.315	0.347
Black	0.051	0.042
Non-White, Non-Black	−0.128	−0.160

NOTES: This table compares OLS regression coefficients related to the investment decisions of parents in Add Health (columns labeled "Data") to those simulated using the estimated model parameters.

Table A17: Model Fit — Adolescent Activity Choices

	Athletics		Extracurricular Clubs	
	Data (1)	Model (2)	Data (3)	Model (4)
Peer Shares – Athletics	0.595	0.639	−0.093	−0.143
Peer Shares – Clubs	−0.064	−0.003	0.862	0.723
Social Skills	0.029	0.022	0.000	−0.001
Cognitive Skills	0.023	0.063	0.052	0.048
Mental Health	0.006	0.005	0.003	−0.003
Investment	0.033	0.039	0.018	0.020
Female	−0.285	−0.242	0.055	0.048
Black	0.019	0.091	0.002	−0.135
Non-White, Non-Black	0.005	0.131	0.008	0.063

NOTES: This table compares OLS regression coefficients from Add Health (columns labeled "Data") to the same OLS coefficients computed on simulated data generated using the estimated model parameters (columns labeled "Model"). Columns (1) and (2) report coefficients from a linear probability model for participation in athletics. Columns (3) and (4) report coefficients from an analogous linear probability model for participation in extracurricular clubs.

Table A18: Model Fit — Education Shares

	No College		Some College		College		Beyond College	
	Data (1)	Model (2)	Data (3)	Model (4)	Data (5)	Model (6)	Data (7)	Model (8)
Full Sample	0.174	0.130	0.482	0.492	0.213	0.236	0.131	0.142

NOTES: This table compares the empirical distribution of educational attainment in Add Health (columns labeled "Data") to the distribution implied by simulated outcomes generated using the estimated model parameters (columns labeled "Model"). Each pair of columns reports the share of individuals attaining the indicated education category: no college, some college, college completion, and education beyond college.

Table A19: Model Fit — Education Linear Probability Models

	Some College		College		Beyond College	
	Data (1)	Model (2)	Data (3)	Model (4)	Data (5)	Model (6)
Social Skills	0.001	0.033	0.004	0.032	0.002	0.018
Cognitive Skills	−0.094	−0.165	0.090	0.079	0.078	0.072
Mental Health	−0.014	−0.021	0.014	0.011	0.016	0.051
Female	0.019	0.040	−0.012	0.001	0.002	0.011
Black	0.006	−0.027	−0.024	0.005	0.004	0.003
Non-White, Non-Black	−0.014	0.002	0.000	−0.010	0.000	0.004

NOTES: This table compares coefficients from linear probability models (LPMs) estimated in Add Health (columns labeled "Data") to the same LPM coefficients estimated on simulated data generated using the estimated model parameters (columns labeled "Model"). Each outcome is an indicator for attaining the stated education level. Columns (1) and (2) use an indicator for some college; columns (3) and (4) use an indicator for college completion; and columns (5) and (6) use an indicator for education beyond college.

Table A20: Model Fit — Labor Market Moments

	Working		Log Income	
	Data (1)	Model (2)	Data (3)	Model (4)
Some College	0.064	0.163	0.171	0.175
College	0.140	0.154	0.568	0.558
Beyond College	0.117	0.162	0.646	0.651
Female	−0.119	−0.073	−0.370	−0.346
Black	−0.008	0.015	−0.180	−0.172
Non-White, Non-Black	0.001	0.024	0.070	0.077

NOTES: This table compares OLS regression coefficients estimated in Add Health (columns labeled "Data") to the same OLS coefficients estimated on simulated outcomes generated using the estimated model parameters (columns labeled "Model"). Columns (1) and (2) report coefficients from a linear probability model for working. Columns (3) and (4) report coefficients from an OLS regression with log income as the dependent variable.

B A Brock-Durlauf Condition for a Unique Peer Equilibrium

This appendix provides a sufficient condition for the peer equilibrium to be unique. The argument is in the spirit of Brock and Durlauf (2001): equilibrium peer shares are a fixed point of a best-response map, and uniqueness follows from a contraction.

B.1 Environment and peer equilibrium

Each child chooses a binary activity pair $(a, e) \in \{0, 1\}^2$, where a indicates athletics and e indicates clubs. Let

$$s \equiv (\bar{a}, \bar{e}) \in [0, 1]^2$$

denote neighborhood peer shares. For child i, utility from option (a, e) takes the form

$$U_i(a, e; s) \;=\; V_i(a, e; s) \;+\; \varepsilon_{i,ae}, \tag{B1}$$

where $\{\varepsilon_{i,ae}\}$ are i.i.d. Type-I extreme value with scale parameter $\sigma > 0$.

The deterministic component $V_i(a, e; s)$ is affine in s. Only the peer interaction terms are relevant for the contraction bound, so we write them explicitly as

$$V_i(a, e; s) \;=\; \widetilde{V}_i(a, e) \;+\; a\big(\lambda_a \bar{a} + \lambda_{a,e} \bar{e}\big) \;+\; e\big(\lambda_{e,a} \bar{a} + \lambda_e \bar{e}\big), \tag{B2}$$

where $(\lambda_a, \lambda_e, \lambda_{a,e}, \lambda_{e,a}) \in \mathbb{R}$ are unrestricted unless stated otherwise.

Given s, the multinomial logit choice probabilities are

$$P_i(a, e \mid s) \;=\; \frac{\exp(V_i(a, e; s)/\sigma)}{\sum_{(a',e') \in \{0,1\}^2} \exp(V_i(a', e'; s)/\sigma)}. \tag{B3}$$

Define conditional choice expectations

$$m_{a,i}(s) \equiv \sum_{(a',e')} a' \, P_i(a', e' \mid s), \qquad m_{e,i}(s) \equiv \sum_{(a',e')} e' \, P_i(a', e' \mid s).$$

The best-response map $G : [0, 1]^2 \to [0, 1]^2$ is

$$G(s) \;\equiv\; \begin{pmatrix} G_a(s) \\ G_e(s) \end{pmatrix} \;\equiv\; \begin{pmatrix} \mathbb{E}_i[m_{a,i}(s)] \\ \mathbb{E}_i[m_{e,i}(s)] \end{pmatrix}. \tag{B4}$$

A peer equilibrium is a fixed point $s^* \in [0,1]^2$ such that $s^* = G(s^*)$.

B.2 Existence

Claim (Existence). *At least one peer equilibrium exists.*

Proof. For each i, $P_i(a,e \mid s)$ is continuous in s because $V_i(a,e;s)$ is continuous and the logit denominator is strictly positive. Hence $m_{a,i}(s)$ and $m_{e,i}(s)$ are continuous, and therefore G is continuous. Since $G(s) \in [0,1]^2$ for all $s \in [0,1]^2$, Brouwer's fixed point theorem implies existence of a fixed point. ■

B.3 A derivative identity for multinomial logit

The uniqueness bound uses a standard logit derivative identity. Fix a scalar index x and suppose that, holding all else fixed, $V_i(a,e;s)$ depends on x only through an affine term

$$V_i(a,e;s) \;=\; \widehat{V}_i(a,e) \;+\; b(a,e)\,x, \tag{B5}$$

where $b(a,e)$ does not depend on x. Let $f(a,e)$ be any bounded function of the option. Define

$$\mathbb{E}[f \mid i,x] \equiv \sum_{(a',e')} f(a',e')\,P_i(a',e' \mid x).$$

Lemma B.1 (Covariance derivative). *Under Equation B3 and Equation B5,*

$$\frac{\partial}{\partial x}\mathbb{E}[f \mid i,x] \;=\; \frac{1}{\sigma}\,\mathrm{Cov}_{i,x}(f,b), \tag{B6}$$

where the covariance is taken with respect to the logit probabilities $P_i(\cdot \mid x)$.

Proof. Differentiate Equation B3. The logit score implies

$$\frac{\partial}{\partial x}P_i(a,e \mid x) = \frac{1}{\sigma}\,P_i(a,e \mid x)\Big(b(a,e) - \mathbb{E}[b \mid i,x]\Big).$$

Multiplying by $f(a,e)$ and summing over (a,e) yields Equation B6. ■

We will also use a range bound for covariances.

Lemma B.2 (Range bound). *If $X \in [x_L, x_U]$ and $Y \in [y_L, y_U]$ almost surely, then*

$$|\,\mathrm{Cov}(X,Y)| \;\le\; \frac{(x_U - x_L)(y_U - y_L)}{4}. \tag{B7}$$

Proof. For any random variable supported on $[x_L, x_U]$, Popoviciu's inequality gives $\mathrm{Var}(X) \leq (x_U - x_L)^2/4$, and likewise $\mathrm{Var}(Y) \leq (y_U - y_L)^2/4$. By Cauchy–Schwarz, $|\mathrm{Cov}(X,Y)| \leq \sqrt{\mathrm{Var}(X)\,\mathrm{Var}(Y)}$. Combining yields Equation B7. ■

B.4 Contraction and uniqueness with sign flexibility

We now bound the Jacobian of G. From Equation B2, the coefficient on $\bar{a}$ in option (a, e) is

$$b_{\bar{a}}(a,e) \;=\; \lambda_a a + \lambda_{e,a} e, \tag{B8}$$

and the coefficient on $\bar{e}$ is

$$b_{\bar{e}}(a,e) \;=\; \lambda_{a,e} a + \lambda_e e. \tag{B9}$$

Lemma B.3 (Range bounds without sign restrictions). *For* $(a, e) \in \{0,1\}^2$,

$$\max_{a,e} b_{\bar{a}}(a,e) - \min_{a,e} b_{\bar{a}}(a,e) \leq |\lambda_a| + |\lambda_{e,a}|, \tag{B10}$$

$$\max_{a,e} b_{\bar{e}}(a,e) - \min_{a,e} b_{\bar{e}}(a,e) \leq |\lambda_e| + |\lambda_{a,e}|. \tag{B11}$$

Proof. The set of possible values of $b_{\bar{a}}(a,e)$ is $\{0, \lambda_a, \lambda_{e,a}, \lambda_a + \lambda_{e,a}\}$. For any two elements x, y in this set, the difference satisfies $|x - y| \leq |\lambda_a| + |\lambda_{e,a}|$ by the triangle inequality. Therefore the maximum pairwise difference, which equals $\max b_{\bar{a}} - \min b_{\bar{a}}$, is bounded by $|\lambda_a| + |\lambda_{e,a}|$. The argument for $b_{\bar{e}}$ is identical. ■

Apply Lemma B.1 with $f(a,e) = a$ and $x = \bar{a}$. Since $a \in \{0,1\}$ has range one, Lemmas B.2 and B.3 imply the uniform bound

$$\left|\frac{\partial}{\partial \bar{a}} m_{a,i}(s)\right| \;\leq\; \frac{|\lambda_a| + |\lambda_{e,a}|}{4\sigma}. \tag{B12}$$

Similarly, with $f(a,e) = a$ and $x = \bar{e}$,

$$\left|\frac{\partial}{\partial \bar{e}} m_{a,i}(s)\right| \;\leq\; \frac{|\lambda_e| + |\lambda_{a,e}|}{4\sigma}. \tag{B13}$$

Repeating the same steps with $f(a,e) = e$ yields the analogous bounds for $m_{e,i}(s)$:

$$\left|\frac{\partial}{\partial \bar{a}} m_{e,i}(s)\right| \;\leq\; \frac{|\lambda_a| + |\lambda_{e,a}|}{4\sigma}, \qquad \left|\frac{\partial}{\partial \bar{e}} m_{e,i}(s)\right| \;\leq\; \frac{|\lambda_e| + |\lambda_{a,e}|}{4\sigma}. \tag{B14}$$

Since $G_a(s)$ and $G_e(s)$ are averages over i, the same bounds apply to the partial derivatives of G.

Proposition B.1 (Brock-Durlauf contraction condition). *If*

$$|\lambda_a| + |\lambda_e| + |\lambda_{a,e}| + |\lambda_{e,a}| \ < \ 4\sigma, \tag{B15}$$

then G is a contraction on $[0,1]^2$ under the sup norm, and the peer equilibrium is unique.

Proof. Let $\|\cdot\|_\infty$ denote the sup norm on $\mathbb{R}^2$. By the mean value theorem and the bounds in Equation B12–Equation B14, for any $s, s' \in [0,1]^2$,

$$\|G(s) - G(s')\|_\infty \leq \Big(\sup_{u \in [0,1]^2} \max \Big\{ \Big|\frac{\partial G_a(u)}{\partial \bar{a}}\Big| + \Big|\frac{\partial G_a(u)}{\partial \bar{e}}\Big|, \ \Big|\frac{\partial G_e(u)}{\partial \bar{a}}\Big| + \Big|\frac{\partial G_e(u)}{\partial \bar{e}}\Big| \Big\} \Big) \, \|s - s'\|_\infty.$$

The maximum row sum is bounded by

$$L \equiv \frac{|\lambda_a| + |\lambda_e| + |\lambda_{a,e}| + |\lambda_{e,a}|}{4\sigma}.$$

Under Equation B15, $L < 1$, so G is a contraction. The Banach fixed point theorem implies that G has a unique fixed point in $[0,1]^2$. ■

B.5 A convenient sign convention

In our preferred specification, own-activity peer effects are nonnegative and cross effects are nonpositive:

$$\lambda_a \geq 0, \qquad \lambda_e \geq 0, \qquad \lambda_{a,e} \leq 0, \qquad \lambda_{e,a} \leq 0. \tag{B16}$$

Under Equation B16, condition Equation B15 simplifies to

$$\lambda_a + \lambda_e - \lambda_{a,e} - \lambda_{e,a} \ < \ 4\sigma, \tag{B17}$$

since $|\lambda_{a,e}| = -\lambda_{a,e}$ and $|\lambda_{e,a}| = -\lambda_{e,a}$.

B.6 Parameter Estimates

Equation B17 provides us with the criterion to check our estimated parameters against. Plugging in the values obtained via our simulated method of moments procedure (Table 6), we find

$$1.128 + 1.958 - 0.904 - 0.404 = 1.778 < 3 = 4(0.750).$$

Therefore, the Brock-Durlauf sufficient condition holds at our estimates. In particular, the Lipschitz constant implied by the bound in Proposition B.1 satisfies

$$L \le \frac{\lambda_a + \lambda_e - \lambda_{a,e} - \lambda_{e,a}}{4\sigma} = \frac{1.778}{3} \approx 0.593 < 1,$$

so the best-response map G is a contraction on $[0,1]^2$ (under the sup norm). By the Banach fixed point theorem, the peer equilibrium is unique.

A practical implication is that successive approximation converges globally: for any initial guess $s^{(0)} \in [0,1]^2$, the iteration $s^{(k+1)} = G(s^{(k)})$ converges to the unique fixed point s^*, with geometric rate bounded by L. Finally, note that Equation B17 is a sufficient condition, not a necessary one. Even if it were violated, uniqueness could still be obtained, but satisfaction of the inequality guarantees uniqueness and stability under our maintained specification.