Family and School in Child Development:

The Effect of Family Instability, the Role of the Father, and School Quality on Cognitive Outcomes

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Abstract

This study estimates a cognitive production function during childhood. We focus on family transitions, paternal contribution, and school quality. We estimate the parameters of the model using data from the ECLS-B, ECLS-K, and FFCWS using alternative specifications. Empirical specification takes into account unobserved heterogeneity of children and families, endogeneity of family formation, and the cumulative nature of cognitive development. In addition, we use the abundant data on school and teacher characteristics at the classroom level. After conducting cross-validation across these specifications, we employ our results to investigate how various family and school inputs contribute to racial test score gaps.

1 Introduction

The increase in non-marital births and mixed families in the U.S has subsequently brought increased attention on how family instability can affect child development. (Fomby and Cherlin, 2007; Osborne et al., 2007; Craigie et al., 2010). However, as Bernal (2008) points out, the question of what determines children's cognitive achievement and the role that parental time and goods play remains largely unresolved. In addition, despite a wide range of research on school quality and its impact on student achievement, there is a disagreement about the impact of school quality on student achievement (Fryer and Levitt, 2006; Hanushek and Rivkin, 2006) as well as about the growth of the racial achievement gap over developmental stages (Clotfelter, Ladd, and Vigdor, 2009).

In previous studies on the effects of family instability, potential endogeneity problems are not clearly addressed, resulting in biased estimation results. Couples who experience relationship transitions may be systematically different from those who are stable in their relationship in terms of their preferences and unobserved characteristics that could have an effect on a child's outcomes. Also, a child's initial skill endowment and unobserved characteristics of a mother and father can influence parental investment decisions. Also, recent economic literature emphasizes the cumulative nature of child development (Todd and Wolpin, 2007). However, this point has not been properly considered in the above mentioned previous studies.

In this paper we study the impact of various parental and school inputs on childhood outcomes. We focus on the father's contribution and the changes in living arrangements as well as school and teacher characteristics at the classroom level. This paper seeks to answer: (1) How does the racial test score gap evolve over time through different childhood stages?; (2) How much can family and non-familial factors account for the differences in the early cognitive achievement among racial groups? If they can, which factors are more important during the development stages?

In order to increase confidence in our estimation results, we use three sets of data to investigate child development from birth to early adolescence. Each data set has its own strength in terms of the targeted sample used and the available information. Currently, the Fragile Families and Child Wellbeing Study (FFCWS) provides information on children's lives from birth to age 5 with a special focus on families with low income. Furthermore, the

Early Childhood Longitudinal Study collected a nationally representative sample of children from birth to kindergarten (ECLS-B) and kindergarten to the eighth grade (ECLS-K: 98˜99). These three data sets give us an opportunity to apply various estimation methods to control for potential endogeneity problems and to incorporate cumulative impacts of past inputs using repeated observations of test scores and behavioral and health measures.[1]

To take into account endogeneity and the cumulative nature of child development, we use the child-fixed effect model and the value-added model using the rich data on parental and school inputs and children's outcomes. Because we have five repeated observations of each child with around 8,000 children from ECLS-K, we can further implement a first-differenced version of the value-added specification. We compare the results from different specifications given the assumptions upon which each method is based.

The achievement gap between black and white children remains despite a narrowing of the gap during the 1970s. The National Assessment of Educational Progress (NAEP) shows that the racial achievement gap for high school students has narrowed slightly in reading and remained stable in mathematics since 2000. We employ our estimation results to explore how family instability and lack of paternal involvement could explain the remaining racial achievement gap which is not captured after controlling for socioeconomic conditions and differences in school quality.[2]

Our study is closely related to the analysis offered by Fryer and Levitt (2004, 2006) and that offered by Todd and Wolpin (2003, 2007). However, we extend previous studies by using full waves of the two ECLS data sets to cover developmental stages from birth to the eighth grade. We compare results from ECLS with those from FFCWS, which mainly focuses on low-income families. Building upon the work of Fryer and Levitt, we use additional waves of the ECLS-K along with the ECLS-B, investigating a longer spectrum of child development. By exploiting the panel structure of the ECLS data sets,

[1]The current version of this paper is mainly based on an analysis using the ECLS-K. The analysis using the FFCWS extends the analysis of the family instability and the role of the father figure. The analysis from ECLS-B depicts the overall pattern of racial and family structure gaps before children enter kindergarten, which is the starting point of the ECLS-K. More study of noncognitive outcomes and a more sophisticated analysis using ECLS-B will be added in the next version.

[2]It(Clarify the source) is reported that nonmarital births among blacks is 70.7% compared with 26.6% among whites and 49.9% among Hispanics. There is also a wide discrepancy in marriage rates among these racial groups. As of 2002, 26% of black women were married as compared with 51% of white women. Based on these observations, we speculate that the high degree of family instability and paternal absence among minorities could be an important factor in explaining gaps in cognitive achievement among races, especially for blacks.

we apply alternative specifications in order to consider any unobserved heterogeneity and to incorporate the cumulative nature of child development and finally consider an Hispanic population.[3] In our analysis, we partially respond to the controversial importance of lagged inputs. Due to the abundance of data on school and teacher characteristics available at the classroom level, we have an opportunity to revisit the importance of school quality in child development, reinforcing the work by Todd and Wolpin.

As a result of limited access to data on the paternal side, previous studies have had difficulty separately investigating the contribution of a father figure and a mother. The ECLS collected information on resident and non-resident father figures, and the FFCWS even followed a non-resident biological father from birth, providing an opportunity to study paternal effects. We explore whether there is a unique role for a father figure in a child's skill formation.

Some findings from our analysis deserve specific attention. In contrast to the pattern of black-white achievement gaps, Hispanics catch up to the white population by the eighth grade. However, there is difference between gender and subjects among the racial groups. Black-white achievement gaps grow rapidly until the third grade and then stabilize by the eighth grade. In contrast to the wide agreement on the association between family structure and negative child outcomes, once we control for key observable characteristics, we do not find any evidence that family structure per se has a substantive effect. In addition, the family structure gap differs widely among racial groups and is sensitive to the grade in which the test is taken. This result calls for more investigation on family transition dynamics, which cannot be adequately captured by a simple analysis of static family structures. Moreover, by comparing the results of alternative specifications, we find that endogeneity and heterogeneity are important in the study of family instability on child outcomes. Finally, the analysis of the proficiency level shows that the achievement gap is mainly due to the lag or absence of higher proficiency levels in both math and reading. This would play a critical role in exacerbating future racial inequality in advanced studies and labor market outcomes.

The rest of the paper is organized as follows: Section 2 introduces related literature. Section 3 lays out a decision model to guide estimation frameworks, followed by a brief discussion of alternative empirical specifications in Section 4. Section 5 describes the data.

[3]Fryer and Levitt's study provide analysis from cross-sectional regressions.

Section 6 presents empirical results, including parameter estimates of each specification with model fit and cross validation tests. We apply our results to racial achievement gaps and differences in family structure. The last section discusses the study's limitations and possible extensions. The appendix contains tables, graphs, and additional details on the data.

2 Related Literature

This paper builds upon a large body of previous studies on child development[4], family structure and instability, the role of a father as well as school quality, and racial achievement gap. It can be seen that all the topics are closely related to each other. In this section we briefly summarize what has been done and discuss what has not been resolved in the literature to note what can be possibly pursued. Due to the numerous issues on school quality literature, we pay attention to the set of school quality literature which is closely linked to racial achievement gap and discuss both topics in one subsection.

2.1 Family Instability

Many studies have been performed on the effects of a divorce and family structure on their children and adult members with respect to their cognitive and behavior outcomes and mental and physical health (e.g., Amato, 2000; 2005). Given the high rates of multi-partnered fertility and an increase in non-marital birth, researchers have recently studied the dynamic impact of family transition. Waldfogel et al. (2010) review studies using the FFCWS and add their own analysis by constructing dummy variables summarizing family stability and family structure. They report that family instability is associated with lower child cognitive scores, increased behavioral problems, and poorer health (Fomby

[4]Regarding (early) child development, rather than summarizing the large body of literature, we refer to well-established scholarship for the details. Almond and Currie (2010) provide an excellent review of early child development. Bernal (2008) and Bernal and Keane (2009; 2010) study effects of maternal versus alternative care providers' time inputs on children's cognitive development using a sample of single mother families. Tartari (2007) studies the relationship between marital status and a child's cognitive achievement within a structural dynamic framework. Using a dynamic factor model, Cunha and Heckman (2008) and Cunha et al. (2010) study identification of the technology of skill formation, accounting for interaction between cognitive and noncognitive outcomes. Finally, Todd and Wolpin (2003, 2007) provide an empirical study of racial achievement gaps as well as an excellent guidefor understanding principal methods used in this paper.

and Cherlin, 2007; Osborne and McLanahan, 2007).[5]

As a theoretical background for negative impact of family instability, we can consider the following mechanisms. Social stress theory implies that relationship changes increase stress in a cumulative way. Hence, multiple changes are likely to induce negative results to a child's cognitive capabilities as well as to adults themselves, which might, once again, have indirect impact to the child. Secondly, selection hypothesis posits that partnership instability and negative child outcomes are both products of third unobserved factors such as mother's personality and unobserved endowment.[6] Although we cannot distinguish the impact supported by social stress hypothesis and that of selection hypothesis, by considering unobserved heterogeneity in the empirical specification, we can partially control the selection hypothesis.

Recent work by Wagmiller et al. (2010) contains an important finding on the heterogeneous impact of family transition according to socioeconomic status of a family. They find the benefits of parental marriage to children living in more advantaged single-parent families prior to marriage. However, racial and ethnic minority children and children with less educated single mothers benefit very little academically from their mothers' marriage. This finding implies that when we study the impact of family instability, we need to pay attention to the circumstances around the family transition and also its direction.

2.2 Fatherhood

Cabrera et al. (2000) argues that there have been fundamental changes in the nature of paternal involvement and family life relevant to child development such as women's increased labor force participation, increased absence of nonresidential fathers in the lives of their children, and increased involvement of fathers in intact families. Simple tabulation of the FFCWS questionnaires on parental involvement such as "Who helps a child to

[5]Fomby and Cherlin (2007), using NLSY79 and CNLSY, study the association between the number of family structure transitions and cognitive and behavioral outcomes . Using the FFCWS, Osborne and McLanahan (2007) study the effects of maternal partnership changes between birth and age 3 on children's behavior. Following their approach, we use the number of transitions as a proxy for family instability in analyzing the ECLS data. For the FFCWS we additionally construct a duration variable on the relationship between a father figure and a child using the date of the relationship change reported in the mother surveys. As mentioned in the introduction, however, these studies do not clearly treat potential endogeneity problems.

[6]As a third mechanism, researchers sometimes mention reverse causality, which implies that a child with lower cognitive outcomes and behavior problems may increase maternal stress and will cause partnership instability.

study math?" reveals the increase in father's involvement in child development, which has departed from the previous notion of bread-winner.

Marsiglio et al. (2000) point out that developmentalists acknowledge father involvement as both influential and critical to larger networks of relationships within families (i.e. relationships with mothers). Since the 1970s, there has been an increased interest in the role of fathers within families in various disciplines. Many of these studies have focused on involvement of a father in coparenting, either a resident or nonresident, and on the connection between father involvement and a variety of aspects related to children's developmental outcomes (e.g. Carlson and McLanahan, 2010; Lamb, 2010).

Expanding upon the previous studies as well as using the recently available rich data on paternal involvement, we ask whether there is a unique role for the father in child development through a variation invoked by family transitions. In other words, we ask whether mother's increased input and other types of child investment can compensate for an absence of a father.[7]

2.3 Racial Achievement Gap and School Quality

Over the decades, there has been a large body of work performed on the racial achievement gap. However, it is still one of the research areas that have drawn the keen interest of scholars across multiple disciplines. Studies have tried to investigate the various possible mechanisms underlying racial achievement gap: differences in genetics (Herrnstein and Murray, 1994), differences in poverty and family structure (Brooks-Gunn and Duncan, 1997), racial segregation and neighborhood (Card and Rothstein 2007), and differences in peer culture and socialization (Fryer and Torelli, 2010). In this study, by exploiting such abundant data on family, school, and neighborhood factors, we revisit the contribution of each factors on the growth of racial gaps.

In a recent review of studies based on several national data sets, Duncan and Magnuson (2005) note that racial achievement differences appeared in all of them even though the size of the difference varied by study and measure of achievement.[8] Using the ECLS-K

[7] Using a CES production function we want to investigate the substitution pattern among maternal, paternal, and other types of inputs.

[8] Scholars have pointed out that ECLS-K uses different test instruments, which produce smaller raw gaps than those used in other national studies such as the Children of the National Longitudinal Survey of Youth (CNLSY) or NAEP (Duncan and Magnuson, 2005).

until the third grade, Fryer and Levitt (2004, 2006) find that blacks enter school substantially behind whites in reading and math. However, controlling for a small number of covariates explains the gap between blacks and whites. However, over the first four years of school, for instance, blacks lose substantial ground relative to other races - averaging 0.1 standard deviations per school year. By the end of third grade, there is even a greater black-white test score gap that cannot be captured by observable characteristics. Using ECLS-B for children aged eight to twelve months, Fryer and Levitt find that mental ability scale shows only minor racial differences in test outcomes between blacks and whites, which disappear with the inclusion of a limited set of covariates. However, compared to whites, black and Hispanic children lose ground by age two (Fryer and Levitt, 2011).[9] In this study we extend their work to cover all available ECLS data from birth to the eighth grade to follow the trajectories of the racial achievement gap including Hispanics. We use kindergarten samples as a bridge between ECLS-B and ECLS-K to check whether ECLS provides consistent descriptions on the racial achievement gap.

There is a discrepancy about the impacts of school quality upon the achievement gap. While Fryer and Levitt (2006) find school quality could not explain the divergent academic trajectories of black and white students by the end of third grade, analyzing Texas Schools Project (TSP) panel data, Hanushek and Rivkin (2006) find a substantial school effect on the black-white achievement gap. In their study, the proportion of inexperienced teachers and the racial composition of schools fully explain increases in the black-white achievement gap between grades 3 and 8. Rivkin, Hanushek, and Kain (2005) also stress the importance of teacher effectiveness on reading and mathematics achievement.[10] A recent study by Condron (2009) supports that school factors play an elevated role in generating the black-white achievement gap using the first grade data from the ECLS-K. Another interesting discrepancy pertains to the growth of the achievement gap. Against to the work by Fryer and Levitt, Clotfelter, Ladd, and Vigdor (2009) find no appreciable growth in the gap as students progress through school using data from North Carolina public school

[9] As they point out, there is a possibility that intelligence has multiple dimensions, and racial differences are present only in those dimensions that emerge later in life. However, their results hint that a racial achievement gap starts even in the very early stages of life.

[10] In their study, little of the variation in teacher quality is captured by observable characteristics. Hence, the question of the underlying mechanism of teacher effectiveness remains to be resolved. However, there has been a growing body of literature demonstrating that teacher effects on academic achievement are substantial in size (Clotfelter, Ladd, and Vigdor 2006; Rockoff 2004).

students in grades 3 to 8.

3 A Model of Investment decisions

Although we do not develop a structural model in this paper, here we briefly sketch a model to guide us to specify an empirical model. Major building blocks of the model consists of a utility function, budget and time constraints, and a cognitive production function. An optimization problem based on these elements can be solved to yield demand functions for the inputs.

Model starts when couples have a new baby and each decision is made once a year. There are three types of union status: married (d_u=1), cohabiting (d_u=2), and single (d_u=3). Couple's initial match quality θ_0 is drawn from a known distribution conditional on union status and demographic characteristics - couples' education level, employment status, duration of relationship, race and so on. There are three types of decision makers in the model: mother, biological father, and step father. Each agent makes decisions on how many hours to work, h_{i1}, how many hours to spend with a child, h_{i2}, and how many hours to enjoy for his/her own leisure, h_{i3}. Additionally, a mother makes a decision on union status and consumption for her child. Father figures make decisions on the share of his labor income transferred to a mother, τ. Father figure's involvement on child care in terms of time and material support depends on the common demographic characteristics X_i. If a father reside with a child, match quality between the partners also affects father's child care decision and this is also a determinant of the motion of match quality. If a father is separated from a child, distance from the child and his new relationship status affect his decisions. For now we assume that fertility choice, and welfare participation is exogenous. By further assuming that there is no saving and borrowing, consumption of each agent is determined by the budget constraint. We regard consumption is a partial public good to other partner.

3.1 Preference

We assume that biological father and step father get different utility from the interaction with and outcome of a child, hence we differentiate the parameter for each group.

$$u_i(c_i, c_{-i}, h_{i1}, h_{i2}, d_u, \theta, q), \text{ for i} = m,\ f_b,\ f_s$$

where, d_u: union status, θ: relationship quality, q: child quality, c_{-i}: consumption of a partner

3.2 Constraint

Each agent has time constraint,

$$h_{i1} + \kappa h_{i2} + h_{i3} = 1, \text{ for i} = m,\ f_b,\ f_s$$

where κ plays a role to capture the fact that only a fraction κ of one hour to be spent with a child is the cost of child care since child care delivers the utility on its own. Intuitively the remaining fraction (1-κ) is leisure.

With a consideration of working hours and ratio of transfer, the budget constraint is following:

For a mother:

$$c_m + g = w_m h_{m1} + \tau w_f h_{f1}$$

$$\text{where } w_i = R_i \Psi_i \text{ (rental price}\times\text{human capital)}$$

For a father:

$$c_f = (1 - \tau) w_f h_{f1}$$

3.3 Cognitive Production Function

We assume that child quality, q, can be approximated by the cognitive outcome and it is determined by the following function:

$$q_{t+1} = F(h_{mt}^2, \alpha(\nu) h_{ft}^2, \theta_t, q_t, \varepsilon_t^q)$$

where ν is a duration of relationship with a child, and $\alpha(\nu)$ is a concave function of ν to reflect the instability effects. Couple's match quality is denoted by θ and ε_t^q is a child quality shock.

4 Empirical Specification

We estimate six alternative specifications to see how endogeneity and unobserved heterogeneity have influences on the results and to answer for our main questions on the impacts of family and school inputs. In the below we introduce the specification of each model in a brief manner with an additional assumption that there is no unobserved inputs for the simplicity. Todd and Wolpin (2003, 2007) provide details on these model specifications with underlying assumptions they are based on and the limitations of each model with the additional consideration on unobserved inputs. We understand cognitive development is an outcome of a production function where various family and school factors work as an input. This production function is assumed to be influenced by child's initial endowment of mental ability and current inputs as well as lagged inputs.

4.1 Contemporaneous Specification

Most simplest case would be a contemporaneous specification, which assumes that only current inputs matter and there is no unobserved child or family heterogeneity.

$$T_{ia} = X_{ia}\alpha_1 + e_{ia} \tag{1}$$

where, T_{ia} is a test score at age a and X_{ia} is observed inputs when a child's age is a.

4.2 Cumulative Specification

Cumulative specification expands contemporaneous specification to consider the cumulative nature of child development by including lagged inputs.

$$T_{ia} = X_{ia}\alpha_1 + X_{ia-1}\alpha_2 + ... + X_{i1}\alpha_a + e_{ia} \tag{2}$$

where X_{ia}: observed input at age a

4.3 Value Added and Value Added Plus Specification

Although value added model imposes a strong assumption on the orthogonality of contemporaneous omitted inputs and lagged test scores, it is generally regarded as a better

specification than contemporaneous one. (Todd and Wolpin, 2003)

$$T_{ia} = X_{ia}\alpha_1 + \gamma T_{ia-1} + e_{ia} \tag{3}$$

Todd and Wolpin (2007) suggest that we can incorporate cumulative nature of child development and improve model fit by including lagged inputs in the value added specification. They called this model as value added plus specification and show that this specification performs better than simple value added one.

4.4 Child Fixed Effect Model

Since we have multiple math and reading scores for the same child, by assuming $\beta_a = \beta_{a-1}$ for all ages, we can eliminate child fixed effect from equation (4).

$$T_{ia} = X_{ia}\alpha_1 + \beta_a \mu_{i0} + e_{ia} \tag{4}$$

$$T_{ia} - T_{ia-1} = (X_{ia} - X_{ia-1})\alpha_1 + (\beta_a - \beta_{a-1})\mu_{i0} + e_{ia} - e_{ia-1} \tag{5}$$

4.5 First-differenced version of the VA specification

Assuming β_a is constant for all ages, by subtracting lagged test scores from equation (6) we can cancel out individual fixed effect.

$$T_{ia} = X_{ia}\alpha_1 + \gamma T_{ia-1} + \beta_a \mu_{i0} + e_{ia} \tag{6}$$

$$T_{ia} - T_{ia-1} = (X_{ia} - X_{ia-1})\alpha_1 + \gamma(T_{ia-1} - T_{ia-2}) + (\beta_a - \beta_{a-1})\mu_{i0} + e_{ia} - e_{ia-1} \tag{7}$$

However, by construction, the first-differencing results in a correlation between lagged test score gain, $T_{ia} - T_{ia-1}$, and first-differenced error term, $e_{ia} - e_{ia-1}$, in equation (7). As proposed by Anderson and Hsiao (1981), we can instrument for the lagged test score gain with the second lagged level, T_{ia-2}, or second lagged difference, $T_{ia-2} - T_{ia-3}$. As pointed out by Blau (1999), this method has not been widely used due to limitations of the data. Although we can apply this method using five repeated individual test scores and important variables, still we have a concern on a severe efficiency loss. In addition, this estimation

method is based on the assumption that the error term e_{ia} is serially uncorrelated.[11] In this reason, we provide both estimation result from simple first-differenced version of the value added model, suffering endogeneity bias, and estimates from Arellano-Bond method, suffering efficiency loss and possibly weak instrument problem.

Additionally, we could consider implementing 'quasi structural estimation' suggested by Bernal and Keane (2010). For this estimation, welfare rules such as TANF and EITC, father's distance from child, parents' marital status at age 16, and proportion of matchable male and female and divorce rate could be used as potential instruments. From concern about weak instrument, however, we have not pursued this approach yet.[12]

5 Data

The Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) followed a sample of about 14,000 children born in 2001 beginning with infancy through the start of kindergarten (U.S. Department of Education, 2007). Using a nationally representative sample, it tracked children throughout the early developmental period, using both parent interviews and direct child assessments. The data set includes information from parent surveys, interviewer observation of parent-child interactions, and mental and motor skill tests. To measure mental proficiency, the ECLS-B uses an abbreviated version of the BSID known as the Bayley Short Form–Research Edition (BSF-R), which was designed to measure the development of children early in life in 5 broad areas.[13] For the preschool and kindergarten level, the assessment of math and reading skills was guided by the design of the ECLS-K kindergarten assessments.

The ECLS-K followed a nationally representative sample of 21,260 children who were

[11] In practice, we implement IV estimation using the method further developed by Arellano and Bover (1995) and Blundell and Bond (1998) to include additional moment conditions. They show that the benefit is considerable, especially when γ is high and T is small.

[12] The question of how much impact welfare rules have on union formation and dissolution decisions is crucial to our study, since it is the underlying force that induces family instability and changes in parental inputs. However, there is not a firm agreement on this issue. Moffitt (1997) notes that "while a neutral weighing of the evidence still leads to the conclusion that the welfare system affects marriage and fertility, research needs to be conducted to resolve the conflicting findings". On the question of non-marital birth, Moffitt (1995) concludes that there is little evidence of strong effects of welfare on nonmarital fertility. However, Rosenzweig (1999) finds that increasing generosity of welfare tends to increase out-of-wedlock births.

[13] Further details about the study design and data collection methods are available at the ECLS website (http://nces.ed.gov/ecls).

in kindergarten in the 1998–1999 school year. Approximately 20 children per school were included in approximately 1,000 schools. The study collected six waves of data as a full sample: fall and spring of kindergarten, spring of first, third, fifth and eighth grade. Additionally, one-fourth of a randomly selected sample were interviewed in the fall of first grade. Data were collected from multiple sources, including direct cognitive assessments of children, interviews with parents and surveys of teachers and school administrators.

Finally, the Fragile Families and Child Wellbeing Study has followed a cohort of approximately 5,000 children born between 1998 and 2000 in 20 medium to large cities in 15 states. Approximately 3,700 of the children were born to unmarried mothers and 1,200 to married mothers. This data contains a large sample of unmarried and non-residential fathers and includes detailed longitudinal economic, attitudinal, and behavioral information collected independently from both the mother and the father.

With these three data sets, we can study child development from birth to the eighth grade. Although each data set uses different samples, ECLS-B and ECLS-K are nationally representative and the FFCWS represents large cities with over 200,000 residents. Specific survey timing and the coverage of the each data set is summarized in Figure 9.[14]

Table 1 presents weighted descriptive statistics for all variables used in the analysis.[15] Regarding family background, we can see that blacks by far show a higher portion of single parent families, approximately 50 percent, and also a higher frequency in family transitions. Reflecting on the family structure and racial income inequality, the black population's mean income level is the lowest among the racial groups. In terms of employment, black mothers participate in the labor market most actively followed by whites, Asians, and Hispanics when the child is in the kindergarten. The mother's participation rate increases with age until the child reaches the 8th grade and white mothers show the largest increase from 69 percent to 79 percent. Across all periods, among the families who have a father at home, black fathers' employment rate is the lowest. In regards to the home input variable, we observe that blacks show a relative advantage to Hispanics and even Asians.[16]

[14]The FFCWS will update 9 year old survey in early 2012. It will provide additional cognitive test scores at age 9, enabling us to investigate long term consequences of events occuring in the early stages of life.

[15]We provide details about how we construct variables used for the estimation in the Appendix.

[16]This is partially because of the way we construct the home input variable. Items included in the factor analysis capture the general cultural factor that blacks share more time within their families and enjoy more family activities. Once we add more variables on the physical conditions of housing and neighborhood

Regarding school quality, we do not see any significant difference in teachers' educational attainments by students' race. However, in terms of teachers' experiences and tenure at the current school, children from black and Hispanic population are disadvantaged compared to the children from white and Asian population. Teachers' motivations, as well as school climate, favor white and Asian groups. Overall the observed school quality gap grows as grade progresses. A higher proportion of children who are eligible for free lunch captures the economic disadvantage experienced by children from minority groups. Finally, in terms of class size, whites have a relative advantage in this dimension while Hispanics and Asians show higher mean class sizes.

By comparing the variables on the conditions at the time of birth between the samples from kindergarten and those from the 8th grade, we can see that there is higher sample attrition among the economically disadvantaged children. The share of children whose mothers participated in the WIC program at the time of birth and gave the first birth during the teenage years decreases, but, the mother's educational level increases during the survey periods. However, we do not see any particular difference among the racial groups.

6 Results

6.1 Racial Achievement Gap in the ECLS

Figure 1 depicts the mean IRT scores from kindergarten through the 8th grade. The graph uses seven test scores for both math and reading for whites, blacks, and Hispanics for both genders. We can see growing gaps for the first four years in school, followed by more stable results. In our analysis using standardized scores, we can see that the black-white achievement gaps are approximately 0.6 standard deviations for math and 0.4 standard deviations for reading at kindergarten. By the eighth grade it worsens to approximately one standard deviation for both boys and girls in both subjects. In contrast, the Hispanic population eliminates the math gap but maintains a reading gap of approximately 0.6 standard deviations. After controlling for family and school inputs, the magnitude of the gaps is reduced by approximately half; however, the pattern remains similar to the analysis before introducing controlls. One striking fact is that the gaps for Hispanic girls are mostly

environment, we expect that there will be some change in the home input measure.

accounted for by controlling for key inputs.

Analysis from the ECLS-B shows significant racial gaps even at age 2. Achievement gaps in math after controlling for socioeconomic background are approximately 0.1 standard deviation for boys and 0.2 standard deviations for girls at the kindergarten level. Regarding reading gaps, Hispanics are behind whites approximately 0.2 standard deviations at the pre-school level; however, the gap gets smaller at the kinderegarten level. Overall, the achievement gap from the ECLS-B at the kindergarten level is comparable to that of ECLS-K.

6.2 Basic Results

In Tables 2 and 3 we show the estimation results from alternative specifications for math and reading. Coefficients of demographic variables and conditions at birth are expected signs. Even though we use school characteristics at the classroom level, separately for math and reading, in most cases we do not find any statistically significant effects of teachers' attained education and experience in most cases. Teachers' tenure at their current schools matter only for reading. The school climate variable, capturing relationships among and motivations of teachers and school administrators, turns out to be an important factor. However, the coefficient of class size is not an expected sign in either subject.

Comparing the coefficient of the number of family transitions, we can see that the coefficients vary across the specifications. Interestingly, when we take into account endogeneity of family transitions and unobserved heterogeneity, the impacts of family transitions decrease. This finding indicates the importance of considering endogeneity and unobserved heterogeneity in the study of family dynamics. However, the inflation of the coefficient in the first differenced value added model calls for more analysis to understand the direction of bias.

6.3 Model Fit and Cross Validation

In Figures 4 - 7, we show a model fit of each specification by comparing the predicted mean scores from each model with sample mean test scores by race and gender. Overall, we can see that most of the specifications follow the trend. Among the six specifications, however, the value added plus model seems to fit the data best.

To check the reliability of the estimated models, we use cross-validation methods by comparing out-of-sample root mean squared error (RMSE).[17] Consistent with the model fit results, both validations, using random holdout and selected holdout samples show that the value added plus model performs best, minimizing the RMSE. (Table 4)

6.4 Lagged inputs

Fryer and Levitt (2004) maintain that home input gaps cannot account for black-white test score gaps, because home input gaps remain roughly constant over time, whereas test score gaps widen with age. In contrast to their interpretation, however, Todd and Wolpin (2007) find home input gaps are important in accounting for racial test score gaps. They maintain that by allowing for lagged inputs in the cumulative specification, we can explain a widening black-white test score gap because a constant home input gap implies a widening cumulative gap over time.[18] To respond to the contested importance of lagged inputs, we test the joint significance of lagged home inputs in both math and reading scores. Regardless of the included periods of lagged inputs, the null hypothesis that all coefficients are jointly zero is rejected at conventional levels. In our main estimation results (Tables 2 and 3), the columns for the cumulative specification and the column for the value added plus specification show the importance of lagged inputs. We can see that lagged inputs are as influential as current inputs.[19]

6.5 Highest Proficiency Level Analysis

In Table 5 we summarize the distribution of the highest proficiency level by race for kindergarten and eighth grade. Similar to the IRT raw score gap, minorities also lag behind white children in the math and reading proficiency. Regarding specific skills in mathematics,

[17] Details on the cross-validation method are well explained by Todd and Wolpin (2007). We generate 10 random holdout samples for the simulation.

[18] Todd and Wolpin point out that the contemporaneous model used by Fryer and Levitt is based on the assumption that inputs do not accumulate, and does not allow for endogeneity of inputs. In response to this criticism, Fryer and Levitt (2006) hold that "to the extent that current and lagged environments are highly correlated, controlling for current inputs is likely to yield similar estimates on average of the racial test score gap, and indeed, that is the case."

[19] However, the coefficient of the third lagged home input is negative and statistically significant. In addition, this reuslt does not show a clear pattern such as presented by Todd and Wolpin (2007). We are currently investigating this puzzling result. We will update Hausman and Wu tests for the specification test in the next version of this manuscript.

when they start kindergarten in the fall, more than half of white children have mastered ordinality and sequence (level 3) or above (level 4 = addition/subtraction). In contrast, only 37 percent of black children attained these levels and the number is even lower for Hispanics, only 33 percent. By the eighth grade, however, blacks are substantially behind in proficiency levels. Compared to the fact that three fourths of white children have mastered a skill level of 7 or higher, only 42 percent of blacks reached these levels. This level is even lower than Hispanics' 56 percent. We find a similar trend in reading skills.

We estimate the ordered logit model for the highest proficiency level for the same periods (Table 6). If we control for key socioeconomic characteristics and school quality measures, the absolute value of coefficients on racial dummies diminishes. Across the specifications, however, we can see that the racial gap with regard to the higher order skills also grows and is more striking in the black population. Based on this evidence, we conjecture that current racial gaps are partially due to an under-development of more advanced skills, which could play a critical role in further increasing disparity in future academic achievement and labor market outcomes.

6.6 Family Structure versus Family Transition

There is a wide body of research on the association between family structure and negative consequences in children's cognitive and behavior outcomes. However, our study sheds a different light on this result. In Figure 8 we show standardized IRT math and reading score gaps from kindergarten to the eighth grade using five test outcomes. These graphs show IRT raw score gaps before controlling for any observed characteristics. We observe substantial gaps in the scores of children from single parent families or step families compared with children residing with two biological parents. Overall, children in a single-parent family experience more negative consequences compared with children in the step family and it seems that boys are more influenced by family structure.

These gaps, however, largely diminish once we control for a extensive set of family and school quality measures. We can no longer find a consistent trend. The gaps among the different family structures fluctuate as children age and it is not clear whether a child in a single-parent family or a child in a step-parent family indeed fares worse. To understand this puzzling result, we also estimate the model by separate racial groups. Before

controlling for observed characteristics, white children from single or step parent families show consistent negative outcomes of approximately 0.3 standard deviations below children from families with two biological parents. In contrast, for black and Hispanic children, it is hard to draw any conclusion based on the results. Moreover, after controlling the key socioeconomic family background and school quality measures, we cannot find any significant difference based on family structure for all racial groups. The results show a clear discrepancy depending on which age test scores we use in the analysis. This result is consistent with the analysis using the ECLS-B. Most of the significant racial differences in mental skills from 9 months to kindergarten disappear once we control for a child's age, birth weight, and socioeconomic background variables with the exception of a fewer cases such as kindergarten girls' reading scores. (Table 8)

Based on these observations, we conjecture that given the well known fact of increasing family instability, static classifications of family structure do not deliver meaningful information on children's cognitive outcomes. However, family instability measured by the number of family transitions shows significant negative coefficients across the alternative specifications. Although we are cautious in interpreting the meaning of this coefficient, we learn that to investigate family influence on child outcomes, beyond the simple cross-section analysis we need to pay more attention to the dynamic aspects and changes over time.[20]

6.7 Unique Father's Role?

In this section we explain the results from the analysis using the FFCWS. Tables 9 - 11 provide summary statistics on relationship stability and biological father involvement after nonmarital birth. For the first five years after a child's birth, we can see substantial changes in the relationship status in the FFCWS. About 23% of the married couples were separated and only 36% lived together if they were not married at the time of the child's birth. We also find frequent changes in mothers' partners, especially among the cohabiting couples

[20]In this regard, we need to track a child's family history over his or her child's life to measure the family instability more accurately. We need to consider the direction of and reason for the changes in family structure. In future investigations, we will want to distinguish the short-term and long-term outcomes and further consider the timing of the events and durations of relationship before family formation and dissolution.

and single mothers over the five years.[21] As the child ages, the fathers' involvement with their separated children noticeably diminishes while the share of nonresidential fathers increases.

We use a "duration of a relationship between a father figure and a child" using the reported date of the relationship change from the mother surveys instead of simply using the existence of a father figure at the given time.[22] We include these variables in the value added specification on the PPVT scores. We find the biological father's duration of residence with his child has a significant impact on the child's PPVT score, even after controlling for various socioeconomic backgrounds, the mother and father's cognitive skills, and the child's demographic information. It is worthwhile to mention that the father's cognitive skills are as important as those of the mother, which are measured by Wechsler Adult Intelligence Scale (WAIS).[23] However, we cannot find any impact of the existence of either a biological or a stepfather at home in the child fixed effect model.

6.8 Discussion on Relative Share of Family and School Factors across the Grade Level

Based on our estimation result (Tables **), we discuss the relative contribution of family and school inputs on the racial achievement gap across the different stages of a child life. We focus primarily on whether school factors contribute to a decrease in racial achievement gaps and to overcome the disadvantages caused by the initial inequality resulting from family background. For this analysis, we conduct the Oaxaca decomposition with different specifications. Across the specifications we find a common pattern that family factors are more important in explaining racial gaps; however, the importance of school factors grows as a child ages.[24]

[21] In fact, these numbers underestimate the true number of transitions. Since the survey did not directly ask about the number of coresident relationships at the third wave, we just infer the number from the other relevant information available such as marriage and partnership status. At the fourth wave, however, there is a direct question about this information.

[22] Based on the social stress theory, both children and parents need time to adjust to a new environment and new relationships in order to productively enhance the children's cognitive outcomes.

[23] In the preliminary analysis using the ECLS-B, again, we find that father's education level is as important as the mother's education. Recent study by Bronte-Tinkew et al. using the ECLS-B finds that early positive father-child interactions reduce a child's cognitive delay.

[24] We do not include this preliminary result here. We will conduct the additional analysis done by Todd and Wolpin (2007) to attempt to account for the sources of gaps in test scores across races.

7 Conclusion

In our analysis of family instability on children's cognitive development, we use the number of family transitions and the duration of a child's coresidence with a father figure as proxy variables to reflect family instability; however, it is not clear how to interpret these coefficients. Each variable reflects a broad set of environmental and behavioral factors, which are correlated with other covariates. Hence, we need cautious imposing causal interpretations on our results. To better assess these results, we need to develop an appropriate measure for capturing family instability that properly summarizes the number and directions of transitions, the duration of each transition, and the quality of familial relationships in general. More crucially, as suggested by Tartari (2007), ultimately we want to understand the mechanism of skill formations, in which inputs affect outcomes, not simply the overall effect resulting from a change in family structure.

There has been growing interest in the development of non-cognitive skills and health outcomes. In order to extend our analysis of cognitive outcomes, we will want to consider the interaction among the various skills and also the interaction between family and school factors throughout a child's developmental stages. As a next step, we will want to test the following hypothesis: family instability and a low degree of paternal involvement have a negative impact on cognitive outcomes and an even stronger negative impact on behavior outcomes in early childhood. However, cognitive outcomes would increasingly deteriorate in the subsequent years , since both cognitive and non-cognitive skills, as well as health status, are interrelated.

In addition to family influences, we will need to incorporate the study of teacher's effect on social and behavior skill development presented by Jennings and Diprete (2010). They find that a teachers' effect on behavioral outcomes is sizable and somewhat larger than his or her effects on academic development. They argue that because social and behavioral skills have a positive effect on the growth of academic skills, teachers who are good at enhancing social and behavioral skills provide an indirect boost to academic skills.

Furthermore, we are interested in whether schools, local institutions, and relevant public policies (e.g., child support, child care subsidy, paternal leave, and etc.) contribute to a decrease in inequality during a child's life with regard to his or her interaction with family and neighborhood environments. As Todd and Wolpin (2007) point out, to analyze policy

implications, we need to account for the possibility that changing the level of a single input affects decisions about other inputs. In this regard, we need to analyze how families make decisions about what inputs provide for their children using a structural model.

As divorce and cohabitation are becoming more widespread, resulting in growing family instability, presumably the incentive of guardians to invest in their biological or step-children will decrease. To derive testable implications, we want to model an inefficient investment pattern for non-biological or step-parental children in the families that experience higher instability. Also, the possibility of coordination failure among the couples in child development and its consequences needs to be investigated. Another possible direction in which to continue would be to investigate more sophisticated relationships between different types of investments and formation of different skills as we try to identify the unique role of paternal investment in child development.

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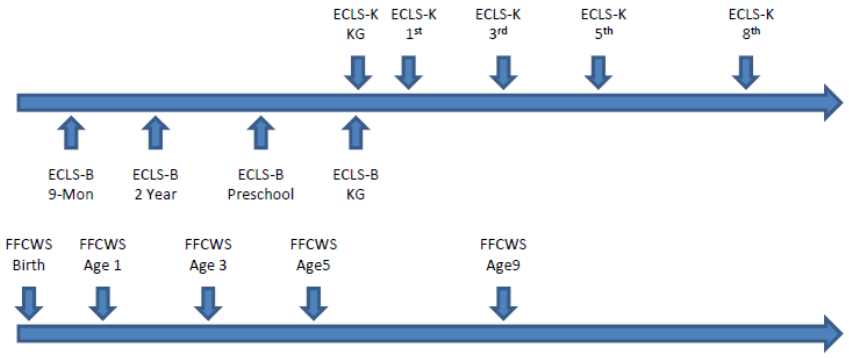
Appendix - Data

Figure 9: Survey Timing of the Each Data Set



Here we provide how we construct several key variables used in the analysis.

- Class size and teachers' education attained, tenures, and experiences are calculated separately for math and reading. ECLS-K surveyed all teachers for reading, but, surveyed one of the teachers for math or science class since the fifth grade. We use the mean characteristics of available two teachers for math teachers if math teachers were not surveyed.
- School climate variable is constructed through the factor analysis using the following questions. Questions containing negative implications are reverse coded.
  - Staff members in this school generally have school spirit
  - The level of child misbehavior (for example, noise, horseplay, or fighting in the halls or cafeteria) in this school interferes with my teaching
  - Many of the children I teach are not capable of learning the material I am supposed to teach them
  - I feel accepted and respected as a colleague by most staff members
  - Teachers in this school are continually learning and seeking new ideas
  - Routine administrative duties and paperwork interfere with my job of teaching
  - Parents are supportive of school staff

  - The academic standards at this school are too low
  - There is broad agreement among the entire school faculty about the central mission of the school
  - The school administrator knows what kind of school he/she wants and has communicated it to the staff
  - The school administrator deals effectively with pressures from outside the school (for example, budget, parents, school board) that might otherwise affect my teaching
  - The school administrator sets priorities, makes plans, and sees that they are carried out
  - The school administration's behavior toward the staff is supportive and encouraging
  - I really enjoy my present teaching job
  - I am certain I am making a difference in the lives of the children I teach
  - If I could start over, I would choose teaching again as my career

- For the variable, number of family transitions, we impose one if a child does not live with biological father at the start of the survey. From then, if there is a change in mother's partnership status between the waves, we add one in each event. Hence, there is a limitation that this variable underestimates the true number of transitions and inevitably there is a measurement issue.

- Home Input (There is variation on the available questions across the waves.)
  - Tell stories to {CHILD}?
  - Would you say not at all, once or twice, 3-6 times, or every day?
  - Sing songs with {CHILD}?
  - Help {CHILD} to do arts and crafts?
  - Involve {CHILD} in household chores, like cooking, cleaning, setting the table, or caring for pets?
  - Play games or do puzzles with {CHILD}?
  - Talk about nature or do science projects with {CHILD}?
  - Build something or play with construction toys with {CHILD}?
  - Play a sport or exercise together?
  - Practice reading, writing or working with numbers?
  - Read books to {CHILD}?

- Number of children's books Do you have a library card?
- Does {CHILD} have {his/her} own library card?
- In the past month has anyone in your family visited a library with {CHILD}?
- Do you have a home computer that {CHILD} uses?
- Dance lessons?
- Organized athletic activities, like basketball, soccer, baseball, or gymnastics?
- Organized clubs or recreational programs, like scouts?
- Music lessons, for example, piano, instrumental music or singing lessons?
- Art classes or lessons, for example, painting, drawing, sculpturing?
- Organized performing arts programs, such as children's choirs, dance programs, or theater performances?