The Difference a Home Makes: Examining the Relationship of Housing Conditions over Time on Childhood Development Outcomes

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PROVIDENCE, RHODE ISLAND

MAY 2015

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Contents

Abstract

This study seeks to expand our understanding of the impact of housing conditions on childhood development by incorporating multiple temporal dimensions – timing, duration, and stability – simultaneously. Using data from the Fragile Families Study, I identify distinct housing condition trajectories which are more commonly experienced by children in this sample. These trajectories are then used in regression models to measure their effect on later childhood development outcomes – parent-rated health ratings and standardized Peabody Picture Vocabulary Test scores - while also adjusting for time-constant and time-varying confounding characteristics.

The analysis of multiple temporal dimensions to poor housing reveals a couple of things. First, defining "poor" or "bad" housing is a tricky task. When the trajectory classes do not represent clear and consistent conditions, relationships between housing condition exposures and childhood development are less clear. For example, any type of change to the tenancy of housing, whether it is "improving" by going from renting to owning or it is "declining" by going from owning to renting, is associated with lower standardized PPVT scores and lower odds of better health. In other words, the stability of exposure to housing conditions seems to matter. Second, family income and family structure matter for housing trajectories. When time-varying income and family structure characteristics were included in the regression model, the housing trajectory coefficients were no longer statistically significant. Additional analyses reveal that changes to family structure impacts membership to a particular housing trajectory.

1 Introduction

Providing "good" housing has long been a critical feature of U.S. policy. In 1949, Congress passed the 1949 Housing Act in order to ensure "a decent home in a suitable living environment for every American family" (Maybank 1949:1). Since that time, policies have ranged from promoting and creating permanent or semi-permanent housing for all, ensuring housing conditions meet a minimum set of criteria for health and safety, providing affordable housing options in safe neighborhoods with access to amenities like good schools, commerce, and jobs, and creating accessible pathways towards homeownership (Katz et al. 2003; Lubove 1962; Marcuse 1986; Schwartz 2010).

The provision of housing remains a focus of policymakers largely because of the assumed relationship between housing conditions and the economic and physical well-being of individuals and families (Schwartz 2010). However, existing research on the relationship between housing and child development simplifies the relationship between housing and well-being. Specifically, most existing research focuses primarily on the conditions, experiences, and interactions children face at home (such as the presence of environmental toxins or hazards and overcrowding), failing to consider exterior and material conditions of the housing unit itself (Levanthal and Newman 2010). Furthermore, the majority of existing research does not adequately consider the temporal dimensions of exposure to housing conditions. While much is known about the effects of individual housing factors, research is still needed to better understand whether the timing, duration, and stability of those housing factors changes the magnitude of impact on residents.

This project seeks to explore and describe housing as both interactions of multiple attributes of housing (tenancy, housing unit type, and household moves) and the nature of

the exposure (timing, duration, and stability) to housing conditions on children. Rather than looking at a single snapshot of a child's housing conditions – whether the parents are renters or owners, the type of housing unit, the frequency of moves, and so on – this project will identify and use housing trajectories which capture the cumulative exposure to set of housing conditions over time.

Using data from the Fragile Families and Child Well-being Study, I will first examine the housing conditions of families. The study specifically focuses on families of lower socio-economic standing and headed by unmarried or single parents (Bendheim-Thoman Center for Research on Child Wellbeing 2008). In particular, I will examine the timing, duration, and stability of housing conditions measured as tenancy, housing unit type, and frequency of household moves and I will address the following questions:

(1) What housing trajectories are most commonly experienced during early childhood (birth to age 9)?

(2) What impact do different housing trajectories have on health and cognitive development in later childhood (age 9)?

(3) What role do time-constant and time-varying socioeconomic factors play in linking housing trajectories to later childhood development outcomes?

2 Background

There is a growing body of literature examining the relationship between the home environment and children's health (e.g. Kreiger and Higgens 2002; Newman 2008; Northridge and Sclar 2002; Stewart and Rhoden 2006) and child development(e.g. Evans, Saltzman, and Cooperman 2001; Evans 2006; Herbers et al. 2012; Mueller and Tighe

2007; Ziol-Guest and McKenna 2014). Understanding the context of children's health and development has increasingly become important as scholars discover that childhood well-being is related to future social, economic, and physical well-being as adults (e.g. Ferraro, Shippee, and Schafer 2009; Warren 2009).

2.1 Housing Factors Affecting Childhood Development

Housing is a complex concept, comprised of multiple definitions and characteristics. One dimension of housing is the housing unit's physical attributes and availability. This includes the quality and safety of the unit, as well whether individuals have access to housing at all. Second, housing can be understood in terms of how it relates to the people occupying it. Are the occupants renting the unit or do they own it? Is the cost of housing affordable for the individual or family occupying it? What type of unit is it? Is it spacious enough to accommodate everyone (is it overcrowded)? Do the occupants feel stable and secure in terms of being housed in the present and the near or far future? Finally, housing units are often related to the neighborhoods in which they are situated and whether they are proximate to good employment, school opportunities, and other social services.

For this particular study, I am interested in three key housing characteristics: tenancy (whether the occupant of the unit is the owner or a renter), housing unit type, and whether the household moves frequently. As evidenced by the existing literature, each of these characteristics has been studied in depth in relation to child well-being. Homeownership has long been heralded as necessary for the well-being of the family, with many government dollars put forth to stimulate homeownership among residents (Alm, Follain, and Beeman 1985; Green and White 1997; Schwartz 2010). Many studies

have found that growing up in an owned home is good for health (Fogelman et al. 1989), math and reading achievement (Haurin, Parcel, and Haurin 2002), high school completion (Aaronson 2000; Green and White 1997), and child behavior (Boyle 2002; Haurin et al. 2002). In addition, homeownership may provide a greater sense of security by eliminating the threat of eviction or lease termination (Levanthal and Newman 2010).

Both intuitively and evidentially, we know that physically inadequate, unstable, or unaffordable housing can be problematic for individuals and families. For example, lack of shelter or even physically deteriorated housing can result in death or life-threatening health conditions (e.g. Hynes et al. 2000; Sandel, Sharfstein, and Shaw 1999). Furthermore, children's health is closely associated with the physical adequacy and safety of the housing unit. Studies have shown consistent evidence of the relationship between children's respiratory health and poor housing conditions (Fisk, Lei-Gomez, and Mendell 2007; Sandel and Wright 2006; Wu and Takaro 2007), as well some relationships between poor housing quality and childhood injuries (Evans and English 2002; Kreiger and Higgens 2002). For example, results from the Moving to Opportunity program in Boston, a randomized mobility experiment, show that moving to low-poverty neighborhoods and improved housing conditions is related to increased safety, fewer behavior problems among boys, and better health for household heads (Katz, Kling, and Liebman 2001). Furthermore, overcrowding in a home may ease the transmission of infectious diseases (Baker, Taylor, and Henderson 1998; Gove, Hughes, and Galle 1979; Mann, Wadsworth, and Colley 1992).

High housing costs may also put a family's well-being at risk if too much of the family's income is committed to shelter and less is available for food, transportation, or

medical care (Evans 2006; Kreiger and Higgens 2002). For example, a study of welfare reform in Indiana found that families in public housing, as compared to families using housing vouchers, were better able to afford medical care because they had lower housing cost burdens (Lee et al. 2003). The lower cost burden of housing frees up available household income to spend on other household necessities.

A series of qualitative studies have also found that there are psycho-social aspects of housing that are important to family and individual well-being. Homes provides a sense of personal haven and autonomy and status in the community and broader society, in turn affecting one's sense of self, and relieving levels of stress (Evans et al. 2000; Kearns, Hiscock, and Ellaway 2000; Ridgway et al. 1994; Schorr 1963). Psychological stress related to frequent moves may affect the home environment influencing children's development. More specifically, the strain of managing multiple moves (e.g. dealing with evictions, searching for new housing, coping with the financial burden of a move), whether they are voluntary or forced moves from the home (Desmond 2012), may lead to stress on both the parent and the child, resulting in strained relationships between parent and child which can affect development outcomes (Clark 2010; Cohen and Wardip 2011; Ziol-Guest and McKenna 2014).

The observed impacts of the Great Recession of the 2000s highlights the need for better research on housing and strong housing policy, particularly due to the greater number of cases of housing problems extending beyond the working class to middle-class families. In addition to the millions of foreclosed properties[1] during the Great Recession, more households, nearly 40.9 million households in 2012, remain cost-burdened by their

[1] RealtyTrac, the leading online marketplace for foreclosure properties, reports year-end foreclosure market reports annually. In 2010, RealtyTrac reported a record 2.9 million U.S. properties filed for foreclosure (RealtyTrac 2011). Other reports estimate four million homes were foreclosed each year of the Great Recession (IPR 2014).

housing, paying more than 30 percent of their household income (Joint Center for Housing Studies of Harvard University 2014). Not only were children and families abruptly removed from their homes, the resulting financial and material hardships caused by high cost of housing and the low availability of safe and adequate housing affect the location and quality of the next housing unit selected by families. The long-lasting impacts of the instability caused by the housing crisis on children and families remains to be seen. While efforts are made to improve the housing circumstances of families, it is necessary to further our understanding on whether and how housing conditions are related to children's development outcomes to ensure that interventions do not have deleterious effects on already vulnerable youth and families.

However, the complexity of the relationship between housing and well-being makes it difficult to separate from the income level of the residents, isolate and identify a specific housing condition, or fully take into account the characteristics of residents. For example, some social scientists question the existence of the "homeownership effect,"[2] as the effect may be due to self-selection of individuals who are able to become homeowners rather than renters or have greater residential mobility (Aaronson 2000; Levanthal and Newman 2010).

This paper seeks to better understand the effect of housing factors on childhood development by exploring the interaction of different factors, as well as the changes to those factors, over a continuous period of time. For example, while one may define "unstable" housing conditions as frequent household moves, the effect of many moves

[2] The "homeownership effect" refers to the alleged positive effects of homeownership on family well-being, child well-being, community and civic engagement, and other more socially desirable outcomes (Aaronson 2000; DiPasquale and Glaeser 1999; Green and White 1997). Proponents of the "homeownership effect" argue that homeownership increases residential stability and that such stability can provide better environments for children and families to thrive academically and economically (Green and White 1997), as well as encourage families to invest more in their local community (DiPasquale and Glaeser 1999).

may be different if household moves are also related to changes in housing type, such as moving from a mobile home to an apartment to a single-family unit, and changes in tenancy, such as going from renting to owning.

2.2 A Life Course Perspective on Housing and Childhood Development

The emphasis on the effect of housing conditions over time builds on the insights of the life course perspective literature. In other words, the timing of events and transitions helps shape the life course (Elder, Jr., Johnson, and Crosnoe 2003). Particular importance is given to the relationship between life stages and childhood circumstances that affect adult well-being (Ferraro et al. 2009; Gewirtz 1969; White, Kaban, and Attanucci 1979).

For example, one study showed that the disruption of the physical environment of a child seven years of age or younger is associated with a significantly negative effect on school achievement (Haveman, Wolfe, and Spaulding 1991). Another study has shown that while long-term poverty has substantive impacts on ability and achievement, the period of exposure (to poverty) makes a difference on the magnitude and significance of the impact (Guo 1998). Thus, it is important to distinguish the timing of socioeconomic influences on a child's biological and cognitive development. The degree of long-term impacts of childhood disadvantages may also be affected by the duration and stability of the disadvantage (Ferraro et al. 2009; Sharkey and Elwert 2011; Ben-Shlomo and Kuh 2002; Wilson, Shuey, and Elder, Jr. 2007).

Although life course theory foregrounds the relationship of explanatory characteristics between and across life stages, much of the existing research operates under the assumption that the temporal dimensions described above – timing, duration,

and stability – operate independently of one another. Concurrent inclusion and measurement of these temporal processes may reveal a more nuanced understanding of childhood housing disadvantage on later childhood development outcomes, contributing to both housing research and life course theory. The generation of housing trajectories over the childhood life stage may reveal more about the timing, duration, and stability of the housing disadvantage. For example, the timing of housing disadvantage in a child's life may have different impacts on well-being; an infant may not acutely experience the difference between living in a cramped apartment as a toddler or an older child (8 or 9 years old) may. The duration of poor housing conditions may affect child attainment differently as well. Longer periods of poor housing conditions may represent an enduring deficit in economic resources and ever-present stress on parents and families. The instability or stability of a particular set of housing conditions, whether good or poor, may create adaptation problems for families. Parents may be able to develop strategies to protect and dampen the negative effects of poor housing conditions if those conditions remain consistent. However, constantly changing housing conditions, such as going from renting to owning back to renting, may reduce a family's ability to adapt and generate stability for a child's well-being.

3 Methods

3.1 Data Sources

The Fragile Families and Child Wellbeing Study (FFCWS) a longitudinal study of 4,897 newborn children born in large U.S. cities between 1998 and 2000, including four follow-up interviews when the child has turned one, three, five, and nine years of age,

respectively, provides individual-level data on childhood development outcomes, housing conditions, and other potential covariates.[3] The survey aims to understand the conditions and capabilities of unmarried parents, especially fathers; the nature of the relationships between unmarried parents; how children of these types of families fare; and how families and children are affected by policies and environmental conditions. Approximately three-quarters of the study's focal children were born to unmarried parents; the study, as such, focuses especially on unmarried parents and their children, or families referred to as "fragile" as they are considered to be at greater risk of breaking up and being impoverished than "traditional" families comprised of married parents (Bendheim-Thoman Center for Research on Child Wellbeing 2008). "Fragile families," for the purpose of this study, are defined as low-income families and families headed by unmarried and/or single parents. The cities selected for the sample were chosen using a stratified random sample of all American cities with population sizes of 200,000 people or more and grouped by policy and labor market environments to ensure diversity.

The core FFCWS study also involves interviews with mothers and fathers at the time of the focal child's birth and thereafter, as well as interviews with the primary caretaker (if not the mother or father) and the child (when s/he is old enough to respond). The data for each wave were collected by telephone conversations or in-person interviews. The parent interviews (conducted with the mother and father separately) collect information on attitudes, relationships, parenting behavior, demographic characteristics, physical and mental health conditions, economic and employment status, neighborhood characteristics, and program participation of the parent, household, and

[3] The first wave was collected at the time of birth of the child between 1998 and 2000. The second wave was collected between 1999 and 2001 after the child had turned at least one year of age, the third between 2001 and 2003 when the child turned 3 years old, the fourth between 2003 and 2005 when the child is 5 years old, and the latest wave between 2007 and 2010 when the child is 9 years of age.

focal child. The FFCWS also incorporate in-home assessment that collects information on the variety of domains of the child's environment including the physical environmental and parenting qualities. This is done through in-home observations and interviews, as well as measures of child development outcomes like anthropometrics, child behaviors, and cognitive ability. The in-home assessments were only conducted when the children were about three, five, and nine years old.

The analysis sample for this study restricts the full FFCWS sample to 1,648 children/mother observations who participated in all waves and interviews and assessments (mother interview and in-home assessment) between birth and age 9. There is some degree of sample attrition and to the extent that there is nonrandom attrition, the analysis will produce biased results. This is addressed by comparing the full FFCWS sample to the restricted sample on key covariates.[4]

3.2 Measures

3.2.1 Outcome Variables

This study focuses on two outcomes of interest related to childhood development: the mother's report of the child's overall health and the child's cognitive development as assessed by the Peabody Picture Vocabulary Test (PPVT). The PPVT is administered by the survey enumerator at the time of the in-home assessment.

During each survey wave, mothers rate their child's overall health on a five-point scale: poor, fair, good, very good, or excellent. Treated as a continuous variable, lower values of health indicate poorer health and higher values denotes better health. Previous review of other literature examining parent-child agreement on health-related quality of

[4] The results are shown in the appendix.

life measures find that assessments of child's health may be affected by the closeness of the parent-child relationship and whether the person answering is involved in the child care, as well as whether the child has specific health conditions (Eiser and Morse 2001; Upton, Lawford, and Eiser 2008). However, the literature also finds some support for the view that parents are able to judge the child's physical health-related quality of life consistently with what a child states (Eiser and Morse 2001). In the FFCWS, the mother assesses the physical health of the child starting from age 1. Given that children cannot provide assessments of their own health at young ages and the proxy focuses on physical health status, the parent-rated child health measure corresponds to this analysis. The average parent-rated health rating at age 9 for the analysis sample is 4.38, falling between "excellent" and "very good" health (Table 2).

The Peabody Picture Vocabulary Test (PPVT) measures the focal child's cognitive development. The enumerator of the survey administers the test during the in-home assessment and interview. The PPVT-III tests verbal ability and assesses receptive vocabulary knowledge and comprehension of spoken English using images rather than text for individuals aged 2 years 6 months and older (Dunn and Dunn 1997). The standardized test score calculated from the raw score allows for comparison between the examinee's performance to that of the norm group. Evidence from test-and-retests of selected participants, as well as comparisons to other aptitude tests, supports the overall reliability of the PPVT as a measure of cognitive development (Williams and Wang 1997). The mean standardized PPVT score at age 9 for the analysis sample is 92.32 with a standard deviation of 14.64; scores range from 37 to 144 points (Table 2).

3.2.2 Explanatory Variables

The primary explanatory variable is children's housing trajectory during early childhood, which is based on various housing condition statuses from birth to age 9. The three housing conditions measured and considered in this study are: housing tenancy (homeowner versus renter), the type of housing unit (apartment, single-family home, or other), and household moves between surveys. Supplemental analyses using alternative measures of housing unit type (seven categories instead of three) and household moves (number of moves between surveys, average number of moves each year between surveys, and categorical measures of number of moves) were conducted. Summaries of findings are in the appendix.

3.2.3 Additional Covariates

The FFCWS data include a wide set of covariates which could be possible confounders of the relationship between housing trajectories and health, cognitive, and emotional development in later childhood. The analysis includes both time-constant and time-varying covariates. They are broadly grouped by the characteristics of the mother, family, and child. Table 1 provides a brief summary of the selected covariates of interest, including details about the type of variable (continuous, binary, or categorical) and the value's coding.

Table 1: Variable List and Coding

Variables	Variable Type	Coding
Maternal Characteristics		
Age at time of child's birth	Continuous	15 through 43 years
Race/ethnicity	Categorical	1 = non-Hispanic white, 2 = non-Hispanic black, 3 = Hispanic, 4 = other
Education at time of child's birth	Categorical	1 = less than high school, 2 = high school or equivalent, 3 = some college or technical school, 4 = college graduate or more
Family Characteristics		
Poverty level	Categorical	1 = 0-49% of poverty threshold, 2 = 50-99%, 3 = 100-199%, 4 = 200-299%, 5 = 300%+
Family structure	Categorical	0 = 1 single parent, 1 = married parents, biological dad, 2 = married parents, not biological dad, 3 = unmarried parents biological dad, 4 = unmarried parents, not biological dad
Number of children	Continuous	1 through 10
Child Characteristics		
Gender	Categorical	0 = boy, 1 = girl
Parent-rated health rating	Categorical	1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent
Peabody Picture Vocabulary Test score	Continuous	37 through 159
Household / Housing Unit Characteristics		
Homeowner	Binary	1 = yes
Housing unit type	Categorical	0 = other, 1 = single-family unit (detached or attached), 2 = apartment
Whether household moved	Binary	1 = yes
Number of moves	Continuous	0 through 20

Time-constant covariates include the mother's self-reported race/ethnicity, education, age at the time of birth of the focal child, and child's gender. Mother's self-reported race/ethnicity is measured as non-Hispanic white (reference), non-Hispanic black, Hispanic, and other. Educational attainment is constructed as a four-category categorical variable: less than high school, high school or equivalent, some college or

technical school, and college graduate or more. Child's age is coded as 1 for female and 0 for male.

Table 2 reports descriptive statistics for these time-constant characteristics and the outcome variables. Mothers are, on average, 25 years of age at the time of the focal child's birth. As expected, given the sampling frame of the FFCWS, the mothers in the analytic sample are more likely to be women of color (non-Hispanic black, Hispanic, or other) and less likely to have a college degree or more at the time of the focal child's birth.

Table 2: Descriptive Statistics for Time-Constant Characteristics[1]

Variable	Mean or Percentage	Standard Deviation
Outcomes (at age 9)		
Parent-rated health rating[2]	4.38	0.83
Peabody Picture Vocabulary Test score[3]	92.32	14.64
Time-Constant Characteristics		
Child's gender		
Male	52.6%	
Female	47.5%	
Mother's age at birth of child	25.40	6.01
Mother's race/ethnicity		
Non-Hispanic white	21.2%	
Non-Hispanic black	52.9%	
Hispanic	22.9%	
Other	3.0%	
Mother's education at birth of child		
Less than high school	35.8%	
High school diploma or equivalent	26.3%	
Some college or technical school	26.0%	
College degree or more	11.8%	

Notes:
1/ For analysis sample only. Sample restricted to observations with value for all covariates of interest
2/ Health scale based on 5-point scale: 1 = poor, 2 = fair, 3 = good, 4 = very good, and 5 = excellent
3/ Peabody Picture Vocabulary Test scores are standardized and range from 38 to 144

Time-varying housing unit characteristics measured at birth and ages 1, 3, 5, and 9 include tenancy (homeowner or renter).The two other time-varying housing unit characteristics, housing unit type (apartment, single-family unit, or other) and whether the household moved, are measured at ages 3, 5, and 9 and ages 1 , 3, 5, and 9 respectively.

Time-varying covariates, measured at birth and ages 1, 3, 5, and 9, include family characteristics such as income (measured as percent of official poverty threshold), family structure (married or unmarried mother and nature of relationship with birth father)[5], and the number of children (other than the focal child) in the family. Geographic location or urban/rural location of the child's home, which would likely affect the type and condition of the housing unit, is not included as the FFCWS primarily samples from cities with large populations, indicating they are selected from urban areas. Measurements at birth of time-varying covariates are included as baseline covariates along with the time-constant variables.

Table 3 presents descriptive statistics for these time-varying characteristics, as well as housing characteristics at each age. The percentage of home owning mothers declines throughout early childhood, with 39.1 percent of the sample reporting homeownership at birth of the focal child declining to 31.6 percent of the sample at age 9. Throughout all ages (3, 5, and 9), the majority of the analytic sample live in apartments; however, the proportion of those living in apartments increases during early childhood with the proportion of those living in single-family homes declining. The percentage of households who report moving between survey waves changes throughout childhood, ranging from 34.8 percent (age 5) to 53.6 percent (age 9). Changes in household moves

[5] Family structure refers to the configuration of parental figures in the home with the focal child. The mother may be married or unmarried and have a relationship with the biological father of the child or a male who is not biologically related to the child (non-biological, social father).

indicates that whereas households did not move frequently while the child was still an infant or toddler, a majority of families moved between ages 5 and 9. This may be due to the timing of the survey. The age 9 follow-up survey was administered between 2007 and 2009, during the Great Recession.

Table 3: Descriptive Statistics for Time-Varying Characteristics[1]

Variable	Birth	Age 1	Age 3	Age 5	Age 9
Housing Unit Characteristics					
Homeowner	39.1%	38.1%	26.2%	28.6%	31.6%
Housing unit type					
Other			2.9%	3.0%	2.0%
Single-family home (attached or detached)			69.5%	70.8%	75.2%
Apartment			27.7%	26.2%	22.8%
Recently Moved (between survey waves)		39.8%	40.8%	34.8%	53.6%
Time-Varying Characteristics					
Family poverty level[2]					
0-49%	17.2%	25.3%	22.3%	21.1%	17.0%
50-99%	17.1%	18.6%	19.8%	20.4%	20.2%
100-199%	26.8%	24.2%	22.5%	24.3%	28.9%
200-299%	14.8%	13.5%	14.4%	14.4%	14.1%
300% +	24.2%	18.3%	20.9%	19.8%	19.8%
Family structure					
Single parent	40.0%	38.1%	39.7%	39.7%	40.5%
Married parents, bio dad	25.4%	29.8%	32.0%	32.8%	30.3%
Married parents, non-bio dad	0.0%	0.4%	1.2%	3.2%	7.8%
Unmarried parents, bio dad	34.6%	27.7%	20.3%	12.9%	9.3%
Unmarried parents, non-bio dad	0.0%	4.1%	6.8%	11.5%	12.1%
Number of kids in household	1.29	2.35	2.36	2.57	2.73
	(1.30)	(1.34)	(1.31)	(1.37)	(1.37)

Notes:
1/ For analysis sample only. Sample restricted to observations with value for all covariates of interest. Showing mean or percentage and standard deviation is shown in parentheses.
2/ Family income shown as percent of poverty threshold

The majority of families in the sample remain at or below the official poverty threshold throughout childhood; however, the proportion of families well above the threshold (300% +) declines from 24.2 percent at birth to 19.8 percent at age 9. As

expected with the sampling frame of the FFCWS, a large proportion (approximately 40 percent) of the analytic sample consists of single mothers throughout early childhood. However, the proportion of families with married parents (either with the biological father or non-biological father figure) increases over time, as does the proportion of mothers cohabitating with non-biological father figures. Lastly, the average number of children in the household (who are not the focal child) increases throughout early childhood. On average, a focal child had 1 -2 siblings at birth, while having 2-3 siblings at age 9.

3.3 Modeling Approach

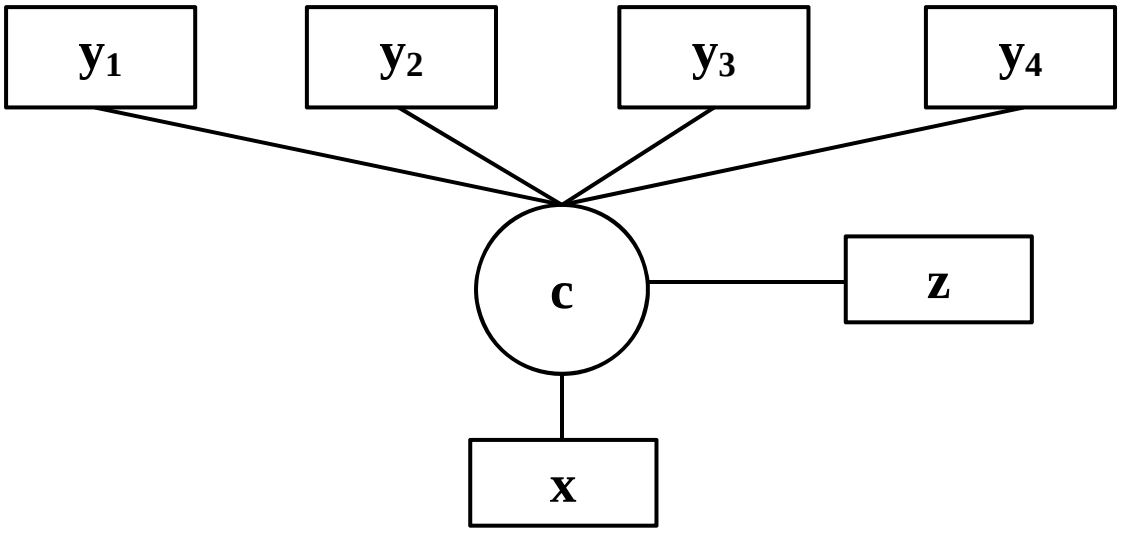
This study is conducted in two parts. First, it examines the timing, duration, and stability of early childhood exposure to housing conditions simultaneously. Rather than looking at timing, duration, and stability of exposure to different housing conditions separately, this study uses longitudinal latent class analysis (LCA) to simultaneously account for each of these temporal dimensions (Jones and Nagin 2007; Muthén and Muthén 2012).[6] The early childhood housing trajectories are then included in models predicting individual health and cognitive development.

LCA suggests that there is an underlying unobserved categorical variable that separates a population between latent classes which are mutually exclusive (Collins and Lanza 2010). As this variable is unobserved, class membership is inferred by examining the relationships among a set of observed indicators. Mixture models are estimated to capture the heterogeneity in class membership, size and underlying pattern of exposure to

[6] Latent class growth analysis (LCGA) was also considered for this analysis. Whereas in LCA no assumptions are made about the form of the dependence among housing condition indicators over time, in LCGA growth parameters (intercepts and slopes) can vary to capture the shape of within-class trajectories (Muthén 2002). LCA was used in order to allow for possible classes of children who move in and out of different housing circumstances to emerge. This would not be as easily obtained with LCGA, as the functional form is not easily represented by growth parameters.

housing conditions by an unobserved (latent) categorical variable with the observed outcomes at each time point (observed characteristics of housing condition in each year) serving as indicators of the latent class variable (Muthén 2001, 2004). The mixture modeling framework used in this study is adapted from the one developed by Muthén (2001, 2004) and is portrayed in Figure 1. The *y*'s refers to a time-ordered series of dichotomous and categorical indicators of housing condition (housing tenancy, housing unit type, and household moves); *x* refers to the categorical and continuous covariates discussed earlier (maternal characteristics, family, and child characteristics); *z* denotes the outcome variables, standardized PPVT scores and parent-rated child health at age 9; and *c* represents the latent categorical variable with *k* classes.

Figure 1: General Modeling Framework: Latent Class Analysis



Note: y's refers to the time-ordered series of dichotomous variables indicating housing condition status at time *t*; *c* refers to the latent categorical variable

There are three key components to the model shown above: *c* is related to *x*, the *y*'s are related to *c*, and *z* is related to both *c* and *x*. The latent categorical variable with *k*

classes (*c*) is related to categorical and continuous covariates (*x*) through a multinomial ordered logistic regression joining class membership to individual (child and mother) and family characteristics. Outcome variables (*z*) are related to *c* and *x* via a regression function. In the case of this study, the continuous outcome variable measuring standardized PPVT score is related through a multiple regression model, while the categorical outcome variable measuring parent-rated child health is related through a logistic regression model. Finally, the time-ordered categorical variables indicating housing condition status (*y*) is related to *c* by trajectories based on maximum-likelihood estimations of the probability of observing each individual's sequence of measurements. In other words, if we let the latent variable *c* have *k* trajectory classes ($K = 1, 2, \ldots, k$) and y_j refers to housing condition status at age *j* ($j = 1, 2, \ldots, J$), the estimated trajectory class probabilities for individual *i* are given by

$$\Pr(c = K|y, y_2, \ldots, y_J) = \frac{\Pr(c_i=J)\Pr(y|c_i=J)\Pr(y_2=c_i=J)\ldots\Pr(y_k|c_i=J)}{\Pr(y_1,y_2,\ldots,y_k)} \quad (1)$$

where $Pr(y_1, y_2, \ldots, y_k)$ is the joint probability of all y's. The model coefficients from this estimation determine the trajectory's shape and can vary across subgroups. Thus, it is possible to find more than one subgroup in the population. Furthermore, each individual can have partial class membership, suggesting some uncertainty in the classification of individuals. In other words, the estimated probability of falling in trajectory class *k* of the latent variable *c* is given by a multinonimal logit regression with a vector of baseline covariates, *x*

$$\log\left[\frac{\Pr(c=K)}{\Pr(c=k)}\right] = \delta_K + x\theta_K \quad (2)$$

The best-fitting trajectory classes are identified by comparing various classes based on three statistical criteria: the Bayesian Information Criterion (BIC), Entropy, and

the Lo-Mendell-Rubin (LMR) likelihood ratio test. A model is selected if it is determined to be more parsimonious and accurate (lower BIC), to be better differentiated between trajectory classes (higher Entropy), and to have a significant LMT test statistics (Celeux and Soromenho 1996; Lo, Mendell, and Rubin 2001; Raftery 1995, 1996).

Next, I estimate the effect of the housing trajectories over early childhood (birth to age 9) on cognitive development and health at age 9. I control for baseline covariates, including both time-varying and time-constant characteristics, as well as compute robust standard errors to correct for within-individual correlation (Robins, Hernan, and Brumback 2000). Specifically, to estimate the effect of trajectories of housing conditions over early childhood on later childhood health (as rated by the mother), I fit ordered logit regression models that take the form:

$$ln\left[\frac{\Pr(P \leq m)}{\Pr(P>0)}\right] = \tau_m - [\alpha + \beta H + X_0\gamma] \quad (3)$$

where P represents parent-rated health at age 9, m a category of the outcome, τ a threshold, H the housing trajectory from birth to age 9, and X_0 the vector of baseline covariates.

To estimate the effect of trajectories of housing conditions over early childhood on later cognitive and emotional development as measured by the PPVT, I fit OLS regression models for the dependent variable *T,* standardized PPVT score, that takes the form:

$$T = \alpha + \beta H + X_0\gamma + \varepsilon \quad (4)$$

4 Results

4.1 Early childhood housing trajectories

LCA is used to first determine which early childhood housing trajectories are most common between birth and age 9. Trajectories are estimated for each housing condition variable– tenancy, housing unit type, and household moves – and then combined to generate a set of trajectories including all three variables.

4.1.1 Tenancy

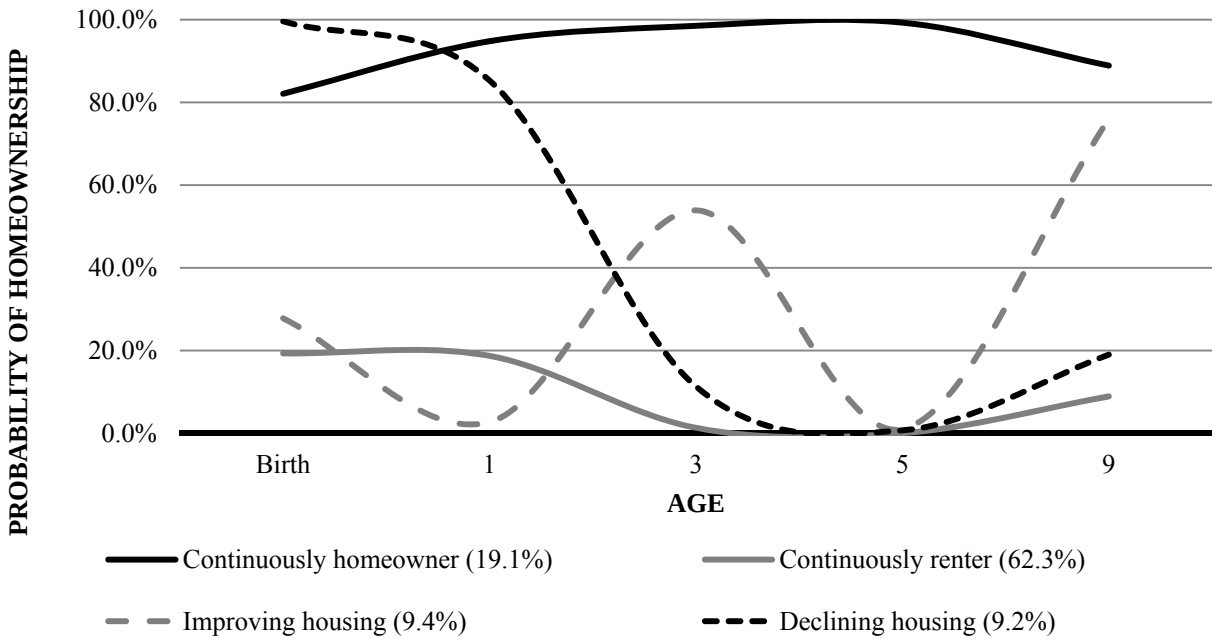
To begin, four distinct trajectories are identified using housing tenancy (homeowner vs. renter) at birth, age 1, age 3, age 5, and age 9 of the focal child. Goodness-of-fit indices suggest that four classes fit the data better than three or five classes, as summarized in Table 4. Compared to the five class model, the four class model produces a lower value of BIC, a higher value of Entropy, and a statistically significant value from the Lo-Mendell-Rubin (LMR) tests. The three class model improves upon the four class model in terms of Entropy, but is a worse model fit in terms of BIC. While the six class model reports a statistically significant value from the LMR tests, the model has a higher value of BIC and lower value of Entropy than the four class model.

Table 4: Model Selection for Trajectories of Housing Tenancy

Number of Latent Classes	BIC	Entropy	Vuong-Lo-Mendell-Rubin Likelihood Ratio Test	Lo-Mendell-Rubin Adjusted LRT Test
2	7801.632	0.953	0.0000	0.0000
3	7650.276	0.968	0.0000	0.0000
4	7602.085	0.912	0.0000	0.0000
5	7639.875	0.861	0.2540	0.2641
6	7680.180	0.862	0.0000	0.0000

As shown below in Figure 2, the four housing tenancy trajectories can be described as follows: continuously homeowner, continuously renter, improving (going from renter to homeowner), and declining (going from homeowner to renter). The "continuously homeowner" group accounts for 19.1% of the sample and experiences a higher likelihood of living in a homeowner-occupied unit (mother is the homeowner) through early childhood. On the other hand, the "continuously renter" group accounts for 62.3% of the sample and has a higher likelihood of living in a renter-occupied unit (mother is the renter) throughout childhood. About 9.4% of individuals lived in rented units during early, early childhood and moved to owned units in later childhood ("improving housing"). Finally, about 9.2% of individuals lived in owned units in early childhood only to move to rented units by later childhood ("declining housing").

Figure 2: Trajectories of Housing Tenancy Status over Early Childhood



4.1.2 Housing unit type

Although the data provided by the FFWS categorizes housing units into seven different categories, for the purposes of this study the seven categories are reduced to three: other (mobile homes, trailers, or other), apartment (with or without common areas), and single family units (detached or attached, including town houses). In addition to the difficulty of interpreting seven different categories across multiple classes, use of all seven categories does not yield improved results.[7]

Three trajectories are identified using housing unit type at age 3, age 5, and age 9 of the focal child. Unlike housing tenancy, data about the housing unit type is only collected as part of the in-home assessments during the follow-up surveys. Goodness-of-fit indices suggest that three classes fit the data better than two, four, five, or six classes, as summarized in Table 5. While the two class model reports a statistically significant value from the LMR tests, the model has a higher value of BIC and a lower value of Entropy than the three class model.

Table 5: Model Selection for Trajectories of Housing Unit Type

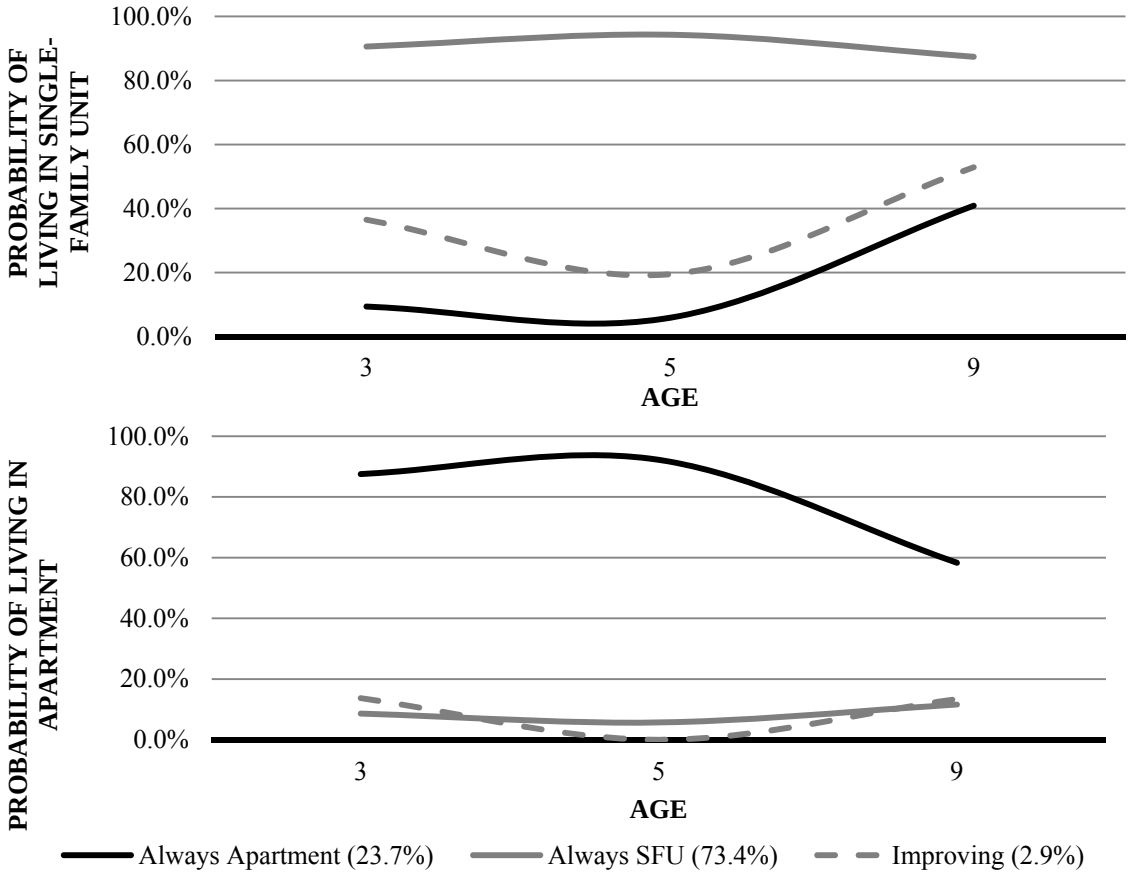
Number of Latent Classes	BIC	Entropy	Vuong-Lo-Mendell-Rubin Likelihood Ratio Test	Lo-Mendell-Rubin Adjusted LRT Test
2	5875.189	0.856	0.0000	0.0000
3	5778.043	0.897	0.0000	0.0000
4	5826.273	0.876	0.6392	0.6440
5	5877.075	0.864	0.4868	0.4922
6	5928.694	0.857	0.0076	0.0077

As shown below in Figure 3, the three housing unit type trajectories can be described as follows: always single-family (SF) homes, always apartment, and improving

[7] See appendix for results of LCA of alternative measures of housing conditions, including a categorical variable measuring housing unit type using seven categories.

(declining likelihood of living in "other" type of housing). The "always SF homes" group accounts for the majority of the sample (73.4%) and members of this class experiences a higher likelihood of living in a single-family housing unit (either attached or detached) throughout early childhood. The "always apartment" group accounts for the majority share of the sample at 23.7% and represents children who have a higher likelihood of living in an apartment unit throughout most of their early childhood. About 2.9% of the sample transition are estimated to have a higher likelihood of living in "other" units (mobile homes, trailers, or other) during early childhood and into apartments or single-family homes by age 9 ("improving").

Figure 3: Probability of Housing Type (Single-family unit or Apartment) by Trajectory Class over Early Childhood



4.1.3 Household moves

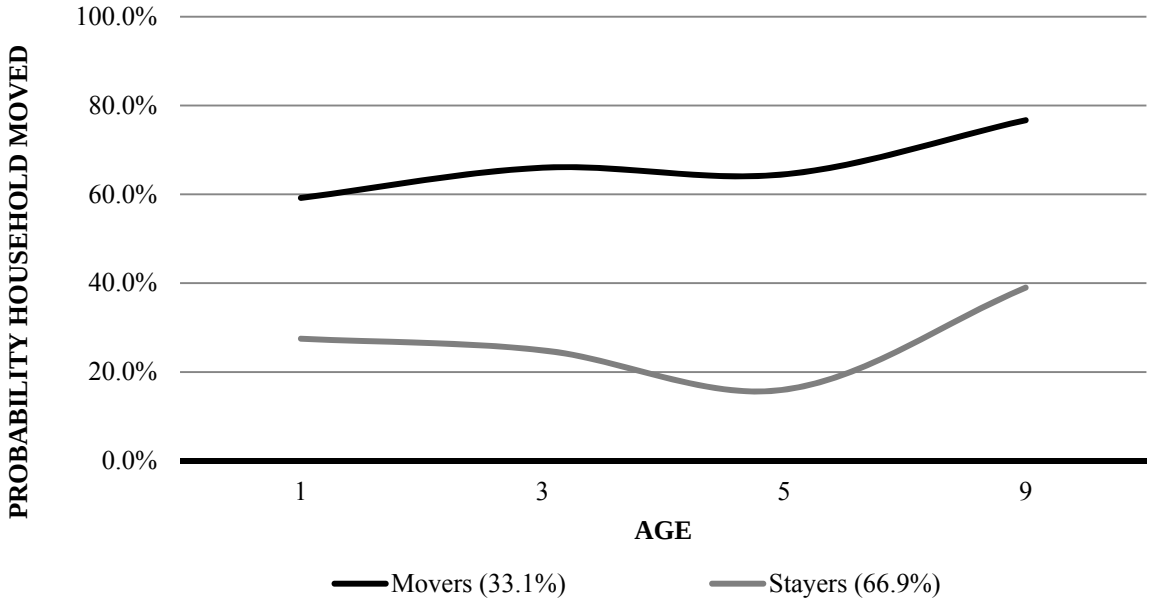
Two distinct trajectories are identified using the dichotomous variable measuring whether or not the household moved during the period between surveys at age 1, age 3, age 5, and age 9 of the focal child. Goodness-of-fit indices suggest that two classes fit the data better than three, four, five, or six classes, as summarized in Table 6. Although the two class model has a lower value of Entropy than the three and four class models, it is the only model to produce statistically significant values from the LMR tests. Additionally, the two class model produces the lowest value of BIC.

The two household move trajectories can be described as follows: movers and stayers (Figure 4). The "movers" group accounts for 33.1% of the sample and experiences a higher likelihood of moving at each age observed. The "stayer" group accounts for the majority of the sample (66.9%) and has a lower likelihood of moving throughout childhood. For those in the "stayers" group the probability of moving remains below 40% throughout childhood.

Table 6: Model Selection for Trajectories of Household Moves

Number of Latent Classes	BIC	Entropy	Vuong-Lo-Mendell-Rubin Likelihood Ratio Test	Lo-Mendell-Rubin Adjusted LRT Test
2	8700.661	0.417	0.0000	0.0000
3	8731.229	0.506	0.1674	0.1776
4	8768.040	0.521	0.8941	0.8950
5	8805.102	0.395	0.5302	0.5303
6	8842.132	0.395	0.0556	0.0556

Figure 4: Probability of Moving by Trajectory Class over Early Childhood



A trajectory class typified by changing mover status (e.g. did not move at infancy, but moved through later childhood or moved during early childhood and did not move during later childhood around age 5 or 9) is not included. This, along with the smaller proportion of "movers" in the sample may indicate that those who move at any point during the study may be lost for a follow-up interview. Further examination of sample attrition is needed to better understand the implications of potential non-random sampling.

4.1.4 All housing condition variables

Three distinct trajectories are identified using all housing condition variables – the dichotomous variable measuring the tenancy (homeowner versus renter) of the household, the categorical variable measuring the housing unit type (apartment, single-family unit, or other), and the dichotomous variable measuring whether or not the household moved between surveys.

Goodness-of-fit indices suggest that three classes fit the data better than two, four, five, or six classes, as summarized in Table 7. Although the two class model has a higher value of Entropy than the three class model, it produces a higher value of BIC. The four class model produces a lower BIC, but also has a lower value of Entropy.

Table 7: Model Selection for Trajectories of All Housing Condition Variables

Number of Latent Classes	BIC	Entropy	Vuong-Lo-Mendell-Rubin Likelihood Ratio Test	Lo-Mendell-Rubin Adjusted LRT Test
2	22531.229	0.969	0.0000	0.0000
3	21848.520	0.925	0.0000	0.0000
4	21604.505	0.833	0.0000	0.0000
5	21480.422	0.857	0.0003	0.0003
6	21363.295	0.864	0.0000	0.0000

The three overall housing condition trajectories can be described as follows: renters in living in apartments, stayer homeowners in single-family homes, and mover renters in single-family homes (Figure 5). The "renter in apartment" group accounts for 20.4% of the sample and experiences a higher likelihood of renting an apartment throughout early childhood and experiencing some likelihood of moving (between 24.3 to 56.5 percent). The "stayer owners in single-family home" group accounts for nearly a quarter of the sample (23.7%) and maintains a very high probability of living in single family home and being a homeowner throughout childhood and is unlikely to move at any age. Finally, the "mover renters in single-family homes" group accounts for the majority of the sample (55.9%). Members of this group have a low probability of being a homeowner, but a very high likelihood of living in a single-family home. The probability of moving remains around 50 percent at every age; the likelihood does increase to 63.8 percent by age 9.

4.2 Early childhood housing trajectories and childhood development outcomes

4.2.1 Parent-rated child's health

Table 8 through Table 11 summarizes the results from an ordered logit regression model for the impact of early childhood housing trajectories on parent-rated child's health at age 9. Three models are presented for each set of housing trajectories (tenancy, housing unit type, household moves, and full housing condition variables): unadjusted, with time-constant covariates[8], and all covariates (time-constant and time-varying). Time-constant covariates include gender of the focal child (dichotomous), age of the mother at the time of the birth of the child (in years), race or ethnicity of the mother, and mother's educational level at the time of the birth of the child (categorical), as well as baseline measurements of time-varying covariates taken at birth. Time-varying covariates include the family's income/poverty level (categorical, as percentage of the poverty threshold), family structure (categorical noting whether single or married parents, biological or social father), and the number of kids under 18 years of age in the household at birth, age, 1, 3, 5, and 9.

[8] The values measured at birth for the time-varying covariates are included as baseline covariates for the model including time-constant covariates.

Figure 5: Probabilities of Multiple Housing Conditions (Tenancy, Housing Unit Type, and Household Moves) by Trajectory Class over Early Childhood

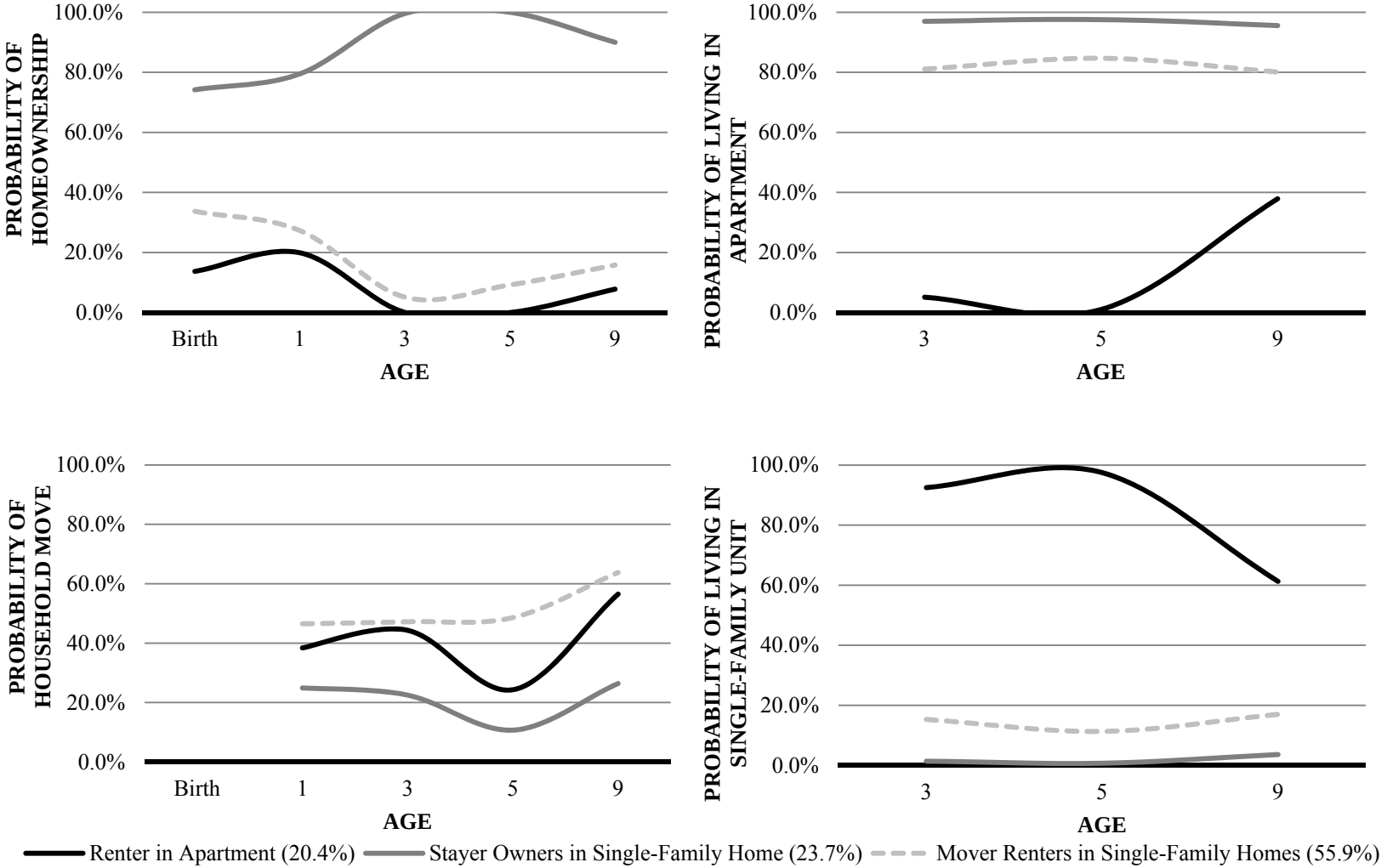


Table 8: Ordered Logit Regression of Parent-rated Child's Health at Age 9 on Housing Tenancy Trajectories

N = 1,645	Model 1 Unadjusted	Model 2 Time-constant covariates[1]	Model 3 All covariates[2]
(1) Continuously homeowner (reference group)	--	--	--
(2) Continuously renter	-0.490***	-0.201	-0.064
	(0.129)	(0.169)	(0.177)
(3) Improving housing	-0.017	0.151	0.219
	(0.191)	(0.204)	(0.213)
(4) Declining housing	-0.416*	-0.199	-0.059
	(0.187)	(0.216)	(0.223)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Time-constant covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements of time-varying covariates (taken at birth).
2/ "All covariates" refer to time-constant and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Model 1, the unadjusted model, shows that cumulative exposures to unstable housing, defined here as not living in an owner-occupied unit or changing tenancies during childhood, are associated with poorer health at age 9. It should be noted that "improving housing" (going from renter-occupied to owner-occupied units) is not statistically significant. Continuously living in renter-occupied housing is significantly associated with health, reducing the odds of better health levels by 38.7% ($e^{-0.490} = 0.61$; $p < 0.01$) as compared to those continuously residing in owner-occupied homes. Living in declining housing, defined here as living in owner-occupied housing as an infant/toddler and then moving to renter-occupied housing, is also significantly associated with health, reducing the odds of better health by 34.0% ($e^{-0.416} = 0.66$; $p < 0.10$).

While still negative in Models 2 and 3, which each include different combinations of time-varying and time-constant covariates, the impact of continuously renting and

declining housing on health is less than in Model 1. However, in both models, the coefficients on the housing tenancy trajectories are no longer statistically significant. It was suspected that a strong correlation may exist between tenancy and family income (represented here as family poverty status), however a series of Chi-square tests of independence between housing tenancy trajectory class membership and family poverty status indicates the variables are independent for each age's poverty status. However, examination of just the tenancy trajectory class representing "continuously renter" indicates that there may be some correlation between membership to that specific trajectory class and family poverty status.

Similar models (unadjusted, regression-adjusted for time-constant covariates only, adjusted for time-varying covariates only, and final model including both time-varying and –constant covariates) are estimated using the housing unit type trajectories. The results are summarized in Table 9.

Table 9: Ordered Logit Regression of Parent-rated Child's Health at Age 9 on Housing Unit Type Trajectories

N = 1,645	**Model 1 Unadjusted**	**Model 2 Time-constant covariates[1]**	**Model 3 All covariates[2]**
(1) Always Apartment (reference group)	--	--	--
(2) Always Single Family Unit	0.199*	0.085	0.018
	(0.116)	(0.121)	(0.127)
(3) Improving	0.050	-0.031	-0.078
	(0.259)	(0.266)	(0.281)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Time-constant covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements of time-varying covariates (taken at birth).
2/ "All covariates" refer to time-constant and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

The unadjusted model shows that cumulative exposures to what could be considered higher quality housing (living in a single-family home as compared to living in an apartment) are associated with better health at age 9. Continuously living in single-family homes is significantly associated with increasing the odds of better health levels by 22.0% ($e^{0.199} = 1.22$; $p < 0.10$) as compared to those continuously residing in apartments. It should be noted that "improving" (going from "other" housing unit types to apartments) is not statistically significant and the "always single-family unit" class is statistically significant at the 10 percent level.

In the subsequent models which include time-constant and time-varying covariates, the effect of housing unit type trajectory on parent-rated child health is no longer statistically significant. Furthermore, the magnitudes of the coefficients are lower with the inclusion of other explanatory variables, switching direction in the case of the "improving" group. This may indicate that the type of unit may not completely capture the quality of the housing conditions in terms of spaciousness, cleanliness, durability of the unit, etc. There also may be a relationship between the available income after cost of housing between single-family home dwellers and those living in apartments.

The results of the ordered logit regression models of parent-rated child's health at age 9 on household move trajectories (two classes) are summarized in Table 10.

Table 10: Ordered Logit Regression of Parent-rated Child's Health at Age 9 on Household Move Trajectories

N = 1,645	Model 1 Unadjusted	Model 2 Time-constant covariates[1]	Model 3 All covariates[2]
(1) Movers (reference group)	--	--	--
(2) Stayers	0.169*	0.108	0.075
	(0.101)	(0.109)	(0.114)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Time-constant covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements of time-varying covariates (taken at birth).
2/ "All covariates" refer to time-constant and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

The unadjusted model shown in the table above indicates that cumulative exposures to consistent housing conditions (staying in the same housing unit throughout childhood as compared to frequently moving) are associated with better health at age 9. Continuously living in the same housing unit improves health levels by 18.4% ($e^{0.169} = 1.184$; $p < 0.10$) as compared to those who frequently move.

The second column summarizes the results of the ordered logistic model with time-constant covariates (including baseline measurements of time-varying covariates). The coefficient for the "stayer" trajectory is no longer statistically significant and slightly smaller in magnitude. The inclusion of both time-constant and time-varying covariates results in even further reduced estimates – similarly statistically insignificant and smaller in magnitude - as summarized in the third column.

Lastly, the results of the ordered logit regression models of parent-rated child's health at age 9 on full housing condition trajectories (three classes) are summarized in Table 11.

Table 11: Ordered Logit Regression of Parent-rated Child's Health at Age 9 on Full Housing Condition Trajectories

N = 1,645	Model 1 Unadjusted	Model 2 Time-constant covariates[1]	Model 3 All covariates[2]
(1) Renter in Apartment (reference group)	--	--	--
(2) Stayer Owner in Single-Family Unit	0.568***	-0.340*	0.168
	(0.150)	(0.179)	(0.191)
(3) Mover Renter in Single-Family Unit	0.084	0.067	0.019
	(0.126)	(0.129)	(0.135)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Time-constant covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements of time-varying covariates (taken at birth).
2/ "All covariates" refer to time-constant and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

The unadjusted model shown in the first column indicates that the cumulative exposure to more "stable" housing conditions – staying in the same owner-occupied single-family home – is associated with better health at age 9. Living in the same owned single-family home is associated with better health at age 9. Continuously living in the same housing unit is associated with increasing the odds of better health levels by 76.5% ($e^{0.568} = 1.77$; $p < 0.01$) as compared to those who live in rented apartments consistently throughout childhood. Those who live in rented single-family homes and have a higher probability of moving are also associated with better health at age 9, but these estimates are not statistically significant.

The addition of time-constant covariates reduces the magnitude of the positive effect on health, but does not render it statistically insignificant as we observed in the previous models. Living in the same, owned, single-family home is associated with increasing the odds of better health levels by 40.5% ($e^{0.340} = 1.41$; $p < 0.10$). However, as

with the other trajectory models inclusion of time-varying covariates results in coefficient estimates that are no longer statistically significant (the third column).

The change in the statistical significance of the coefficients for housing condition trajectory class after the inclusion of time-varying covariates may be due to the close relationship between housing conditions and family structure. More specifically, a change in family structure, for example, a mother marrying or cohabitating with a new partner or separating from an existing partner, may lead to changes in housing circumstances. This will be discussed in more detail later in this paper.

4.2.4 Peabody Picture Vocabulary Test

Table 12 through Table 15 provides preliminary summaries of the results for the impact of early childhood housing tenancy trajectories on standardized PPVT scores at age 9.

Table 12: Regression of Standardized PPVT Score at Age 9 on Housing Tenancy Trajectories

N = 1,618	**Model 1 Unadjusted**	**Model 2 Time-constant covariates[1]**	**Model 3 All covariates[2]**
(1) Continuously homeowner (reference group)	--	--	--
(2) Continuously renter	-12.781***	-2.854***	-1.232
	(0.999)	(1.107)	(1.104)
(3) Improving housing	-5.345***	-0.464	-0.660
	(1.471)	(1.379)	(1.374)
(4) Declining housing	-8.892***	-1.236	-0.019
	(1.432)	(1.430)	(1.438)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Time-constant covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements of time-varying covariates (taken at birth).
2/ "All covariates" refer to time-constant and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Table 12 above summarizes the regression results of standardized PPVT score at age 9 on housing tenancy trajectories. As shown in Model 1, the unadjusted model, all housing tenancy trajectories are statistically significant at the 0.01 level. Being "continuously renter" is associated with a lower standardized PPVT score as compared to being "continuously homeowner" (about 12.8 points lower). Experiencing both "improving housing" and "declining housing" are associated with lower PPVT scores than being "continuously homeowner." The magnitude of the change in PPVT scores for those who experience "improving housing" is lower than the more unstable housing states "continuously renter" and "declining housing." This supports the possible explanation that stability of housing condition matters; even "improving" housing conditions leave children worse off, which still denote some degree of instability as it involves changes in the housing circumstances. Membership in the "improving" housing class trajectory results in lower PPVT scores than living in more consistent conditions.

When time-constant covariates are introduced, the magnitude of the coefficients decrease significantly and all classes other than "continuously renter" are no longer statistically significant. Being "continuously renter" remains statistically significant with the inclusion of either sets of covariates; but the inclusion of both sets of covariates renders the coefficient statistically not significant. The inclusion of both time-constant and time-varying covariates results in all classes being no longer statistically significant.

Table 13 below summarizes the regression results of standardized PPVT score at age 9 on housing unit type trajectories. Being in "always single-family unit" housing types throughout childhood is associated with higher PPVT scores (approximately 4.7 points higher) than always living in apartments. The coefficient estimate is statistically

significantly at the 0.01 level. The "improving" housing type trajectory class is not statistically significant, although the coefficient is positive.

As expected given the previous model results, the addition of time-constant covariates to the model results in less statistically significant and lower magnitude coefficients. Always living in single-family units is still associated with higher average standardized scores on the PPVT, but only by 1.4 points than those who always live in apartments.

Table 13: Regression of Standardized PPVT Score at Age 9 on Housing Unit Type Trajectories

N = 1,618	Model 1 Unadjusted	Model 2 Time-constant covariates[1]	Model 3 All covariates[2]
(1) Always Apartment (reference group)	--	--	--
(2) Always SFU	4.659***	1.439*	0.811
	(0.812)	(0.747)	(0.758)
(3) Improving	0.989	-1.298	-1.346
	(1.737)	(1.675)	(1.602)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Time-constant covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements of time-varying covariates (taken at birth).
2/ "All covariates" refer to time-constant and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Table 14 summarizes the results of the regression of PPVT scores on household move trajectories. Again, while statistically significant in the unadjusted model, the coefficients for household move trajectories become statistically not significant with the inclusion of covariates of both time-constant and time-varying covariates. In the unadjusted model, being a "stayer," or not moving throughout early childhood, is

associated with higher standardized PPVT scores (by 3 points) as compared to "movers," or those who move frequently throughout childhood.

Table 14: Regression of Standardized PPVT Score at Age 9 on Household Move Trajectories

	Model 1 Unadjusted	Model 2 Time-constant covariates[1]	Model 3 All covariates[2]
(1) Movers (reference group)	--	--	--
(3) Stayers	3.037***	0.629	0.426
	(0.722)	(0.670)	(0.674)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Time-constant covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements of time-varying covariates (taken at birth).
2/ "All covariates" refer to time-constant and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Lastly, Table 15 summarizes the results of the regression of PPVT scores on full housing condition trajectories. As expected, the more "stable" housing trajectory class – those living in owner-occupied single-family units who do not move during childhood – are associated with higher PPVT standardized scores, over 12 points higher than those who live in rented apartments. Those living in rented single-family units are also associated with a slightly higher PPVT standardized score of about 1.5 points than those who live in apartments, even though they are more likely to move than the reference group.

The inclusion of time-constant covariates reduces the magnitude of the coefficients and changes the statistical significance; the coefficient for mover renters living in single-family units is no longer statistically significant. Consistently living in an owner-occupied single-family unit is associated with a standardized PPVT score that is

3.3 points higher than that for children living in rented apartments. The inclusion of both time-constant and time-varying covariates results in the loss of statistical significance for all trajectory classes.

Table 15: Regression of Standardized PPVT Score at Age 9 on Full Housing Condition Trajectories

N = 1,645	Model 1 Unadjusted	Model 2 Time-constant covariates[1]	Model 3 All covariates[2]
(1) Renter in Apartment (reference group)	--	--	--
(2) Stayer Owner in Single-Family Unit	12.278***	3.289***	1.630
	(1.089)	(1.125)	(1.154)
(3) Mover Renter in Single-Family Unit	1.453*	0.920	0.586
	(0.853)	(0.793)	(0.798)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Time-constant covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements of time-varying covariates (taken at birth).
2/ "All covariates" refer to time-constant and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

4.3 Family Structure and Housing Trajectory Classes

In all of the models, the addition of time-varying covariates, specifically family income and family structure, results in the loss of statistical significance for the coefficients related to housing trajectory class. To explore this further, simple logit models were estimated to examine the effect of family income and family structure on each set of housing condition trajectory classes. Surprisingly, most of the regression coefficients are not statistically significant. This, however, may reflect the case that it is not so much the family income or structure status, but changes to status between survey waves. The results are shown in Table 16.

Table 16: Regression of Housing Condition Trajectory on Family Income and Structure

Trajectory Type	Tenancy	Housing Type	Moves	All
Family Income				
at birth	-0.082*	0.022	0.051	-0.075
	(0.045)	(0.061)	(0.055)	(0.057)
at age 1	-0.158***	0.072	0.031	-0.026
	(0.051)	(0.062)	(0.059)	(0.057)
at age 3	-0.045	0.236***	0.040	0.046
	(0.053)	(0.066)	(0.062)	(0.060)
at age 5	-0.070	0.037	0.120**	-0.080
	(0.055)	(0.064)	(0.061)	(0.057)
at age 5	-0.156***	0.015	0.037	-0.094*
	(0.054)	(0.062)	(0.056)	(0.053)
Family Structure				
at birth	-0.020	-0.040	0.017	-0.029
	(0.034)	(0.048)	(0.045)	(0.046)
at age 1	0.010	-0.024	-0.046	-0.010
	(0.034)	(0.048)	(0.046)	(0.048)
at age 3	0.007	-0.056	-0.002	-0.079
	(0.037)	(0.048)	(0.046)	(0.049)
at age 5	0.066*	0.040	-0.041	0.051
	(0.034)	(0.047)	(0.042)	(0.046)
at age 5	0.061*	0.086*	-0.060	0.118***
	(0.033)	(0.044)	(0.040)	(0.043)

Notes: Robust standard errors in parentheses. Constant coefficients not shown.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)

To further explore the possibility that housing trajectories are partly determined by changes to family income or family structure, ordered logit regression models were estimated with dichotomous variables of whether or not family income (or family structure) status changed between survey waves (1 = yes, status changed). As the results summarized in Table 17 indicate, housing tenancy trajectory class membership is strongly related to change in family income and change in family structure. This appears to also be the case for household moves (column 3). Changes in family structure has a

strong relationship to predicting housing trajectory class membership for trajectories determined using all three housing condition variables. This may partially explain why the addition of time-varying covariates mediates the statistical significance of housing trajectory class on standardized PPVT scores and child health ratings (Table 11 and Table 15)

Table 17: Regression of Housing Condition Trajectory on Change in Family Income and Change in Family Structure

Trajectory Type	Tenancy	Housing Type	Moves	All
Change in Family Income				
between birth and age 1	0.389***	-0.077	-0.005	0.174*
	(0.107)	(0.119)	(0.115)	(0.103)
between age 1 and age 3	0.364***	-0.255**	-0.243**	0.109
	(0.104)	(0.122)	(0.115)	(0.107)
between age 3 and age 5	0.222**	-0.158	-0.236**	0.056
	(0.101)	(0.120)	(0.112)	(0.104)
between age 5 and age 9	0.334***	-0.107	-0.205*	0.166
	(0.104)	(0.118)	(0.113)	(0.101)
Change in Family Structure				
between birth and age 1	0.341***	-0.017	-0.215*	0.231*
	(0.101)	(0.135)	(0.121)	(0.126)
between age 1 and age 3	0.406***	-0.101	-0.656***	0.225*
	(0.103)	(0.132)	(0.120)	(0.131)
between age 3 and age 5	0.319***	-0.196	-0.275**	0.098
	(0.105)	(0.130)	(0.121)	(0.125)
between age 5 and age 9	0.352***	0.062	-0.405***	0.282**
	(0.102)	(0.126)	(0.115)	(0.115)

Notes: Robust standard errors in parentheses. Constant coefficients not shown.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)

5 Discussion & Conclusion

This study seeks to expand our understanding of the impact of housing conditions on childhood development by incorporating multiple temporal dimensions – timing, duration, and stability – simultaneously. I identify distinct trajectories of exposure to poor housing, measured in terms of housing tenancy (renter versus homeowner), housing unit type, frequency of household moves, and a combination of all three variables over early- to mid-childhood. These trajectories are then used in regression models to measure their effect on later childhood development outcomes while also adjusting for time-constant and time-varying confounding characteristics.

There are certain limitations to the findings of this study related to the data and approach. The dataset used, the Fragile Families Child Wellbeing Study, is limited to children primarily born to single-parents and/or low-income households in urban cities in the United States. Data is only collected for the study as funding becomes available, which explains the four-year time span between the fourth and fifth follow-up studies. Furthermore, depending on the foci of the original study, identical measures of housing conditions and characteristics of the household are not available For example, several of the housing characteristics used to create the housing trajectories are from the in-home assessment that were completed at ages 3, 5 and 9 and only for households from the baseline survey group that agreed to allow an enumerator into their home for assessment. I address this inconsistency by only using the measures which are reported in the same manner for at least ages 3, 5, and 9. Other measures which have lower response rates or which have changes in how they are asked or collected, such as physical housing unit

condition characteristics, are not included at this time. Otherwise, all measures used in the study are coded as closely as possible.

While imperfect, the examination of housing conditions over childhood allows me to look at the role of cumulative exposure to poor housing conditions across the early life course. This, however, does not exclude the study from the possibility of omitted variable bias. As such, the results of the study should be viewed conservatively. Additionally, there may be within-group heterogeneity where in individuals identified in the same housing trajectory may demonstrate variation. For example, only two household move trajectories are identified, but within the "stayer" trajectory, an individual may have moved once, while another never moved since birth. The trajectories, therefore, should be understood as approximations of the more common housing trajectories that individuals in the data sample experience.

The analysis of multiple temporal dimensions to poor housing reveals several things. First, defining "poor" or "bad" housing is a tricky task. Four sets of trajectories were identified using housing tenancy, housing unit type, household moves, and all three simultaneously as the basis for the trajectories. At first there appeared to be obvious distinctions between "good" and "poor" housing characteristics: owning is better than renting (tenancy), single-family units are better than apartments (housing unit type), and staying is better than moving (household moves). However, when the trajectory classes do not represent clear and consistent conditions, relationships between housing condition exposures and childhood development are less clear. For example, any type of change to the tenancy of housing, whether it is "improving" by going from renting to owning or it is "declining" by going from owning to renting, is associated with lower standardized

PPVT scores and lower odds of better health. The stability of exposure to housing conditions seems to matter.

When conditions are stable (either always "bad" or always "good), effects of housing conditions are as expected. In unadjusted models (no other confounding variables), cumulative exposures to not living in an owner-occupied unit are associated with poorer health at age 9 and lower PPVT scores. Continuously living in renter-occupied housing is significantly associated with health reducing the odds of better health levels by 38.7% ($e^{-0.490} = 0.61$; $p < 0.01$) as compared to those continuously residing in owner-occupied homes. Experiencing frequent households moves during childhood is significantly associated with lower health status (reduces the odds of better health levels by 18%) and lower PPVT scores (3.3 points) than those who stay in the same housing unit. Children brought up in rented apartments with some frequency of moves are likely to have lower PPVT scores and worse health ratings than children brought up in the same owner-occupied single-family home.

Changes in tenancy and household moves may better capture features of "unstable" or disruptive housing conditions – switching from owning to renting (or vice versa), usually marks a move being made by the household. Distinctions in housing condition may be less obvious when looking only at housing unit as no other information is available about the characteristics of the unit. For instance, is it smaller? What is the physical state of the unit? Differences between a low-quality single-family unit and a higher-quality apartment unit may be very minimal.

The results suggest that time-constant and time-vary socioeconomic factors play a significant role in explaining the relationship of childhood housing trajectories and

childhood development outcomes. Exclusion of other factors such as family structure, family income levels, and maternal characteristics may overstate the impact of housing trajectories.

It should be noted that it necessary to situate the findings of this study in the context of the dataset's sample. The FFCWS focuses on the outcomes of children born to "fragile" families, which is understood as single or unmarried parent households living in U.S. cities within a contemporary societal and political context. The role of housing in explaining childhood outcomes may be different for children growing up in two-parent, middle-class families. Despite this limitation, the regression results and identification of housing trajectories do indicate that it is worthwhile to study the changes in the stability of housing conditions during the life course. Further study of the temporal dimensions of housing conditions, particularly the simultaneity of housing characteristics with other socioeconomic factors, may provide a better estimate of the impact of housing conditions in both generating and resulting in inequality over the life course, including childhood.

6 Appendices

6.1 Comparison of Analysis Sample to Full Dataset

The following section examines the full dataset against the analysis sample used in this study. Appendix Table 1 summarizes the percent of missing values by variable for the full dataset and the sample analysis. Since the sample analysis was restricted to observations reporting values for all key variables, there are no missing values in the sample analysis dataset. There is a significant proportion of missing data in the full dataset, especially for observations taken at later ages. This is partly due to attrition between surveys waves, as well as participation rates in the in-home assessment. As noted in the data section, the in-home assessment was not administered to all available participants.

Appendix Table 2 and Appendix Table 3 summarize the means and distributions of the time-constant and time-varying variables, respectively, considered in the study by dataset (full dataset and sample analysis dataset). The sample dataset, comprised of those who remained in the survey for all five waves, has a highly proportion of non-Hispanic black mothers (52.90% in the sample and 47.61% in the full dataset) and a lower proportion of Hispanic mothers (22.90% in the sample and 27.34% in the full dataset). While the average age of the mother at the time of the focal child's birth is similar (25.4 years old for the sample and 25.3 years old for the full), the sample dataset includes better educated mothers, with 26.00% of mothers having some college or technical school and 11.80% of mothers having a college degree or more, as compared to 24.30% having completed some college and only 10.71% having earned a college degree or more in the full dataset.

Appendix Table 1: Comparison of Missing Data in Full Dataset and Sample

	Full Dataset	Sample
Number of Observations	4,897	1,648
Maternal Characteristics		
Age at time of child's birth	0.06%	0.00%
Race/ethnicity	0.22%	0.00%
Education at time of child's birth	0.10%	0.00%
Family Characteristics		
Poverty level		
at birth	0.00%	0.00%
at age 1	10.88%	0.00%
at age 3	13.60%	0.00%
at age 5	15.48%	0.00%
at age 9	28.90%	0.00%
Family structure		
at birth	0.00%	0.00%
at age 1	10.88%	0.00%
at age 3	13.60%	0.00%
at age 5	15.48%	0.00%
at age 9	28.22%	0.00%
Number of children		
at birth	0.80%	0.00%
at age 1	11.31%	0.00%
at age 3	14.01%	0.00%
at age 5	15.97%	0.00%
at age 9	28.67%	0.00%
Child Characteristics		
Gender	0.00%	0.00%
Parent-rated health rating (at age 9)	25.87%	0.00%
Peabody Picture Vocabulary Test score (at age 9)	31.67%	0.00%
Housing Unit Characteristics		
Homeowner		
at birth	0.76%	0.00%
at age 1	12.11%	0.00%
at age 3	14.93%	0.00%
at age 5	19.54%	0.00%
at age 9	30.84%	0.00%
Housing unit type		
at age 3	48.81%	0.00%
at age 5	42.15%	0.00%
at age 9	31.37%	0.00%
Whether moved		
at age 1	10.90%	0.00%
at age 3	13.62%	0.00%
at age 5	15.60%	0.00%
at age 9	28.26%	0.00%

Appendix Table 2: Comparison of Means and Distribution of Time-Constant Variables of Full Dataset and Sample Analysis Dataset

	Full Dataset		Sample Analysis	
	Mean	**SD**	**Mean**	**SD**
Number of Observations	4,897		1,648	
Outcomes (at age 9)				
Parent-rated health rating[2]	4.36	0.83	4.38	0.83
Peabody Picture Vocabulary Test score	92.72	14.95	92.32	14.64
Time-Constant Characteristics				
Child's gender				
Male	52.44%		52.60%	
Female	47.56%		47.50%	
Mother's age at birth of child	25.3	6.04	25.4	6.01
Mother's race/ethnicity				
Non-Hispanic white	21.08%		21.20%	
Non-Hispanic black	47.61%		52.90%	
Hispanic	27.34%		22.90%	
Other	3.97%		3.00%	
Mother's education at birth of child				
Less than high school	39.70%		35.80%	
High school diploma or equivalent	25.29%		26.30%	
Some college or technical school	24.30%		26.00%	
College degree or more	10.71%		11.80%	

Generally, those in the sample dataset are more likely to be homeowners than those in the full dataset at any age, and also more likely to live in a single-family unit home. However, both the full dataset and the sample analysis dataset have similar proportions of families with incomes at or below the official poverty threshold at all ages. Mothers in the full dataset are more likely to be married or cohabitating with a man who is not the biological father of the focal child than those in the sample dataset. Mothers in the sample dataset are slightly more likely to be married or cohabitating with the biological father of the focal child.

Appendix Table 3: Comparison of Means and Distributions of Time-Varying Variables of Full Dataset and Sample Analysis Dataset

	Birth		Age 1		Age 3		Age 5		Age 9	
Variable	**Full**	**Sample**	**Full**	**Sample**	**Full**	**Sample**	**Full**	**Sample**	**Full**	**Sample**
Housing Unit Characteristics										
Homeowner	34.42%	39.10%	34.92%	38.10%	23.26%	26.20%	25.53%	28.60%	29.47%	31.60%
Housing unit type										
Other					3.35%	2.90%	3.64%	3.00%	3.24%	2.00%
Single-family (detached or attached)					66.77%	69.50%	69.86%	70.80%	73.55%	75.20%
Apartment					29.88%	27.70%	26.51%	26.20%	23.21%	22.80%
Time-Varying Characteristics										
Family poverty level										
0-49%	18.95%	17.20%	25.09%	25.30%	22.62%	22.30%	21.58%	21.10%	17.52%	17.00%
50-99%	17.21%	17.10%	18.58%	18.60%	19.46%	19.80%	19.23%	20.40%	19.90%	20.20%
100-199%	25.77%	26.80%	25.07%	24.20%	25.03%	22.50%	26.12%	24.30%	28.95%	28.90%
200-299%	15.50%	14.80%	13.73%	13.50%	13.54%	14.40%	13.82%	14.40%	13.79%	14.10%
300% +	22.56%	24.20%	17.53%	18.30%	19.45%	20.90%	19.26%	19.80%	19.84%	19.80%
Family structure										
Single parent	39.35%	40.00%	38.97%	38.10%	38.69%	39.70%	40.01%	39.70%	40.91%	40.50%
Married parents, bio dad	24.24%	25.40%	30.00%	29.80%	32.05%	32.00%	31.22%	32.80%	29.02%	30.30%
Married parents, not bio dad	0.00%	0.00%	0.73%	0.40%	1.84%	1.20%	4.03%	3.20%	8.71%	7.80%
Unmarried parents, bio dad	36.41%	34.60%	27.29%	27.70%	19.38%	20.30%	12.85%	12.90%	9.19%	9.30%
Unmarried parents, not bio dad	0.00%	0.00%	4.01%	4.10%	8.04%	6.80%	11.89%	11.50%	12.18%	12.10%
Number of kids in household	1.26	1.29	2.30	2.35	2.30	2.36	2.49	2.57	2.65	2.73
	(1.31)	(1.30)	(1.33)	(1.34)	(1.34)	(1.31)	(1.35)	(1.37)	(1.35)	(1.37)

6.2 Alternative Explanatory Variable Measures

6.2.1 Housing Type (7 categories)

The FFCWS codes the housing unit type variable using seven categories: apartment building, single-family detached home, single-family attached home, mobile home or trailer, row house or town house, apartments with no common areas, and other. For the study, the seven categories were collapsed into three: other (mobile home or trailer or other), single-family home (single-family detached home, single-family attached home, o row house or town house), and apartment (apartment building or apartments with no common areas).

Trajectories were identified using longitudinal LCA using the alternative housing tenancy variable with seven categories and the results are shown in Appendix Table 4. The results do not give a clear indication that any particular number of latent classes is preferred (with the exception that six classes are not). The best possible balance of BIC and Entropy values may be with five latent classes, but to interpret five classes based on seven categorical values would be difficult.

Appendix Table 4: Model Selection for Trajectories of Housing Tenancy (Seven Categories)

Number of Latent Classes	BIC	Entropy	Vuong-Lo-Mendell-Rubin Likelihood Ratio Test	Lo-Mendell-Rubin Adjusted LRT Test
3	12636.077	0.881	0.0000	0.0000
4	12349.502	0.893	0.0000	0.0000
5	12339.467	0.912	0.0000	0.0000
6	12373.231	0.901	0.7592	0.7592

6.2.2 Annual Average Frequency of Moves (3 categories)

The FFCWS asks mothers whether they moved the period between surveys and the number of times of they moved. Alternative measures of household moves were examined: whether moved (binary variable, used in study), number of moves between surveys (count), number of moves between surveys (categorical), average moves per year (count), and average moves per year (categorical). A distinction is made between average moves per year and number of moves between surveys because of the irregular number of years between surveys. Because of the unstandardized count of household moves may not completely capture how frequent moves take place between these irregular periods, only average annuals moves were considered in addition to the binary "moved" variable. Longitudinal latent class analysis is based on categorical variables, so the count variable is further excluded from the analysis at this time.

Based on the count of average household moves per year, a three-category categorical variable was generated: did not move, moved no more than an average of once a year, and moved frequently (more than one a year, on average). The results of the latent class analysis are shown in Appendix Table 5. As indicated in the table, it is unclear which number of latent classes is appropriate, particularly between two and four latent classes. Additionally, both sets of classes report low Entropy values, indicating low only moderate differentiation between trajectory classes.

Appendix Table 5: Model Selection for Trajectories of Average Annual Household Moves (Three Categories)

Number of Latent Classes	BIC	Entropy	Vuong-Lo-Mendell-Rubin Likelihood Ratio Test	Lo-Mendell-Rubin Adjusted LRT Test
2	10157.785	0.458	0.0000	0.0000
3	10200.650	0.635	0.2419	0.2474
4	10258.205	0.620	0.0000	0.0000
5	10316.442	0.587	1.0000	1.0000

6.3 Methodological Comparison

Conventional OLS models using "snapshot" housing condition measures were estimated to compare against the estimates obtained from regression models using the trajectories. "Snapshot" measures refer to the single, moment-in-time, measure of a characteristic and are explored for the ages available (1, 3, 5, and 9 years of age). Duration indicators are not available because the FFCWS does not measure at what point during the period between surveys a change in housing status takes place.

Appendix Table 6 through Appendix Table 9 summarize the ordered logit regression results of parent-rated child health at age 9 on various housing characteristics and covariates. There is little consistency in the regression estimates for any set of housing characteristics. For example, while having a home-owning mother at the time of the birth of the focal child is positively associated with higher odds of better health, the same is not true at age 1 or age 3. The inclusion of baseline and time-varying covariates changes the statistical significance of all the housing variables.

Appendix Table 10 through Appendix Table 13 summarize the regression results of standardized PPVT score at age 9 on different housing characteristics. As with the

regression models of parent-rated child health at age 9, the models of standardized PPVT scores at age 9 on housing conditions do not yield statistically significant coefficients or reveal mixed results.

This indicates that it is not enough to include time-varying housing variables to understand the temporal relationship between housing conditions and childhood well-being. The interaction between time (the age when the housing condition was measured) and the housing status yields inconsistent and statistically not significant results. Additionally, in instances such as the FFCWS where data is collected irregularly, it is not possible to generate other temporal variables, such as variables measuring duration. As an alternative, using housing trajectories appears more suitable to ensure that temporal dimensions of inequality are not omitted from regression models.

Appendix Table 6: Regression Results of Parent-rated Child Health at Age 9 on Housing Tenancy

	Model 1 Unadjusted	**Model 2 Baseline Covariates[1]**	**Model 3 All Covariates[2]**
Housing Tenancy ("renter" is reference group)			
age birth	3.204***	1.103	0.923
	(0.804)	(0.752)	(0.750)
at age 1	0.485	-0.119	-0.064
	(0.790)	(0.721)	(0.732)
at age 3	2.148	-1.017	-1.370
	(1.537)	(1.488)	(1.532)
at age 5	3.441**	1.658	1.124
	(1.664)	(1.517)	(1.593)
at age 9	5.107***	1.938**	0.673
	(1.021)	(0.952)	(0.974)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Baseline covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements (taken at birth) of family income, family structure, and number of children in the household.
2/ "All covariates" refer to baseline covariates and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Appendix Table 7: Regression Results of Parent-rated Child Health at Age 9 on Household Moves

	Model 1 Unadjusted	Model 2 Baseline Covariates[2]	Model 3 All Covariates[3]
Household Moves ("stay" is reference group)			
at age 3	-0.134	-0.088	-0.080
	(0.131)	(0.133)	(0.135)
at age 5	-0.011	0.019	0.069
	(0.132)	(0.134)	(0.134)
at age 9	-0.136	-0.091	-0.082
	(0.118)	(0.121)	(0.122)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Baseline covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements (taken at birth) of family income, family structure, and number of children in the household.
2/ "All covariates" refer to baseline covariates and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Appendix Table 8: Regression Results of Parent-rated Child Health at Age 9 on Housing Unit Type

	Model 1 Unadjusted	Model 2 Baseline Covariates[1]	Model 3 All Covariates[2]
Housing Unit Type ("Other" housing type is reference group)			
at age 3			
Single-family unit	0.087	-0.005	-0.056
	(0.329)	(0.346)	(0.364)
Apartment	-0.084	-0.109	-0.143
	(0.344)	(0.360)	(0.376)
at age 5			
Single-family unit	-0.117	-0.107	-0.075
	(0.298)	(0.304)	(0.312)
Apartment	-0.106	-0.070	0.015
	(0.317)	(0.324)	(0.330)
at age 9			
Single-family unit	0.551*	0.507	0.379
	(0.323)	(0.333)	(0.342)
Apartment	0.319	0.328	0.227
	(0.337)	(0.350)	(0.360)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Baseline covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements (taken at birth) of family income, family structure, and number of children in the household.
2/ "All covariates" refer to baseline covariates and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Appendix Table 9: Regression Results of Parent-rated Child Health at Age 9 on Housing Characteristics

	Model 1 Unadjusted	Model 2 Baseline Covariates	Model 3 All Covariates
Housing Tenancy ("renter" is reference group)			
age birth	0.053	-0.020	0.010
	(0.112)	(0.119)	(0.122)
at age 1	-0.044	-0.076	-0.063
	(0.119)	(0.121)	(0.123)
at age 3	0.009	-0.044	-0.055
	(0.215)	(0.223)	(0.228)
at age 5	0.128	0.061	0.039
	(0.214)	(0.221)	(0.230)
at age 9	0.398***	0.362**	0.287*
	(0.150)	(0.155)	(0.162)
Housing Unit Type ("other" housing type is reference group)			
at age 3			
Single-family unit	0.071	0.010	-0.046
	(0.335)	(0.350)	(0.365)
Apartment	-0.050	-0.107	-0.142
	(0.351)	(0.366)	(0.379)
at age 5			
Single-family unit	-0.146	-0.136	-0.090
	(0.306)	(0.309)	(0.318)
Apartment	-0.066	-0.076	0.006
	(0.328)	(0.334)	(0.341)
at age 9			
Single-family unit	0.518	0.501	0.386
	(0.330)	(0.337)	(0.344)
Apartment	0.435	0.419	0.307
	(0.347)	(0.357)	(0.365)
Household Move ("stay" is reference group)			
at age 1	-0.033	-0.030	-0.013
	(0.103)	(0.105)	(0.108)
at age 3	0.113	0.087	0.106
	(0.105)	(0.107)	(0.112)
at age 5	0.043	0.018	0.037
	(0.110)	(0.114)	(0.117)
at age 9	-0.148	-0.159	-0.119
	(0.104)	(0.105)	(0.107)

Notes: Robust standard errors in parentheses.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed tests)
1/ Baseline covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements (taken at birth) of family income, family structure, and number of children in the household.
2/ "All covariates" refer to baseline covariates and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Appendix Table 10: Regression Results of Standardized PPVT Score at Age 9 on Housing Tenancy

	Model 1 Unadjusted	Model 2 Baseline Covariates[1]	Model 3 All Covariates[2]
Housing Tenancy ("renter" is reference group)			
age birth	3.204***	1.103	0.923
	(0.804)	(0.752)	(0.750)
at age 1	0.485	-0.119	-0.064
	(0.790)	(0.721)	(0.732)
at age 3	2.148	-1.017	-1.370
	(1.537)	(1.488)	(1.532)
at age 5	3.441**	1.658	1.124
	(1.664)	(1.517)	(1.593)
at age 9	5.107***	1.938**	0.673
	(1.021)	(0.952)	(0.974)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Baseline covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements (taken at birth) of family income, family structure, and number of children in the household.
2/ "All covariates" refer to baseline covariates and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Appendix Table 11: Regression Results of Standardized PPVT Score at Age 9 on Household Moves

	Model 1 Unadjusted	Model 2 Baseline Covariates[2]	Model 3 All Covariates[3]
Household Moves ("stay" is reference group)			
at age 3	-2.055***	0.318	0.470
	(0.738)	(0.660)	(0.647)
at age 5	-0.777	-0.367	-0.333
	(0.755)	(0.642)	(0.644)
at age 9	-1.052	-0.766	-0.679
	(0.762)	(0.682)	(0.673)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Baseline covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements (taken at birth) of family income, family structure, and number of children in the household.
2/ "All covariates" refer to baseline covariates and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Appendix Table 12: Regression Results of Standardized PPVT Score at Age 9 on Housing Unit Type

	Model 1 Unadjusted	Model 2 Baseline Covariates[1]	Model 3 All Covariates[2]
Housing Unit Type ("other" housing type is reference group)			
at age 3			
Single-family unit	1.386	0.120	1.071
	(2.091)	(1.918)	(1.950)
Apartment	-1.440	-0.618	0.074
	(2.146)	(1.982)	(2.006)
at age 5			
Single-family unit	1.415	1.222	0.876
	(2.188)	(1.973)	(1.934)
Apartment	-1.084	0.072	0.452
	(2.254)	(2.036)	(2.014)
at age 9			
Single-family unit	4.759*	3.769	2.191
	(2.877)	(2.466)	(2.354)
Apartment	3.649	4.306*	3.327
	(2.950)	(2.539)	(2.424)

Notes: Robust standard errors in parentheses.
* p < 0.10; ** p < 0.05; *** p < 0.01 (two-tailed tests)
1/ Baseline covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements (taken at birth) of family income, family structure, and number of children in the household.
2/ "All covariates" refer to baseline covariates and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

Appendix Table 13: Regression Results of Standardized PPVT Score at Age 9 on Housing Characteristics

	Model 1 Unadjusted	Model 2 Baseline Covariates	Model 3 All Covariates
Housing Tenancy ("renter" is reference group)			
age birth	3.049***	1.142	1.006
	(0.826)	(0.774)	(0.774)
at age 1	0.498	-0.113	-0.088
	(0.795)	(0.726)	(0.737)
at age 3	1.697	-1.580	-1.986
	(1.586)	(1.508)	(1.548)
at age 5	3.349*	1.637	1.343
	(1.736)	(1.559)	(1.627)
at age 9	5.478***	2.299**	1.062
	(1.065)	(0.988)	(1.009)
Housing Unit Type ("other" housing type is reference group)			
at age 3			
Single-family unit	0.959	0.238	1.105
	(2.075)	(1.924)	(1.971)
Apartment	-0.130	-0.403	0.152
	(2.149)	(1.998)	(2.035)
at age 5			
Single-family unit	0.929	1.431	1.219
	(2.172)	(2.002)	(1.992)
Apartment	0.567	0.622	0.871
	(2.294)	(2.112)	(2.106)
at age 9			
Single-family unit	3.620	3.599	2.140
	(2.947)	(2.541)	(2.422)
Apartment	5.135*	4.776*	3.533
	(3.032)	(2.630)	(2.505)
Household Move ("stay" is reference group)			
at age 1	-0.505	0.440	0.599
	(0.722)	(0.672)	(0.667)
at age 3	0.259	-0.248	-0.289
	(0.720)	(0.653)	(0.657)
at age 5	-0.225	-0.805	-0.779
	(0.725)	(0.684)	(0.680)
at age 9	-0.266	0.130	0.369
	(0.732)	(0.670)	(0.675)

Notes: Robust standard errors in parentheses.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed tests)
1/ Baseline covariates include gender of the focal child, age of the mother at the birth of the child, race or ethnicity of the mother, and mother's educational level (categorical) at the time of the birth of the child, as well as baseline measurements (taken at birth) of family income, family structure, and number of children in the household.
2/ "All covariates" refer to baseline covariates and time-varying covariates. Time-varying covariates include the family's income (poverty) level, the family structure type (categorical), and the total number of children (under the age of 18) in the household at birth and ages 1, 3, 5, and 9.

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