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THE ECONOMICS OF PARENTING WITH NEIGHBORHOOD AND PEER EFFECTS

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ABSTRACT

As children reach adolescence, peer interactions become increasingly central to their development, whereas the direct influence of parents wanes. Nevertheless, parents may continue to exert leverage by shaping their children's peer groups. We study interactions of parenting style and peer effects in a model where children's skill accumulation depends on both parental inputs and peers, and where parents can affect the peer group by restricting who their children can interact with. We estimate the model and show that it can capture empirical patterns regarding the interaction of peer characteristics, parental behavior, and skill accumulation among US high school students. We use the estimated model for policy simulations. We find that interventions (e.g., busing) that move children to a more favorable neighborhood have large effects but lose impact when they are scaled up because parents' equilibrium responses push against successful integration with the new peer group.

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1 Introduction

The two most important influences on children's development are their parents and their peers. The importance of these two factors evolves as children grow up: once children pass into adolescence, parents' ability to hold sway over them wanes, whereas the influence of peers looms larger. Yet, parents can try to influence how their adolescent children select their peers. They can choose neighborhoods and schools, and coax their children into activities and hobbies that expose them to a favorable peer group. Or, more directly, they can push their children to associate with or stay away from specific peers.

In this paper, we examine the determinants and consequences of parental decisions that are aimed at shaping their children's peer groups. We build on evidence from the Add Health study, which follows a large group of children in the United States throughout the high school years. The data set includes information on children's grades, test scores, and socio-economic characteristics of their families. Crucially for our purposes, it also provides rich information on parents' behavior and on children's friendship networks. We are specifically interested in how parents intervene in peer-group formation. The data set includes a question that addresses this issue directly: "Do your parents let you make your own decisions about the people you hang around with?" We classify a parent whose child answers "No" as adopting an authoritarian parenting style about friends—or more simply, as *authoritarian*.[1] Conversely, when the child answer "Yes," a parent is classified as adopting a nonauthoritarian style.

The first question we address is whether parents' choice between the authoritarian versus nonauthoritarian style can be understood from the perspective of a rational-choice theory of parenting, where parents are concerned about their children's present and future welfare and are responsive to the characteristics of both

[1] Of course, the notion of an authoritarian parenting style (stretching back to Baumrind 1967) is usually more general and covers many aspects of behavior; we use the shorthand "authoritarian" because we are specifically interested in parents' impact on peer selection. In the developmental psychology literature, the notion of authoritarian parenting style often carries a negative connotation and is associated with unfavorable outcomes (see, e.g., Brooks 2013). In contrast, following Doepke and Zilibotti (2017), we do not attach a value judgement to the use of authoritarian parenting, and simply use "authoritarian" to denote parents who restrict their children's choices.

their children and the surrounding community. We begin answering this question by documenting correlations between the parenting style parents adopt and the peer environment their children face. We find that parents are more likely to be authoritarian (i.e., meddle in their children's peer choices) when the average quality of the peer group (measured by grades) is low and when its variance is high. Informally speaking, parents are more authoritarian when their children are exposed to the influence of "bad apples." Authoritarian parenting also appears to be effective: intervening in a child's peer formation is associated with an improvement over time in the quality of a child's set of friends.

These correlations are consistent with the view that parents' actions are a purposeful response to the environment that their children face. To study the implications of this hypothesis more formally, we develop a model that combines dynamic skill acquisition by children (Cunha and Heckman 2007) with endogenous formation of friendship networks (Agostinelli 2018) and a rational-choice theory of parent-child interactions. In the model, building on Doepke, Sorrenti, and Zilibotti (2019), parents' concern for their children has a paternalistic component: parents place relatively more weight on the children's accumulation of skills than do the children themselves. This motivates interventions aimed at fostering skills. Parental interventions can take two forms. First, parallel to what we observe in the Add Health data, parents can adopt an authoritarian parenting style to influence their child's selection of friends. Second, parents can invest time to directly support their children's skill formation, such as helping them with homework or motivating them to work hard. We interpret such time investments as an element of an *authoritative* parenting style.[2] The two strategies are not exclusive: parents may decide to combine elements of authoritarian and authoritative parenting.

Children form friendships based on the mutual agreement of two potential friends, where the utility a child derives from a friendship depends on their own and the friend's characteristics as well as on match-specific shocks. Authoritarian parent-

[2]Authoritative parenting is generally characterized by high parental engagement and by explaining the reasoning behind parents' views rather than just demanding obedience as in the authoritarian style. See Doepke and Zilibotti (2019) for a detailed discussion of parenting styles from an economic perspective.

ing lowers the utility a child earns from befriending lower-skill peers, which captures the effect of parental disapproval. If successful, this intervention improves the quality of a child's peer group, which in turn feeds back into the child's own accumulation of skills. However, in line with the child development literature, authoritarian parenting has some negative repercussions. Meddling in the choice of friends puts a strain on the parent-child relationship, making the child less receptive to other parental interventions.

These opposing effects yield a tradeoff for parents between improving the selection of peers and the collateral damage caused by parental interference. The resolution of this tradeoff hinges on the peer environment a child is exposed to. Influencing the choice of friends is more urgent in riskier neighborhoods where certain social interactions could lure children into hazardous behavior. In contrast, in homogeneous neighborhoods where most potential peers have a solid family background, parents can grant their children leeway and spare them the downsides of an authoritarian upbringing.

We estimate the model to match a set of data moments and find that it provides a good fit for the empirical relationships between child skills, peers skills, and parenting style observed in the Add Health study. The primary source of identification in the estimation is the within-school and within-grade variation in the makeup of the potential peer group. Even so, the model provides a good fit for the observed variation in parenting styles across schools from richer and poorer neighborhoods, which is not directly targeted.

The estimated model implies a flexible interaction between different dimensions of parenting style. For nonauthoritarian parents, authoritative investments in a child's skills are a substitute input for the quality of the child's peers (in line with Agostinelli 2018). As a result, parents increase their time investment when their children face a worse peer group. In contrast, the time investment of authoritarian parents does not respond to the quality of peers. These findings suggest that parents regard authoritative time investments and authoritarian restrictions on the choice of friends as alternative strategies for responding to a problematic peer environment.

Having confirmed that parenting choices can indeed be understood as a rational

response to incentives arising from a child's environment, we move on to a second question: What are the implications of endogenous parenting for the effects of policy interventions that are also aimed at shaping peer effects?

We focus specifically on a busing policy that moves children from a low-quality school (measured by average test scores) to a better one. Our model implies that bused children face two barriers to integration. The first is homophily bias in children's preferences, i.e., the tendency for children to associate with peers who are similar to themselves. The second is the endogenous response of parents in the host neighborhood. We find that the strength of these barriers hinges on the scale of the intervention. A small-scale policy that moves only a few children has large beneficial effects on the moved children and hardly any negative impact on the children already at the receiving school. However, for two reasons, the effectiveness of the policy declines sharply as it is scaled up to cover more children. First, if only few children are bused, they have no choice other than to mingle with the children in the new school. In contrast, when the policy is scaled up, homophily bias induces the bused children to increasingly stick together and mix less with others. Second, as more children are bused, parents at the receiving school increasingly turn authoritarian to prevent their own children from befriending the new arrivals. In other words, parents' equilibrium responses push against successful integration.

Beyond busing, other examples of policies where similar effects may arise include school choice policies and tracking policies within schools. We also study counterfactual policies that alter the peer environment for all children by reducing initial inequality in skills either within or across neighborhoods. Reducing initial inequality across the board or within neighborhoods (e.g., through policies targeting early child development) generally has beneficial effects on the accumulation of skills, in significant part because lower inequality reduces the use of authoritarian parenting. Results are less favorable for a policy that reduces inequality across neighborhoods, for instance by removing all residential segregation so that the composition of all neighborhoods turns identical, while holding constant overall inequality. In our model, this policy has a negative average effect on skill accumulation because inequality increases within most

neighborhoods, which due to homophily bias and the defensive response of parents, increases barriers against the successful integration of children from different backgrounds. All these findings underline the importance of taking parental responses into account when considering the effects of policies that are aimed at shaping peer effects.

Relationship to Literature

This paper links three strands of the recent literature on the determinants of child development. The first is the literature on children's skill formation, including James Heckman's recent work with different coauthors (e.g., Cunha and Heckman 2007; Cunha, Heckman, and Schennach 2010), which has led to new insights on how children's skills and attitudes evolve as a function of endowments and parental and other inputs.[3] We build on this literature in our modeling of children's skill acquisition, and also introduce new elements, such as alternative investment strategies (parenting styles), through which parents can foster their children's skills.

The second strand of literature is the growing body of multidisciplinary research studying the importance of neighborhood effects for human capital formation and inequality of opportunity.[4] This literature shows that children who grow up in distressed areas tend to reach lower outcomes and display less upward mobility when compared to children from wealthier areas (e.g., Cutler and Glaeser 1997; Chetty et al. 2014). In a recent study, Chetty, Hendren, and Katz (2016) argue that moving to a less poor area improves long-term outcomes for children who move at a young age. The importance of childhood exposure to neighborhoods is also supported by recent papers studying tax records of millions of US families moving across different areas (Chetty and Hendren 2018a, 2018b) and

[3]Other important studies in this literature include Todd and Wolpin (2003), Heckman, Stixrud, and Urzua (2006), Todd and Wolpin (2007), Cunha and Heckman (2008), Almlund et al. (2011), Dahl and Lochner (2012), Løken, Mogstad, and Wiswall (2012), Heckman, Pinto, and Savelyev (2013), Del Boca, Flinn, and Wiswall (2014), Agostinelli and Wiswall (2016), Agostinelli and Sorrenti (2018), Attanasio, Meghir, and Nix (2019), and Attanasio et al. (2020). For literature reviews, see Heckman and Mosso (2014) and Attanasio (2015).

[4]See Jencks and Mayer (1990), Sampson, Morenoff, and Gannon-Rowley (2002) and Durlauf (2004) for early reviews.

the findings of Chyn (2018) on the effects of a program of public housing demolitions in Chicago that forced poor families to relocate to less disadvantaged areas.

These empirical studies leave open the question through which mechanism the benefits of exposure to better neighborhood arise. In addressing this question, our study complements the theoretical literature on social interactions within neighborhoods (e.g., Brock and Durlauf 2001a; Brock and Durlauf 2001b ; Brock and Durlauf 2002; Durlauf and Ioannides 2010) and the empirical literature on peer effects in education.[5] Calvó-Armengol, Patacchini, and Zenou (2009) estimate a friendship network model using, as we do, the Add Health data. Their main finding is that a child's position in the network, as measured by its Bonacich centrality, has an impact on school performance.[6] A recent study by List, Momeni, and Zenou (2019) documents large spillover effects of programs targeting disadvantaged children on the cognitive and noncognitive skills of other local children. In line with our modeling approach, the evidence suggests that these spillovers operate through children's social networks. Angrist and Lang (2004) study the effect of a desegregation busing policy in the Boston area. They find that negative spillovers on the receiving community are small, although there are some negative effects on local black children who are more likely to interact with the bused children. These results are consistent with the findings of our counterfactual policy analysis. Two recent macroeconomic papers by Eckert and Kleineberg (2019) and Fogli and Guerrieri (2018) study the effect of neighborhood choice on human capital accumulation and social mobility. We do not explicitly model the choice of neighborhood, but unlike these studies, we provide a microfoundation for peer effects and the process of friendship formation, and we allow for direct parental interventions in children's peer group formation.

[5] Case and Katz (1991) is an early contribution on the effect of neighborhood peers on the behaviors of youths. Papers estimating peer effects in education under a variety of identification strategies include Hoxby (2000), Sacerdote (2001), Zimmerman (2003), Sacerdote (2011), Arcidiacono et al. (2012), Carrell, Sacerdote, and West (2013), Tamayo Castano (2016), and Feld and Zölitz (2017). Altonji and Mansfield (2018) address econometric issues in the estimation of group treatment effects in the presence of selection effects. Blume et al. (2011) and Blume et al. (2015) provide an overview of the identification of various social interactions models.

[6] Other studies on peer effects using the Add Health data set include Bifulco, Fletcher, and Ross (2011), Badev (2016), Mele (2019), and Olivetti, Patacchini, and Zenou (2020).

The third related strand of literature consists of recent work on the economics of parenting that merges insights from the developmental psychology literature with the Beckerian tradition of family economics, including Doepke and Zilibotti (2017), Doepke and Zilibotti (2019), and Doepke, Sorrenti, and Zilibotti (2019). While the psychology literature (following Baumrind 1967) regards parenting styles as given traits of parents, the economics literature treats them as the endogenous choice of rational parents who seek to influence the behavior of their children, with whom they disagree on occasion.[7] Strategic interaction between parents and children is also central to Del Boca et al. (2019), who focus on monetary incentives that parents provide for their children (related to Weinberg 2001) rather than on interference with friend selection. Relative to this literature, the key innovation of this paper is to consider how parenting choices interact with peer effects.[8] In terms of modeling peer interactions, we build on Agostinelli (2018), who estimates a dynamic model of skill formation where children choose their own peer groups.[9] However, in his setting, parents do not choose a parenting style or interfere in their children's peer selection, which is the main focus of our study.

In the following section, we describe the data and provide descriptive evidence. In Section 3, we develop a structural model of parent-child interactions with peer effects. Section 4 describes the model estimation. Section 5 uses the model for policy analysis, and Section 6 concludes. The appendix contains additional empirical results, details on the measurement of skills and parenting styles, and

[7]Earlier work on the economics of parenting includes Akabayashi (2006) and Lizzeri and Siniscalchi (2008), who emphasize informational frictions and learning. More recently, Kim (2019) models the role of parental punishment as a parent-child communication channel. Other empirical studies on different dimensions of parenting include, among others, Patacchini and Zenou (2011), Zumbuehl, Dohmen, and Pfann (2018), Brenøe and Epper (2019), and Cobb-Clark, Salamanca, and Zhu (2019).

[8]The link between parenting and peer effects has been stressed previously in the developmental psychology literature. For instance, Brooks (2013) describes parenting as a "process of action and interaction between parent and child .... Society is a third dynamic force in the process. ...The child, the parent, and society all influence the process of parenting, and, in turn, are changed by it" (pp. 6–7). The impact of parents through shaping their children's peer environment is acknowledged even by authors who are skeptical of the influence of parents on adolescent children, such as Harris (1998) .

[9]A contemporaneous nonstructural paper by Özdemir (2019) also uses the Add Health data to study the response of parents to the environment, with a special focus on the differential effects of time investments of mothers and fathers.

robustness exercises.

2 Parenting, Peers, and Skills in the Add Health Data

In this section, we describe the data and document empirical correlations between skill accumulation, peers, and parental interventions that motivate our structural theory.

2.1 Data

The National Longitudinal Study of Adolescent to Adult Health (Add Health) is a nationally representative longitudinal survey of adolescents in the United States. The original data set includes about 90,000 students from 132 schools in the school year 1994–95. Students are in grades 7–12. Our analysis focuses on the baseline survey (Wave I) and the 1996 follow up (Wave II).

A subsample of students is selected for a home interview that includes questionnaires for both the students and their parents. The data set includes detailed information on family background, grades, and test scores. The survey asks questions that can be used for measuring parenting styles. Importantly for our research, the survey also asks detailed questions on students' peers. Each student is asked to nominate their best five male and best five female friends. Since students are observed repeatedly, we have information on how peer groups evolve over time. In addition, we can study how students' characteristics (including grades and tests scores) affect peer group formation.

We are interested in children's answers to the question: "Do your parents let you make your own decisions about the people you hang around with?" We consider a parent whose child answers "No" as behaving in an authoritarian fashion about friends. We classify such parents as authoritarian; all others are nonauthoritarian. The authoritarian group comprises 13 percent of parents in the sample we use in our analysis. We also construct a measure of parental investment based on activities parents do together with their children, such as working on a project for school, talking about a party the child attended, or talking about a personal

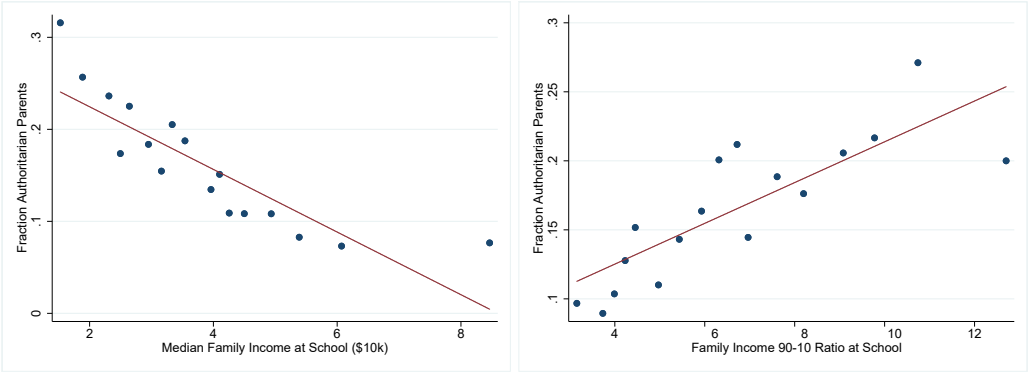
problem.[10] We consider parental investments of this kind as an element of an authoritative parenting style. The data set does not provide information on monetary investments in child-rearing activities.

Appendix Table A-1 provides the summary statistics of our main variables. Appendix B provides additional information on how we measure skills and parental investments.

2.2 Authoritarian Parenting Across Schools

In this section, we provide some descriptive evidence. Our main hypothesis is that parenting behavior is driven by parents' concern about children's skill formation. Therefore, we expect parents to be more authoritarian when their children are exposed to peers who may disrupt human capital accumulation. The data supports this conjecture.

Figure 1: Authoritarian Parenting and Neighborhood Characteristics



The figure shows how the incidence of the authoritarian parenting style varies with within-school average family income (left panel) and inequality (right panel). Inequality is measured by the 90th–10th percentile ratio of within-school family income.

Figure 1 shows how authoritarian parenting varies across schools with different characteristics. The left panel displays a binned scatter plot of the relationship between median family income and the fraction of authoritarian parents at the school level, whereas the right panel shows the relationship between income inequality and authoritarian parenting. The figure shows that across schools, the

[10] See Appendix Table A-1. We restrict attention to activities done by the child with its mother to avoid selection problems, since the father is often not present.

Table 1: Authoritarian Parenting and Peer Environment Across Schools

	Authoritarian	
	(1)	(2)
Median Family Income	-0.033***	-0.021***
at School	(0.005)	(0.004)
90-10 Family Income	0.006*	0.005*
at School	(0.003)	(0.003)
Mean Dep	0.154	0.154
Obs	15064	15064
Clusters	114	114
Controls	No	Yes

The table shows the estimated coefficients of regressions whose dependent variable is an indicator variable for authoritarian parenting at the individual level. The regressions include mother's education, family income, child's race, age, and gender as control variables. Standard errors are clustered at the school level.

proportion of parents adopting the authoritarian parenting style is decreasing with the median income and increasing with income inequality. Broadly speaking, parents are more likely to meddle in the choice of friends when there are more children from disadvantaged families present. The differences are quantitatively large. Moving from a neighborhood (school) with a median income of $20,000 to one with a median income of $60,000 or more decreases the percentage of parents behaving in an authoritarian fashion from 26 percent to 8 percent. Likewise, moving from the three most equal to the three most unequal bins is associated with more than doubling the share of authoritarian parents. The same pattern emerges in multiple regressions where we simultaneously include median income and income inequality and control for parental characteristics, as shown in Table 1.

While our definition of authoritarian parenting focuses on parental intervention in peer formation, the patterns documented above are robust to other ways of

Table 2: Authoritarian Parenting and Peer Environment within Schools

	Authoritarian					
	(1)	(2)	(3)	(4)	(5)	(6)
Mean GPA within Grade	-0.114**		-0.064	-0.059		-0.036
	(0.046)		(0.047)	(0.042)		(0.043)
SD GPA within Grade		0.329***	0.269***		0.206**	0.181**
		(0.087)	(0.087)		(0.087)	(0.089)
Mean Dep	0.130	0.130	0.130	0.130	0.130	0.130
Obs	10057	10057	10057	10057	10057	10057
Clusters	63	63	63	63	63	63
Controls	No	No	No	Yes	Yes	Yes
School F.E.	Yes	Yes	Yes	Yes	Yes	Yes

The table shows the estimated coefficients of regressions whose dependent variable is an indicator variable for authoritarian parenting at the individual level. The SD GPA grade is the standard deviation in GPA across pupils within school and grade. All regressions include school fixed effects, as well as mother's education, family income, and child's race, age, and gender as control variables. Standard errors are clustered at the school level.

measuring parenting style. In Appendix Figure A-1, we construct measures of parenting styles based on the values parents emphasize in child rearing, similar to Doepke and Zilibotti (2017).[11] The figure shows that parents tend to be more permissive in wealthier and more equal neighborhoods, while they tend to be more authoritative and authoritarian in poorer and more unequal neighborhoods. This is consistent with the cross-country evidence documented by Doepke and Zilibotti (2017).

[11]We use the answer parents give to the following question: "Of the following, which do you think is the most important thing for a boy/girl to learn? Be well-behaved, work hard, think for himself, help others, be popular." We classify parents as authoritarian when they choose "be well-behaved," as authoritative when they choose "work hard," and as permissive when they choose "think for themselves." In the figure, we exclude parents who choose either "think for himself" or "be popular." The result does not change significantly if we classify the excluded parents as permissive.

2.3 Authoritarian Parenting Within Schools

A natural concern is that the correlation might be driven by omitted variables at the neighborhood level. To address this concern, we consider within-school regressions exploiting variations across cohorts. We focus on the same measure of peer quality that we will use in our structural model below, namely, a student's grade point average (GPA). Table 2 shows the results of regressing parenting style (authoritarian) on the mean and standard deviation of GPA among the children in a given school cohort. Parents are significantly more inclined to be authoritarian when their children are exposed to peers with low and unequal skills (where inequality is measured by the standard deviation of GPA) even when controlling for school fixed effects and family characteristics.[12] Remarkably, the correlation of parenting style with inequality in GPA is stronger and more robust than that of parenting style with the mean GPA. The range of variation for the standard deviation of GPA within grade is [0.47, 0.97]. Moving from the least to the most unequal cohort in the sample is associated with an increase of the incidence of the authoritarian parenting style between 9 (sixth column) and 16.5 (second column) percentage points. This is a large change, given that about 13 percent of parents in the sample are authoritarian in our sample.

The next question is whether authoritarian parenting makes a difference. To address this issue, we study the correlation between parenting style and the change in the quality of peers. In these regressions, we use information on each child's network of friends and test whether, conditional on the child's skill and on the average GPA of her friends, an authoritative parenting style is associated with a higher GPA of its peers in the following year.[13] We control for school and grade fixed effects and exploit the variation across the realized set of friends for each child. Table 3 shows that in most cases the dummy for an authoritarian style has a positive coefficient. While the estimated coefficient is small and statistically insignificant in the entire sample, there is significant heterogeneity. In particular, the coefficient turns larger and highly significant when we zoom in on intact

[12] Appendix Table A-2 shows that the results are robust to using the Gini coefficient instead of the standard deviation as a measure of inequality.

[13] Note that we lose many observations because this regression requires that we observe both the GPA of the child and that of all her friends.

Table 3: Authoritarian Parenting and Dynamics of Peer Quality

	Next Period Peer GPA				
	(1)	(2)	(3)	(4)	(5)
	All	Intact Families	Intact Families Only:		
			Low-Income Neighborhood	Medium-Income Neighborhood	High-Income Neighborhood
Child's GPA	0.177***	0.251***	0.345***	0.226***	0.282*
	(0.022)	(0.030)	(0.089)	(0.023)	(0.145)
Peer GPA	0.317***	0.297***	0.147	0.358***	0.179
	(0.035)	(0.065)	(0.171)	(0.052)	(0.153)
Authoritarian	0.013	0.198**	0.286*	0.107	0.212
	(0.042)	(0.081)	(0.144)	(0.077)	(0.170)
Obs	1895	974	175	615	184
Clusters	56	55	16	23	16

The table shows the estimated coefficients of regressions whose dependent variable is the average GPA of peers in the second wave of interviews. The Peer GPA grade is the average GPA of peers in the first wave of interviews. All regressions include school-grade fixed effects, as well as mother's education, family income, and child's race, age, and gender as control variables. Standard errors are clustered at the school level.

families, i.e., families in which both parents are present. For these families, an authoritative parenting style is associated with a 0.20 average increase in the skills of future friends. The point estimate is even larger (0.29) in low-income neighborhoods where more parents are authoritarian. An intuitive interpretation for this heterogenous effect is that the parental intervention is magnified by the presence of two parents. While these regressions are suggestive, they are subject to important caveats related to selection issues. The costs and benefits of being authoritarian, both in terms of skill formation and potential psychological costs, may vary with the characteristics of children and the environment in a systematic and nonlinear way. We will show below with the aid of a structural model that a large causal effect of authoritative parenting is consistent with a small reduced-form regression coefficient.

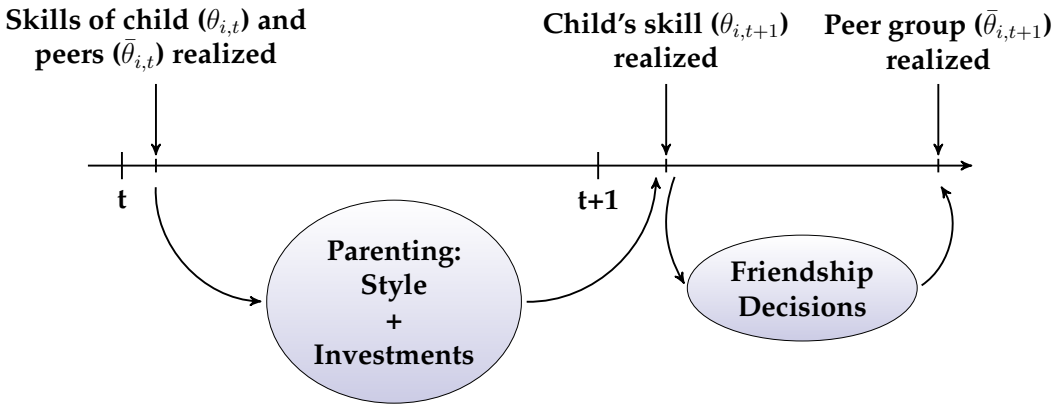
Overall, the correlations described in this section suggest a rational motive for parents to interfere in the process of peer selection. To test this hypothesis more

formally and to perform counterfactual policy analysis, we construct and estimate a structural model.

3 A Model of Parents, Peers, and Skill Accumulation

Consider an economy comprising a set of neighborhoods indexed by n, each populated by families composed of a child and a parent. The focal point of our analysis is the accumulation of children's skills $\theta_{i,t}$, where i is the index of a child and t denotes the time period. We model the interaction of parent and child from period $t = 1$ to period $t = T$. In our empirical application this interval corresponds to the four years of high school (grades 9 to 12), so that $T = 4$.

Figure 2: Model Timing



The figure shows the timeline of the model. The child's skills at $t = 0$ are drawn from the initial distribution. The peers' skills at $t = 0$ are determined by the peer environment (the distribution of children's skills at the school and grade level) and by the random utility preferences without parental interventions. From period $t = 1$ onward, θ_t and $\bar{\theta}_t$ are endogenous state variables.

Each neighborhood n is characterized by a set $\mathcal{X}^n$ of children living in the neighborhood and by the initial ($t = 1$) skill distribution of these children. All children living in a given neighborhood attend the same school. Figure 2 outlines the timing of events within each period. At the beginning of the period, the child's current skill level $\theta_{i,t}$ is realized. Next, the child forms friendships with some of the other children of the same age in the same school. The characteristics of these

friends (which affect skill formation) are summarized by the variable $\bar{\theta}_{i,t}$. The parent can now make two choices that affect the evolution of the child's skills and peers. First, the parent can undertake (authoritative) parenting investments $I_{i,t}$ that affect the child's skill formation. Second, the parent chooses her parenting style, $P_{i,t} \in \{0, 1\}$, where $P_{i,t} = 1$ means that the parent behaves in an authoritarian fashion by interfering in the child's next round of friendship decisions. At the beginning of the next period, the child's updated skill $\theta_{i,t+1}$ is realized and the new group of friends with the average skill $\bar{\theta}_{i,t+1}$ is formed. These events are repeated until the final year of high school. Then, the child enters adult life with skills $\theta_{i,T+1}$.

3.1 Preferences of Parents and Children

The structure of preferences builds on Doepke and Zilibotti (2017) and Doepke, Sorrenti, and Zilibotti (2019). In particular, the utility of the parent combines elements of altruism and paternalism. Altruism means that the child's utility enters the parent's utility so that the parent wants the child to be "happy." In contrast, paternalism implies that the parent evaluates the child's choices and educational outcomes from her own standpoint. Specifically, the parent's paternalistic self attaches a higher weight on the child's skill accumulation than does the child herself. The conflicting motives of altruism and paternalism imply that the parent's behavior responds to the environment in a way that can be fitted to data. The paternalistic motive explains why the parent may want to interfere in the child's friendship decisions (against the child's wishes), and the altruistic motive explains why the parent will interfere only when the benefits of doing so are high relative to the child's loss of utility.

To keep the model parsimonious, we limit attention to the choices and state variables that are part of our empirical analysis and omit other factors such as goods consumption. In our notation, we employ the convention that lowercase variables correspond to the child and uppercase variables correspond to the parent. The individual state variables for a family are the child's skills $\theta_{i,t}$ and the characteristics of the child's peers $\bar{\theta}_{i,t}$. An additional aggregate state variable is the distribution of the children $\mathcal{X}^n$ in the neighborhood over skills at age t, which matters for friendship formation and peer effects. However, since in our analysis

families do not switch neighborhoods, the aggregate state is taken as given by each family.[14] Thus, our notation omits the aggregate state as an explicit state variable. Instead, we denote the dependence of utility and choices on neighborhood characteristics by indexing value functions by neighborhood n.

The parent decides on parenting style ($P_{i,t}$ and $I_{i,t}$), and the child chooses peers, i.e., who to be friends with. We express the preferences of parent and child with value functions that summarize utility in a period after the child's current skills and peer group have already been realized so that the decisions concern the evolution of these variables into the next period.

The value function for child i in neighborhood n in period t is given by:

$$v_t^n(\theta_{i,t}, \bar{\theta}_{i,t}) = \max \left\{ \mathrm{E} \left[u(\mathcal{F}_{i,t+1}) | \theta_{i,t}, \bar{\theta}_{i,t} \right] \right\}. \tag{1}$$

Here $u(\mathcal{F}_{i,t+1})$ captures the utility derived from peer interactions with the set of friends $\mathcal{F}_{i,t+1}$ chosen in period t, where $\mathcal{F}_{i,t+1} \subseteq \mathcal{X}^n$. The friend set $\mathcal{F}_{i,t+1}$ determines the next period's peer quality $\bar{\theta}_{i,t+1}$. The friendship decisions, in turn, hinge on both the child's and the parent's decisions in a way that will be made precise below.[15] The (conditional) expectation in the value function reflects the presence of taste shocks affecting the process of friendship formation. Current peer quality $\bar{\theta}_{i,t}$ enters the value function because it affects the evolution of the child's skills and the decisions of parents.

The representation of preferences in Equation (1) implies that children only care about the flow utility accruing from spending time with their friends with no regard for the effects of peers on their skill formation. A more general representation could include the discounted continuation utility from the next period

[14] In principle, because there is a finite number of families in each neighborhood, peer interactions imply there is a feedback from a family's decisions to the aggregate state, i.e., each family affects skill accumulation in other families. In practice, given the size of neighborhoods in the estimated model, this feedback effect is very small, so we assume that parents take the skill distribution in the neighborhood as given.

[15] Note that given that utility is summarized after friendship formation at time t has already been completed, the utility derived from forming friendships with time-t friends $u(\mathcal{F}_{i,t})$ does not appear in the time-t value function (instead, it appears at time $t-1$).

onward.[16] In other words, we ignore the possibility that children strategically prefer peers with high grades because of the help these peers may offer them in improving their school proficiency. This assumption simplifies our empirical analysis by allowing us to obtain analytical expressions that can be estimated directly. The loss of generality relative to the formulation in Footnote 16 is very limited. In our estimation, children take into account the value of other children's skills because these affect (as we will see) the value of being friends with them. Therefore, the ultimate determinants of their choice would be the same as in our formulation, although the functional forms would be different.

The parent's total utility in period t is given by the value function:

$$V_t^n(\theta_{i,t}, \bar{\theta}_{i,t}) = \max \Big\{ \mathrm{E} \Big[U(I_{i,t}, P_{i,t}, \epsilon_{i,t}) + Z \left[\lambda \tilde{u}(\theta_{i,t}, P_{i,t}) + (1-\lambda) u(\mathcal{F}_{i,t+1}) \right] + B V_{t+1}^n(\theta_{i,t+1}, \bar{\theta}_{i,t+1}) | \theta_{i,t}, \bar{\theta}_{i,t} \Big] \Big\}. \quad (2)$$

Here $U(I_{i,t}, P_{i,t}, \epsilon_{i,t})$ is the parent's period utility, which depends on parenting style ($P_{i,t}$ and $I_{i,t}$), chosen optimally by the parent. Utility also depends on taste shocks $\epsilon_{i,t}$, which ensure a smooth mapping from state variables into decisions. The parent also cares about the child, where Z is the overall weight attached to the child's welfare.

Parental concern about children has an altruistic and a paternalistic component. The altruistic component with weight $1-\lambda$ consists of the child's actual period utility $u(\mathcal{F}_{i,t+1})$. The paternalistic component with weight λ is the parent's own evaluation of the current actions and outcomes of the child. The paternalistic concern is focused on the child's accumulation of skills $\theta_{i,t}$, where we allow for the possibility that the parent's evaluation of the child's skill interacts with parenting style $P_{i,t}$. Hence, paternalistic utility enters as $\tilde{u}(\theta_{i,t}, P_{i,t})$. Note that, at time t, the parent takes the quality of the child's current peers $\bar{\theta}_{i,t}$ as given, but the parent can influence future peer formation (and hence future peer quality $\bar{\theta}_{i,t+1}$) through

[16] Formally, the more general representation would be

$$v_t^n(\theta_{i,t}, \bar{\theta}_{i,t}) = \max \left\{ \mathrm{E} \left[u(\mathcal{F}_{i,t+1}) + b v_{t+1}^n(\theta_{i,t+1}, \bar{\theta}_{i,t+1}) | \theta_{i,t}, \bar{\theta}_{i,t} \right] \right\}.$$

Our myopic formulation corresponds to setting $b = 0$.

the choice of parenting style $P_{i,t}$.[17]

The continuation utility at the end of high school is identical to the child's continuation utility, and thus depends on θ_{T+1}:

$$V^n_{T+1} = v^n_{T+1}(\theta_{i,T+1}),$$

where the function $v^n_{T+1}(\theta_{T+1})$ (corresponding to the child's utility as an adult) is taken as given and assumed to be identical across neighborhoods.

Taking stock, the focal point of the theory is a disagreement between the parent and the child about the tradeoff between the enjoyment of the present (i.e., interactions with friends) and investment in future skills. For instance, a child may want to hang out with "cool" kids who do not necessarily do well in school, whereas associating with "nerdy" high-GPA peers may be good for school performance but also more boring for the child.

3.2 The Technology of Skill Formation

Having described preferences, we now turn to the technology of skill formation for adolescent children. The initial distribution of children's skills is drawn from the distribution $F^n(\theta_{i,1})$. In reality, this initial distribution depends on families' socio-economic conditions, neighborhood effects, and earlier actions by parents and children. Since we do not have information on those variables before children enter high school, we treat initial conditions as exogenous.[18]

Subsequently, skills evolve as a function of family inputs and peer influences. For each child i, next period's skill $\theta_{i,t+1}$ depends on the current stock of skills $\theta_{i,t}$, a summary statistic of the quality of peers $\bar{\theta}_{i,t}$ (e.g., the average level of skills), parental investments $I_{i,t}$, and the parent's choice of whether to interfere in the

[17] The disagreement between parents and children does not hinge on the simplifying assumption that children are myopic. We could obtain the same results if we replaced Equation (1) with the more general formulation given in Footnote 16. Disagreement could arise both through the parametrization of the functions u and $\tilde{u}$ in Equation (2), which reflect the within-period disagreement between parent and child, and through allowing for the possibility that the parent's discount factor B is larger than the child's discount factor b.

[18] As we discuss below, we estimate the model using only within-school-grade variation in the data.

child's choice of peers $P_{i,t} \in \{0, 1\}$. We formalize the technology of skill formation as follows:

$$\theta_{i,t+1} = s(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}, P_{i,t}). \tag{3}$$

The direct effect of parenting style $P_{i,t}$ in Equation (3) captures the impact of the quality of the parent-child relationship on skill accumulation. While we do not impose any a priori restriction in the estimation, we expect an authoritarian parenting style to have a negative effect on skill accumulation. This could arise either from discord between parent and child or from time use: time that the parent spends trying to talk kids out of meeting certain people is not available for more productive investments. The total effect of an authoritarian parenting style can still be positive because P_t affects the composition of the peer group and hence peer quality $\bar{\theta}_{i,t}$.

3.3 Endogenous Peer Selection

We model the formation of friendships as a random utility model. Every period, each child meets all potential peers $\mathcal{X}^n$ in the neighborhood and can try to be friends with some of them. There is no capacity constraint in the number of friends nor any decreasing marginal utility to the number friendships. The potential utility $f_{i,j,t+1}$ that child i would derive from forming a new friendship with $j \in \mathcal{X}^n$ is given by:

$$f_{i,j,t+1} = g(\theta_{i,t+1}, \theta_{j,t+1}, P_{i,t}, \eta_{i,j,t+1}). \tag{4}$$

Here $\eta_{i,j,t+1}$ is an independent and identically distributed (i.i.d.) taste shock that guarantees that the probability that a friendship is established is a smooth function of fundamentals. Note that, in general, $\eta_{i,j,t+1} \neq \eta_{j,i,t+1}$, which captures the common situation where, say, child i wants to be friends with j but not vice versa. The utility from forming a friendship depends on both the own skill of child i and the skill of the potential friend j. This specification allows for homophily bias in terms of skills.[19]

[19]The homophily bias is a common tendency of people in social networks to be drawn toward others who are similar to them in some significant dimension (see e.g., McPherson, Smith-Lovin, and Cook 2001; Currarini, Jackson, and Pin 2009; Jackson 2010, and, in a context similar to ours, Agostinelli 2018).

The parenting style $P_{i,t}$ affects how much utility accrues to the child when it forms friendships with children of different skill levels. Since parents want to encourage skill formation, we assume that an authoritarian parenting style ($P_{i,t} = 1$) lowers the utility of befriending a low-skill peer relative to a high-skill one. This could be done by rewarding the child in some way for making "desirable" friends or by meting out punishments for befriending less desirable ones.

Friendships are subject to mutual agreement: a friendship between child i and child j is formed if and only if

$$f_{i,j,t+1} > 0 \;\; \& \;\; f_{j,i,t+1} > 0, \tag{5}$$

where we normalize the value of not forming a friendship to zero. As already mentioned, $\mathcal{F}_{i,t+1} \subseteq \mathcal{X}^n$ denotes the set of friendships involving child i in period $t+1$, i.e., the set of $j \in \mathcal{X}^n$ for which Equation (5) is satisfied. The friendship utility $u(\mathcal{F}_{i,t+1})$ that determines the child's utility (1) is then:

$$u(\mathcal{F}_{i,t+1}) = \sum_{j \in \mathcal{F}_{i,t+1}} f_{i,j,t+1}.$$

The process of friendship formation entails externalities across families. Friendships are formed by mutual consent. When a parent meddles in the process of friendship formation, her intervention affects not only her child, but also other children. Given that parents do not care about other children, their decisions generally fail to be socially optimal.

3.4 Friendship Formation in the First and Last Periods

The value functions (1) and (2) in the first period (corresponding to ninth grade) depend on the initial quality of peers $\bar{\theta}_{i,1}$. Rather than taking this state variable as parametric, we assume that only the initial distribution of skills is given and that friendships are formed through the endogenous process discussed above. This approach allows us to run policy analyses where we counterfactually vary the initial skill distribution and adjust the network of friends accordingly. A limitation is that we do not observe parenting style in the preceding period. For this

reason, we assume that parents cannot affect the initial choice of friends.[20] Since this happens in the period when children enter high school and are exposed to new peers, this entails only a limited loss of generality.

In the last period $T = 4$ (corresponding to 12th grade), the parental decision problem is different because the continuation utility V^n_{T+1} does not depend on the quality of peers. This reflects that the children have to form new peer groups after leaving high school, and at any rate these future peers are not observed in the Add Health data. Setting $P_{i,T} = 1$ does not affect future peers' skills, and parenting style will be optimally chosen solely based only on the parents' taste shocks.

3.5 Functional Forms for Estimation

To estimate the model, we impose functional forms and restrictions that allow us to summarize the model by a list of parameters.

Initial Conditions. The initial distribution of children skills within each neighborhood n is drawn from a log-normal distribution. This specification captures the initial (and to us unobserved) sorting of families into different neighborhoods characterized by different initial distributions of children's skills. We define the initial conditions for each neighborhood n as follows:

$$\ln \theta_{i,1} \sim N(\mu^n, (\sigma^n)^2), \tag{6}$$

where μ^n and σ^n represent the neighborhood-specific mean and the standard deviation of the log-skills.

Once the initial heterogeneity of children's skills within the neighborhood is realized, children select their initial peer group according to their preferences for friends (Equation (4)).[21] At this stage, the initial vector of state variables $\{\theta_{i,1}, \bar{\theta}_{i,1}\}$

[20] Formally, we set $P_{i,t-1} = 0$ when evaluating Equation (4) and Equation (5) at time $t = 1$.

[21] As noted, we do not have information about parenting style at time $t = 0$. Note that in our sample, children start high school at time $t = 1$, where they meet many new potential friends. For this reason, we find it plausible to assume that parents have a limited effect on the process of selection in the first period.

is determined, and the dynamic parent-child interaction starts according to the model described above.[22]

Technology of Skill Formation. We parameterize the technology of skill formation with the following nested CES production function:

$$s(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}, P_{i,t} = p) = A_p(t) \times H_p(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}), \tag{7}$$

where $p \in \{0, 1\}$, $A_p(t) = exp(\psi_0 + \psi_1 \cdot t + \psi_2 \cdot p)$, and

$$H_p(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}) = \left[\alpha_{1,p}\, \theta_{i,t}^{\alpha_{4,p}} \;+\; (1 - \alpha_{1,p}) \left[\alpha_{2,p}\, \bar{\theta}_{i,t}^{\alpha_{3,p}} + (1 - \alpha_{2,p})\, I_{i,t}^{\alpha_{3,p}}\right]^{\frac{\alpha_{4,p}}{\alpha_{3,p}}}\right]^{\frac{\alpha_{5,p}}{\alpha_{4,p}}}.$$

Note that all parameters of the skill formation technology depend on P, namely, whether the parent chooses an authoritarian parenting style. First, this affects the total factor productivity $A_p(t)$, capturing the potential disruptive effect of authoritarian parenting on the parent-child relationship documented by the developmental psychology literature. Our estimation below indeed finds that $\psi_2 < 0$, i.e., an authoritarian parenting style depresses skill accumulation. Second, parenting style affects the parameters $\alpha_{1,p}$ and $\alpha_{2,p}$, capturing the weights of the different inputs. Our estimation finds that the authoritarian style attenuates the influence of peers. Third, an authoritarian parenting style also affects the elasticity-of-substitution parameters $\alpha_{3,p}$ and $\alpha_{4,p}$ and the returns-to-scale parameter ($\alpha_{5,p}$). Here the data suggest the parenting style determines whether peer effects are a substitute or a complement to other inputs in the production of skills.

Parent's Preferences. We specify the parent's period utility in (2) as follows:

$$U(I_{i,t}, P_{i,t}, \epsilon_{i,t}) = \delta_1 \ln(1 - I_{i,t}) + \delta_2 P_{i,t} + \epsilon_{i,t}(P_{i,t}), \tag{8}$$

where δ_1 and δ_2 define the disutility of authoritative investment and of engaging in an authoritarian parenting style, respectively, and $\epsilon_{i,t}(P_{i,t})$ is a taste shock

[22] An alternative specification for the initial conditions would be to specify an exogenous bivariate joint distribution of children's skills and peer quality. However, in this case the initial peer quality would be exogenously determined and hence policy-invariant. Our model specification allows for immediate endogenous peer selection, which is important when evaluating policies that change the initial neighborhood composition, as we do below.

that is conditional on the parenting style. We assume that this shock follows a type-I extreme value distribution. The paternalistic utility of the parent takes the following form:

$$\tilde{u}(\theta_{i,t}, I_{i,t}, P_{i,t}) = \delta_3 \ln(\theta_{i,t}) \cdot (1 + \delta_4 P_{i,t}), \tag{9}$$

where δ_3 captures the level of the parent's paternalistic enjoyment of the child's skills, which may depend on the parenting style through parameter δ_4. The utility derived from the child's adult skills $\theta_{i,T+1}$ takes the same form as the period-by-period paternalistic utility from skills:

$$V^n_{T+1} = \delta_3 \ln(\theta_{i,T+1}).$$

In the empirical model, we set $Z = B = 1$. This is without loss of generality. An increase in either B or Z is equivalent to a proportional decrease in cost parameters δ_1 and δ_2. Changing B and/or Z would affect the numerical estimates of those parameters without altering the model fit or the counterfactual experiments.

Child's Preferences. The (marginal) utility child i earns from being friends with child j relative to not being friends with j is:

$$\begin{aligned} f_{i,j,t+1} = \gamma_0 + \gamma_1 \ln\theta_{i,t+1} + \gamma_2 \ln\theta_{j,t+1} + \gamma_3 (\ln\theta_{i,t+1} - \ln\theta_{j,t+1})^2 \\ + \gamma_4 \mathbb{1}(\theta_{j,t+1} < \theta_{i,t+1}) (\ln\theta_{i,t+1} - \ln\theta_{j,t+1})^2 P_{i,t} + \eta_{i,j,t+1}. \end{aligned} \tag{10}$$

Here, $\eta_{i,j,t+1}$ is a random taste shock for being friends with child j, which we assume to be i.i.d. standard logistic distributed. The terms $\gamma_1 \ln\theta_{i,t+1}$ and $\gamma_2 \ln\theta_{j,t+1}$ capture, respectively, the effect of child i's and child j's skills on the utility child i earns from being friends with child j, where γ_1 and γ_2 are parameters that will be estimated. The quadratic term $(\ln\theta_{i,t+1} - \ln\theta_{j,t+1})^2$ captures potential homophily bias in the formation of friends. A negative coefficient $\gamma_3 < 0$ would imply that the higher the difference in skills between the two children, the lower the utility for child i to be friends with child j.

The coefficient γ_4 captures the effect of an authoritarian parenting style on the preferences for child j's skills. In particular, if $\gamma_4 < 0$, authoritarian parenting

imposes a penalty whenever the child is friends with a lower-skill peer, where the penalty increases with the GPA gap between the two children. This formulation captures the idea that parental intervention (through, e.g., moral suasion, threat of punishment, or incentives) is designed to improve the quality of the child's peer selection.

We can now characterize the conditional probability that a friendship link between child i and child j is formed as:[23]

$$Pr(j \in \mathcal{X}_{i,t+1} | \theta_{i,t+1}, P_{i,t}, \theta_{j,t+1}, P_{j,t}) = \frac{\exp(\Gamma_{i,j})}{1+\exp(\Gamma_{i,j})} \frac{\exp(\Gamma_{j,i})}{1+\exp(\Gamma_{j,i})}, \tag{11}$$

where:

$$\Gamma_{i,j} = \gamma_0 + \gamma_1 \ln \theta_{i,t+1} + \gamma_2 \ln \theta_{j,t+1} + \gamma_3 (\ln \theta_{i,t+1} - \ln \theta_{j,t+1})^2 + \gamma_4 \mathbb{1}(\theta_{j,t+1} < \theta_{i,t+1}) (\ln \theta_{i,t+1} - \ln \theta_{j,t+1})^2 P_{i,t},$$

$$\Gamma_{j,i} = \gamma_0 + \gamma_1 \ln \theta_{j,t+1} + \gamma_2 \ln \theta_{i,t+1} + \gamma_3 (\ln \theta_{j,t+1} - \ln \theta_{i,t+1})^2 + \gamma_4 \mathbb{1}(\theta_{i,t+1} < \theta_{j,t+1}) (\ln \theta_{i,t+1} - \ln \theta_{j,t+1})^2 P_{j,t}.$$

The presentation of the parent's and child's preferences completes the description of the effects of parenting style in our model. To summarize, authoritarian parenting has a direct effect on the technology of skill formation given the current child's skill and peers. In addition, authoritarian parenting affects the process of peer formation by discouraging the child from choosing low-skill friends. Our estimates below imply that, conditional on an existing set of friends, an authoritarian parenting style entails productivity losses in the skill formation technology. The reason some parents still choose to be authoritarian must then lie in the benefits of an improved quality of future peers. It follows from this argument

[23] The conditional probability in Equation (11) might suggest a potential strategic interaction between parents when deciding about their own parenting style. However, under our assumptions, only the parent of the higher-skill child can actively affect the probability in Equation (11), so there is in fact no strategic interaction among parents. Note that in our model parents have an additional motive to invest in their children's skills, namely, to give them more opportunities to condition their children's choice of peers in the future.

that in wealthy and homogeneous neighborhoods, where most potential friends are highly skilled and there is little risk that one's child might associate with low-skill peers, the cost of an authoritarian parenting style is high while the benefit is small. Conversely, parents will tend to be authoritarian in neighborhoods where children face a high risk of exposure to low-skill peers.

4 Model Estimation

We estimate the model using the Simulated Method of Moments (SMM) by matching a set of moments generated from the Add Health data. More specifically, we follow an indirect inference approach where some of the target moments are estimated coefficients of reduced-form regressions including school-grade fixed effects.

We take the initial distribution of skills as exogenous, assuming that these are a sufficient statistic for fixed characteristics and past history, including innate ability, socio-economic status, parental behavior before adolescence, and random shocks, which we do not observe in our data.[24] Since residential choice can lead to ex ante sorting of families with different characteristics, we do not use the variation across schools in the estimation.[25] Instead, we identify the parameters using within-school-grade variation in the data. After the first period, heterogeneity in skills and exposure to peers is partly endogenous (as determined by the laws of motion of the model) and partly determined by preference shocks.

We target the following 28 moments:

1. Probability of parents being authoritarian: Aggregate fraction and regression of parenting style on current period own child's and peers' skills (three moments, see Table A-3).

[24] Appendix B provides details on the way we measure children's skills.

[25] The results are robust to controlling for parental education as discussed below (see Appendix C.2 and Table C2-1). One might still be concerned about selection by unobserved heterogeneity before high school starts. The mobility of the families with teenagers that enter our sample is, in contrast, rather low. Therefore, selection is a less severe concern when we compare pupils within school and grade.

2. Dynamics of a child's skills: Mean by school grades and regressions of a child's next-period skills on previous period own skills, peers' skills, and authoritarian parenting style (eleven moments, see Table A-4).

3. Dynamics of peers' skills: Number of friends and regressions of next-period peers' skills on previous period own skills, peers' skills, and authoritarian parenting style (eight moments, see Table A-5).

4. Parental investment: Mean and regressions of parental investments on current period own skills, peers' skills, and authoritarian parenting style (six moments, see Table A-6).

To estimate the model, we must define the neighborhoods in which children form friendships and solve for a local equilibrium in each neighborhood. A natural choice would be to have as many environments as there are schools in our sample. However, when implementing a simulation-based estimator, this approach becomes computationally infeasible. To overcome this issue, we pursue a parsimonious approach where a neighborhood is characterized by the mean and standard deviation of a log-normal distribution of initial skills. We carry out the estimation using synthetic neighborhoods based on the variation across schools observed in the Add Health sample. Specifically, we sort schools by average child skills and then form four synthetic neighborhoods from the quartiles of this distribution.

Table 4 summarizes the characteristics of these neighborhoods (from the lowest to the highest quartile). Using the data, we can map the quartiles of the skill distribution to quartiles of the income distribution. As expected, average grades are higher in high-income neighborhoods. The median real family incomes in 2016 US dollars for the four synthetic neighborhood are \$5,000 (Neighborhood 1), \$48,000 (Neighborhood 2), \$81,000 (Neighborhood 3), and \$102,000 (Neighborhood 4).

We first report the parameter estimates, then turn to the fit of the model to the target moments, and finally discuss the fit to untargeted moments.

Table 4: Characteristics of Synthetic Neighborhoods

	Mean (μ_e)	Standard Deviation (σ_e)	Population
Neighborhood 1	-0.55	0.87	269
Neighborhood 2	-0.28	0.98	307
Neighborhood 3	0.23	0.96	300
Neighborhood 4	0.59	0.84	210

The table shows the mean and standard deviation of grades (from log-normal distributions) in four synthetic neighborhoods. The associated distributions are the initial conditions in the structural estimation of the dynamic model of skill formation.

4.1 Parameter Estimates

Skill Formation Technology. Table 5 displays the estimates of the parameters of the skill formation technology in Equation (7). Recall that the parameters are different for parents adopting an authoritarian ($P = 1$) and a nonauthoritarian ($P = 0$) parenting style. For $P = 1$, we obtain estimates of the two elasticities of substitution close to unity.[26] Therefore, we report estimates of a parsimonious model in which we impose a Cobb-Douglas production such as:

$$H(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}, 1) = \theta_{i,t}^{\bar{\alpha}_{1,1}} \ \bar{\theta}_{i,t}^{\bar{\alpha}_{2,1}} \ I_{i,t}^{\bar{\alpha}_{3,1}}, \tag{12}$$

where $\bar{\alpha}_{1,1} = \alpha_{1,1}\alpha_{5,1}$, $\bar{\alpha}_{2,1} = (1 - \alpha_{1,1})\alpha_{2,1}\alpha_{5,1}$, and $\bar{\alpha}_{3,1} = (1 - \alpha_{1,1})(1 - \alpha_{2,1})\alpha_{5,1}$.

In contrast, the estimated elasticities are significantly different from unity for nonauthoritarian parents. Consider, first, $\alpha_{4,0}$. When $P = 0$, we estimate $\alpha_{4,0} > 0$, which implies that parental investment and peer quality are substitutes, as in Agostinelli (2018). This elasticity is primarily identified by the covariation between inputs in the technology of skill formation. For authoritarian parents, parental investment barely responds to the skills of the child and the peers, consistent with a unit elasticity. In contrast, nonauthoritarian parents spend more time with their children when the peer group is weak, consistent with an elasticity of substitution larger than unity.

The estimates of the other parameters also reveal interesting patterns. An author-

[26] The point estimates for the unconstrained CES specification are $\alpha_{1,p} = 0.772$, $\alpha_{2,p} = 0.382$, $\alpha_{3,p} = 0.009$, $\alpha_{4,p} = 0.009$, and $\alpha_{5,p} = 0.502$. See Appendix Table C1-1.

Table 5: Estimated Parameters of the Skill Formation Technology

	Cobb-Douglas (Authoritarian = 1)
Child's Skills ($\alpha_{1,1}$)	0.412 [0.321,0.460]
Peer Skills ($\alpha_{2,1}$)	0.214 [0.168,0.370]
Investments ($\alpha_{3,1}$)	0.073 [0.045,0.095]
	CES (Authoritarian = 0)
Complementarity Parents vs. Peers ($\alpha_{4,0}$)	0.784 [0.755,0.801]
Share Self-Production ($\alpha_{1,0}$)	0.564 [0.558,0.569]
Share Peer Skills ($\alpha_{2,0}$)	0.395 [0.385,0.404]
Complementarity Self-Production vs. Parents-Peers ($\alpha_{3,0}$)	-1.680 [-1.767,-1.587]
CES Returns to Scale ($\alpha_{5,0}$)	1.087 [1.046,1.175]
	Total Factor Productivity
TFP Constant (ψ_0)	0.418 [0.389,0.446]
TFP Age Trend (ψ_1)	0.025 [0.023,0.030]
TFP Parenting Style (ψ_2)	-0.299 [-0.326,-0.280]

The table shows the estimated parameters of the skill formation technology. See Equation (7) for $P = 0$ and Equation (12) for $P = 1$. The 95 percent confidence intervals in brackets are calculated via 100 school-clustered bootstrap repetitions. The point estimates are the averages among the bootstrap repetitions.

itarian parenting style reduces both the total factor productivity and the relative importance of peer effects.[27] Both results are intuitive and in line with the findings of the child development literature. For nonauthoritarian parents, we find a strong complementarity between the child's skills and the composite input of peer effects and parental investments ($\alpha_{3,0} < 0$). In plain words, nonauthoritarian parents invest more time when the child has high skill. This complementarity has an important implication: a combination of nonauthoritarian parenting

[27] In Appendix C.1, Tables C1-2 and C1-3, we estimate two specifications imposing that authoritarian and nonauthoritarian parents operate the same technology of skill formation. The fit of the model deteriorates significantly suggesting that a tradeoff between the influence on peer selection and the direct effect on human capital accumulation is an essential feature of the choice of parenting style in our theory.

and authoritative investments is highly productive for gifted children. Therefore, high-skill children are less likely to be subject to an authoritarian parenting style and more likely to attract other types of time-intensive (authoritative) parental investments. This insight casts a new light on the conventional wisdom in the child development literature that an authoritarian parenting style leads to poor child outcomes. This wisdom is rooted in the positive correlation found in observational data. Our structural theory implies that children with low cognitive or noncognitive abilities are more likely to attract an authoritarian parenting style. Thus, part of the correlation observed in the data might reflect (and according to our estimates, indeed does reflect) a reverse causation.

Table 6: Estimated Parent's Preference Parameters

Disutility of Investment (δ_1)	1 (Normalized) [-,-]
Disutility of Authoritarian (δ_2)	-2.208 [-2.516,-2.084]
Child's Skills (δ_3)	2.184 [2.049,2.336]
Authoritarian $\times$ Child's Skills (δ_4)	-0.208 [-0.225,-0.173]

The table shows the estimated parents' preference parameters; see Equations (8) and (9). The 95 percent confidence intervals in brackets are calculated via 100 school-clustered bootstrap repetitions. The point estimates are the averages among the bootstrap repetitions.

Preferences. Table 6 displays the estimates of parents' preferences. In the estimation, we exogenously set $\lambda = 0.95$, i.e., parents are highly paternalistic. It is difficult to find sources of variation in the data to credibly identify this parameter. The results are rather insensitive to changes in λ, as long as we stay in a high range. For lower values of λ, we cannot match the observed share of authoritarian parents.[28] According to our estimates, parents dislike being authoritarian (δ_2<0), and more so when children have high skills (δ_4<0).

[28]The results are very similar for any $\lambda \geq 0.9$. One could construct an alternative model where λ varies across parents and only some of them choose an authoritarian parenting style. This model would yield similar results.

Table 7: Estimated Child's Preference Parameters

Child i 's Skills (γ_1)	-0.184 [-0.199,-0.173]
Child j 's Skills (γ_2)	-0.191 [-0.201,-0.177]
Homophily (γ_3)	-0.286 [-0.320,-0.266]
Authoritarian (γ_4)	-0.468 [-0.502,-0.384]
Constant (γ_0)	-1.484 [-1.517,-1.438]

The table shows the estimated child's preference arameters, see Equation (10). The 95 percent confidence intervals in brackets are calculated via 100 school-clustered bootstrap repetitions. The point estimates are the averages among the bootstrap repetitions.

Table 7 shows the estimates for the child's preferences in the random utility model. The coefficients of own and peer skills are both negative, indicating that high-skill children are both less keen on forming friendship ties and less popular with other children. Intuitively, from a child's perspective, low-skill peers are more attractive friends than "nerdy" high achievers. The estimate of the homophily parameter has a negative sign. As this parameter multiplies the squared difference between own and peer skills, the negative point estimate implies a positive homophily bias, i.e., the larger the difference in skills between the two children, the less valuable the friendship. The parameter γ_4 captures the penalty from socializing with low-skill peers when parents are authoritarian. This penalty is quantitatively large: the estimate is almost twice the size of the homophily coefficient γ_3. Thus, an authoritarian parenting style has a strong causal effect on the child's future peer selection.

These estimation results paint a clear picture of the tradeoff involved in the choice of parenting style. An authoritarian parenting style entails a productivity loss in the skill formation technology but improves peer selection over time. Being authoritarian is therefore more attractive in poor neighborhoods, where the benefit

of improving the selection of friends is large. Also, all else being equal, it is the parents of children with many low-skill friends who have the strongest incentive to behave in an authoritarian fashion because their children's skill formation benefits little from their current peers. Finally, the (authoritative) time investment responds more to the quality of peers if the parent is nonauthoritarian. Specifically, parents who give children leeway spend more time with them when the quality of the peer environment is low. For all these reasons, parents are less prone to be authoritarian in wealthier neighborhoods.

4.2 Robustness: Heterogenous Effects by Education

In our main estimation, we kept the structural model parsimonious by limiting initial heterogeneity (before the first friendships are formed) to the single dimension of skill. A potential concern is that parenting style may correlate with and be partly determined by other characteristics that the model abstracts from. If so, the effect of parenting style could spuriously proxy for the effect of another variable.

A characteristic that is especially likely to be relevant is parental education, which is correlated with parenting style and could have independent effects on child development. To address this concern, we re-estimate the model while allowing for some of the key parameters to vary with parental education. We focus on mother's education to avoid selection problems related to the fact that in many families, fathers are not present. We distinguish between mothers with high education (some college or more) and with low education (high school or less). We allow this binary measure of mother's education to affect the preferences for parenting style and the total factor productivity in the skill formation technology. Arguably, these are the two most natural differences related to education. More educated mothers may dislike being authoritarian, and they may enhance the productivity of the technology of skill formation irrespective of the parenting style.

We find that parameters we assume to be independent of mother's education are estimated to be very similar to those estimated in the benchmark model. In the more flexible model, highly educated mothers have a higher cost of being au-

thoritarian and induce higher total factor productivity in the technology of skill formation. However, in neither case is the difference quantitatively large.[29] The estimation results suggest that allowing for heterogeneity in parents' education is not essential, at least during the high school years that we focus on. We therefore use the more parsimonious model without a direct role for parental education.

4.3 Sample Fit

Tables A-3 through A-6 report information about the sample fit of the model. Recall that the model is estimated by indirect inference, i.e., the SMM estimation targets the regression coefficients from the data. All regressions, both in the data and in the model, include school-grade fixed effects. The tables show how successful the simulated model is in matching the targeted moments.

Table A-3 focuses on the results of linear probability models where $P = 1$ (i.e., being authoritarian) is regressed on the child's and the peers' skills. For the reasons discussed above, parents are less likely to interfere with peer formation when their own children are proficient and when the peer group is of high quality. The model closely matches the sign and magnitude of the coefficients and also accurately predicts the total fraction of authoritarian parents.

Table A-4 displays results for the dynamics of skills. In the upper panel, the child's next-period skills are regressed on her own current skills, the average skills in her peer group, and the parenting style to which she is subjected. Both in the model and in the data, the coefficient of the child's skills is the largest; the coefficient of the peers' skills is smaller and yet sizeable. Both in the model and in the data, the reduced-form effect of parenting style on the next period's skills is small.[30] In particular, the point estimate is negative in the model and positive

[29] The results can be found in Appendix C.2.

[30] In the data, the effect is positive but statistically insignificant. Interestingly, the regression coefficient turns positive and highly significant if we restrict the sample to intact (i.e., two-parent) families. In the data the small size of the effect is largely explained by families with single mothers—a similar argument applies to Table A-5 below. Since our model abstracts from this dimension, we conservatively target the small positive coefficient that we find for all families. Our structural estimate implies a large causal effect of an authoritarian parenting style even though the targeted reduced-form effect (that is confounded by selection issues) is small. The causal effect would be even larger if we targeted the regression coefficient for intact families.

but statistically insignificant in the data. The lower panel shows the evolution of mean skills throughout the high school years in the model and in the data. Again, the fit is very good.

Table A-5 compares the regression coefficients for the evolution of peer skills in the model and in the data. In the data, the correlation of authoritarian parenting with the quality of peers in the next period is insignificant. Interestingly, the correlation is also low in the linear regression generated by the model, in spite of the large positive causal effect of authoritarian parenting on the selection of peers discussed above.

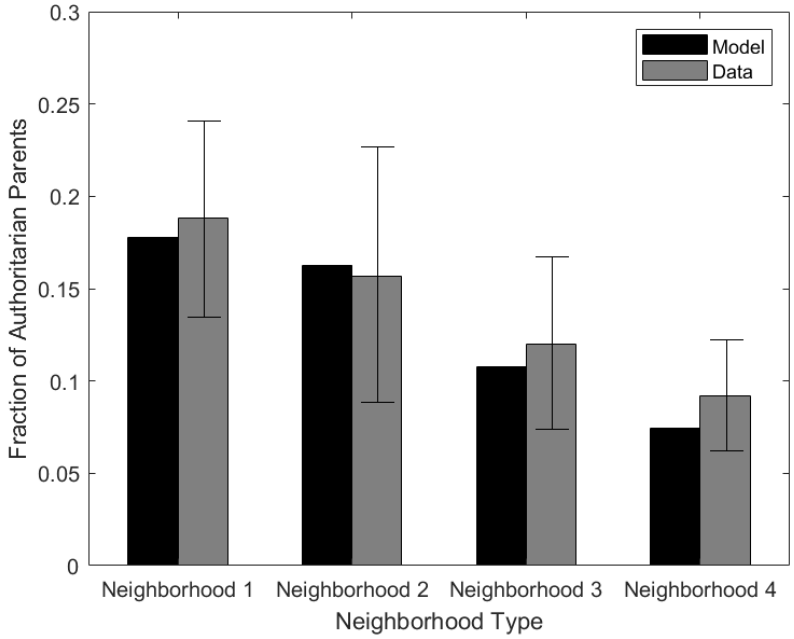
Table A-6 displays results for authoritative parental investments broken down by (authoritarian versus nonauthoritarian) parenting style. For authoritarian parents, time investments are unresponsive to both the child's and the peers' skills. The model accounts for this finding by estimating a unit elasticity (Cobb Douglas) in the skill formation technology. In contrast, when $P = 0$ parental investments are positively associated with the child's skills and negatively associated with the peers' skills. The model accounts for this pattern by estimating a higher elasticity of substitution in the CES technology, as discussed above. Note that the average level of investment also strongly depends on the parenting style, with a good fit between the model and data.

4.4 Fit for Non-Targeted Moments: Parenting Across Neighborhoods

In this section, we assess the accuracy of the estimated model in matching non-targeted moments. We compare the model predictions with data moments across the four synthetic neighborhoods that determine the peer environment. Recall that our estimation targets the coefficients of linear regressions exploiting within-school-grade variation. Since we did not target any variation across neighborhoods, this variation is an ideal testing ground to evaluate the success of the model in fitting non-targeted moments.

Figure 3 shows the fraction of authoritarian parents in each neighborhood predicted by the model and its empirical counterpart, namely, the average across all the schools that make up a synthetic neighborhood. In the data, the fraction of authoritarian parents is strongly decreasing as one moves from the less to the

Figure 3: Out-of-Sample Fit: Parenting Style and Neighborhood

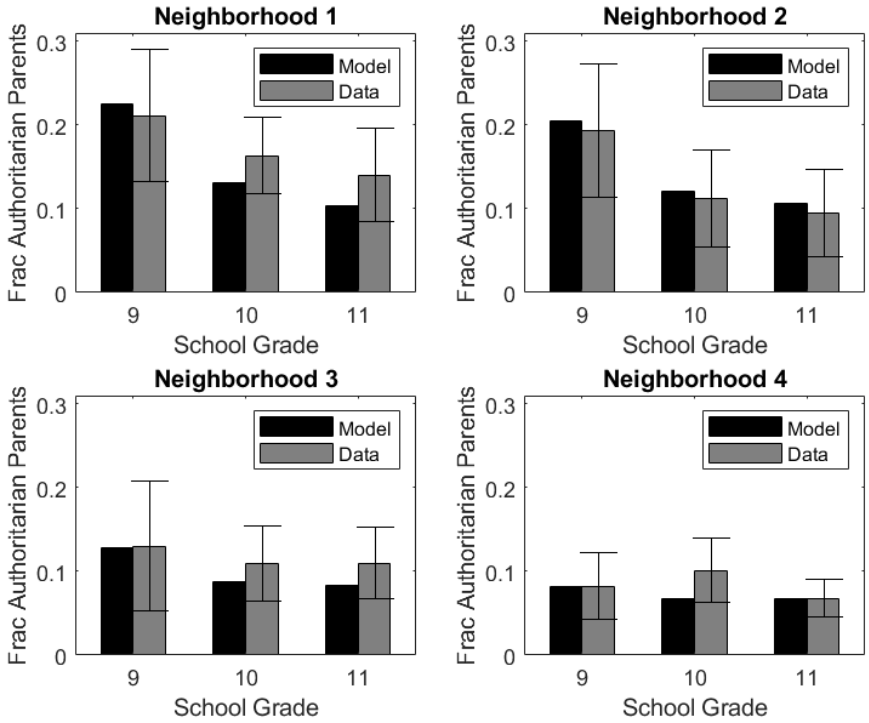


The figure shows the out-of-sample predictions of the model. The figure displays the fraction of authoritarian parents by neighborhood type as predicted by the model and as observed in the data. We calculate the model's predicted fraction of authoritarian parents as the average fraction among 50 different model simulations.

more advantaged neighborhoods. The model matches the data closely. In the poorest neighborhood, 18 percent of parents are authoritarian, while in the most affluent synthetic neighborhood this share is only 7 percent. In the model, the difference hinges on the estimated parameters of the skill formation technology. In high-quality neighborhoods, parents face better initial conditions in terms of both the peer environment and the skills of their own children. Because an authoritarian parenting style reduces the productivity of these inputs (by lowering total factor productivity and the effect of peers), the opportunity cost of authoritarian parenting is higher compared to poor neighborhoods, where parents are more focused on improving the child's peer group.

Figure 4 breaks down this result further by grade and neighborhood. Here, we see that in the two low-SES (socio-economic status) neighborhoods, the fraction of authoritarian parents declines as children advance through the grades,

Figure 4: Out-of-Sample Fit: Parenting Style Dynamics and Neighborhood



The figure shows the out-of-sample predictions of the model. The figure displays the fraction of authoritarian parents over school grades by neighborhood type as predicted by the model and as observed in the data. We calculate the model's predicted fraction of authoritarian parents as the average fraction among 50 different model simulations.

whereas the relationship is flat in the two high-SES neighborhoods. Once again, the estimated model fits these empirical observations well.

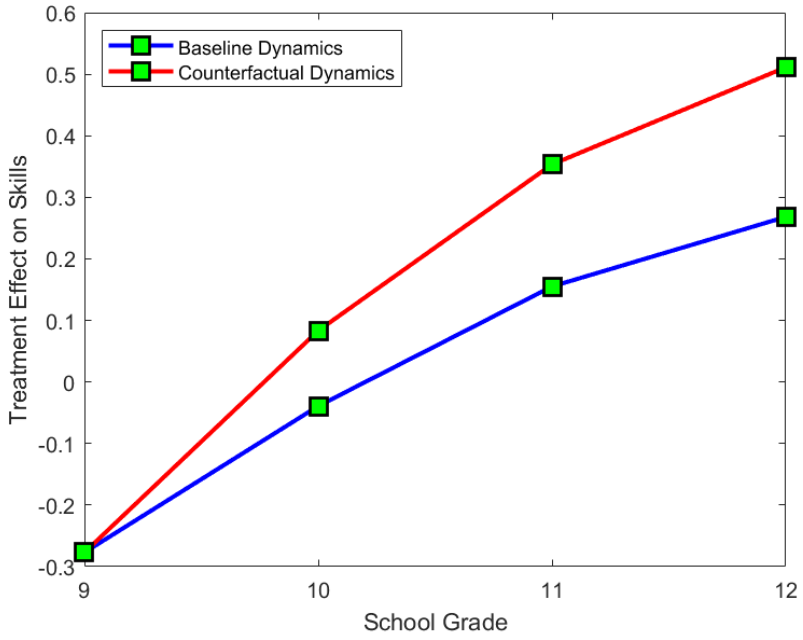
5 Parents, Peers, and the Effect of Policy Interventions

In this section, we study how parenting practices respond to policy interventions that change the peer environment. In particular, we run counterfactual policy experiments based on the estimated structural model. We consider two sets of experiments. The first is a "busing policy" that moves some children from a disadvantaged to a wealthy neighborhood. The second is a change in the initial conditions, which we interpret as resulting from interventions affecting children's skills before they start high school.

5.1 Busing Policy

Consider a policy experiment moving children from the synthetic neighborhood with the second-lowest SES (henceforth, N2) to the synthetic neighborhood with the highest SES (henceforth, N4). Recall that the median family income of N2 is \$48,000, whereas that of N4 is \$102,000. These numbers compare to a national median family income of \$58,000 in 2016, the year in which income is measured. The initial difference in children's mean skills between these neighborhoods is 0.87 standard deviations. We are interested in the individual treatment effect of being moved to a better neighborhood, the mechanisms behind this treatment effect, and how the treatment effect changes as the policy is scaled up to include more students.

Figure 5: Treatment Effects of Moving



The figure shows the treatment effect on a child's skills of moving a child in 9th grade from N2 to N4. The blue line displays the baseline skills dynamics for the median child in the skills distribution in N2. The red line shows the counterfactual skills dynamics if the child is moved to N4 at the beginning of her 9th grade. The skill dynamics are calculated by averaging among 50 different model simulations.

Individual Treatment Effects: Figure 5 shows the dynamic treatment effect for

a single child who is relocated from N2 to N4 when entering 9th grade. The blue line displays the average evolution of skills for a typical child staying in N2 throughout the high school years. The red line shows the counterfactual evolution of skills if the same child is moved to N4. The treatment effect starts showing up in 10th grade because skills are predetermined at the beginning of 9th grade. Subsequently, a growing gap opens up between the benchmark and counterfactual skills. The treatment effect increases over time because of the dynamic complementarity between skill accumulation and friendship formation. More concretely, the gain in skills accruing to the moved child in 10th grade has a positive effect on skill accumulation in the following periods and also improves the peer group the child is exposed to owing to the homophily bias in preferences.

To gauge the quantitative importance of the policy, we compare our treatment effect with the quasi-experimental evidence of Chyn (2018). Chyn studies the effect of a plausibly exogenous shock, namely public housing demolition, that forced many families to leave very poor neighborhoods in Chicago. Three years after demolition, the displaced families lived in neighborhoods with lower poverty and less violent crime compared to similar families who did not have to move. The children who moved out of the very poor neighborhoods earned on average $602 more per year during their first adult years than those who stayed—a difference of 16 percent. In addition, displaced children had 14 percent fewer arrests for violent crimes and a significantly lower probability of dropping out of high school.

To compare the effect of moving one child from N2 to N4 in our model to Chyn's results, we perform the following back-of-the-envelope calculation. First, we convert differences in children's school performance into differences in earnings by regressing adult earnings in the Add Health data on our measure of skills during adolescence. Second, we note that according to our estimates, a child bused from N2 to N4 experiences an increases in skills equal to about 0.2 standard deviations. These two pieces of information imply that moving a child (in isolation) from N2 to N4 increases future annual earnings by about $900 to $1,000.[31]

Our back-of-the-envelope calculation yields an effect that is 50 percent larger

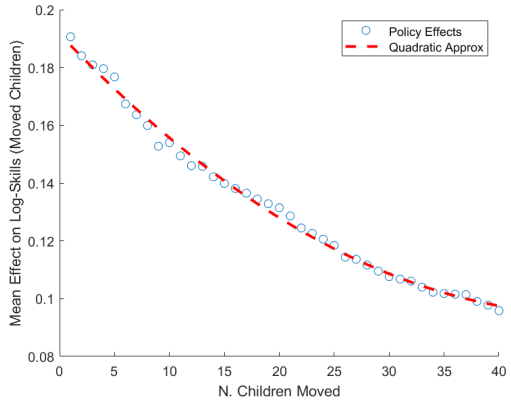
[31] For comparability with Chyn (2018), we express monetary values in 2012 dollars.

than the causal effect estimated by Chyn (2018). To account for the difference, recall that our busing policy moves children from a moderately poor neighborhood to the best available neighborhood in the economy. This change in neighborhood quality is larger than the typical experience of a child who was displaced by the public housing demolition. Furthermore, our monetization of the skill differences in Add Health is based on an empirical correlation of test scores and earnings that may be larger than the causal effect of test scores. With these caveats taken into account, the sizeable policy effects predicted by the model are in the ballpark of recent estimates of neighborhood effects in the literature.

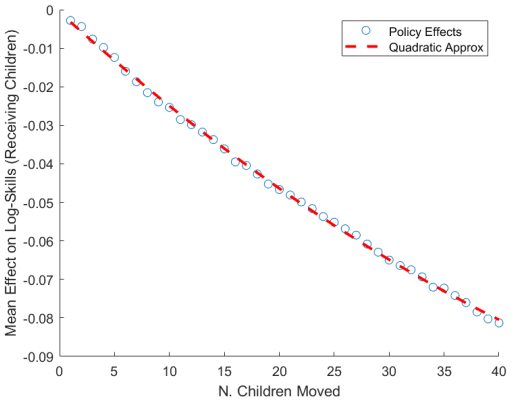
Scaling Effects: Figure 5 refers to the case in which one child is moved in isolation from N2 to N4. If many children are moved together, the treatment effect changes, because the policy has a larger effect on the peer environment in N4. Figure 6 shows how the effect of busing children from N2 to N4 changes with the scale of the policy. The upper and lower panels show the effects for the children who are relocated and for those in the receiving community, respectively. A small-scale policy yields large gains for the moved children and very small effects on the receiving community. As the number of children increases, the positive effects for the moved children decline, while the negative effects for the receiving community increase. The differences are quantitatively large. When 40 children are moved together, the positive treatment effect on bused children is almost cut in half compared with the case of a single bused child. Moreover, the children in the wealthy neighborhood experience skill losses that are almost as large as the gains of the arriving ones. Given that there are more receiving children than new arrivals (there are initially 210 children in each school), the average effect on skill accumulation for all children involved (i.e., both moved and receiving children) turns negative as the policy is scaled up.

Multiple factors contribute to the deteriorating effect of the policy as it is scaled up. To start with, there is a mechanical dilution effect: as more children are relocated, the peer environment of the receiving neighborhood worsens. In addition, there are two more interesting endogenous mechanisms. The first is the endogenous peer group formation. In our model, lower-skill children are attractive as peers. This implies that as more low-skill children arrive, peer groups become

Figure 6: Policy and Scaling Effects on Skills



(a) Moved Children



(b) Receiving Children

The figure shows the equilibrium policy effect on skills in 12th grade of moving children from N2 to N4 as a function of the number of moved children. Panel (a) illustrates the average effect for moved children. Panel (b) illustrates the average effect for receiving children. Each dot represents the average impact on skills for either moved children (Panel a) or receiving children (Panel b) for a given number of moved children. Each dot is calculated by averaging among 50 different model simulations.

disproportionately tilted toward them. In addition, because of the homophily bias, a large share of the bused children form ties with each other, thereby reducing the benefits from liaising with the high-skill children in the receiving community.

The second mechanism stems from the behavioral response of parents. Panels

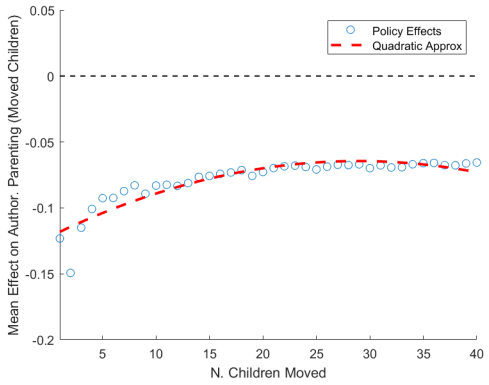
(a) and (b) of Figure 7 show how the parents of relocated children adjust their behavior as the scale of the program increases. If a single child moves from N2 to N4, the parent turns less authoritarian, which is a rational response to the more favorable peer group in N4. On its own, this shift in parenting style promotes skill accumulation. However, the authoritative investment of the nonauthoritarian parents decreases in response to the improved peer environment. Both of these effects fade away as more children are relocated to N4.

Panels (c) and (d) of Figure 7 show the response of parents in the host community. The scale of the policy increases the share of authoritarian parents. Intuitively, as more low-skill children arrive, parents in N4 increasingly worry about their own children befriending them, and more of them turn authoritarian. Other parents, especially those of the most proficient children, do not turn authoritarian but rather increase the time (authoritative) investments to compensate for the weaker peer environment. Both parental responses increase with the scale of the policy.

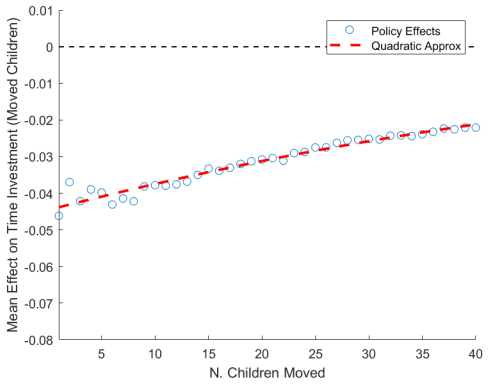
Both the homophily in peer-group-formation and the endogenous pushback of parents lead to more segregation as the policy is scaled up. In other words, as more children are bused, there is less mixing between the locals and the new arrivals.

The Importance of Endogenous Parenting Behavior: Given the presence of multiple channels, how important is the endogenous response of parents alone? To answer this question, we run alternative policy counterfactuals in which we hold parenting style fixed at the baseline level while allowing all other channels (dilution of the peer group and endogenous peer group formation) to operate. The results are shown in Figure 8. The upper panel compares the effect of the busing policy on the skill accumulation of the moved children with (blue dots) and without (red dots) an endogenous response in parenting. The gains would be substantially larger if parents did not change their behavior. A large share of this difference stems from the decline in authoritative investments. Bused children's parents who were already nonauthoritarian "slack off," i.e., spend less time with their children because their children now have better peers, and peer effects and time investments are substitutes. This effect is stronger when only a few children are moved because the peer environment in N4 is best in this case. An effect of

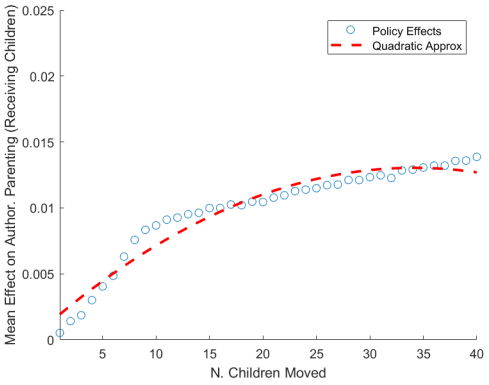
Figure 7: Policy and Scaling Effects on Parental Behavior



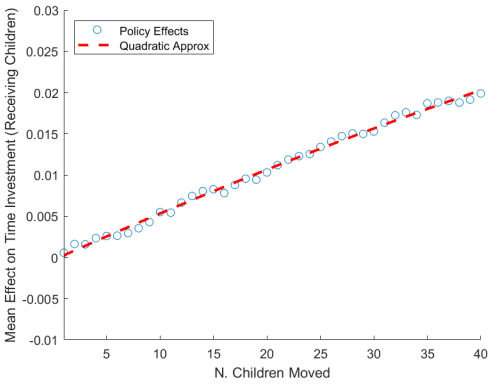
(a) Authoritarian (Moved)



(b) Time Investment (Moved)



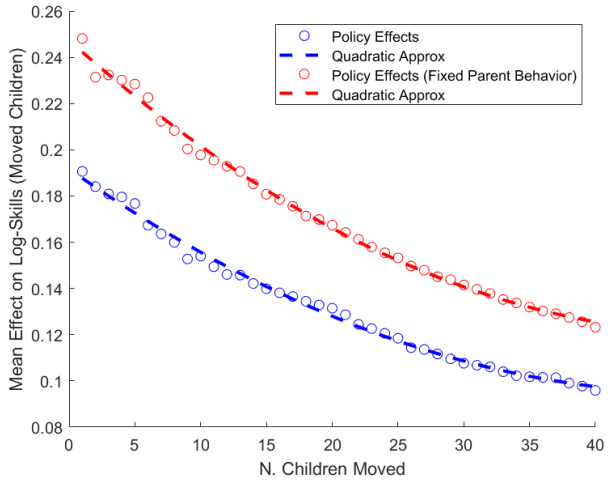
(c) Authoritarian (Receiving)



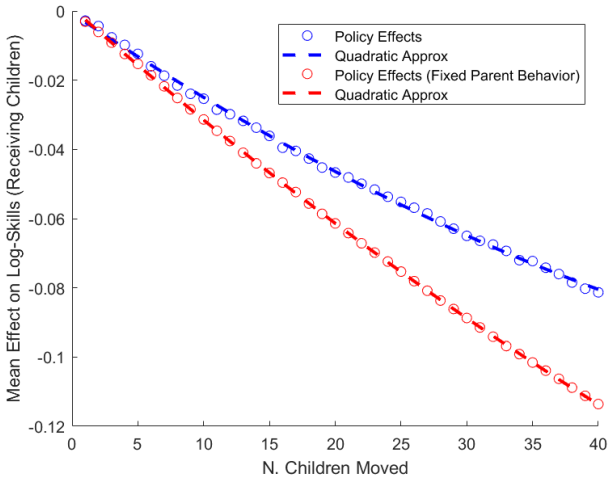
(d) Time Investment (Receiving)

The figure shows the equilibrium policy effect on the probability of being authoritarian (Panels (a) and (c)) and on parental time investment (Panels (b) and (d)) of moving children from N2 to N4 as a function of the number of moved children. Panels (a) and (b) illustrate the policy effect on parental behavior for moved children. Panels (c) and (d) illustrate the policy effect on parental behavior for receiving children. Each dot represents the average impact on parenting style or parental investments for either moved children (Panels (a) and (b)) or receiving children (Panels (c) and (d)) for a given number of moved children. Each dot is calculated by averaging among 50 different model simulations.

Figure 8: Endogenous Parental Behavior and Policy Effects



(a) Moved Children



(b) Receiving Children

The figure shows the quantitative importance of the endogenous parental response for the counterfactual policy effects. The outcome is skills in 12th grade. The blue lines represent the equilibrium policy effects on skills in 12th grade of moving children from N2 to N4 as a function of the number of moved children (as in Figure 6). The red lines show the effect of the policy when parental behavior is held fixed. Panel (a) illustrates the effect for moved children. Panel (b) illustrates the effect for receiving children. Each dot represents the average impact on skills for a given number of moved children. Each dot is calculated by averaging among 50 different model simulations.

the opposite sign is that fewer parents of the bused children behave in an authoritarian fashion, but this effect appears to be smaller. Finally, skill accumulation is adversely affected by the behavior of parents in the receiving community (more of them turn authoritarian).

The lower panel of the figure displays results for the skill accumulation of the children living in N4. Holding parenting behavior constant would increase skill losses, and more so as the program is scaled up. The parents of these children rationally protect them from a less favorable peer environment, at the expense of the poorer children. The quantitative effect is large: when 40 children are moved from N2 to N4, the change in parenting style of parents in N4 reduces the negative effect on their children's skill accumulation by about 30 percent.

5.2 Changing Initial Conditions

In this section, we study counterfactual changes in the initial distribution of skills, emphasizing different forms of reductions in inequality. We can interpret these experiments as interventions occurring before children reach high school, which range from early childhood education policies to targeted interventions in middle school.

Altering the initial distribution of skills will affect the process of friendship formation from the first period onward and will also affect skill formation through peer effects and endogenous parental responses. We evaluate the effect of these policies by comparing moments of the skill distribution in 12th grade.

The first column of Table 8 describes how we change initial conditions. The other columns report the effects (relative to the baseline) on the mean skill accumulation, on three measures of inequality (where the 10th percentile is reported to zoom in on poor families), and on parenting decisions. The table shows the aggregate effect (across all neighborhoods) and its breakdown into below- and above-median neighborhoods.

No Inequality. The first experiment equalizes the initial human capital of all students while keeping the national mean at the baseline level. Although there is no inequality in the first year, some differences materialize over time because

Table 8: Counterfactual Policy Experiments: Changing Initial Conditions (e.g., Early Childhood Interventions)

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Aggregate					
	Mean	90–10 Ratio	10th Percentile	Gini	Author Parenting	Time Inv
No Inequality	6.80%	-40.90%	43.33%	-0.11	-0.06	0.07
No Between-Neighb. Inequality	-4.23%	-12.32%	2.34%	-0.03	0.01	0.00
No Within-Neighb. Inequality	10.94%	-13.82%	27.33%	-0.03	-0.07	0.06
Truncate Local Distrib. at 10th percent	8.32%	-6.68%	13.89%	-0.01	-0.03	0.00
Halving Cost of Parental Investments	27.45%	10.39%	19.17%	0.02	-0.03	0.16
	Panel B: Low-Income Neighborhood					
	Mean	90–10 Ratio	10th Percentile	Gini	Author Parenting	Time Inv
No Inequality	29.63%	-33.95%	64.11%	-0.09	-0.11	0.05
No Between-Neighb. Inequality	15.91%	-0.38%	15.28%	-0.00	-0.03	-0.02
No Within-Neighb. Inequality	7.40%	-32.51%	34.18%	-0.09	-0.08	0.05
Truncate Local Distrib. at 10th percent	6.45%	-11.20%	14.96%	-0.03	-0.04	0.01
Halving Cost of Parental Investments	25.15%	9.69%	17.91%	0.02	-0.03	0.16
	Panel C: High-Income Neighborhood					
	Mean	90–10 Ratio	10th Percentile	Gini	Author Parenting	Time Inv
No Inequality	-15.96%	-19.29%	-6.01%	-0.05	0.00	0.09
No Between-Neighb. Inequality	-25.47%	19.28%	-33.32%	0.04	0.08	0.02
No Within-Neighb. Inequality	11.58%	-19.85%	25.19%	-0.05	-0.03	0.04
Truncate Local Distrib. at 10th percent	8.72%	-8.23%	14.63%	-0.02	-0.02	-0.01
Halving Cost of Parental Investments	29.42%	6.24%	23.93%	0.01	-0.02	0.17

The table shows the results for a set of different counterfactuals (each row represents a different counterfactual). All the results are compared to the baseline economy. Each result is calculated by averaging among 50 different model simulations. Columns (1) to (3) are percentage changes relative to the baseline model, and columns (4) to (6) are absolute changes compared to the baseline.

random utility shocks lead to the formation of different peer networks. However, final inequality falls drastically short of the baseline, which is hardly surprising. More interestingly, equalizing opportunities increases the average skill accumulation—the gain in poor neighborhoods exceeds the loss in rich ones. This results stems, in part, from a decline in the popularity of the authoritarian parenting style in poor neighborhoods: the share of authoritarian parents drops from 17 to 9 percent. In the equal-opportunity society, parents cease to be worried about protecting their children from bad influences, which boosts the productivity of the skill formation technology (recall that an authoritarian parenting style is associated with lower total factor productivity). This effect is reinforced by a significant increase in authoritative parental investments across all neighborhoods. Authoritative investments increase in poor neighborhoods because parents stop being authoritarian. In previously rich neighborhoods, parents compensate for

the worse peer environment by increasing their own time investment.

No Inequality Between Neighborhoods. The second experiment equalizes initial conditions across neighborhoods, setting inequality in each location equal to the nationwide level in the baseline economy. In other words, the overall inequality (measured by the variance of the log-normal distribution of skills) is unchanged, but all inequality is within neighborhoods. The policy can be interpreted as an eradication of residential segregation. Like in the first experiment, the policy increases skill accumulation in low-income neighborhoods and decreases it in high-income neighborhoods. However, the aggregate effect in terms of average skill accumulation is now negative. Although inequality declines, the gain for the families in the bottom decile is small. This might be surprising at first glance, given that disadvantaged children now live in more diverse neighborhoods where they can interact with strong peers. However, eliminating residential segregation does not guarantee that those children will actually form many friendships with high-skill peers. Both the homophily bias and the increasing number of authoritarian parents raise new barriers to the social integration of children of different initial skills.

No Inequality Within Neighborhoods. In the third experiment, we remove all within-neighborhood inequality while leaving intact the original inequality between neighborhoods.[32] While the reduction in overall inequality is similar to the previous case, this experiment boosts the average skill accumulation more strongly. Average skills across the economy now increase, and the gains are especially large for families in the bottom decile, who enjoy a 27 percent gain relative to the baseline. Both the demise of the authoritarian parenting style and the increase in authoritative investments explain these results.

No Lower Tail Inequality. The fourth experiment consists of truncating the initial skill distribution at the 10th percentile within each neighborhood and redistributing the lower tail in proportion to the original distribution at each other

[32]Note that in this experiment total inequality declines because we do not compensate the reduction in within-neighborhood inequality by an increase between neighborhoods. If we do the compensation so as to hold total inequality at the same level as in the baseline, the average effect is still positive but highly asymmetric across rich and poor neighborhoods, which is largely driven by the artificial increase in between-neighborhood inequality.

percentile. This can be interpreted as a form of early childhood intervention that targets the most-disadvantaged groups in each neighborhood's population. This policy generates larger average gains than those associated with shutting down inequality altogether. Although part of this gain accrues mechanically, the endogenous dynamics of skills and peers ensure that the gains are persistent and are even amplified over time. The policy triggers a significant decrease in the incidence of the authoritarian parenting style by about one quarter relative to the baseline. This counterfactual highlights an additional benefit of early childhood interventions that has not been captured by past research: by reducing the share of "problematic" low-skill peers in the population, the policy makes parenting more relaxed overall, which reduces the barriers faced by the more disadvantaged children and improves skill formation.

Subsidy to Time-Intensive Parental Investments. Finally, we consider a policy that reduces the cost of authoritative investments. The size of the policy is such that the investment cost halves, resulting in an increase of investment by 16 percentage points (the investment variable ranges between 0 and 1 with an average of 0.33). The effects of the policy are beneficial across the board. While a large part of the gains stem from higher parental investments, there is also a shift in parenting styles, with a reduction in the share of authoritarian parents by 2–3 percentage points.

Across all the policies considered, we find that endogenous parental responses play an important role in shaping the effects of the intervention. There is a particularly high upside to interventions that reduce local inequality. Such policies improve the peer environment and thereby reduce the share of parents that adopt an authoritarian style. This shift in parenting has a direct positive impact on skill accumulation (through productivity) and additional benefits for inequality because it promotes interactions between peers from different backgrounds.

6 Conclusions

In this paper, we examine the effect of parenting style on the skill formation of children during the high school years. This is a phase when peers increasingly replace parents as the most important influence on children. Nevertheless, we

argue that parents continue to play an important role, in significant part because of their influence on their children's peer formation, i.e., on who their children's friends are.

We capture the mutual interactions between children, parents, and peers by constructing and estimating a dynamic rational choice model of skill formation with endogenous peer effects. In the model, children choose who to be friends with. Parents can choose whether to intervene in their child's choice of friends by discouraging friendships with low-skill peers. We interpret the choice to interfere in peer formation as adopting an authoritarian parenting style. This choice of parenting style involves a tradeoff: while an authoritarian parenting style can improve the quality of the child's peer group, the interference jeopardizes a harmonious family life and may make the child less receptive to other forms of parental investments. Indeed, our estimation implies that authoritarian parenting reduces the productivity of the technology of skill formation. As a result, parents adopting a nonauthoritarian style give up on directly influencing their child's selection of friends, but are more effective at fostering their children's skill formation through other time investments.

The choice of parenting style hinges on the peer environment that children face. In an affluent and homogeneous neighborhood, parents have little reason to be concerned about their children's peer selection, and are likely to adopt a nonauthoritarian style. In contrast, in low-income and unequal neighborhoods where there is high exposure to the influence of disruptive peers, parents are more likely to choose to be authoritarian. This is particularly true for parents of children who themselves have relatively low skills, because such children (given homophily bias in peer preferences) are especially likely to associate with low-skill peers.

The model is estimated using an indirect inference approach that exploits variation in skills and peers within school and grades. The estimated model provides a good out-of-sample fit across neighborhoods with different socio-economic characteristics.

We use the estimated model to evaluate the impact of a counterfactual busing policy whereby children from a low-SES neighborhood are moved to a school in an affluent area. Our model is well-suited to study how the benefits of the

policy change as it is scaled up, i.e., many disadvantaged children are moved to a better school at the same time. We find that scaling up substantially lowers the treatment effect: when 40 children instead of a single child are moved, the improvement in the moved children's skills is almost cut in half. A significant part of the treatment effect stems from endogenous parental behavior. As more children are moved, more parents in the affluent host community adopt an authoritarian parenting style and discourage their own children from befriending the new arrivals. This defensive response reduces the benefits of the policy as it is scaled up.

The conclusions of our study raise broader questions about the interpretation of reduced-form estimates of neighborhood effects (e.g., Chetty, Hendren, and Katz 2016). When a single family moves to a better neighborhood, the children may indeed enjoy large gains, in part because of better peer effects. However, larger-scale policies such as building social housing in affluent areas can trigger reactions that limit their effectiveness. Our analysis highlights two types of barriers that might emerge as the scale of a policy intervention grows. The first is homophily bias in children's preferences. Residential proximity does not guarantee that children from different socio-economic status will mingle with each other and form friendships. The second is endogenous parenting decisions. When a large number of children are moved from disadvantaged areas into an affluent community, local parents may start to actively discourage their children from mixing with the newcomers.

The common thread across all policy experiments we consider is that the two forces of endogenous peer group formation and endogenous parenting behavior have a substantial impact on outcomes. This is also apparent when we study the effect of policies that reduce skill inequality before children enter high school. Policies that increase the heterogeneity of peer groups tend to reinforce segregation, driven both by homophily bias in children's preferences and by an increase in authoritarian parenting. The result of a counterfactual experiment in which we remove residential segregation entirely is a testimony to the challenge of promoting integration. This policy has a negative effect on average skill accumulation and limited benefits even for children in the bottom decile of the skill

distribution. In contrast, policies that curb lower-tail local inequality are promising. Generally, successful policies work at least in part through a reduction in the popularity of the authoritarian parenting style.

Our analysis does not consider a variety of aspects that may be important in reality. We have no information on residential choice before children start high school. We also do not emphasize heterogeneity in the quality of parental inputs across families. The data show, for instance, that parenting style has heterogeneous effects across intact and single-parent family environments. Also, our data are from the 1990s. New technologies may affect the structure of social interaction across children as well as the effect of parents' interference with the process of skill formation. Another limitation is that we proxy peer effects by the average quality of friends. The dynamics of children's networks are clearly more complex and worth a more thorough investigation. In spite of these and other limitations, our paper provides a first theory- and data-driven exploration of the dynamic interaction between parenting, children's decisions, and society in the process of skill formation of teenagers.

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Appendices

A Additional Figures and Tables

This section provides additional figures and tables aimed at complementing the empirical analysis of the paper.

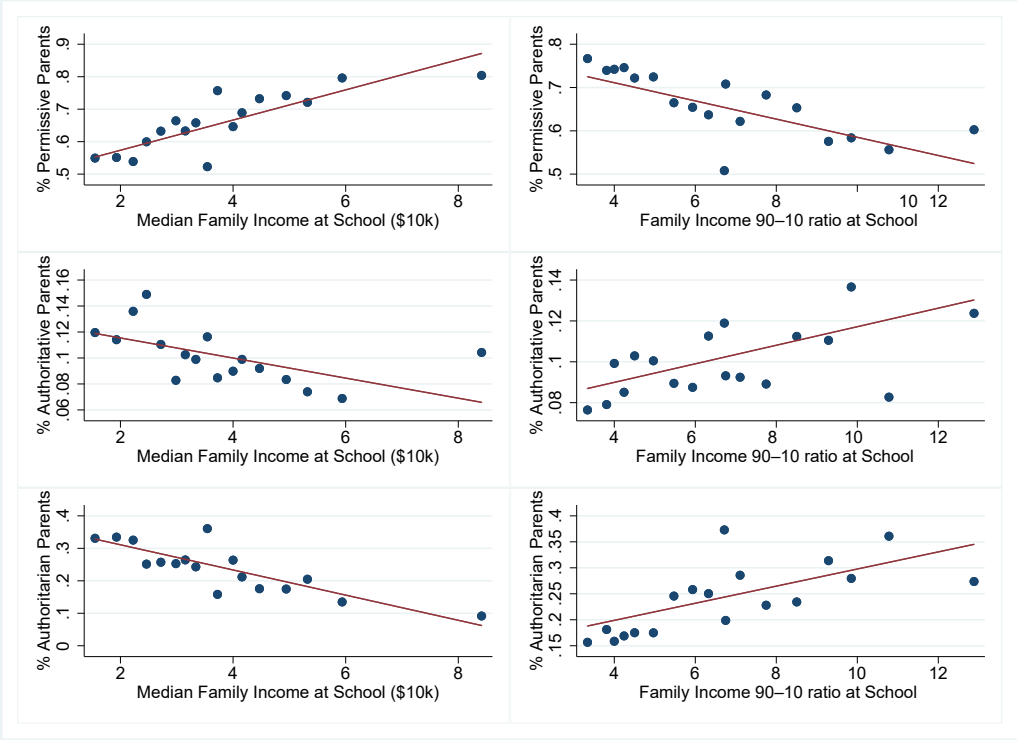
Figure A-1 shows the correlation between parenting styles and neighborhood quality. The definition of parenting styles mirrors the one in Doepke and Zilibotti (2017) and is based on the answer parents give to the question: "Of the following, which do you think is the most important thing for a boy/girl to learn? Be well-behaved, work hard, think for himself, help others, be popular." We define authoritarian parents as those who choose "be well-behaved," authoritative parents as those opting for "work hard," and permissive parents as those who choose "think for themselves." Neighborhood quality is defined as the median family income in the school attended by the child (left panels), or as the 90–10 ratio for family income at the school level (right panels).

Table A-1 shows the summary statistics for the variables used in the empirical analysis.

Table A-2 replicates the analysis of the effect of neighborhood quality on authoritarian parenting by using the within-school within-grade GPA Gini coefficient as the measure for inequality.

Tables A-3 through A-6 show the sample fit of the model. Table A-3 reports the sample fit for the estimates of a linear probability model of authoritarian parenting style on a child's and peers' skills. Table A-4 focuses on the linear regression model of a child's next-period skills on current skills, peers' skills, and authoritarian parenting style. Table A-5 shows the estimates for the regression of the next-period average peers' skills on the child's current period skills, peers' skills, and authoritarian parenting style. Finally, Table A-6 reports the estimates for regressions of authoritative parental investments on the child's current period skills and peers' skills, with a breakdown between authoritarian and nonauthoritarian parents.

Figure A-1: Parenting Style and Neighborhood Quality



The figure shows how the incidence of the three parenting styles (permissive, authoritative, and authoritarian) varies with within-school average family income (left panel) and inequality (right panel). The measure of parenting style follows Doepke and Zilibotti (2017) and is discussed in the text. Inequality is measured by the 90th–10th percentile ratio of within-school family income. The top, central, and bottom panel show the incidence of permissive, authoritative, and authoritarian parenting style, respectively.

Table A-1: Sample Statistics

	Wave I: In-School Inteview		
	Mean	SD	Obs
English Grade	2.84	0.97	38,300
Math Grade	2.71	1.03	38,300
History Grade	2.89	0.99	38,300
Science Grade	2.81	1.01	38,300
Child's GPA	2.81	0.78	38,300
N of Schools	66		
	Wave I: In-Home Inteview		
	Mean	SD	Obs
Real family income (in 2016 US dollars)	75,544	81,151	7,685
Talked with your mom about a party you attended	0.52	0.50	9,627
Talked with your mom about a personal problem	0.41	0.49	9,627
Worked with your mom on a project for school	0.11	0.31	9,627
Do your parents let you choose your own friends?	0.13	0.34	10,057
PPVT Score	66.16	11.13	9,838
	Wave II		
	Mean	SD	Obs
English Grade	2.89	0.93	3,744
Math Grade	2.70	1.02	3,744
History Grade	2.94	0.97	3,744
Science Grade	2.86	0.98	3,744

The table shows some summary statistics for the variables and sample used in our estimation. Note that we restrict the original sample in Add Health to high schools with at least 200 children and to cohorts with at least 100 students.

Table A-2: Authoritarian Parenting and Neighborhood Quality

	Authoritarian					
	(1)	(2)	(3)	(4)	(5)	(6)
Mean GPA within Grade	-0.114**		0.025	-0.059		0.025
	(0.046)		(0.056)	(0.042)		(0.052)
Gini GPA within Grade		0.032***	0.036***		0.021**	0.025**
		(0.008)	(0.011)		(0.009)	(0.011)
Mean Dep	0.130	0.130	0.130	0.130	0.130	0.130
Obs	10057	10057	10057	10057	10057	10057
Clusters	63	63	63	63	63	63
Controls	No	No	No	Yes	Yes	Yes
School F.E.	Yes	Yes	Yes	Yes	Yes	Yes

The table shows the estimated coefficients of regressions whose dependent variable is an indicator variable for authoritarian parenting at the individual level. The Gini GPA grade is the Gini coefficient for GPA at the school and grade level. All models include school fixed effects. The regressions include mother's education, family income, and child's race, age, and gender as control variables. Standard errors are clustered at the school level.

Table A-3: Sample Fit of the Model: Parenting Style

	Authoritarian	
	(1)	(2)
	Model	Data
Child's Skills	-0.075	-0.016
Peer Skills	-0.021	-0.017
Mean Dep. Variable	0.135	0.140

The table shows the sample fit for the estimates of a linear probability model of authoritarian style on a child's skills and on the peer's skills. Column (1) displays the estimates generated from the simulated model. Column (2) shows the estimates from the data. We calculate the model's predicted coefficients by averaging among 50 different model simulations.

Table A-4: Sample Fit of the Model: Skill Accumulation

	Next-Period Skills					
	Pooled Sample		Authoritarian = 0		Authoritarian = 1	
	(1)	(2)	(3)	(4)	(5)	(6)
	Model	Data	Model	Data	Model	Data
Child's Skills	0.889	0.823	0.917	0.835	0.776	0.650
Peer Skills	0.316	0.144	0.332	0.129	0.194	0.212
Authoritarian	-0.048	0.047				
Mean Child's Skills (Grade 9)	-0.039	-0.017				
Mean Child's Skills (Grade 10)	0.053	0.082				
Mean Child's Skills (Grade 11)	0.204	0.130				
Mean Child's Skills (Grade 12)	0.313	0.341				

The table shows the estimates for a linear regression model of the next-period child's skills on the current period child's skills, peer's skills, and parenting style. Odd columns display the estimates generated from the simulated model. Even columns show the estimates from the data. We calculate the model's predicted coefficients by averaging among 50 different model simulations.

Table A-5: Sample Fit of the Model: Peer Skills

	Next Period Peer Skills					
	Pooled Sample		Authoritarian = 0		Authoritarian = 1	
	(1)	(2)	(3)	(4)	(5)	(6)
	Model	Data	Model	Data	Model	Data
Child's Skills	0.283	0.223	0.277	0.223	0.321	0.152
Peer Skills	0.179	0.314	0.183	0.327	0.149	0.248
Authoritarian	0.070	0.012				
Mean Number of Friends	6.812	6.935				

The table shows the estimates for a linear regression model of next-period average skill of peers on current period child's skills, peer's skills, and parenting style. Odd columns display the estimates generated from the simulated model. Even columns show the estimates from the data. We calculate the model's predicted coefficients by averaging among 50 different model simulations.

Table A-6: Sample Fit of the Model: Parental Investments

	Parental Investments			
	Authoritarian = 0		Authoritarian = 1	
	(1)	(2)	(3)	(4)
	Model	Data	Model	Data
Child's Skills	0.153	0.114	0.003	0.035
Peer Skills	-0.093	-0.065	0.002	0.028
Mean Dep. Variable	0.028	0.025	-0.178	-0.192

The table shows the estimates for a linear regression model of authoritative parental investments on current period child's skills and peer's skills with breakdown by (authoritarian) parenting style. Odd columns display the estimates generated from the simulated model. Even columns show the estimates from the data. We calculate the model's predicted coefficients by averaging among 50 different model simulations.

B Measuring Skills and Parental Investments in Add Health

In this section we provide additional details on how we measure children's skills and parental investment in Add Health.

Parenting Style. We measure parenting style using the following yes-no question asked to children during the in-home survey: "Do your parents let you make your own decisions about the people you hang around with?" We classify a parent whose child answers "No" as adopting an authoritarian parenting style.

Other Parental Investments (Time). We measure parental investments using the following yes-no questions asked to children during the in-home survey about certain activities they engaged in with their mothers: "Talked with your mom about a party you attended"; "Talked with your mom about a personal problem"; "Worked with your mom on a project for school."We aggregate the three measures using a principal component analysis.

Children's Skills: We measure children's skills using both grades at school (English, Math, History and Science) and a standardized test of receptive vocabulary (Peabody Picture Vocabulary Test, PPVT).[33] Similar to Cunha and Heckman (2007), Cunha, Heckman, and Schennach (2010), Agostinelli and Wiswall (2016), Attanasio, Meghir, and Nix (2019), and Attanasio et al. (2020), we use a linear measurement system to have a comparable scaling between different measures. The measurement model maps each of the five observed measures above ($M_{i,t}^m$) into children's skills ($\theta_{i,t}$) as follows:

$$M_{i,t}^m = \nu_{0,m} + \nu_{1,m} \ln \theta_{i,t} + \eta_{i,t}^m. \tag{B-1}$$

This model allows us to have a linear transformation for each measure m that measures the children's skills: $\widetilde{M}_{i,t}^m \equiv \frac{M_{i,t}^m - \nu_{0,m}}{\nu_{1,m}} = \ln \theta_{i,t} + \widetilde{\eta}_{i,t}^m$.[34] Once we have the set of re-scaled measures $\left\{\widetilde{M}_{i,t}^m\right\}_{m=1}^5$, we aggregate them using a principal component analysis to deal with the measurement error (η). The estimates of the measurement parameters in Equation (B-1) are shown below:

[33] Add Health includes the PPVT scores only for Wave I.

[34] The re-scaled measurement error is $\widetilde{\eta}_{i,t}^m = \frac{\eta_{i,t}^m}{\nu_{1,m}}$.

Table B-1: Estimates for the Measurement Model in (B-1)

	ν_0	ν_1
English Grade	2.55	0.76
Math Grade	2.48	0.55
Math Grade	2.60	0.82
History Grade	2.51	0.76
PPVT	60.53	2.65

The table shows the estimates for the measurement model in Equation (B-1). The parameter are estimated under a zero mean and unitary variance normalization of the log-skills in 9th grade (see Cunha and Heckman (2007), Cunha, Heckman, and Schennach (2010), and Agostinelli and Wiswall (2016) for further details).

C Robustness Analysis

C.1 Additional Specifications for the Technology of Skill Formation

Tables C1-1 through C1-3 provide the results for a set of robustness analyses. In all the different exercises we use the same estimator as in our baseline estimation algorithm (Simulated Method of Moments). We describe each case below.

General CES Technology for Both Parenting Styles. In this first robustness exercise we specify a different unconstrained CES technology for each parenting style (authoritarian and nonauthoritarian parents). Because the model is already over-identified, we do not add additional statistics to our set of moments to match. Moreover, we already included key identifying information as we already allowed the auxiliary regressions about next-period skills to differ between authoritarian and nonauthoritarian parents (see Table A-4). Table C1-1 shows the estimates for the new technological parameters. The estimated complementary parameter for authoritarian parents is close to zero, suggesting that the technology in this case is effectively Cobb-Douglas. The rest of the parameters are in line with our baseline estimates (see Table 5).[35]

Restricted CES Technology. In this case we impose various restrictions on how the technology of skill formation varies between authoritarian and nonauthoritarian parents. In the first case, we impose that authoritarian and nonauthoritarian parents share the same technology of skill formation (CES), although we still allow parenting style to affect the technological TFP. We estimate the specification of this new model. Table C1-2 shows the results for the estimated technology. We estimate a lower effect of parenting style on the technological TFP (ψ_2) relative to our baseline estimates. However, the specification is not able to replicate the heterogeneity of the elasticity of parental investments with respect to peers' skills between authoritarian and nonauthoritarian parents (previously reported in Table A-6). In the second case, we restrict the TFP to also be invariant to parenting style on top of the same technological restrictions described above. The results are shown in Table C1-3. Even in this case, this specification is not able to repli-

[35] In Section 4.1 we discuss how to compare the parameters between the CES and the Cobb-Douglas case.

cate the heterogeneous responses of parental investments with respect to changes in peer quality between authoritarian and nonauthoritarian parents.

Taken together, these robustness checks suggest that allowing the technology of skill formation to vary between authoritarian and nonauthoritarian parents is essential for getting a good model fit and that imposing a Cobb-Douglas specification for authoritarian parents fits the data well.

Table C1-1: Estimates for the Technology of Skills Formation (General Two CES Case)

	CES (Authoritarian = 1)
Complementarity Parents vs. Peer ($\alpha_{4,0}$)	0.009
Share Self-Production ($\alpha_{1,0}$)	0.772
Share Peer Skills ($\alpha_{2,0}$)	0.382
Complementarity Self-Production vs. Parents-Peer ($\alpha_{3,0}$)	0.009
CES Return to Scale ($\alpha_{5,0}$)	0.502
	CES (Authoritarian = 0)
Complementarity Parents vs. Peer ($\alpha_{4,1}$)	0.789
Share Self-Production ($\alpha_{1,1}$)	0.565
Share Peer Skills ($\alpha_{2,1}$)	0.381
Complementarity Self-Production vs. Parents-Peer ($\alpha_{3,1}$)	-1.613
CES Return to Scale ($\alpha_{5,1}$)	1.103
	Total Factor Productivity
TFP Constant (ψ_0)	0.393
TFP Age Trend (ψ_1)	0.024
TFP Parenting Style (ψ_2)	-0.365

The table shows the estimates for the technology of skill formation for the general model with two CES production functions.

Table C1-2: Estimates for the Technology of Skills Formation (One Technology for All Parents)

	CES (For All Parents)
Complementarity Parents vs. Peers ($\alpha_{4,0}$)	0.808
Share Self-Production ($\alpha_{1,0}$)	0.558
Share Peer Skills ($\alpha_{2,0}$)	0.393
Complementarity Self-Production vs. Parents-Peers ($\alpha_{3,0}$)	-1.766
CES Return to Scale ($\alpha_{5,0}$)	0.954
	Total Factor Productivity
TFP Constant (ψ_0)	0.427
TFP Age Trend (ψ_1)	0.028
TFP Parenting Style (ψ_2)	-0.026

The table shows the estimates for the technology of skill formation. In this case, we assume one technology for all parents.

Table C1-3: Estimates for the Technology of Skills Formation (One Technology for All Parents with same TFP)

	CES (For All Parents)
Complementarity Parents vs. Peers ($\alpha_{4,0}$)	0.817
Share Self-Production ($\alpha_{1,0}$)	0.564
Share Peer Skills ($\alpha_{2,0}$)	0.397
Complementarity Self-Production vs. Parents-Peers ($\alpha_{3,0}$)	-1.755
CES Return to Scale ($\alpha_{5,0}$)	0.947
	Total Factor Productivity
TFP Constant (ψ_0)	0.423
TFP Age Trend (ψ_1)	0.027

The table shows the estimates for the technology of skill formation. In this case, we assume one technology for all parents with the same TFP term.

C.2 Model with Parental Education

In this section we generalize our model by including heterogeneous parents with respect to their education. In particular, we divide parents into low- and highly educated parents ($E_i \in \{0, 1\}$), depending on whether they attained a college degree. We allow parental education to affect both technology and preferences: highly educated parents have a differential TFP term as well as a different parameter for the disutility of engaging in an authoritarian parenting style.

The new technology of skill formation is defined as follows:

$$s(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}, P_{i,t} = p) = A_p(t) \times H_p(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}), \tag{C2-1}$$

where $p \in \{0, 1\}$, $A_p(t) = exp(\psi_{0,1} + \psi_{0,2} \cdot E_i + \psi_1 \cdot t + \psi_2 \cdot p)$, where $\psi_{0,2}$ represents the additional TFP for highly educated parents ($E_i = 1$). A positive value for $\psi_{0,2}$ means that highly educated parents have higher total factor productivity relative to low-educated parents. The rest of the technological parameters are the same as in Equation (7).

Low- and highly educated parents differ in their disutility of being authoritarian. We model the new parents' preferences as follows:

$$U(I_{i,t}, P_{i,t}, \epsilon_{i,t}) = \delta_1 \ln(1 - I_{i,t}) + \delta_{2,1} (1 + \delta_{2,2} \cdot E_i) P_{i,t} + \epsilon_{i,t}(P_{i,t}), \tag{C2-2}$$

where the parameter $\delta_{2,2}$ captures the differential cost of engaging in an authoritarian parenting style. A negative value for $\delta_{2,2}$ means that highly educated parents are less prone to be authoritarian relative to low-educated parents.

The model is estimated using the Simulated Method of Moments (SMM), where we add to the previous set of moments two additional statistics to match: 1) the auxiliary coefficient of the marginal effect of parental education on the probability of becoming authoritarian, and 2) the auxiliary coefficient of the marginal effect of parental education on the next-period skills.[36]

Table C2-1 shows the estimates for the new parameters. The results suggest

[36] In Add Health we measure parental education based on the mother's reported highest grade concluded.

that TFP differences between parents are minimal, while highly educated parents show a 25 percent higher disutility in becoming authoritarian relative to low-educated parents. The rest of the estimated parameters are unchanged with respect to our previous estimates.

Table C2-1: Estimates for Heterogeneous TFP and Preferences by Education

Technology:	
TFP Contant ($\psi_{0,1}$)	0.412
Additional TFP (highly educated parents, $\psi_{0,2}$)	0.012
Preferences:	
Disutility of Authoritarian ($\delta_{2,1}$)	-2.110
Additional Disutility of Authoritarian (highly educated parents, $\delta_{2,2}$)	-0.510

The table shows the main estimates for the TFP technology and preferences for a model with heterogeneous parents (education). In this case, parents are heterogeneous with respect to their education (college graduates versus non-college graduates). The table shows the estimated parameters. The rest of the model's parameters are assumed homogeneous, and they are omitted from the table because they are in line with the previous estimates. Results are available upon request.

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WHEN THE GREAT EQUALIZER SHUTS DOWN: SCHOOLS, PEERS, AND PARENTS IN PANDEMIC TIMES

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When the Great Equalizer Shuts Down: Schools, Peers, and Parents in Pandemic Times
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ABSTRACT

What are the effects of school closures during the Covid-19 pandemic on children's education? Online education is an imperfect substitute for in-person learning, particularly for children from low-income families. Peer effects also change: schools allow children from different socio-economic backgrounds to mix together, and this effect is lost when schools are closed. Another factor is the response of parents, some of whom compensate for the changed environment through their own efforts, while others are unable to do so. We examine the interaction of these factors with the aid of a structural model of skill formation. We find that school closures have a large and persistent effect on educational outcomes that is highly unequal. High school students from poor neighborhoods suffer a learning loss of 0.4 standard deviations, whereas children from rich neighborhoods remain unscathed. The channels operating through schools, peers, and parents all contribute to growing educational inequality during the pandemic.

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Education, then, beyond all other divides of human origin, is a great equalizer of conditions of men—the balance wheel of the social machinery.

—Horace Mann, 1848

1 Introduction

Of the many facets of the Covid-19 pandemic, the impact on children's education stands out as having particularly long-lasting consequences. Schools were closed for months in most countries, and early evidence suggests that online education that was offered as an alternative is a poor substitute. School closures threaten to widen inequality not only across cohorts but also across socio-economic groups. For example, online education relies on access to technology like computers and fast internet that not all families can afford. Likewise, parents' ability to support their children's learning depends on their own knowledge and on whether they can work from home during the crisis. Because learning is a cumulative process, part of the effects of the disruption will persist until children reach adulthood, thereby affecting their future success in labor markets, family formation, and other dimensions of social life.

How should policy be designed to mitigate learning losses and their effects? The Covid-19 crisis is still ongoing and unlikely to be resolved for a number of months. During this time, policymakers must decide whether to continue school closures, open all schools, or follow a more flexible policy of partial openings. If partial openings are pursued, they must determine how to target openings. Another important question is whether additional programs should be offered after the pandemic subsides and which groups of students deserve special attention. Given that organizing such programs on a large scale requires planning and resources, decisions must be taken soon.

For answering these and other related questions, we need to understand both the size of the problem and the channels through which the crisis affects children. The fact that online learning is less effective than in-school learning is well recognized. But the accumulation of both cognitive and non-cognitive skills does not depend on schools alone. Especially for older children, peer interactions are another crucial ingredient, and school closures and lockdown measures during the

pandemic drastically change children's social interactions and peer environment. The response of parents is no less important: they can complement education in school, replace some of the inputs usually provided by teachers, and influence their children in other ways such as through their choice of a parenting style. Parents' ability to do all of this interacts with their own exposure to the crisis, such as whether they lost their job or could work from home during lockdowns.

In this paper, we provide a first assessment of how these channels interact during a pandemic. We focus on the impact on the education of students in high school, from grades 9 to 12. We organize our analysis with a structural model of skill acquisition based on Agostinelli et al. (2020). The model captures how children's skill acquisition depends on educational inputs such as the quality of schools, parental inputs that include educational investments and parenting style, and on peer groups that are endogenously chosen. We use pre-crisis evidence from the Add Health data set to discipline the time-invariant parameters of the model.

We model the impact of the Covid-19 pandemic through a set of temporary changes in the economic environment. First, the switch to remote learning lowers the overall productivity of the learning technology. The size of the productivity loss is chosen to match evidence on lower test score growth during the current crisis. Second, there are changes to the peer environment: children may lose contact with some peers, and new peer connections are shaped by the peer environment in the neighborhood of residence rather than the school. We discipline this part of the model using evidence from Add Health on the impact of losing peer connections on learning, and on differences in the peer environment at the level of neighborhoods and schools (which draw students from multiple neighborhoods). Third, remote learning makes greater demands on parents, who have to supply some inputs usually provided by teachers and take a greater role on organizing, inciting, and supporting their children's learning. This aspect of the model is matched to empirical evidence on the increase in the time parents spend on helping their children with school during the current crisis. We also take into account that parents' ability to spend time helping their children depends on their own constraints, such as whether the parent is able to work from home during the pandemic. We use evidence on how the ability to work from

home correlates with parental characteristics to quantify these constraints.

Our quantitative model is able to replicate the impact of the Covid-19 crisis on student's educational performance and on parents' time allocation. Our structural model implies that each channel of change to children's skill acquisition contributes to widening educational inequality during the crisis. Beyond the direct impact of the switch from in-person to virtual schooling, children from low-income families are also affected by a decline in positive peer spillovers, and parents in low-income families face greater challenges in supporting their children's learning, in large part because they are less likely to be able to work from home. In our baseline calibration, these effects combine to generate a skill loss relative to a counterfactual of no pandemic of 0.4 standard deviations for children from a census block at the 20th percentile of the income distribution, versus almost no losses at all for children from the richest neighborhoods. Learning gaps are reduced somewhat in subsequent years, but are still large at the end of high school, when less than half of the gap opened during the pandemic is closed.

We can then use the structure of the model to decompose how different channels working through schools, peers, and parents contribute to overall learning losses and to changes in educational inequality. While each channel makes a sizeable contribution, the peer effects channel turns out to be the most important: in a counterfactual that keeps the peer environment constant but introduces all other pandemic-induced changes, the change in educational inequality is reduced by more than 60 percent.

We also discuss policies that may be used to prevent some of the learning losses and widening educational inequality predicted by our structural model. Opening schools would be the obvious solution, but clearly educational benefits must be weighed against repercussions in terms of spreading of the pandemic. Still, the large detrimental effects on overall skill acquisition and inequality implied by our analysis can inform tradeoffs faced by policymakers, such as how much priority to give to opening schools relative to other sectors of the economy. Our results also highlight which groups of students would benefit most from restoring in-person schooling. Beyond students from low-income families in general, this also includes students who are already undergoing a change in the peer en-

vironment, such as those who enter high school after having completed middle school, who are especially vulnerable to the detrimental effects of being separated from peers. Some of the impact of the pandemic on children's education could be mitigated by expanded in-school support once the pandemic is under control, for example by shortening the summer break in 2021 or offering targeted services to disadvantaged groups.

Our paper builds on three strands of the literature. The first is the economic literature on children's skill formation, including the contributions by Cunha, Heckman, and Schennach (2010), Del Boca, Flinn, and Wiswall (2014), Agostinelli and Wiswall (2016), and Attanasio et al. (2020) and recent work considering the role of parenting styles that is summarized by Doepke, Sorrenti, and Zilibotti (2019). The second related literature considers neighborhood effects for children's skill acquisition, such as Chetty, Hendren, and Katz (2016), Chetty and Hendren (2018a, 2018b), Eckert and Kleineberg (2019), and Fogli and Guerrieri (2018).[1] Finally, our work is part of the emerging literature on the consequences of the Covid-19 pandemic for families and children. Our work relates in particular to Fuchs-Schündeln et al. (2020), who also use a structural model to examine the impact of pandemic-induced school closures on educational inequality. Their contribution is complementary to ours; Fuchs-Schündeln et al. (2020) examine on the macroeconomic angle and account for the economic impact of the crisis, government transfers, and different stages of education, whereas we focus on the interaction of influences of schools, peers, and parents at the high school stage and discipline the analysis using data on children's educational performance and parents' behavior during the crisis. Alon et al. (2020) also consider effects of school closures, but with a focus on implications for parents' labor supply rather than children's education. We link our work to additional empirical contributions specifically on the impact of the pandemic on children's education in Section 2 below.

In the next section, we provide descriptive evidence that sheds light on how a

[1] Within this literature, Calvó-Armengol, Patacchini, and Zenou (2009) consider the role of a child's position in her local friendship network (measured by the Katz-Bonacich centrality) on school performance. More recently, List, Momeni, and Zenou (2019) have documented large spillover effects (operating through children's social networks) of programs targeting disadvantaged children.

pandemic changes children's education and peer environment. In Section 3, we present a structural model of skill acquisition, peer formation, and parenting that we will take to the data. In Section 4, we calibrate the model to match evidence on children's skill acquisition and on the changes brought about by the Covid-19 pandemic. In Section 5, we present our main results on how different changes during a pandemic affect children's overall learning and educational inequality. Section 6 discusses policy implications of our analysis, and Section 7 concludes.

2 Empirical Evidence: How School Closures Affect Children's Education

Our analysis focuses on three channels through which school closures affects child development and human capital formation. The first is the direct effect of suspending in-person teaching and replacing it with online instruction. The second is the change in the peer environment when children stop going to school, which includes the psychological impact of losing contact with some friends and a changed pool for making new connections. The third is the parents' response. Parents have to replace some of the inputs usually provided by professional teachers with their own efforts, subject to the constraints imposed by the requirements of their own work. We start our analysis by describing evidence that allows a first assessment of the importance of these channels.

Effect of School Closures in the United States. A benchmark to evaluate the direct effect of the interruption of in-person teaching is what happens during regular summer breaks.[2] A RAND Corporation study from McCombs et al. (2014) uses results for standardized MAP tests to measure the extent of learning losses. They document a 4-point drop in the mathematics score on the RIT scale during each summer break, which compares with an 8-point gains that accrue from sixth to eighth grade during regular school years. In English, students gain five points during the school year and lose two points during summer. These figures suggest that a child who does not engage at all with learning activities during a school closure lasting three months could lose four points in math and two points in

[2]The discussion in this paragraph follows Doepke and Zilibotti (2020). For evidence on summer losses see also Downey, von Hippel, and Broh (2004).

English. In comparison, a child who keeps on learning at the usual speed gains about 2.7 points in math (i.e., a third of the gain during an academic year) and 1.7 points in English during the same period. The achievement gap between these two scenarios is about seven points in math and four points in English. This is larger than the typical learning gain during a school year. Therefore, if some families can fully make up for the lack of in-person teaching while others make no remedy, a gap equivalent of more than an entire year of schooling can arise.[3]

Effect of School Closures: International Evidence. A number of studies provide first assessments of the effects of Covid-induced school closures in different countries. Maldonado and De Witte (2020) compares standardized test scores of Belgian students attending the last year of primary school who were affected by school closures (cohort of 2020) with those of previous cohorts. Students exposed to school closures experience a decrease in mathematics and language scores by 0.19 and 0.29 standard deviations, respectively. These are large effects. Moreover, school closures deepen existing inequality as children from more disadvantaged backgrounds experience larger learning losses. Engzell, Frey, and Verhagen (2020) find similar results in the Netherlands, a country with a relatively short 8-weeks lockdown and high degree of technological preparedness. Their difference-in-differences finds large learning losses, especially for students from less affluent families.[4] In short, a variety of international studies point at large effects on learning of school closures.

Time Diaries. Time diaries for children's activities during the crisis also help us understand why the pandemic has unequal effects across the socio-economic ladder. The analysis of a sample of German parents in Grewenig et al. (2020) suggests that low-achieving students may suffer more from the lack of educator support during school closures. Compared to high achievers, these students appear to disproportionately replace learning time with less productive activities

[3]Kuhfeld et al. (2020a) reach similar conclusions based on the evidence about learning losses because of absenteeism, summer breaks, and weather-related school closures. Kuhfeld et al. (2020b) find smaller effects when comparing a cohort of student assessed in the fall 2019 with that of the cohort of students assessed in the fall 2020. However, the authors acknowledge that their preliminary results might severely underestimate the effect of the pandemic on students' achievements due to selective attrition in the studied sample.

[4]Di Pietro et al. (2020) provide an insightful report covering a few European countries.

such as watching TV or playing computer games. Andrew et al. (2020) reach similar conclusion for a sample of English children.

Losing Contact with Friends. School closure also affects children's socialization with peers. A large literature in economics and developmental psychology documents large peer effects in education.[5] To evaluate the effects of Covid on socialization, we consider the Add Health data set, which focuses on a representative sample of high school students in the United States. One aspect of the peer-interaction channel is that the forced separation from friends can have psychological effects that hinder the learning process. Detachment from close friends can be a source of stress and instability. In particular, we study how separations affect children's learning in normal (non-pandemic) times. In the Add Health data set, parents and children are interviewed twice over two different school years (Wave I and Wave II In-Home). When some children are not in the Wave II sample, although they were active respondents of the Wave I In-Home survey, we infer that they have left the school. We can then study the effect of a child leaving the school on the academic performance of their friends who continue in the school.

Table 1 provides regression results. For children moving from 8th to 9th grade, the loss of one friend is associated with a deterioration of more than 10 percent in growth in the grade point average (GPA).[6] The result is robust to controlling for other determinants of school performance and for school fixed effects, and is larger for boys than for girls (see Table A-1 in the appendix). The negative effect is twice as large for children who lose two or more friends relative to those who lose only one friend. Table 2 shows the result of a specification where separation is interacted with the pre-separation GPA of the child. The negative effects are larger for low achievers. In other words, high achievers appear to be more resilient and cope better with losing contact with friends. Taking stock, there

[5]See, e.g., Durlauf and Ioannides (2010), Sacerdote (2011), and Epple and Romano (2011) for extensive reviews on the role of peer effects in education.

[6]The descriptive analysis in this section ignores important econometric issues in the study of peer effects. For instance, it is possible that a correlated shock hits the families of two friends, inducing one of them to move. This shock (e.g., a job loss) could have direct effects on the performance of the stayer. For this reason, we refrain from a strict causal interpretation. Note that we control for school fixed effects that reduces but does not eliminate these concerns.

is evidence that forced separation from friends negatively affects children's academic performance, and that this impact is particularly large for children who are already struggling in school.

Interestingly, the effect of being separated from friends is small and statistically insignificant in higher grades beyond 9th grade (see Table A-2 in the appendix). One interpretation of this finding is that children may be especially vulnerable to changes in their peer environment when they are changing schools (i.e., entering high school in grade 9 after completing middle school). Older children who continue in the same school may have already established a stable group of friends in their new environment, so that losing one or two peers has less of an impact. This observation suggests that children who switch schools may be especially vulnerable during the pandemic.[7]

Changes in the Peer Environment. Beyond losing existing friends, the pandemic also changes children's ability to form new peer connections. Schoolmates who live far away may no longer be potential friends once children stop attending school in person. Instead, the peer interactions that are still possible happen at the level of the neighborhood. Even if children are able to make new connections, this distinction matters because the peer environment may differ at the level of the school and the neighborhood. To quantify these effects, we suppose here that when schools close down, children's peer environment is restricted to the neighborhood in which they live, which we assume to be the census block of their residence. The Add Health data allows us to infer the characteristics of census blocks where each child lives.[8] While US school districts are characterized by a high degree of social sorting by international standards, the extent of socio-economic segregation is even higher if children's peer interactions get confined to the block level. In other words, schools operate as an equalizer insofar as they mix children from different socio-economic backgrounds.

Figure 1 shows a bin scatter plot displaying the correlation between median fam-

[7] See Appendix Tables A-1 to A-5 for additional regression results on the effects of peer separation.

[8] The contextual data section in Add Health includes information matched from the 1990 US Census. We use median household income at the census block to characterize the neighborhood where children live.

Table 1: Effect of Peer Separation on Child's GPA (Sample of Children in 8th Grade)

	Change in GPA (from Grade 8 to Grade 9)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
One or More Peers Left	-0.123**	-0.112**	-0.107*						
	(0.051)	(0.051)	(0.054)						
N. of Peers who Left				-0.105**		-0.096**		-0.090**	
				(0.040)		(0.040)		(0.043)	
1 Friend					-0.102*		-0.093*		-0.095
					(0.055)		(0.055)		(0.058)
2 Friends (or More)					-0.218**		-0.196**		-0.172
					(0.093)		(0.092)		(0.104)
N	1235	1235	1235	1235	1235	1235	1235	1235	1235
Controls	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes
School F.E.	No	No	Yes	No	No	No	No	Yes	Yes

The table shows the disruptive effects of losing social ties in the transition from middle school to high school. The outcome is the change in a child's GPA during the transition from middle school to high school. In columns (1)-(3), the independent variable is whether or not a child lost a friend or more during the transition (dummy variable). In columns (4), (6) and (8), the dependent variable is the number of friends that a child lost. In columns (5), (7) and (9), the independent variables are whether a child lost one friend or two (or more) friends during the transition (dummy variables).

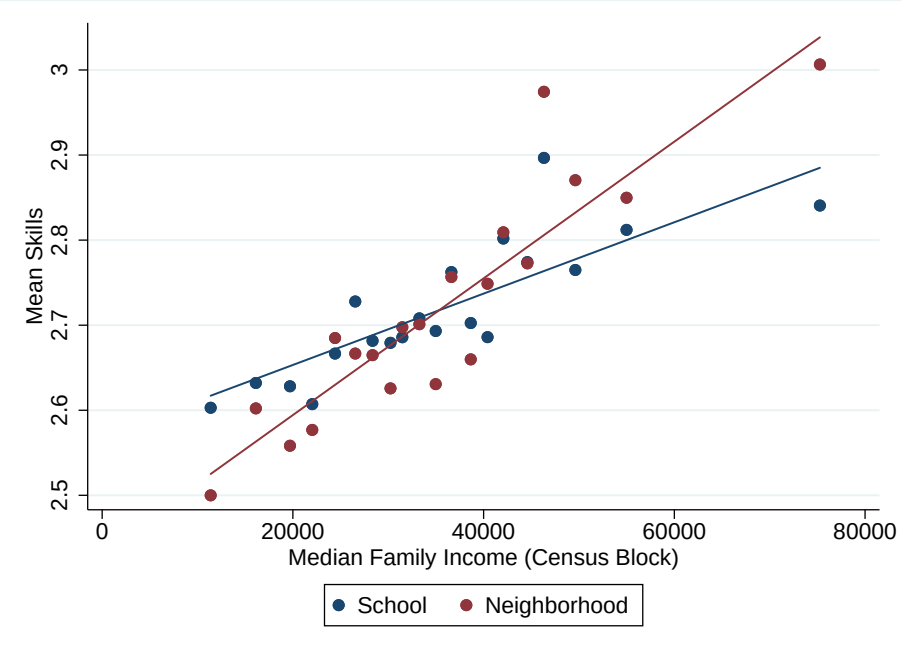
Table 2: Effect of Peer Separation on Child's GPA: Heterogeneity

	Change in GPA (from Grade 8 to Grade 9)			
	(1)	(2)	(3)	(4)
N. of Peers who Left	-0.314**	-0.268**	-0.576**	-0.540*
	(0.135)	(0.131)	(0.287)	(0.296)
N. of Peers who Left × Child's GPA (t-1)	0.086**	0.067*		
	(0.040)	(0.040)		
N. of Peers who Left × Peers' GPA (t-1)			0.166*	0.155
			(0.093)	(0.098)
N	1235	1235	1223	1223
Controls	Yes	Yes	Yes	Yes
School F.E.	No	Yes	No	Yes

The table shows the heterogeneous disruptive effects of losing social ties in the transition from middle school to high school. The outcome is the change in a child's GPA during the transition from middle school to high school. In columns (1)-(2), we interact the number of friends that a child lost with the child's own GPA during 8th grade. In columns (3)-(4), we interact the number of friends that a child lost with the child's peer quality during 8th grade.

ily income at the census block level and the average grade of children attending the same school (blue) or living in the same census block (red). As expected, the correlation is positive, namely, children living in richer blocks are exposed to academically stronger peers. The important observation is that the regression line is substantially steeper as we move from schools to blocks. For the children of poorer families, schools provide an opportunity to socialize with children from more privileged environments (relative to the block where they live). In contrast, the children of richer families meet children from less affluent families. Thus, the evidence on the peer environment channel adds to the overall theme that pandemic restrictions increase inequality in educational opportunities, here through the peer groups that children have access to.

Figure 1: Peer Quality: School vs Neighborhood



The figure shows the relationship (scatter plot) between peer quality and median family income at the census block level. The blue dots represent the predicted peer quality that children are exposed to at school by the median family income of the census block where children live. The red dots represent the peer quality composition of the census blocks where children live. Peer quality is measured by children's GPA.

Changes in Parenting: Knowledge and Time Constraints. Another channel through which a pandemic affects learning is through changes in parents' behavior and parental investment. Virtual schooling places new demands on parents, from making sure that children have access to the technology they need to replacing some of the tutoring, encouragement, and admonishment usually provided by teachers. Not all parents are equally able to provide these inputs. In some cases, knowledge might be a constraint, for example when helping children with homework in advanced high school math. Time constraints are likely to be even more important. Most parents have to earn a living in addition to being substitute teachers, which limits the inputs they can provide. These constraints are especially binding for single parents with limited resources, and single parenthood is more prevalent among parents with less education and lower earnings prospects. For parents who were employed during the crisis, a key issue was

whether they could do their work from home, such as academics and other office workers working from their home office, or had to go to another workplace, such as most workers in manufacturing, supermarkets, and other retail outlets. Once again, the aspect of working from home introduces an element of inequality across the socio-economic ladder. Mongey, Pilossoph, and Weinberg (2020) show that workers with less income and education are more likely to be unable to work from home during the crisis than others. In our analysis below, we use survey evidence from Adams-Prassl et al. (2020a, 2020b) to quantify the extent to which the ability to work from home varies across the income scale.

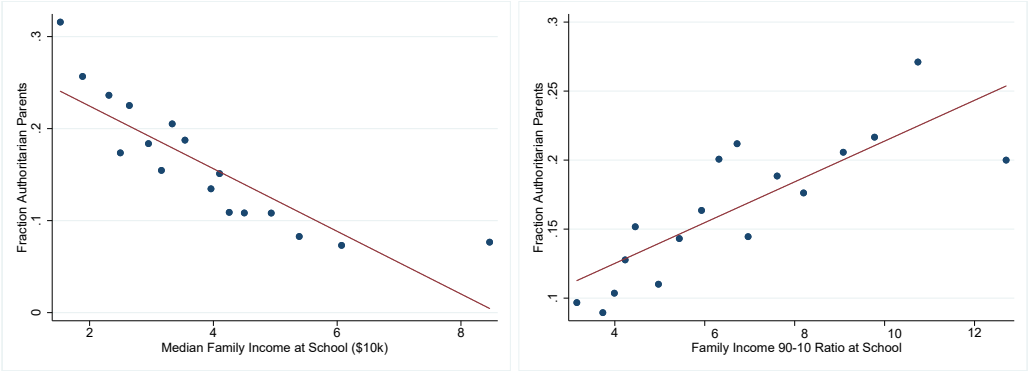
Changes in Parenting Style. Beyond the the impact of knowledge and time constraints, parenting styles tend to adjust to changes in the peer environment. Here a relevant observation—which is the focus of our previous research in Agostinelli et al. (2020)—is that parents become more authoritarian when children are exposed to a more unequal environment. In particular, some parents actively discourage their children from interacting with lower-achieving peers, especially when their children are low achievers themselves. The evidence discussed above suggests that the peer environment deteriorates for poor families during the pandemic. Thus, we expect parents from a lower socio-economic background to turn more authoritarian during school closure periods. This has two effects. First, changes in parenting style makes it even harder for the most disadvantaged children to interact with stronger peers. Second, an authoritarian parenting style (albeit rational from the point of view of parents) has a negative direct effect on the process of skill formation and reduces educational achievement.

Agostinelli et al. (2020) zoom in on a narrower dimension of authoritarian parenting, namely, meddling with the choice of friends.[9] Figure 2 reproduces Figure 1 in Agostinelli et al. (2020). It shows how authoritarian parenting varies across schools with different characteristics. The left panel displays a binned scatter plot of the relationship between median family income and the fraction of authoritarian parents at the school level, whereas the right panel shows the

[9] A parent is considered authoritarian or not depending on how her or his child answers to the question: "Do your parents let you make your own decisions about the people you hang around with?" A parent whose child answers "No" is classified as behaving in an authoritarian fashion; all others are nonauthoritarian.

relationship between income inequality (defined as the 90th–10th percentile ratio of within-school family income) and authoritarian parenting. The figure shows that across schools, the proportion of parents adopting the authoritarian parenting style is decreasing with the median income and increasing with income inequality. Broadly speaking, parents are more likely to meddle in the choice of friends when there are more children from disadvantaged families present. The differences are quantitatively large. The same pattern emerges in multiple regressions where we simultaneously include median income and income inequality and control for parental characteristics.[10] The results are robust to within-school regressions exploiting variations across cohorts.

Figure 2: Authoritarian Parenting and Neighborhood Characteristics



The figure shows how the incidence of the authoritarian parenting style varies with within-school average family income (left panel) and inequality (right panel). Inequality is measured by the 90th–10th percentile ratio of within-school family income.

Taking Stock. The evidence reviewed in this section has established the following points.

1. School closures have a negative impact on children's accumulation of skills,

[10]Similar patterns exist when one considers broader definitions of parenting styles. For instance, we consider the answer parents give to the question: "Of the following, which do you think is the most important thing for a boy/girl to learn? Be well-behaved, work hard, think for himself, help others, be popular." We define authoritarian parents as those who choose "be well-behaved," authoritative parents as those opting for "work hard," and permissive parents as those who choose "think for themselves." When we use these definitions, we continue to find that parents tend to be more permissive in wealthier and more equal neighborhoods, while they tend to be more authoritative and authoritarian in poorer and more unequal neighborhoods.

and learning losses are particularly acute for children from low-income families.

2. Separation from peers reduces children's learning. School closures and social distancing also lead to more segregation in the peer environment for children from rich and poor families.

3. School closures place additional demands on parents, and richer and better-educated parents are better positioned to meet these demands. In addition, parents' responses to their children's environment are likely to lead to more authoritarian parenting in less affluent neighborhoods.

We now construct and structurally estimate a model that allows us to quantify the joint effect of these factors on children's learning. The theory emphasizes potential heterogeneous effects across the socio-economic ladder.

3 A Model of Skill Acquisition with Schools, Peers, and Parents

The model is an extension of Agostinelli et al. (2020). We consider an economy where children live in neighborhood n and attend school s. Human capital accumulation is determined by a technology of skill formation where a child's skills $\theta_{i,t}$ is a state variable whose evolution over time is affected by parental investments and peer effects. The distinctive features of our technology is that it allows for interactions between parents' behavior and peer effects, in the sense that parents can decide to interfere with the process of peer formation. Parental decisions crucially hinge on the social environment at the school and at the neighborhood level. In our empirical application the dynamics of the model corresponds to the four years of high school (grades 9 to 12). We first describe the model setup in normal times, and then discuss below how the Covid-19 pandemic temporarily changes the technologies and constraints faced by parents and children.

During normal times, children meet and interact with friends at school. Even though students live in different neighborhoods n, the neighborhood is not a relevant state variable during normal times because peer interactions take place at the school level. A school s is characterized by a set $\mathcal{X}^s$ of attending children and their initial ($t = 1$) skill distribution.

The timing of events in each period is as follows. At the beginning of the period, the child's current skill level $\theta_{i,t}$ is realized. Next, the child forms friendships with some of the other children of the same age in the same school. The characteristics of these friends (which affect skill formation) are summarized by the variable $\bar{\theta}_{i,t}$. The parent can now make two choices that affect the evolution of the child's skills and peers. First, the parent can undertake (authoritative) parenting investments $I_{i,t}$ that affect the child's skill formation. Second, the parent chooses her parenting style, $P_{i,t} \in \{0, 1\}$, where $P_{i,t} = 1$ means that the parent behaves in an authoritarian fashion by interfering in the child's next round of friendship decisions. At the beginning of the next period, the child's updated skill $\theta_{i,t+1}$ is realized and the new group of friends with the average skill $\bar{\theta}_{i,t+1}$ is formed. These events are repeated until the final year of high school. Then, the child enters adult life with skills $\theta_{i,T+1}$.

3.1 Preferences of Parents and Children

Parents' and children's preferences are as in Agostinelli et al. (2020), where we provide a more detailed discussion of the foundations of the preference structure. We employ the convention that lowercase variables correspond to the child and uppercase variables correspond to the parent. The individual state variables for a family are the child's skills $\theta_{i,t}$ and the characteristics of the child's peers $\bar{\theta}_{i,t}$. An additional aggregate state variable is the distribution of the children $\mathcal{X}^s$ in the school over skills at age t, which matters for friendship formation and peer effects. However, since in our analysis families do not switch schools, the aggregate state is taken as given by each family.

The parent decides on parenting style ($P_{i,t}$ and $I_{i,t}$), and the child chooses peers, i.e., who to be friends with. We express the preferences of parent and child with value functions that summarize utility in a period after the child's current skills and peer group have already been realized so that the decisions concern the evolution of these variables into the next period.

The value function for child i in neighborhood n and school s in period t is given by:

$$v_t^{n,s}(\theta_{i,t}, \bar{\theta}_{i,t}) = \max \left\{ \mathrm{E} \left[u(\mathcal{F}_{i,t+1}) | \theta_{i,t}, \bar{\theta}_{i,t} \right] \right\}. \tag{1}$$

Here $u(\mathcal{F}_{i,t+1})$ captures the utility derived from peer interactions with the set of friends $\mathcal{F}_{i,t+1}$ chosen in period t, where $\mathcal{F}_{i,t+1} \subseteq \mathcal{X}^{n,s}$. The friend set $\mathcal{F}_{i,t+1}$ determines the next period's peer quality $\bar{\theta}_{i,t+1}$. The friendship decisions, in turn, hinge on both the child's and the parent's decisions. The expectation in the value function reflects the presence of taste shocks affecting the process of friendship formation. Current peer quality $\bar{\theta}_{i,t}$ enters the value function because it affects the evolution of the child's skills and the decisions of parents.

The parent's total utility in period t is given by the value function:

$$V_t^{n,s}(\theta_{i,t}, \bar{\theta}_{i,t}) = \max \Big\{ \mathrm{E} \Big[U(I_{i,t}, P_{i,t}, \epsilon_{i,t}) + Z \left[\lambda \tilde{u}(\theta_{i,t}, P_{i,t}) + (1-\lambda) u(\mathcal{F}_{i,t+1}) \right] + B V_{t+1}^{n,s}(\theta_{i,t+1}, \bar{\theta}_{i,t+1}) | \theta_{i,t}, \bar{\theta}_{i,t} \Big] \Big\}. \quad (2)$$

Here $U(I_{i,t}, P_{i,t}, \epsilon_{i,t})$ is the parent's period utility, which depends on parenting style ($P_{i,t}$ and $I_{i,t}$), chosen optimally by the parent. Utility also depends on taste shocks $\epsilon_{i,t}$, which ensure a smooth mapping from state variables into decisions. The parent also cares about the child, where Z is the overall weight attached to the child's welfare. Parental concern about children has an altruistic and a paternalistic component. The altruistic component with weight $1-\lambda$ consists of the child's actual period utility $u(\mathcal{F}_{i,t+1})$. The paternalistic component with weight λ is the parent's own evaluation of the current actions and outcomes of the child. The paternalistic concern is focused on the child's accumulation of skills $\theta_{i,t}$, where we allow for the possibility that the parent's evaluation of the child's skill interacts with parenting style $P_{i,t}$. Hence, paternalistic utility enters as $\tilde{u}(\theta_{i,t}, P_{i,t})$. Note that, at time t, the parent takes the quality of the child's current peers $\bar{\theta}_{i,t}$ as given, but the parent can influence future peer formation (and hence future peer quality $\bar{\theta}_{i,t+1}$) through the choice of parenting style $P_{i,t}$.

The continuation utility at the end of high school is identical to the child's continuation utility, and thus depends on θ_{T+1}:

$$V_{T+1}^{n,s} = v_{T+1}^{n,s}(\theta_{i,T+1}),$$

where the function $v_{T+1}^{n,s}(\theta_{T+1})$ (corresponding to the child's utility as an adult) is taken as given and assumed to be identical across schools.

3.2 The Technology of Skill Formation

The initial distribution of children's skills is drawn from the distribution $F^{n,s}(\theta_{i,1})$. This initial distribution would generally depend on families' socio-economic conditions, neighborhood effects, and earlier actions by parents and children, but is treated as exogenous here.

Subsequently, skills evolve as a function of family inputs and peer influences. For each child i, next period's skill $\theta_{i,t+1}$ depends on the current stock of skills $\theta_{i,t}$, a summary statistic of the quality of peers $\bar{\theta}_{i,t}$ (e.g., the average level of skills), parental investments $I_{i,t}$, and the parent's choice of whether to interfere in the child's choice of peers $P_{i,t} \in \{0, 1\}$. The technology of skill formation is:

$$\theta_{i,t+1} = s(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}, P_{i,t}). \tag{3}$$

The direct effect of parenting style $P_{i,t}$ in Equation (3) captures the impact of the quality of the parent-child relationship on skill accumulation.

3.3 Endogenous Peer Selection

We model the formation of friendships as a random utility model. Every period, each child meets all potential peers $\mathcal{X}^{n,s}$ in the school and can try to be friends with some of them. There is no capacity constraint in the number of friends nor any decreasing marginal utility to the number friendships. The potential utility $f_{i,j,t+1}$ that child i would derive from forming a new friendship with $j \in \mathcal{X}^{n,s}$ is given by:

$$f_{i,j,t+1} = g(\theta_{i,t+1}, \theta_{j,t+1}, P_{i,t}, \eta_{i,j,t+1}). \tag{4}$$

Here $\eta_{i,j,t+1}$ is an independent and identically distributed (i.i.d.) taste shock that guarantees that the probability that a friendship is established is a smooth function of fundamentals. Note that, in general, $\eta_{i,j,t+1} \neq \eta_{j,i,t+1}$, which captures the common situation where, say, child i wants to be friends with j but not vice versa. The utility from forming a friendship depends on both the own skill of child i and the skill of the potential friend j. This specification allows for homophily bias in

terms of skills.[11]

The parenting style $P_{i,t}$ affects how much utility accrues to the child when it forms friendships with children of different skill levels. Since parents want to encourage skill formation, we assume that an authoritarian parenting style ($P_{i,t} = 1$) lowers the utility of befriending a low-skill peer relative to a high-skill one. This could be done by rewarding the child in some way for making "desirable" friends or by meting out punishments for befriending less desirable ones.

Friendships are subject to mutual agreement: a friendship between child i and child j is formed if and only if

$$f_{i,j,t+1} > 0 \;\; \& \;\; f_{j,i,t+1} > 0, \tag{5}$$

where we normalize the value of not forming a friendship to zero. As already mentioned, $\mathcal{F}_{i,t+1} \subseteq \mathcal{X}^{n,s}$ denotes the set of friendships involving child i in period $t+1$, i.e., the set of $j \in \mathcal{X}^{n,s}$ for which Equation (5) is satisfied. The friendship utility $u(\mathcal{F}_{i,t+1})$ that determines the child's utility (1) is then:

$$u(\mathcal{F}_{i,t+1}) = \sum_{j \in \mathcal{F}_{i,t+1}} f_{i,j,t+1}.$$

3.4 Friendship Formation in the First and Last Periods

The value functions (1) and (2) in the first period (corresponding to 9th grade) depend on the initial quality of peers $\bar{\theta}_{i,1}$. Rather than taking this state variable as parametric, we assume that only the initial distribution of skills is given and that friendships are formed through the endogenous process discussed above. Given data limitations, we assume that parents cannot affect the initial choice of friends.[12]

In the last period $T = 4$ (corresponding to 12th grade), the parental decision problem is different because the continuation utility $V^{n,s}_{T+1}$ does not depend on

[11] The homophily bias is a common tendency of people in social networks to be drawn toward others who are similar to them in some significant dimension (see e.g., McPherson, Smith-Lovin, and Cook 2001; Currarini, Jackson, and Pin 2009; Jackson 2010, and, in a context similar to ours, Agostinelli 2018).

[12] Formally, we set $P_{i,t-1} = 0$ when evaluating Equation (4) and Equation (5) at time $t = 1$.

the quality of peers. This reflects that children have to form new peer groups after leaving high school, and at any rate these future peers are not observed in the Add Health data. Setting $P_{i,T} = 1$ does not affect future peers' skills, and parenting style will be optimally chosen solely based only on the parents' taste shocks.

The functional forms for estimating the model in pre-pandemic times are as in Agostinelli et al. (2020) and are described in Appendix A.

3.5 Covid-19 in the Model: School Closures and Social Distancing

In this section, we discuss the effect of the Covid pandemic in the model. We model the Covid shock as affecting parameters in a single period (one year of school). We assume that parents and children correctly anticipate that things will return to normal in the following year. Even though the shock is temporary, its effects will be persistent, through the dynamics of a child's own skill accumulation and further ramifications through peer effects and parental responses.

To show where the pandemic-induced parameter changes appear in the model, we first describe the functional forms for the technology of skill formation and parental utility.

Technology of Skill Formation. The technology of skill formation (3) takes the following form:

$$s(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}, P_{i,t} = p) = A_{p,t} \times H_p(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}),$$

where $A_{p,t}$ is a total factor productivity term such that

$$A_{p,t} = -\nu_t + \kappa_t \cdot (\psi_0 + \psi_1 \cdot t) + \psi_2 \cdot p,$$

and the contributions of peers, initial human capital, and parental time to skill formation enter in a CES functional form:

$$H_p(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}) = \left[\alpha_{1,p}\,\theta_{i,t}^{\alpha_{4,p}} + (1-\alpha_{1,p})\left[\alpha_{2,p}\,\bar{\theta}_{i,t}^{\alpha_{3,p}} + (1-\alpha_{2,p})\left(I_{i,t}-\bar{I}\right)^{\alpha_{3,p}}\right]^{\frac{\alpha_{4,p}}{\alpha_{3,p}}}\right]^{\frac{\alpha_{5,p}}{\alpha_{4,p}}}. \quad (6)$$

Consider, first, the total factor productivity term $A_p(t)$. In normal times, $\nu_t = 0$ and $\kappa_t = 1$. When schools are closed (SC), we have $\nu_t = \nu_t^{SC} \geq 0$ and $\kappa_t = \kappa^{SC} < 1$. Relative to the baseline case, productivity falls across the board by a factor $1 - \kappa^{SC}$. In addition, there is a grade-specific productivity loss ν_t^{SC}.

Consider, next, the term $H_p(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t})$. In normal times, $\bar{I} = 0$, while during school closures, $\bar{I} = \bar{I}^{SC} > 0$. The term $\bar{I}^{SC}$ (which is constant across parents) captures a minimum time requirement before their parental investment $I_{i,t}$ becomes productive. This term captures the basic time cost required to manage learning at home during school closures and can be thought of as providing inputs usually coming from teachers.

Parental Utility. Parents' period utility function in Equation (2) takes the form:

$$U(I_{i,t}, P_{i,t}, \epsilon_{i,t}, T) = \delta_1 \ln(T - I_{i,t}) + \delta_2 P_{i,t} + \epsilon_{i,t}(P_{i,t}). \quad (7)$$

In normal times, $T = 1$ for all parents. In pandemic times, the time endowment is given by $T = T^{SC} \in \{\underline{\tau}^{SC}, \bar{\tau}^{SC}\}$, where $\bar{\tau}^{SC} > \underline{\tau}^{SC}$. Heterogeneity in the time endowment during the pandemic captures how the ability to work form home affects parents' ability to support their children's virtual learning.

Effect of School Closures in the Model. We now have all the pieces in place to summarize how the model captures the effects of school closures and social distancing on children's skill acquisition. The following changes are imposed in the pandemic period:

1. The switch to remote learning lowers the total factor productivity in the

technology of skill formation (6). This is captured by two shocks. First, $\kappa_t = \kappa^{SC} < 1$ for all grades. Second, motivated by the evidence of disruptive effects of losing social ties in Section 2, we allow for a grade-specific shock ν_t. In normal times, $\nu_t = 0$ for all grades. During school closures, $\nu_t = \nu_t^{SC} \geq 0$.

2. When schools are closed, peer interactions are confined to the neighborhood n rather than the school s. The relevant state variable becomes the distribution of peer skills in the neighborhood $\mathcal{X}^n$.

3. The switch to remote learning requires parents to spend time on home schooling. We model this as a minimum time requirement $\bar{I}$ in the skill formation technology. The time investment $I_{i,t}$ is productive only as long as $I_{i,t} \geq \bar{I}$. In normal times, $\bar{I} = 0$.

4. Finally, the time constraints faced by parents change during the pandemic. We capture this change by a shock to the time endowment T in the period utility function (7). In particular, we normalize $T = 1$ for every parent in normal times. During pandemic times, we allow the time endowment to be heterogeneous across parents ($T = T_i^{SC}$). This feature captures the different situations of parents who have a flexible work arrangement and are able to work from home during the pandemic (where can they help their children with school) versus those that cannot. Work flexibility status is assumed to be an individual state variable rather than a choice.

4 Model Estimation: Normal and Pandemic Times

We build our analysis on Agostinelli et al. (2020), who estimate the baseline model based on the Add Health data set that follows a set of children through the high school years in the 1990s. We take the estimated model in Agostinelli et al. (2020) to represent skill accumulation in regular times. We then use additional evidence to discipline the shocks occurring during the Covid-19 crisis. For overall learning losses and inequality, we use information on changes in children's test scores during the crisis discussed in Section 2. For changes in the peer environment, we use data on differences in income inequality and peer composition

at the school and neighborhood levels. We also use the reduced-form evidence on the effects of losing peer connections on education from the Add Health data, as described in Section 2. For parental inputs, we use survey evidence from Adams-Prassl et al. (2020a) on parental time use during the pandemic.

By combining these data sources, our model accounts for up-to-date evidence on parental behavior and children's education during the Covid-19 crisis. Doing this in the context of a structural model then allows us to take additional steps. First, we can simulate the model forward to project the impact of current changes on children's education by the time they finish high school, taking endogenous changes in peer effects and parental inputs into account. Second, we can use the structure of the model to decompose the sources of various changes, such as peer influences, parental influences, and changes to the productivity of schooling during school closures. Third, we can use our model for policy analysis.

4.1 Properties of the Estimated Technology of Skill Formation

We start by summarizing the properties of the estimated skill formation technology in normal times, since these are key determinants of the effect of the Covid shock.

The technology of skill formation is allowed to differ across parents adopting an authoritarian ($p = 1$) or nonauthoritarian ($p = 0$) parenting style—formally, all parameters in Equation (3.5) depend on p. Total factor productivity A_p is lower when parents are authoritarian ($A_1 < A_0$), capturing the well-documented disruptive effects of an authoritarian parenting style on the process of skill formation. Moreover, for authoritarian parents the estimated elasticities of substitution in the H_p function (6) are close to unity. Hence, H_p is well-approximated by a Cobb-Douglas production function.

In contrast, the estimated elasticities in (6) are significantly different from unity for nonauthoritarian parents. The estimates imply that:

- Parental investment and peer quality are substitutes: nonauthoritarian parents spend more time with their children when the peer group is weak.

- Parental investment and own child quality are complements: nonauthoritarian parents invest more time when the child has high skill.

These properties of the technology of skill formation imply that when children face a deteriorating peer environment, parents who adopt a nonauthoritarian parenting style will spend more time with their children to offset unfavorable peer effects.

Concerning the choice between being authoritarian or not, parents are prone to turn authoritarian when the peer environment worsens and when their child's own skill goes down.

4.2 Calibration of Covid Effects in the Model

Our calibration focuses on five model features that capture the Covid shock: (i) the Covid-related learning shock κ^{SC}; (ii) the disruptive effect of losing social ties at school ν^{SC}; (iii) the change in peer quality during the school closure; (iv) the basic time cost for parents required to manage learning at home during the pandemic $\bar{I}^{SC}$; and (v) parents' heterogeneous time endowments during the pandemic T_i^{SC}. We assume that the time endowment during COVID can take two values $T_i^{SC} \in \{\bar{\tau}^{SC}, \underline{\tau}^{SC}\}$, where $\bar{\tau}^{SC} > \underline{\tau}^{SC}$, capturing the heterogeneity in work flexibility status among parents.

We divide the calibration exercise into two steps. In the first step, we externally calibrate the first three elements (i)-(iii) by matching the measured changes in learning and social interactions associated with school closures. In the second step of the calibration, we use the simulated method of moments to estimate the parameters in (iv)-(v) by targeting moments related to changes in parents' time allocation during the pandemic.

We carry out our calibration exercise under the assumption that the Covid shock lasts for one school year. This scenario matches the likely outcome in those parts of the United States where schools continue to be closed and are unlikely to reopen before vaccines are widely available in mid-2021. The Covid shock therefore changes model parameters for a single period, and subsequently all parameters return to their previous levels for the remaining periods. The one-time shock

still has persistent effects due to changes in the children's skill accumulation and peer groups.

Calibrating Changes in Learning and Social Interactions during Covid. We first externally calibrate three new model's features capturing Covid-19 in the model.

- Covid learning shock κ^{SC}: we calibrate the learning shock in our model based on the results in Maldonado and De Witte (2020), who use test score data from Belgium to estimate the impact of the Covid crisis on learning. According to their analysis, the 2020 cohort of children leaving primary school (grade 6) experienced a learning loss of approximately 0.2 standard deviations compared to the previous cohort. This Covid-induced learning loss translates into a learning (TFP) shock of κ^{SC}=0.5 in our framework. Given that Maldonado and De Witte (2020) consider the impact of school closures that lasted only a few months, this learning shock is a conservative estimate of the potential impact on learning of the entire pandemic. Still, erring on the conservative side is appropriate given that virtual instruction may have become more effective over time after the initial adjustment.

- Disruptive effect of losing social ties at school ν^{SC}: we use the estimated effects in Table 2 (Column 1) of losing peers in the transition from 8th grade to 9th grade. We divide children's skills during 9th grade into quartiles $Q(\theta) \in \{4, 3, 2, 1\}$ corresponding to GPA grades A, B, C, and D, and then calibrate the disruptive effect as follows: $\nu^{SC} = -0.314 + 0.086 \cdot Q(\theta)$.

- Change peer quality during school closure: we calibrate the change in peer quality based on the evidence in Figure 1. We translate these findings in the following peer quality in the model during the pandemic: $\bar{\theta}^{SC} = 0.1802 + 0.0198 \cdot \textit{Income Percentile}$.

Calibrating Changes in Time Endowments and Allocations. We use two sources to study the change in parental time inputs due to the outbreak of the pandemic. The Covid Inequality Project described in Adams-Prassl et al. (2020a) provides

information on time spent on active childcare and homeschooling for a representative sample of US parents during the pandemic. As these data do not contain information for the pre-pandemic period, we complement them with data on parental time use drawn from the 2019 American Time Use Survey (2019 ATUS-CPS). For the purpose of comparability, we classify as parental time inputs the following activities in ATUS: physical care of children, homework and other school related activities, homeschooling, reading, playing (including arts, crafts, and sports), other educational activities, talking and listening to children, organization of activities, looking after children, attending events, picking up, dropping off or waiting for/with children, providing medical or other health care to children.[13]

We focus on two data moments to characterize the change in parental time inputs due to the outbreak of the pandemic.[14] First, we consider on the average number of daily hours parents spend with children. Parental time with children has grown by a factor of about four, from an average of 1.26 daily hours in 2019 to 5.15 daily hours during the pandemic in 2020. Second, we focus on the relationship between family income and parental time inputs.[15] Wealthier families report more parental time inputs than their less-affluent counterparts. The positive relation between family income and parental time inputs is apparent both in 2019 and 2020, but it strengthens with the outbreak of the Covid-19 crisis. The income effect on parental time inputs is almost four times larger during the pandemic than in 2019.[16]

[13]The analysis of parental time inputs should be interpreted with caution as it relies on the comparison of two different data sets with time variables that are similar but not identical across the two data sources.

[14]For the sake of comparability across data sets, parental time inputs refer to weekdays and to the sample of working parents.

[15]Due to the role of work flexibility in shaping parental time inputs during the pandemic, we rely on additional information provided by the Covid Inequality Project research team to map parental time with children, family income, and work flexibility. We start with additional evidence of a positive and significant effect of work flexibility on parental time inputs during the pandemic. Then, we combined the information on the effect of work flexibility on parental time inputs with the positive relationship between labor income and work flexibility shown in Adams-Prassl et al. (2020b) (Figure 14-a). Finally, using the Current Population Survey (CPS) for 2019 we convert labor income into family income and estimate the relationship between family income and parental time inputs during the Covid-19 crisis.

[16]For completeness, in 2020 the average effect of a $10,000 change in family income on daily hours spent by a parent in activities with children amounts to 0.06.

Table 3: Calibration Fit for Parental Investments (Ratios of During vs. Before Pandemic)

	Data	Model
Ratio of Mean Investments	4.08	4.04
Ratio of Income Gradient of Investments	3.94	4.04

The table shows both data and simulated target moments for the calibration exercise. The first moment represents the ratio of the mean parental investments after and before Covid (2020 vs. 2019). The second moment is the ratio of the income gradients of parental investments after and before Covid (2020 vs. 2019).

Table 3 shows the two matched moments for this calibration exercise. The calibration recovers two structural parameters associated with the Covid shock: the basic time cost required to manage learning at home $\bar{I}^{SC}$, as well as the time endowment for parents who are able to work from home τ^{SC}. We set $\underline{\tau}^{SC} = 1$, that is, parents who cannot work from home have the same time endowment as before the crisis. In contrast, parents who can work from home have a higher endowment, $\bar{\tau}^{SC} > 1$. The underlying assumption is that parents who can work from home have some ability to work and supervise their children's learning at the same time, which increase their effective time endowment (as in Alon et al. 2020).

Table 4: Calibrated Parameters: Time Cost and Time Endowment

	Value
Minimal Time Cost $\bar{I}^{SC}$	0.32
Time Endowment of Work-from-Home Parents $\bar{\tau}^{SC}$	2.42

The table shows the values of the two calibrated parameters: the basic time cost required to manage learning at home ($\bar{I}^{SC}$), as well as the time endowment for parents who are able to work from home ($\bar{\tau}^{SC}$).

Table 4 shows the calibrated parameters. We find that approximately 30 percent of the pre-Covid time endowment needs to be devoted to the child as a basic parental time cost of remote learning. Moreover, we find that the effective time endowment available for childcare for parents who work from home is 2.4 times

higher than the endowments of parents with in-person jobs.

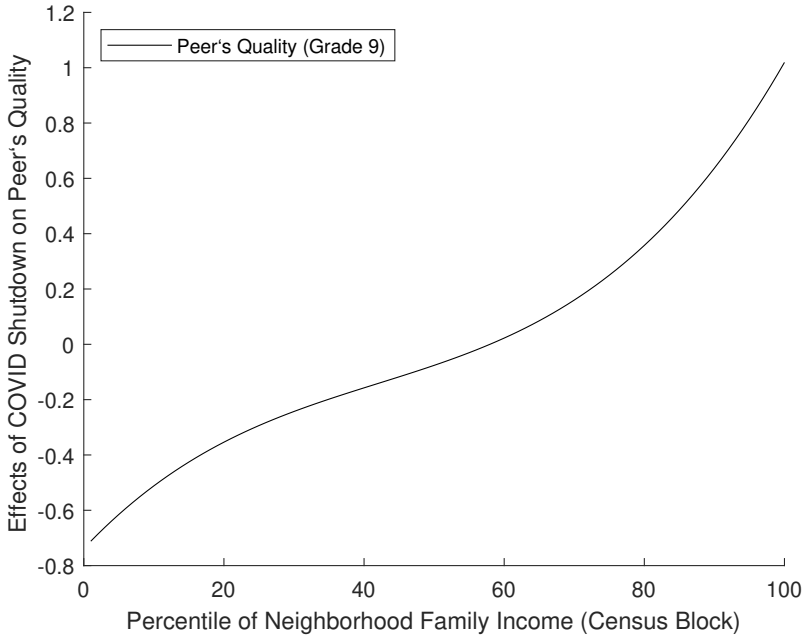
5 The Effect of a Pandemic in the Estimated Model

Our estimated model matches well the evidence on children's skill acquisition, peer formation, and parental behavior during normal times. It also matches well the evidence on average learning losses, changes in the peer environment, and differential time constraints across richer and poorer parents during the Covid-19 crisis. We can then use the estimated model to assess how school, peers, and parents contribute to educational inequality during the pandemic. We can also make forecasts for how human capital accumulation and educational inequality will evolve during the years following the crisis.

Peer Effects. Consider, first, the effect of school closure on peer effects. Figure 3 shows the change in the average GPA of the chosen friends broken down by the percentile of family income at the census block level. The average GPA falls for children from low-income census blocks and increases for children from high-income blocks. This is the result of several forces. First, during the pandemic there is a general decay in the learning process because of the impact of school closures on the productivity of the skill formation technology. Second, the effect varies greatly across the social ladder. Because the peer environment shifts from the school to the neighborhood level, socio-economic segregation increases, causing children living in low-income neighborhoods to have lower-achieving peers than in normal times. Inequality is further exacerbated by the different extent to which rich and poor parents can use their own time to compensate for the lack of in-school instruction. This causes an additional deterioration of the peer environment in low-income neighborhoods, where fewer parents can work from home and hence have less time to help their children.

Overall, peer effects deteriorate far more in low-income neighborhoods. In the richest neighborhoods there is no negative effect at all, partly because interactions move to the neighborhood level where children are more assortatively sorted. In other words, the children from the most affluent families only meet children with a similar background who on average are highly academically proficient.

Figure 3: Simulated Effects of Covid on Endogenous Peer Effects

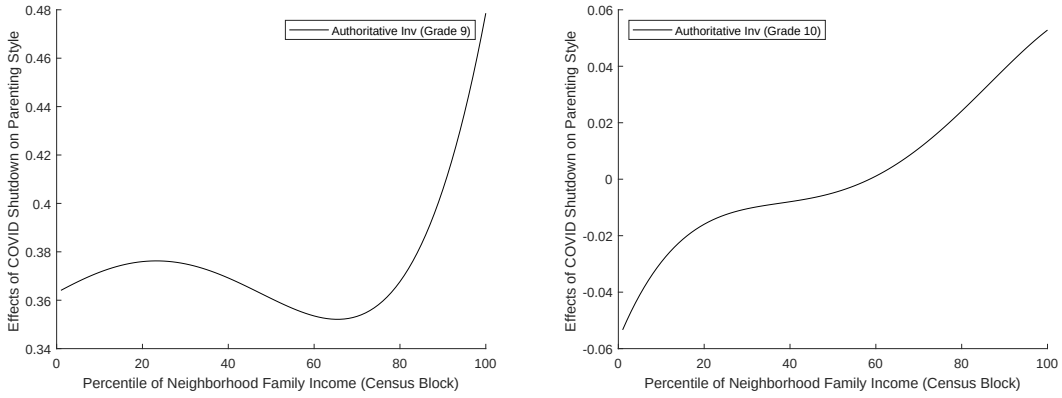


The figure shows the effect of Covid on the endogenous peer quality by neighborhood income. The y-axis displays the change in peer quality after the Covid shock (relative to baseline). The x-axis represents the income percentile of the neighborhood where children live.

Parental Time Investments. Because in our estimated model parental investments are a substitute of peer effects (see Section 4.1), parents in more disadvantaged areas have an incentive to offset a deteriorating peer environment by spending more time on supporting their children's learning. Indeed, Figure A-1 in the Appendix shows that, absent other constraints, it is the parents living in poor neighborhoods who would increase their time investments the most during the pandemic. However, the pandemic has an additional effect: it frees time selectively for parents working from home. The flexibility of work arrangements hinges on a parent's occupation, which in turn is highly correlated with income.

Figure 4 shows the response of time investments for parents of 9th graders, taking into account the different time constraints people face. The time investment increases for all parents, largely because during the pandemic parents must devote a certain number of hours to help their children with school-related tasks.

Figure 4: Simulated Effects of Covid on Parenting: Authoritative Investments



(a) Grade 9 (b) Grade 10

The figure shows the effect of Covid on parental investments by neighborhood income. The y-axis displays the change in parental investments after the Covid shock (relative to baseline). The x-axis represents the income percentile of the neighborhood where children live.

However, the response varies across the socio-economic ladder, with a reverse pattern relative to the case in which parents face uniform constraints. There are no significant differences across the poorest 80 percent of neighborhoods. However, authoritative investments increase steeply in income for the top 20 percent. In the richest neighborhoods, where many parents can work from home, the response of parental investments is 50 percent larger compared to average parents, and 70 percent larger compared to the poorest parents.

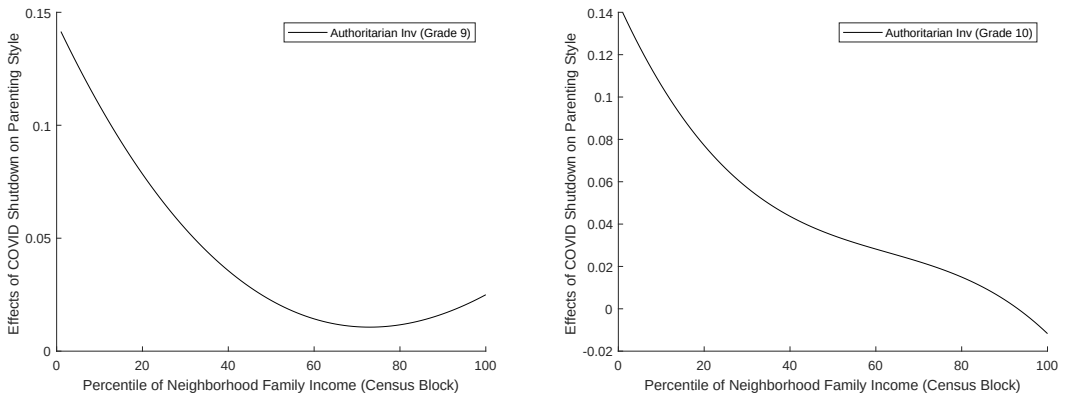
One might have expected poorer parents to make up for the learning gap after the pandemic is over. However, this turns out not to be the case. The right-hand panel of Figure 4 shows the response when the children move to 10th grade after the pandemic is over. Changes in parental investments relative to the pre-pandemic baseline continue being steeply increasing in income. The reason is that in our estimated model authoritative investments are a substitute for peer effects but a complement to children's own skills. For parents living in the poorest neighborhoods, there is a discouragement effect arising from the lower attainment of their own children. In addition, when their children return to school, they are mixed with better peers. Both changes induce parents living in dis-

advantaged neighborhoods to cut the authoritative investments relative to the pre-pandemic baseline. The situation is different for the children of richer parents. The skills of these children did not suffer a comparable setback during the school closure. Moreover, when they return to school these children interact with weaker peers. This induces rich parents living in affluent neighborhoods to increase the authoritative investments relative to the pre-pandemic baseline.

Authoritarian Parenting. Another part of the response generated by the Covid shock is an increase in authoritarian parenting. In the baseline economy, authoritarian parenting is prevalent among poorer families whose children are on average less proficient, while it is almost absent among richer families. Figure 5 shows that the pandemic exacerbates this pattern. In both grade 9 (during Covid) and grade 10 (after Covid), the authoritarian parenting style increases in poor neighborhoods, while remaining unchanged at a low level in richer neighborhoods. The difference in the response is quantitatively large. In the baseline economy, about 18 percent of parents adopt an authoritarian parenting style. For the poorest parents, the model predicts an increase in the prevalence of authoritarian parenting of 14 percentage points. The effect persists beyond the pandemic. To understand why the response is heavily skewed toward poor families, note that authoritarian parenting increases when peer effects deteriorate and when a child's own skills are lower. Both factors apply to poor families during Covid: their children suffer a learning loss and they are more exposed to the influence of low-achieving peers. While adopting the authoritarian parenting style is an individually rational choice in the model, it exerts a negative externality on other disadvantaged children, thereby contributing to wider educational inequality during the pandemic.

Skill Accumulation. Our analysis thus far has highlighted two main channels leading to skewed effects against the poor. The first is an increase in sorting associated with the fact that peer interactions move from the school to the neighborhood level. Because neighborhoods are more segregated than schools, the peer environment deteriorates for children living in poorer neighborhoods and improves for those living in richer neighborhoods. The second concerns parenting style and parental investments. In poor neighborhoods, parents become more

Figure 5: Simulated Effects of Covid on Parenting: Authoritarian Parenting Style



(a) Grade 9 (b) Grade 10

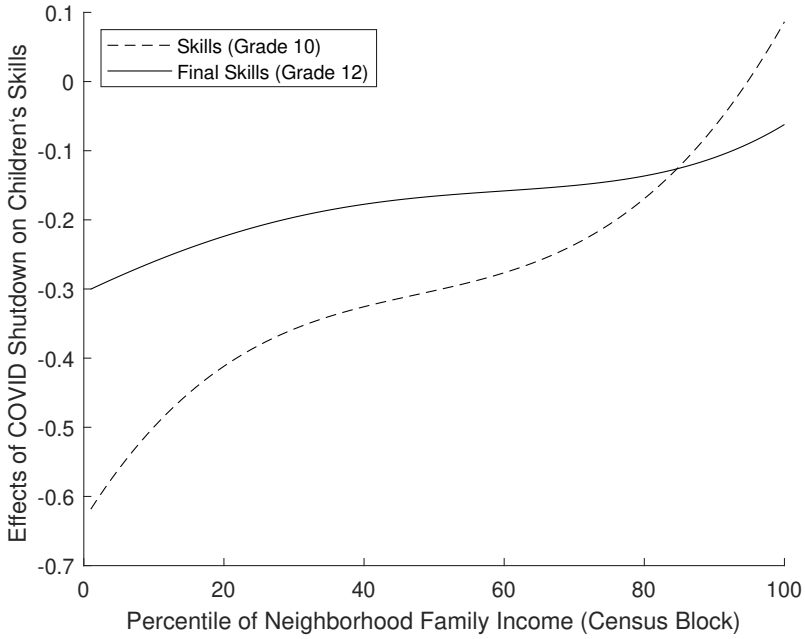
The figure shows the effect of the pandemic on parenting style by neighborhood income. The y-axis displays the change in the fraction of authoritarian parents after the Covid shock (relative to baseline). The x-axis represents the income percentile of the neighborhood where children live.

authoritarian, while in rich neighborhoods parents spend significantly more time with their children. This is the rational response to different time constraints and to the change in the peer environment. The pattern persists after schools reopen.

Figure 6 shows the effect of the Covid shock on the skill accumulation of 9th graders along with the simulated effect for the same children at the end of the high school. The initial impact in 9th grade is large and skewed. There are no significant effects on the skills of children living in the most affluent neighborhoods—for the top decile of neighborhoods we even observe a slight improvement relative to baseline. For children living in rich neighborhoods, the negative effect of school closures is offset by an increase in parental investments along with an improvement in the peer environment. For children living in the poorest neighborhoods, the skill loss when entering 10th grade amounts to 0.6 standard deviations.[17] Many poor working parents cannot respond to the lack of in-class teaching because they cannot work from home. In addition, parents turn more

[17]In terms of the GPA scale (which ranges from 1.0 for a straight-D student to 4.0 for a straight-A student) this change corresponds to a decline of almost half a point; for example, a child who was a straight-B student before would now be getting a C grade in almost half of the subjects.

Figure 6: Simulated Effects of Covid on a Child's Skills



The figure shows the effect of Covid on children's skills by neighborhood income. The y-axis displays the change in children's skills after the Covid shock (relative to baseline). The units are in terms of a standard deviation of skills across children. The x-axis represents the income percentile of the neighborhood where children live.

authoritarian, which imposes a negative externality on the local environment that hits the most disadvantaged children especially hard.

Table 5 shows how each of the three channels (schools, peers, and parents) contributes to rising educational inequality during the pandemic. If we remove the negative learning shock during the pandemic (i.e., the downward shift in the skill accumulation technology that represents the direct effect of switching from in-person to virtual schooling) the income gradient in the impact of the crisis on education would be reduced by about a third. Leaving the learning shock in place but removing inequality in time constraints across parents (as if all parents could work from home, regardless of income), reduces the gradient by slightly more than 20 percent. The change to the peer environment has the largest impact: if we hold peer influences on learning constant at the pre-crisis level, the gradient is reduced by more than 60 percent.

Table 5: Contribution of Covid Effects on Children's Skills by Income

	No Learning Shock	No Peers Shock	No Extra Time Constraints
Inequality of Covid Effects by Income	-32.85%	-61.94%	-22.13%

The table shows the contribution of school, larges, and parents to the income gradient of the effect of the pandemic on skills in 12th grade in Figure 6. Each column shows the reduction in the income gradient when the mechanism is shut down.

We can also use the estimated model to trace out how children's skills evolve over the remaining high school years. Over time, the negative effect turns both smaller and less unequal. The children of richer families suffer some losses because they interact with weaker peers in school. Conversely, as schools reopen the children from disadvantaged backgrounds benefit from returning to school, which offers a less socially segregated environment and better peer effects than does the neighborhood. The long-run losses are about half as large as the short-run losses (in percentage terms). Nevertheless, the outcome continues to be unequal. At the end of high school, the average human capital deficit is about 12 percent, ranging from 5 percent in the most affluent communities to 30 percent in the poorest ones. These are large long-run differences in a society already troubled by dramatic gaps in opportunities.

6 Policy Implications

The severe learning losses already documented during the Covid-19 pandemic and the prospect of widening educational inequality call for well-designed policies that can help offset some of these effects. These policy questions are relevant not just for the ongoing crisis, but also for preparing for the possibility of another pandemic in the near future. In terms of consequences for education, keeping schools open during a pandemic would be desirable, but clearly this has to be weighed against the need to control the pandemic and to stop infections from spreading. Still, policymakers face tradeoffs even during a crisis, and an analysis of the consequences of the pandemic for children's education can help inform these tradeoffs.

A general point about the impact on children's education is that the impacts are hard to undo and can have lifelong consequences for children's future prospects. Unlike a business that can be compensated for pandemic-induced losses, there is no magic trick for making up learning losses incurred during the crisis. This observation suggests that keeping schools open during the crisis should have a higher priority than, say, opening bars and restaurants that can be supported with other means. While this is the approach already taken by a number of countries, other communities, including many US states, have taken the opposite tack of prioritizing keeping businesses open over schools.

Beyond fully opening all schools, another option consists of partial openings, with only a fraction of students attending in-person school to allow for better social distancing. Our analysis can inform which groups would particularly benefit from in-person schooling. One potential criterion is whether a child's parents are able to work from home and support virtual learning. The children of essential workers who cannot work from home during the crisis are especially vulnerable. Some countries have already experimented with providing childcare specifically for the children of essential workers. But the ability to work from home could be used as a more general criterion for who should attend in-person schooling.

In terms of peer effects, our empirical results suggest that children who already have to adjust to a new peer environment because they are switching schools are especially vulnerable to negative repercussions of reduced peer interactions. This channel would suggest that students who enter high school (9th grade) should have a higher priority for in-person schooling compared to 10th or 11th graders who have already established peer networks in high school. The evidence is suggestive that the same would be true for children transitioning from elementary to middle school, although our data does not directly speak to this issue.

Beyond the specific structure of our analysis, it is also worth asking whether additional schooling could be provided at a later time to make up for some of the learning losses during the pandemic. School children in the United States and other countries usually have long summer breaks. It now appears likely that by the summer of 2021 safe, in-person schooling will be possible again. Extending school throughout the summer at least for the more vulnerable groups of chil-

dren might be the last chance to offset at least some of the substantial learning losses that are otherwise likely to have lifelong effects. Investing in such programs would be expensive, but not excessively so relative to support already given to individuals and businesses. Providing a detailed cost-benefit analysis for such programs should be a high priority for researchers in the coming months.

7 Conclusions

The Covid-19 pandemic has brought about the largest disruption to children's learning in many countries in generations. Empirical evidence suggests that learning losses, once accrued, are difficult to fully offset later on, suggesting that the current crisis will affect the economic opportunities of today's children for decades to come. An additional concern is the impact of the pandemic on educational inequality. As Horace Mann famously put it, in regular times schools play a role as a "great equalizer"—they provide a single learning environment and integrated peer groups for children from different backgrounds. The Covid-19 pandemic puts this role of schools at risk.

This paper builds on the observation that children's learning depends not just on schools, but also on inputs provided by their parents and on interactions with their peers. To assess how a pandemic such as the current one affects overall learning and educational inequality, all three channels should be taken into account. We provide such an analysis by using a quantitative model of skill acquisition that explicitly models the behavior of parents, children, and children's peers. We calibrate this model to match evidence from the current crisis, and use the estimated model to shed light on how each factor contributing to children's overall success in education is modified during the pandemic.

The main conclusion from our analysis is that each of the channels we consider contributes to higher educational inequality. Children from poorer families do relatively worse with virtual compared to regular schooling; they are less likely to benefit from positive peer spillovers during the crisis; and their parents are less likely to work from home and hence less likely to be able to provide them with maximum support for virtual schooling. The end result is that learning gaps

grow during the pandemic. Our model also predicts that wider achievement gaps will persist until children finish high school, suggesting that children's long-term prospects are at risk.

Our findings suggest that policy options that could counteract some of these changes, such as extending in-person schooling for at-risk children throughout the summer months, should be considered. Our findings also call for more empirical and structural research on the education crisis brought about by the pandemic. There is now some direct evidence on changes in children's learning during the pandemic, but for other aspects such as changes to peer effects our analysis relies primarily on extrapolation from earlier evidence. More comprehensive evidence on how children's peer environments and parental interactions change during the pandemic will put researchers and policymakers in a better position to evaluate possible countermeasures.

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Appendices

A Functional Forms for Estimation

To estimate the model, we impose functional forms and restrictions that allow us to summarize the model by a list of parameters.

Initial Conditions. The initial distribution of children skills within each school s is drawn from a log-normal distribution. This specification captures the initial (and to us unobserved) sorting of families into different schools characterized by different initial distributions of children's skills. We define the initial conditions for each school s as follows:

$$\ln \theta_{i,1} \sim N(\mu^s, (\sigma^s)^2), \tag{A-1}$$

where μ^s and σ^s represent the school-specific mean and the standard deviation of the log-skills.

Similarly, initial conditions at the neighborhood level (which are relevant during the pandemic are given by:

$$\ln \theta_{i,1} \sim N(\mu^n, (\sigma^n)^2), \tag{A-2}$$

Once the initial heterogeneity of children's skills within the school is realized, children select their initial peer group according to their preferences for friends (Equation (4)). At this stage, the initial vector of state variables $\{\theta_{i,1}, \bar{\theta}_{i,1}\}$ is determined, and the dynamic parent-child interaction starts according to the model described above.

Technology of Skill Formation. We parameterize the technology of skill formation with the following nested CES production function:

$$s(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}, P_{i,t} = p) = A_p(t) \times H_p(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}),$$

where $p \in \{0, 1\}$, $A_p(t) = exp(\psi_0 + \psi_1 \cdot t + \psi_2 \cdot p)$, and

$$H_p(\theta_{i,t}, \bar{\theta}_{i,t}, I_{i,t}) = \left[\alpha_{1,p}\, \theta_{i,t}^{\alpha_{4,p}} \;+\; (1-\alpha_{1,p}) \left[\alpha_{2,p}\, \bar{\theta}_{i,t}^{\alpha_{3,p}} + (1-\alpha_{2,p})\, I_{i,t}^{\alpha_{3,p}}\right]^{\frac{\alpha_{4,p}}{\alpha_{3,p}}}\right]^{\frac{\alpha_{5,p}}{\alpha_{4,p}}}.$$

Note that all parameters of the skill formation technology depend on p, namely, whether the parent chooses an authoritarian parenting style. First, this affects the total factor pro-

ductivity $A_p(t)$, capturing the potential disruptive effect of authoritarian parenting on the parent-child relationship documented by the developmental psychology literature. Our estimation below indeed finds that $\psi_2 < 0$, i.e., an authoritarian parenting style depresses skill accumulation. Second, parenting style affects the parameters $\alpha_{1,p}$ and $\alpha_{2,p}$, capturing the weights of the different inputs. Our estimation finds that the authoritarian style attenuates the influence of peers. Third, an authoritarian parenting style also affects the elasticity-of-substitution parameters $\alpha_{3,p}$ and $\alpha_{4,p}$ and the returns-to-scale parameter ($\alpha_{5,p}$). Here the data suggest the parenting style determines whether peer effects are a substitute or a complement to other inputs in the production of skills.

Parent's Preferences. We specify the parent's period utility in (2) as follows:

$$U(I_{i,t}, P_{i,t}, \epsilon_{i,t}) = \delta_1 \ln(1 - I_{i,t}) + \delta_2 P_{i,t} + \epsilon_{i,t}(P_{i,t}), \tag{A-3}$$

where δ_1 and δ_2 define the disutility of authoritative investment and of engaging in an authoritarian parenting style, respectively, and $\epsilon_{i,t}(P_{i,t})$ is a taste shock that is conditional on the parenting style. We assume that this shock follows a type-I extreme value distribution. The paternalistic utility of the parent takes the following form:

$$\tilde{u}(\theta_{i,t}, I_{i,t}, P_{i,t}) = \delta_3 \ln(\theta_{i,t}) \cdot (1 + \delta_4 P_{i,t}), \tag{A-4}$$

where δ_3 captures the level of the parent's paternalistic enjoyment of the child's skills, which may depend on the parenting style through parameter δ_4. The utility derived from the child's adult skills $\theta_{i,T+1}$ takes the same form as the period-by-period paternalistic utility from skills:

$$V_{T+1}^{n,s} = \delta_3 \ln(\theta_{i,T+1}).$$

In the empirical model, we set $Z = B = 1$. This is without loss of generality. An increase in either B or Z is equivalent to a proportional decrease in cost parameters δ_1 and δ_2. Changing B and/or Z would affect the numerical estimates of those parameters without altering the model fit or the counterfactual experiments.

Child's Preferences. The (marginal) utility child i earns from being friends with child j relative to not being friends with j is:

$$\begin{aligned} f_{i,j,t+1} = \gamma_0 + \gamma_1 \ln\theta_{i,t+1} + \gamma_2 \ln\theta_{j,t+1} + \gamma_3 (\ln\theta_{i,t+1} - \ln\theta_{j,t+1})^2 \\ + \gamma_4 \mathbb{1}(\theta_{j,t+1} < \theta_{i,t+1}) (\ln\theta_{i,t+1} - \ln\theta_{j,t+1})^2 P_{i,t} + \eta_{i,j,t+1}. \end{aligned} \tag{A-5}$$

Here, $\eta_{i,j,t+1}$ is a random taste shock for being friends with child j, which we assume to be i.i.d. standard logistic distributed. The terms $\gamma_1 \ln \theta_{i,t+1}$ and $\gamma_2 \ln \theta_{j,t+1}$ capture, respectively, the effect of child i's and child j's skills on the utility child i earns from being friends with child j, where γ_1 and γ_2 are parameters that will be estimated. The quadratic term $(\ln \theta_{i,t+1} - \ln \theta_{j,t+1})^2$ captures potential homophily bias in the formation of friends. A negative coefficient $\gamma_3 < 0$ would imply that the higher the difference in skills between the two children, the lower the utility for child i to be friends with child j.

The coefficient γ_4 captures the effect of an authoritarian parenting style on the preferences for child j's skills. In particular, if $\gamma_4 < 0$, authoritarian parenting imposes a penalty whenever the child is friends with a lower-skill peer, where the penalty increases with the GPA gap between the two children. This formulation captures the idea that parental intervention (through, e.g., moral suasion, threat of punishment, or incentives) is designed to improve the quality of the child's peer selection.

We can now characterize the conditional probability that a friendship link between child i and child j is formed as:[18]

$$Pr(j \in \mathcal{X}_{i,t+1} | \theta_{i,t+1}, P_{i,t}, \theta_{j,t+1}, P_{j,t}) = \frac{\exp(\Gamma_{i,j})}{1+\exp(\Gamma_{i,j})} \frac{\exp(\Gamma_{j,i})}{1+\exp(\Gamma_{j,i})}, \tag{A-6}$$

where:

$$\Gamma_{i,j} = \gamma_0 + \gamma_1 \ln \theta_{i,t+1} + \gamma_2 \ln \theta_{j,t+1} + \gamma_3 (\ln \theta_{i,t+1} - \ln \theta_{j,t+1})^2 + \gamma_4 \mathbb{1}(\theta_{j,t+1} < \theta_{i,t+1}) (\ln \theta_{i,t+1} - \ln \theta_{j,t+1})^2 P_{i,t},$$

$$\Gamma_{j,i} = \gamma_0 + \gamma_1 \ln \theta_{j,t+1} + \gamma_2 \ln \theta_{i,t+1} + \gamma_3 (\ln \theta_{j,t+1} - \ln \theta_{i,t+1})^2 + \gamma_4 \mathbb{1}(\theta_{i,t+1} < \theta_{j,t+1}) (\ln \theta_{i,t+1} - \ln \theta_{j,t+1})^2 P_{j,t}.$$

The presentation of the parent's and child's preferences completes the description of the effects of parenting style in our model. To summarize, authoritarian parenting has a direct effect on the technology of skill formation given the current child's skill and peers. In

[18] The conditional probability in Equation (A-6) might suggest a potential strategic interaction between parents when deciding about their own parenting style. However, under our assumptions, only the parent of the higher-skill child can actively affect the probability in Equation (A-6), so there is in fact no strategic interaction among parents. Note that in our model parents have an additional motive to invest in their children's skills, namely, to give them more opportunities to condition their children's choice of peers in the future.

addition, authoritarian parenting affects the process of peer formation by discouraging the child from choosing low-skill friends. Our estimates below imply that, conditional on an existing set of friends, an authoritarian parenting style entails productivity losses in the skill formation technology. The reason some parents still choose to be authoritarian must then lie in the benefits of an improved quality of future peers. It follows from this argument that in wealthy and homogeneous schools, where most potential friends are highly skilled and there is little risk that one's child might associate with low-skill peers, the cost of an authoritarian parenting style is high while the benefit is small. Conversely, parents will tend to be authoritarian in schools where children face a high risk of exposure to low-skill peers.

A Additional Figures and Tables

Table A-1: Effect of Peer Separation on Child's GPA by Gender

	Change in GPA (from Grade 8 to Grade 9)			
	Child is Boy		Child is Girl	
	(1)	(2)	(3)	(4)
N. of Peers who Left	-0.100*	-0.124*	-0.100**	-0.080
	(0.059)	(0.073)	(0.049)	(0.052)
N	559	559	676	676
Controls	Yes	Yes	Yes	Yes
School F.E.	No	Yes	No	Yes

The table shows the disruptive effects by gender of losing social ties in the transition from middle school to high school. The outcome is the change in a child's GPA during the transition from middle school to high school. In all the columns, the independent variable is the number of friends that a child lost. In columns (1)-(2), consider the sample of female students, while in columns (3)-(4) we consider the sample of male students.

Table A-2: Effect of Peer Separation on Child's GPA

	Change in GPA		
	(1)	(2)	(3)
Grade 8 (t-1) × N. of Peers who Left	-0.105***	-0.106***	-0.111***
	(0.040)	(0.040)	(0.039)
Grade 7 (t-1) × N. of Peers who Left	0.001	0.004	-0.021
	(0.052)	(0.052)	(0.049)
Grade 9 (t-1) × N. of Peers who Left	-0.028	-0.030	-0.014
	(0.042)	(0.042)	(0.036)
Grade 10 (t-1) × N. of Peers who Left	-0.033	-0.034	-0.013
	(0.025)	(0.025)	(0.023)
Grade 11 (t-1) × N. of Peers who Left	0.039	0.038	0.055*
	(0.025)	(0.025)	(0.032)
N	7611	7611	7611
Controls	No	Yes	Yes
School F.E.	No	No	Yes

The table shows the disruptive effects by grade of losing social ties in the transition from middle school to high school. The outcome is the change in a child's GPA from Wave I survey to Wave II survey. In all the columns, the independent variable is the number of friends that a child lost, interacted with the grade in which children were enrolled to during Wave I.

Table A-3: Balance Test on Peers who Left

	Peers' GPA (t-1)		
	(1)	(2)	(3)
One or More Peers Left	0.013	0.024	-0.017
	(0.041)	(0.038)	(0.029)
N	1230	1230	1230
Controls	No	Yes	Yes
School F.E.	No	No	Yes
Mean Cohort GPA	2.90		
Mean Peers Left GPA	2.81		
P-value	0.065		

The table shows the balance test for the quality of peers who left. Each column shows a regression coefficient, where the dependent variable is the Peers' GPA during Wave I survey, while the independent variable is whether or not a child lost a friend or more during the transition (dummy variable).

Table A-4: Effect of Peer Separation (with Quality) on Child's GPA

	Change in GPA	
	(1)	(2)
One or More Peers Left	-0.117**	-0.075*
	(0.051)	(0.044)
One or More Peers Left × GPA of Peers who Left	0.049	-0.004
	(0.079)	(0.071)
N	1235	1235
Controls	No	No
GPA (t-1)	No	Yes

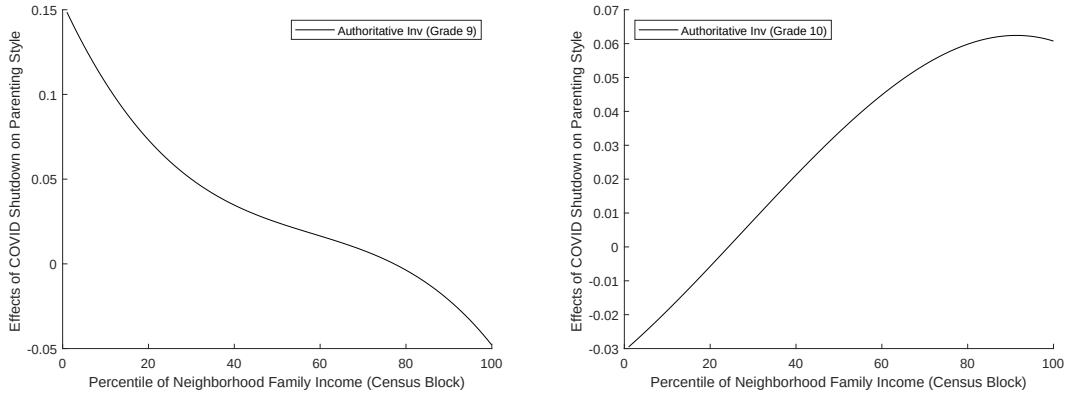
The table shows the heterogeneous disruptive effects of losing social ties in the transition from middle school to high school. The outcome is the change in a child's GPA during the transition from middle school to high school. We interact whether or not a child lost a friend with the baseline GPA of the peers who left.

Table A-5: Effect of Peer Separation on Child's GPA (All grades)

	Change in GPA								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
One or More Peers Left × Grade 8 (t-1)	-0.123**	-0.124**	-0.131**						
	(0.051)	(0.051)	(0.051)						
Grade 8 (t-1) × N. of Peers who Left				-0.105***		-0.106***		-0.111***	
				(0.040)		(0.040)		(0.039)	
1 Friend × Grade 8 (t-1)					-0.102*		-0.103*		-0.113**
					(0.054)		(0.054)		(0.056)
2 Friends (or More) × Grade 8 (t-1)					-0.218**		-0.218**		-0.219**
					(0.093)		(0.091)		(0.087)
One or More Peers Left × Grade 7 (t-1)	0.005	0.008	-0.022						
	(0.058)	(0.057)	(0.054)						
Grade 7 (t-1) × N. of Peers who Left				0.001		0.004		-0.021	
				(0.052)		(0.052)		(0.049)	
1 Friend × Grade 7 (t-1)					0.009		0.012		-0.018
					(0.052)		(0.052)		(0.049)
2 Friends (or More) × Grade 7 (t-1)					-0.015		-0.012		-0.049
					(0.147)		(0.146)		(0.139)
One or More Peers Left × Grade 9 (t-1)	-0.024	-0.025	-0.006						
	(0.055)	(0.055)	(0.047)						
Grade 9 (t-1) × N. of Peers who Left				-0.028		-0.030		-0.014	
				(0.042)		(0.042)		(0.036)	
1 Friend × Grade 9 (t-1)					-0.006		-0.008		0.006
					(0.057)		(0.056)		(0.050)
2 Friends (or More) × Grade 9 (t-1)					-0.093		-0.095		-0.059
					(0.087)		(0.087)		(0.080)
One or More Peers Left × Grade 10 (t-1)	-0.033	-0.034	-0.004						
	(0.031)	(0.031)	(0.032)						
Grade 10 (t-1) × N. of Peers who Left				-0.033		-0.034		-0.013	
				(0.025)		(0.025)		(0.023)	
1 Friend × Grade 10 (t-1)					-0.019		-0.019		0.008
					(0.032)		(0.032)		(0.036)
2 Friends (or More) × Grade 10 (t-1)					-0.085		-0.091		-0.057
					(0.063)		(0.063)		(0.054)
One or More Peers Left × Grade 11 (t-1)	0.087*	0.086*	0.107*						
	(0.045)	(0.046)	(0.058)						
Grade 11 (t-1) × N. of Peers who Left				0.039		0.038		0.055*	
				(0.025)		(0.025)		(0.032)	
1 Friend × Grade 11 (t-1)					0.120*		0.119*		0.128*
					(0.061)		(0.061)		(0.069)
2 Friends (or More) × Grade 11 (t-1)					0.029		0.027		0.065
					(0.044)		(0.045)		(0.056)
N	7611	7611	7611	7611	7611	7611	7611	7611	7611
Controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
School F.E.	No	No	Yes	No	No	No	No	Yes	Yes

The table shows the disruptive effects of losing social ties in the transition from one grade to the next one. This table replicates the results in Table 1 for every grade in the sample.The outcome is the change in a child's GPA from Wave I survey to Wave II survey.

Figure A-1: Simulated Effects of Covid on a Parenting Style: Authoritative Investments (Absent Time Constraints)



(a) Grade 9 (b) Grade 10

The figure shows the effect of Covid on the parental investments by neighborhood income. The y-axis displays the change in parental investments after the Covid shock (relative to baseline). The x-axis represents the percentile of neighborhood income where children live.