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Are housing characteristics experienced by children associated with their outcomes as young adults?

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ABSTRACT

We study the association between childhood housing characteristics and homeownership and a set of behavioral outcomes of young adults. The primary data set is the National Longitudinal Study of Youth-1979 cohort (NLSY79) and the Child and Young Adult surveys of the children of the female NLSY79 respondents, augmented with a record of the characteristics of dwellings occupied by respondents and their children throughout childhood. We find that living in an owner-occupied home during childhood is positively associated with young adults' educational attainment, and is negatively associated with teen pregnancy, criminal convictions, and the likelihood of being on welfare. In contrast, a measure of residential crowding during childhood has an independent relationship only with youths' criminal convictions. We explore several mechanisms that could explain these long run patterns, including unobserved parental heterogeneity and childhood cognition.

1. Introduction

This paper analyzes the association between dwelling characteristics and homeownership status experienced during childhood and young adult outcomes. Dwelling characteristics differ systematically by ownership status, with owner-occupied dwellings typically larger and of higher quality than rented dwellings.[1] A common finding in the literature is that homeownership during childhood is positively associated with young adult outcomes such as educational attainment, employment, and normative behaviors (abiding by the law, and delaying pregnancy, for example). However, it is not clear whether homeownership per se is beneficial or whether the higher quality dwelling characteristics associated with homeownership account for the positive association between homeownership and young adult outcomes (see Green and White, 1997; Haurin et al., 2002a,b; Galster et al., 2007; Aaronson, 2000; Barker and Miller, 2009; Bourassa et al., 2016). Due to lack of suitable data, nearly all previous studies on the association between homeownership and young adult outcomes have been unable to control for important dwelling characteristics. For example, in the data we use, the National Longitudinal Survey of Youth 1979 cohort, the only information about housing is ownership status, self-reported home value, and interviewer observations about several qualitative features of the living space (e.g. cleanliness, clutter, etc.). We address this problem by adding data to the NLSY79 on respondents' dwelling characteristics. The housing characteristics include size, number of bedrooms, year built, and type (single family, mobile home, multi-family). The information is derived from public records and was merged to the NLSY79 records by address and year.[2] We use these data to estimate the relationship of dwelling characteristics and homeownership with young adult outcomes.

Determining whether and how dwelling characteristics and ownership status are associated with young adult outcomes is important because of the wide variation in housing quality in the United States. According to the American Housing Survey, in 2011 2.13 million households lived in "severely deficient" housing—an indicator of the physical condition of the dwelling (U.S. Department of Housing and Urban Development, 2013b: 32). The rate of severely deficient dwellings is three times greater for renters than for homeowners. Many households live in overcrowded housing. While the definition of overcrowding is arbitrary, a common standard is more than one person per

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[1] For example, data from the American Community Survey indicate that the average number of bedrooms and total rooms of an owned home are 3.1 and 6.5, respectively, while the comparable figures for rented units are 2.0 and 4.4. Average household size in owned and rented homes is similar: 2.68 and 2.48.

[2] The data on house characteristics were gathered by the Center for Human Resource Research (CHRR) at Ohio State University. CHRR staff matched NLSY79 respondent addresses to house characteristics reported on publically available web sites. The data were provided to us without the addresses, which are obviously confidential.

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room or more than two persons per bedroom. In 2005, 2.4% of all households in the U.S. resided in dwellings with more than one person per room (Blake et al., 2007).[3] In the NLSY79 sample of respondents with children, 8.1% live in dwellings with more than two persons per bedroom. The percentage of homeowners in the U.S. was 64.4% in 2017, but it was only 39% for unmarried households with children.[4] Thus, many children are part of households that live in a low quality dwelling, and many others reside in rental units. If house characteristics and ownership are important inputs in the production of child and young adult outcomes, then these facts are relevant for the determination of housing policy.

This paper separately identifies the associations of house characteristics and homeownership with young adult outcomes. This distinction between dwelling attributes and ownership is useful for determining the appropriate emphasis of housing policy, which has varied widely over the past 60 years (Schwartz, 2010). For example, it is known that the consumption of lead paint has long term deleterious effects on child cognition and behavior. This suggests that housing policy should be targeted toward the attainment of specific quality standards. However, early attempts at improving quality often resulted in public housing projects that were spatially concentrated in high rise buildings located in low income areas. It has been argued that residential crowding has significant adverse effects on children as it may constrain the ability of children to study for school and develop their cognitive skills (Goux and Maurin, 2005).[5] This argument suggests that housing policy should be targeted toward establishing standards for dwelling size relative to family size.[6] As a third example, the claim that homeownership positively affects young adult outcomes suggests housing policy should be directed towards encouraging ownership, including condominiums as well as single family dwellings.[7] Our study tests whether homeownership and selected dwelling characteristic are associated with young adult outcomes, helping to inform the appropriate emphasis of future housing policy.

Our primary source of data is the National Longitudinal Survey of Youth, 1979 cohort (NLSY79), and the associated Child and Young Adult surveys. Child outcomes have been recorded every other year since 1986, and Young Adult outcomes every other year since 1994. We analyze the longer run relationship of childhood housing characteristics with a set of important young adult outcomes. Because the NLSY79 data do not include information on dwelling characteristics, we collected publicly available data describing house characteristics (number of bedrooms, building age, etc.), and merged these data with the main NLSY79 data. Combining these items with NLSY79 respondent reports of ownership status and the very rich data on other inputs and child development makes this a unique data set.[8]

There are two general pathways by which the housing characteristics experienced during childhood may be related to young adult outcomes. One is a direct association between childhood housing experiences and young adult outcomes. Witnessing and participating in the long-term planning, personal responsibility, and daily care required for homeownership and upkeep may teach important life skills. Children who learn these skills may develop a greater sense of personal responsibility, which could manifest as positive young adult outcomes (e.g., more educational investments, delayed pregnancy, etc.). The other is indirect—childhood housing experiences are associated with contemporaneous cognitive and behavioral development, and these factors influence subsequent young adult outcomes.

Our analysis separately identifies these two pathways. We find that childhood housing characteristics have both direct and indirect associations with young adult outcomes, although the direct long run associations clearly dominate. We find that the cumulative amount of time a child resides in an owner-occupied home is positively associated with the child's subsequent educational attainment (high school graduation and college attendance), and is negatively associated with teen pregnancy, criminal convictions, and the likelihood of being on welfare. This pattern is present even after controlling for a large number of other important determinants of young adult outcomes. Residential density, as measured by bedrooms per person experienced during childhood, is not directly associated with any young adult outcome, with one exception: the number of bedrooms per person is, counterintuitively, positively associated with criminal convictions. More recently built dwellings are positively associated with college attendance and negatively associated with ever being on welfare.

Concerning indirect pathways, we find that young adult outcomes are strongly related to childhood measures of cognition (math and reading) and behavioral problems. Thus, if house characteristics are associated with these childhood outcomes, then there is an indirect route by which housing is associated with youth outcomes. However, there is only modest evidence of associations between childhood housing characteristics and contemporaneous measures of child development. There is evidence that homeownership is negatively associated with behavior problems, and living in a newer dwelling is positively associated with reading comprehension and negatively associated with the presence of behavioral problems.

We use a child production function framework as a guide to specification of our empirical models. In this framework, parents and others (child care providers, schools, and peers) provide time and goods inputs that stimulate the development of children's cognitive and non-cognitive skills via the “technology” of the production function. The relationship between inputs and outcomes in this framework is causal: for example, housing characteristics such as the number of bedrooms per child has a direct impact on the development of skills. One approach to estimating the causal effect of housing characteristics on child outcomes is to exploit an exogenous source of variation in the inputs. A leading example is Goux and Maurin (2005), who show that the sex composition of the two youngest children in large French families has a strong impact on the number of bedrooms per child. Families in which

[3] The rate of overcrowding was substantially higher for Hispanics (12%) and somewhat higher for African Americans (3%) compared to non-Hispanic white households.

[4] Unmarried households with children under 18 comprise about 36% of all households with children. See http://www.census.gov/housing/hvs/files/currenthvspress.pdf

[5] In contrast, Currie and Yelowitz (2000) find that “projects actually have positive effects on both housing quality and children's academic achievement.”

[6] Policies in the 1970s and 1980s aimed to move away from high rise buildings in housing projects by offering vouchers to ensure that low-income households could afford a residence with a quality level above substandard. Andersson et al. (2016) study young adult outcomes of children who lived in public housing or received housing vouchers. They find that living in subsidized housing as a teenager increases earnings and reduces the likelihood of incarceration in early adulthood. The precise mechanisms are not discussed.

[7] In 1994 the Clinton Administration started the President's National Homeownership Strategy. Clinton wrote on November 3, 1994 “Homeownership strengthens families and stabilizes communities. It encourages savings and investment and promotes economic and civic responsibility” (Weiss, 2013). Increasing homeownership opportunities was part of the mission statement of HUD Strategic Plan for FY 2006-FY 2011 (U.S. Department of Housing and Urban Development, 2013a). This was primarily achieved through reducing credit constraints, introducing risk-based pricing of mortgages, and setting targets for minority mortgage lending for the Government Sponsored Enterprises (Fannie Mae and Freddie Mac).

[8] The only nationally representative source of data of which we are aware that includes information on housing characteristics as well as child outcomes is the Panel Study of Income Dynamics (PSID). The information on housing characteristics is reported by respondents. These data were used by Solari and Mare (2012) to study the association between crowding (residents per room) and child outcomes. The PSID also includes dwelling type (single family, multifamily, etc.); however, it does not include the amount of living space or the number of bedrooms, two of the key measures we use.

the two youngest children are of different sex tend to have more bedrooms for a given family size, due presumably to the reluctance of parents to have mixed-sex bedrooms. This plausibly exogenous source of variation provides a powerful source of identification of the effect of density (bedrooms per child) on educational outcomes. This is a very useful approach, but it has two limitations. First, it is country-specific. Using the same approach with the NLSY79 data, we found that the effect of sex composition on density was much weaker than in France. Second, it does not provide estimates of the effects of other inputs or of the interactions among inputs.

We do not have a source of exogenous variation in dwelling characteristics and homeownership. Housing and other input choices are likely to be correlated with unobserved determinants of child outcomes, e.g. unobserved inputs, parent ability, neighborhood quality, etc. It has proven difficult in the housing literature to find a useful instrument for homeownership status in order to estimate the causal effect of ownership on children. Finding instruments for several additional housing characteristics is even more challenging, and we are unable to find such instruments. We use rich controls for other inputs and productivity factors to deal with the possibility of endogeneity of the inputs. However, there are likely to be additional sources of endogeneity.

An important example in this context is the potential for omitted variable bias resulting from missing neighborhood characteristics that are correlated with homeownership, dwelling characteristics, and young adult outcomes. It is plausible that homeownership and dwelling characteristics are correlated with neighborhood amenities such as school quality, availability of playgrounds and parks, air quality, and intangible aspects of “community spirit,” e.g. neighbors watching out for the safety of each other's children (Haurin et al., 2002a). Omitting such variables from our empirical models is likely to impart an upward bias to our estimates. For example, it is well documented that air quality is higher in higher-socioeconomic-status neighborhoods (e.g., Currie et al., 2014). If homeownership and beneficial dwelling characteristics are also more prevalent in such high-SES neighborhoods, then our estimates of the effects of dwelling characteristics and homeownership would be biased upward due to omission of a measure of air quality. We control for county-level characteristics, but the variation of interest is likely to be at a much finer geographic level within counties. So we do not claim to produce consistent estimates of causal effects. The most plausible interpretation of our estimates is as upper bounds on the true effects of homeownership and dwelling characteristics on young adult outcomes. Nevertheless, the new data we bring to bear provide an unusual opportunity to estimate the associations between homeownership, dwelling characteristics, and young adult outcomes.[9]

In the remainder of the paper, we provide a literature review and specify our contributions in Section 2, a discussion of the empirical approach in Section 3, a description of the data in Section 4, discussion of results in Section 5, and conclusions in Section 6.

2. Literature review and contributions

2.1. Transmission mechanisms

Many hypotheses have been proposed to explain why house characteristics affect children. Gove et al. (1979) and Goux and Maurin (2005) argue that crowding causes a lack of privacy and may impair a child's development. Lien et al. (2008) argued that overcrowding affects children's ability to study and thus their cognitive outcomes. Solari and Mare (2012) find that residential density is negatively associated with math and reading achievement.

Living in crowded conditions with little play space has been argued to increase a child's level of stress (Ineichen and Hooper, 1974; Saegert, 1982). In the medical literature, Mann et al. (1992) found that overcrowding is associated with a higher incidence of respiratory illness, Galpin et al. (1992) argued that crowded living conditions were related to a higher rate of stomach infections, and Prescott and Vestbo (1999) noted that crowding is related to stress, more easily transmitted infections, and secondary cigarette smoke. The United Kingdom's Office of the Deputy Prime Minister's (2004) review of the literature indicates that there is strong evidence of a negative effect of overcrowding on the likelihood of childhood meningitis and tuberculosis. However, this review concludes that the observed negative correlation between crowding and child and adult outcomes cannot necessarily be given a causal interpretation, as most studies have not been able to adequately control for confounding factors. We contribute to this literature by using a large, rich, nationally representative data set to revisit this question.

The quality of the home environment is often hypothesized to be an input to the production of child outcomes. Parcel and Menaghan (1994a,b) argue that the home environment affects the development and well-being of children. Similar arguments are present in many other studies (Cunha and Heckman, 2008; Todd and Wolpin, 2003, 2007). However, measurement of the quality of the home environment is difficult. One commonly used measure is the HOME scale (Bradley and Caldwell, 1981, 1984). We contribute to the literature by disaggregating the HOME scale into three distinct subscales: emotional support, cognitive stimulation, and the quality and care given to the interior of the child's home, based on observations made by the interviewer. These measures are subscales of the HOME scale, and measure physical attributes of the dwelling and aspects of the home environment distinct from overcrowding.

The association between homeownership and child outcomes has received substantial attention. Green and White (1997) suggest that homeownership results in better parenting. They argue that being a homeowner teaches the parents skills (e.g. budgeting, planning, problem solving) that they then teach to their children, which causes better child outcomes. Galster (1987) was the first among many studies to find that owner-occupied housing is maintained better than rented dwellings. This behavior is consistent with the financial incentive faced by homeowners; they benefit from gains in a home's value. Differences in maintenance will affect the quality of the dwelling, and Haurin et al. (2002b) argued that one aspect of improved home maintenance is lead paint abatement. The presence of lead in the environment is known to have substantial negative effects on children's cognitive development and behaviors. The Lead-Based Paint Hazard Reduction and Financing Task Force (1995) notes that lead is more likely to be present in older dwellings and in those with peeling paint, and these attributes are more often present in rental dwellings. A third hypothesized transmission mechanism from homeownership to child outcomes is that home ownership increases the owner's satisfaction and self-esteem. This results in a more supportive psychological home environment for children (Rohe and Stegman, 1994; Rohe and Basolo, 1997; Rossi and Weber, 1996) and thus better child outcomes. A related argument is that parental stress is reduced by homeownership (Cairney, 2005). However, researchers have noted that stress can be caused by potential and actual foreclosure (Nettleton, 1998; Bennett et al., 2009; Currie and Tekin, 2015).

As noted in the introduction, homeownership is associated with dwelling characteristics, such as the number of bedrooms, which may independently affect young adult outcomes. An important contribution of our paper is to measure and control for several important dwelling characteristics along with ownership status. By doing this, we avoid attributing the associations between dwelling characteristics and young adult outcomes to homeownership. Other potentially important determinants of young adult outcomes such as residential mobility and

[9] Some previous studies either did not control for neighborhood characteristics or used large area controls such as regions. The PSID restricted data includes census tract information, this used in the studies by Holupka and Newman (2012), Galster et al. (2007), Grinstein-Weiss et al. (2010), and Mohanty and Raut (2009).

neighborhood amenities are also correlated with homeownership status.[10] As noted above, we control for these factors as well, although our neighborhood controls are at the county level rather than the more relevant zip code or census block level. We conceive of mobility and neighborhood characteristics as inputs to the production of child development, chosen by parents along with ownership status and dwelling characteristics. Controlling for these and other relevant inputs allows us to estimate the "marginal productivity" of homeownership status, although as noted above we cannot claim to obtain an unbiased estimate.

2.2. Findings

There are few data sets with information on both characteristics of a dwelling and child outcomes. A high quality home environment as measured by the HOME scale or a version of it has frequently been found to be associated with better cognitive and language development, academic achievement, attention, memory, and school readiness (Haurin et al., 2002b; Luster et al., 2004; Mohanty and Raut, 2009; Todd and Wolpin, 2007). Older studies have found that residence in a high rise building (a type of spatial crowding) results in restricted play opportunities, social isolation, and increased levels of psychological stress in children (Ineichen and Hooper, 1974; Saegert, 1982). Barker and Miller (2009) conclude that the effect of homeownership is weaker for condominiums and mobile homes than for houses, suggesting that structure type might be an important factor affecting child outcomes. Lien et al. (2008) found that educational attainment for young adults was positively related to the floor space of their childhood dwelling and negatively related to occupants per room and building age. As noted above, our key contribution is to estimate the associations of several important dwelling characteristics jointly rather than individually. This is feasible thanks to the new data on dwelling characteristics.

Many studies have found that homeownership has a positive association with child outcomes. However, most early studies used data sets with limited information, and were unable to account for potentially confounding factors (Dietz and Haurin, 2003). For example, many studies did not control for net worth, which is positively correlated with homeownership. Nearly all early studies used cross-sectional data. Recent studies of the impact of homeownership have used data sets that include a richer set of control variables and a longitudinal component. Holupka and Newman (2012) argued that homeownership does not affect child outcomes; rather, the relationship between homeownership and child outcomes is due to unobservables correlated with selection into homeownership. Green and White (1997), who were the first to attempt to control for the endogeneity of homeownership when studying young adult outcomes, found a positive association between homeownership and educational attainment and a negative association with teenage pregnancy. Aaronson (2000) found that controlling for geographic mobility reduced, but did not eliminate, the homeownership associations. Boehm and Schlottmann (1999) found that living in an owned home was associated with an increase in high school and postsecondary school completion. Haurin et al. (2002b) found that homeownership is positively associated with children's cognition. Boyle (2002) and Cairney (2005) found that the children of homeowners have fewer behavioral and emotional problems. Grinstein-Weiss et al. (2010) found that homeownership is associated with better parenting practices, controlling for individual and neighborhood characteristics. Miller and Chen (2007) found that homeownership is associated with better health later in life. Harkness and Newman (2003) argue that households with lower levels of endowments benefit more from improvements in housing.

There are substantial methodological differences among these studies and these differences matter. Galster et al. (2007) treat homeownership, geographic stability and the choice of neighborhood as endogenous in their study of child outcomes. Using instrumental variable estimation, they find that homeownership improves children's educational attainment, particularly college completion.[11] However, Barker and Miller (2009) find that a differences-in-differences approach to estimation results in much smaller effects of homeownership on child outcomes compared to standard estimation approaches.[12] Mohanty and Raut (2009) address selection bias with an instrumental variable approach and control for residential stability, the home environment, and neighborhood quality in their analysis of the effects of home ownership.[13] They find that homeownership improves the home environment, which improves children's reading and math performance. After accounting for this transmission mechanism, they find no additional effect of homeownership.

A significant limitation in the literature on the effects of homeownership is the lack of control for the characteristics of the dwelling. Given the positive correlation of dwelling size and quality with homeownership, the omission of home size, quality, and crowding could result in an estimate of the association between homeownership and child outcomes that is biased upward. An exception is Bourassa et al. (2016), who use Swiss data to study the educational attainment of young adults. Their focal variables are the parental tenure status (own or rent), structure type (single or multifamily), and the density of the occupants of the dwelling unit. They found no associations of tenure status or structure type with educational attainment, but a negative association between density and educational attainment. An important limitation of their study is the much smaller set of control variables. Furthermore, Swiss results may not generalize to the U.S. because the Swiss homeownership rate is much lower (44%) than in the U.S. and their educational system emphasizes technical and vocational training to a much greater extent. Our key contribution to this literature is to estimate the association between homeownership and youth outcomes in a model that controls for dwelling characteristics. This makes it possible to determine whether the homeownership association, if any, is simply an artifact of differences in dwelling characteristics between homeowners and renters.

3. Empirical specification and estimation

The conceptual framework for the analysis is the home production model (Ben-Porath, 1967). Recent applications of the model to child development include Bernal and Keane (2011), Blau (1999), Todd and Wolpin (2003, 2007), and Cunha and Heckman (2008). In this framework child development is viewed as a good produced in the home with inputs of parental time and purchased goods and services. Given our focus on the associations between inputs experienced during childhood and young adult outcomes, we use a cumulative-inputs specification similar to Bernal and Keane (2011). Let q_{it}^{YA} represent a young adult outcome for child i measured at time t in young adulthood. We estimate two main specifications for young adult outcomes. The first can be written as follows, where all of the explanatory variables are cumulative (equivalently, average annual) inputs from birth through age 14:

[10] See Haurin et al. (2002a) for a review of the relationship of tenure choice and neighborhood effects.

[11] Their instruments for homeownership included metropolitan area house prices and rents, mortgage interest rates for 30 year fixed rate loans, county-wide homeownership rate, and various interactions of these variables and lags. We note that this list consists of variables at a level above the household, primarily jurisdictional. Instruments at the level of household are difficult to identify.

[12] They study the change in children's test scores between first and third grade for households that changed ownership status.

[13] Their instruments include race, number of children in the household, home environment, education level, household income, and poverty level, all of which likely affect child outcomes.

$$q^{YA}{}_{it} = \theta_0 + \theta_1 T_{mi} + \theta_2 T_{fi} + \theta_3 G_i + \theta_4 H_i + \theta_5 S_i + \theta_6 X_i + \varepsilon_{it} \quad (1)$$

here, T_{mi} is the mother's time input, T_{fi} is the father's time input, G_i is the purchased goods input other than housing, H_i is a vector of housing inputs (characteristics), S_i is a vector of school inputs, X_i is a vector of child, mother, and family characteristics such as age, race, and education, and ε_{it} is a statistical disturbance. In this specification the parameter vector θ_4 ideally measures the marginal productivity of housing characteristics on cognitive development, holding the amounts of all other inputs fixed.

There are two key restrictions in this specification. The first is that the inputs are not age-specific. Housing characteristics might have associations with child outcomes that different by age. Allowing the associations to differ by age is conceptually straightforward, but can result in a proliferation of parameters. The second is that the model is linear. This can easily be relaxed, but adds many additional parameters. We explore less restrictive specifications in Section 5.4 below, but we are limited by sample size.

The key issue addressed in this specification is whether the associations between housing characteristics and child outcomes persist beyond childhood. This is important because public policy is more appropriately addressed to long term consequences of childhood deprivation than to short run effects that do not persist into adulthood. Children are generally quite resilient, and display “catch up growth” in many areas of physical and mental development in response to early deprivation. However, some consequences of low quality housing, such as mental and physical developmental effects of lead paint poisoning, are known to be long lasting (Lead-Based Paint Hazard Reduction and Financing Task Force, 1995).

We estimate a second specification in order to explore the mechanisms through which childhood housing experiences are associated with young adult outcomes. As discussed in the introduction, housing experiences during childhood may be associated with child development outcomes such as cognitive skill and behavioral problems. These developmental outcomes in turn could be associated with the young adult outcomes of interest here. To determine the importance of this “indirect” association, we add controls for development outcomes during childhood:

$$q^{YA}{}_{it} = \theta_0 + \theta_1 T_{mj} + \theta_2 T_{fi} + \theta_3 G_i + \theta_4 H_i + \theta_5 S_i + \theta_6 X_i + \theta_7 q^{C}{}_{i} + \varepsilon_{it} \quad (2)$$

q_i^C is a vector of cognitive and behavioral outcomes, described below, measured during childhood. If the associations between childhood housing and young adult outcomes operate via the childhood outcomes, then childhood housing (H) will have positive associations with young adult outcomes in Eq. (1), but after controlling for childhood outcomes in Eq. (2) there will not be a positive coefficient on H. If there is an association between childhood housing and young adults even after controlling for childhood outcomes, this suggests that there are other unobserved channels through which housing is associated with young adult outcomes.

In order to determine whether childhood housing is associated with cognitive and behavioral outcomes experienced during childhood, we estimate a third model in which the dependent variable is a childhood outcome at a given child age $t + 1$ and the explanatory variables are measured at child age t, where the length of a period is two years:

$$q_{itj+1} = \beta_0 + \beta_1 \tau_{mijt} + \beta_2 \tau_{fijt} + \beta_3 g_{ijt} + \beta_4 h_{ijt} + \beta_5 s_{ijt} + \beta_6 x_{ijt} + \beta_7 q_{ijt} + \mu_{ij} + \gamma_j + \eta_{ijt} + \varepsilon_{ijt} \quad (3)$$

where q_{itj+1} is the level of cognitive development of child i in family j at date $t + 1$, the τ's are time inputs, the lowercase letters indicate age-specific input measures, μ_{ij} is a unobserved fixed effect for child i in family j (often referred to as the child's “endowment”), γ_j is a mother-specific unobserved effect, η_{ijt} is a transitory shock, and ε_{ijt} is measurement error. Eq. (3) has a value added form: the lagged outcome (q_{ijt}) summarizes the effects of all inputs provided to the child before date t. Conditional on q_{ijt}, the inputs applied between dates t and $t + 1$ determine the change in the child's cognitive ability. This is a commonly used specification (see Todd and Wolpin, 2007).

In order to account for the possibility that the inputs in Eqs. (1) and (2) are endogenous (correlated with the disturbance), it would be desirable to use an instrument variables or fixed effects approach to estimation. However, we do not have access to any useful instruments. With one observation per young adult, we cannot use a child fixed effects specification. We do have multiple young adults from a given family in some cases, so a mother fixed effects estimation approach is feasible in principle. However, in practice there are too few siblings who have both reached young adulthood and insufficient variation in the inputs experienced by siblings during childhood to make this feasible. Thus we estimate Eqs. (1) and (2) by OLS. To deal with the possible biases, we use several approaches, enabled by the richness of the NLSY79 data.

First, we incorporate proxies for key inputs to child development other than housing. The NLSY79 does not have extensive time use or expenditure data, but it has a number of useful proxies for these important non-housing inputs. These include indexes of emotional support and cognitive stimulation received by the child, the mother's level of involvement with and supervision of the child, the amount of contact between the child and the absent father, if the father is absent, and a measure of the quality of the child's school, as perceived by the mother. There are few useful proxies for goods inputs. Our main specification does not include any proxies for goods inputs, but we explore the robustness of the results to incorporating proxies such as family income and household wealth. Second, we control for several important characteristics of the mother and the household, in addition to standard controls such as education, family structure, and demographic characteristics. These include the mother's cognitive ability, as measured by the score on the Armed Forces Qualification Test (AFQT), a widely used and well-validated measure, and background characteristics of the mother such as her parents’ education and whether the mother was born in the US.

In the case of Eq. (3), the structure of the NLSY79 makes it possible to use various fixed effect estimation approaches to deal with bias caused by non-time varying unobserved heterogeneity. (1) The children of mothers who have more than one assessed child share the same unobserved fixed mother-specific characteristics, γ_j. A mother fixed effects estimator will eliminate these characteristics as a source of bias. In this case the estimation uses only variation in housing characteristics across children of a given mother. For children who always lived in the same house, this approach cannot identify the effects of fixed housing characteristics such as ownership, type, and location, but can identify the effects of time varying housing characteristics such as the number of rooms per person (which change when a child is born). We included mother-fixed effects when estimating the background relationship between housing characteristics and child outcomes. (2) We also used a child fixed estimator. This is feasible because most children in the NLSY79 are assessed multiple times during their childhood. This estimator accounts for child-specific time-invariant unobserved characteristics (μ_{ij}), thus using only within-child variation in housing characteristics caused by moves from one house to another[14] and changes in housing characteristics over time, such as those noted above in the mother fixed effects description.

[14] Beginning in the 2000 survey wave, the NLSY asks respondents how many times they moved across cities, counties, or states since the last interview. For the sample used in the PIAT-math estimates in Table 2, the average number of moves between waves is 0.32, or 0.16 per year on average. Unfortunately, the sample size is too small to be able to include mobility as an input, since the survey years before 2000 would be dropped. We explore the role of mobility in a more limited way below.

The fixed effects estimators do not deal with the problem of time-varying unobserved heterogeneity. For example, deterioration in the quality of the relationship between the parents could cause both a decrease in housing quality due to less attention to house cleaning and maintenance, and a decrease in child development as a result of stress and anxiety for the parents and child. If relationship quality is unobserved, this will result in biased estimates of the effects of housing characteristics even with fixed effects estimation. A natural way to deal with this issue is instrumental variables. However, in addition to housing, there are many other potentially endogenous inputs in the production function. This would require many instruments, which we do not have. Thus, we cannot rule out bias due to time-varying unobserved heterogeneity.

4. Data

The data are from the National Longitudinal Survey of Youth-1979 (NLSY79) and the associated child and young adult surveys. This NLSY79 interviewed a cohort of 12,686 individuals ages 14 to 22 in 1979, and has continued to interview them annually or biennially through the present. In even-numbered survey years beginning in 1986, the children of female respondents have been administered a battery of cognitive, social, and emotional development assessments, and a large amount of additional information about the children has been collected from the mothers and the children. Beginning in 1994, children who were at least 15 years old have been interviewed directly as part of the "Young Adult" study. These interviews collect data on many of the same items as the surveys administered to original sample members: education, employment, marital and other relationships, and fertility. The sample of mothers is large, and the retention rate is high after almost 30 years. We use data collected through the 2008 survey round.

4.1. NLSY sample

The original NLSY79 sample included 6283 women. In 2008, 3975 women were interviewed and of these 3352 were mothers. As of the 2008 interview round, the NLSY79 female respondents were ages 43 to 51, and their childbearing was close to complete (Center for Human Resource Research, 2009).

A drawback of the NLSY79 Child and Young Adult data is that the children are not a representative sample of the overall U.S. population of youths of similar ages. Their mothers are representative of the cohorts born in 1957–1964 who were living in the United States in 1979, but the sample has not been refreshed to reflect changing population characteristics resulting from immigration. Also, the oldest children were born to younger mothers, a self-selected group. For example, a youth observed at age 23 in 1998 and born in 1975 must have been born to a teenager, because the oldest NLSY79 respondents were aged 18 in 1975.

4.2. Child and young adult outcomes

The Young Adult survey collects data on many youth outcomes. We focus on their educational achievement, early fertility, receipt of welfare, and criminal record. There are also many measures of child outcomes that may have persistent associations with youth outcomes. We focus on child behavior and cognition. The Behavior Problems Index (BPI) is derived from 28 questions asked of the mother about children aged four and older. This scale is widely used in psychological research, and has been nationally normed based on the National Health Interview Survey in 1981. Examples of items included in the scale are: has sudden mood changes, is high strung, tense, and nervous, is impulsive or acts without thinking, feels worthless, is disobedient at school. (Variable means are listed in Table 1.)

The Peabody Individual Achievement Tests (PIATs) provide a broad measure of academic achievement for children aged five and over. The PIAT Mathematics assessment measures a child's attainment in mathematics as taught in mainstream education. It consists of 84 multiple-choice items of increasing difficulty. The PIAT Reading Recognition subtest measures word recognition and pronunciation ability. Skills assessed include matching letters, naming names, and reading single words aloud. The PIAT Reading Comprehension subtest measures a child's ability to derive meaning from sentences. For each of 66 items of

Table 1
Summary statistics[a].

Outcomes of Interest	Child PIAT-Math regression Mean (Standard Deviation)	Young adult-high school degree by age 20 Mean (Standard Deviation)
PIAT-Math	54.1 (27.9)	48.4 (22.8)
PIAT-Reading Recognition	59.3 (28.9)	55.4 (24.9)
PIAT-Reading Comprehension	52.1 (27.7)	49.7 (23.6)
Behavioral Problems Index	58.4 (28.1)	62.8 (21.9)
High School Graduation by Age 20	–	0.76 (0.43)
Ever Attend College by Age 20	–	0.48 (0.50)
Ever Convicted by Age 20	–	0.18 (0.38)
Ever on Welfare by Age 20	–	0.21 (0.40)
Ever Pregnant by Age 19	–	0.22 (0.41)
Housing Variables		
Bedrooms/Person	0.73 (0.24)	0.72 (0.19)
Year Built/100	19.6 (0.29)	19.6 (0.27)
Home Ownership	0.57 (0.50)	0.41 (0.40)
Multi-family Home	0.08 (0.27)	0.06 (0.16)
Mobile Home	0.005 (0.07)	0.006 (0.04)
Interviewer-Observed Home Characteristics Score	42.0 (34.0)	37.1 (13.3)
Other Inputs		
Total Income/1000		49.4 (53.9)
House value/10,000		23.8 (45.4)
Non-home net worth/10,000		41.4 (113.5)
School Quality Score	14.78 (13.85)	8.38 (4.05)
How Often Mom Knows Who Child is With	1.67 (1.43)	0.94 (0.42)
Biological Father Lives with Child	0.60 (0.49)	0.51 (0.44)
Number of Visits Per Year with Absent Biological Father	0.98 (1.94)	1.24 (1.57)
Mother's Hours of Work Per Week	29.18 (19.12)	28.1 (14.3)
Cognitive Stimulation Score	61.83 (30.08)	53.4 (21.0)
Emotional Support Score	44.76 (31.46}	39.3 (19.7)
Controls		
Mother is an Immigrant	0.09 (0.28)	0.09 (0.29)
Maternal Grandmother's Education	10.01 (4.05)	9.46 (4.05)
Maternal Grandfather's Education	9.16 (5.24)	8.26 (5.21)
Black	0.28 (0.45)	0.34 (0.47)
Hispanic	0.24 (0.43)	0.27 (0.44)
Mother's AFQT Score	38.94 (27.92)	32.10 (25.4)
Mother Married	0.67 (0.47)	0.60 (0.41)
Child/Youth Birth Order	1.94 (1.05)	1.81 (0.99)
Central City Location	0.20 (0.40)	0.19 (0.31)
Sample Size	7576	3148
Number of Children (Number of Mothers)	3745 (1901)	

[a] *Note:* The means and the sample size for the explanatory variables are for the PIAT-Math and Young Adult-High School Degree by Age 20 regressions. The summary statistics and sample sizes differ slightly for other outcome variables. The PIAT, BPI, and AFQT are measured as percentile scores out of 100. Interviewer observed home quality, emotional support, and cognitive stimulation measures have also been converted to percentile scores out of 100. The school quality measure is derived from the mother's grading of the school along 8 characteristics: (1) how much teachers care about their students, (2) effectiveness of the principal as a leader, (3) the skill of the teachers, (4) the safety of the school, (5) extent to which the parents are informed about their student's progress, (6) whether the parents are allowed to help in decisions about the child's schooling, (7) teaching students right from wrong, and (8) ability to maintain order and discipline. The reported letter grades on each item have been converted to a 4.0 scale and summed for a measure of overall school quality. The mean for house value includes zero for renters.

increasing difficulty, the child silently reads a sentence once and then selects one of four pictures that best portrays the meaning of the sentence. The PIAT is a widely used brief assessment of academic achievement, with demonstrably high test-retest reliability and concurrent validity (Baker et al., 1993). It is administered to children aged five and older. We use percentile scores based on national norms.

4.3. Housing

4.3.1. Home ownership

Home ownership is reported by respondents. Unfortunately, the 2002 and 2006 surveys dropped the homeownership question as a cost-saving measure. This omission reduces our sample size.

4.3.2. House characteristics

We augmented the NLSY79 data with measures of house characteristics derived from public sources. The primary public sources are Zillow.com and Melissa.com real estate data. Confidential data on the address of each respondent's current residence (as of a particular survey year) were used to merge housing characteristics for that address. Housing characteristics of all addresses ever reported by the respondent during the 1979–2008 period were collected, so in many cases we have time-varying data on housing characteristics. These characteristics include the number of bedrooms, the type of structure, and the age of the building. We construct a measure of (inverse) residential density: the number of bedrooms per household member.[15] Unfortunately, residential density is only available for NLSY79 homeowners because our external sources of information about their residence are limited to owner-occupied units. In order to include both renters and homeowners in our regression sample, we use supplemental data from the American Housing Survey (AHS) 2007–08, which reports dwelling characteristics for renters as well as their socio-demographic characteristics. We regress AHS renters' housing density on household characteristics that are measured in both the AHS and NLSY79, and use these estimates to generate a fitted value of density for NLSY79 renters. The regression results are reported in Appendix A. This approach introduces measurement error by assigning conditional mean density to renters instead of their unobserved actual density, and therefore could result in differential measurement error across renters and owners.

Another limitation of the data is that we do not have information on neighborhood characteristics below the county level.[16] In variations on the basic model, we include county fixed effects and an extensive set of socio-economic characteristics of the county of residence.[17]

4.3.3. Type of housing

In addition to the characteristics described above, data were also collected on the type of building structure: multi-family unit, mobile home, condominium, or single-family unit. About three-quarters of those living in mobile homes or single-family homes are owners. In contrast, about half of those living in condominiums are owners, and almost 85% of those living in multi-family dwellings are renters. We include indicators for living in a multi-family dwelling or mobile home in our production function regressions, leaving the combination of condominiums and single-family homes as the omitted category.

4.3.4. Quality of the home environment

The NLSY79 provides measures of the home environment. The HOME score index is a compilation of two underlying sub-scores: the emotional support score and the cognitive stimulation score. The emotional support score is derived from the mother's answers and interviewer observations regarding the manner in which the mother interacts with her child, the methods she uses to discipline her child, and how responsive and caring the mother is toward her child. The cognitive stimulation score comes from the mother's answers and interviewer observations regarding activities the mother does with the child, the types of toys, games, and books available for the child in the home, and the safety, lighting, and cleanliness of the home and play area. We use the emotional support sub-score as reported by the NLSY79. Given our interest in the quality of housing, we separate the NLSY-reported cognitive stimulation score into two measures. The first, which we continue to call the cognitive stimulation score, measures only the toys, games, books, and activities components of the original score. The second measure, which we call the interviewer-observed home index, indicates the quality of the child's housing environment, such has how clean, dark or monotonous, cluttered, and safe the interviewer deems the home to be. We choose to include these two measures separately because we specifically want to understand the importance of the quality of the housing environment as well as the quantity of housing in the production function. The interviewer-observed home score can be thought of as a measure of how the mother utilizes the housing that she has available.[18]

4.4. Mother involvement and school quality

The NLSY79 collects data on a handful of variables regarding the mother's involvement with the child's school and friends, as well as the quality of the school. We create an index of overall parental involvement with the school based on whether the mother participates in the local PTA organization, volunteers in the child's classroom, chaperones school field trips, and attends parent-teacher conferences. We also use information on how many of the child's friends the mother knows, and how often the mother knows who the child is with (when not with the mother). Each of these measures serves as a proxy for the general level of mother-involvement with her child's day-to-day activities. These measures are positively correlated and we focus on one of the three mother-involvement variables in our production function regressions. In general, we find the measure of how often the mother knows who the child is with to be the most convincing, although results are robust to using the other variables. As a more explicit control of parental time inputs (T_{it}), we also control for the number of hours the mother works per week. The presence of a biological father and the quantity of length of visits between the child and an absent biological father also help control for parental time inputs.

The school quality measure is derived from the mother's rating of the school on eight characteristics.[19] We convert the ratings to a four point scale and sum the scores for each of the eight characteristics to get

[15] A somewhat larger set of characteristics were collected including lot size and interior square footage. Preliminary exploration of the data indicated that dwelling characteristics are adequately summarized by using residential density (consistent with existing literature), house type, and the year built, with the latter likely being a rough indicator of building quality.

[16] The address information associated with the NLSY data is highly confidential, and is held in the Center for Human Resource Research, Columbus OH. The Center conducted the matching exercise of house characteristics with respondents and provided us with de-identified data. To maintain respondent confidentiality, detailed locational data was not provided. Thus, location of respondents is known at only the county level, not a finer measure such as ZIP code.

[17] The county measures include the crime rate, unemployment rate, teen birth rate, population density, percent Black and Hispanic, female labor force participation rate, rate of females in poverty, and whether the county is urban.

[18] Correlations of Homeowner status with the other housing characteristics are: Bedrooms/Person = 0.15, Year Built = 0.24, Multifamily = −0.30, Mobile Home = 0.01, Interviewer's Home Index = 0.08.

[19] The characteristics are: (1) how much teachers care about their students, (2) effectiveness of the principal as a leader, (3) the skill of the teachers, (4) the safety of the school, (5) extent to which the parents are informed about their student's progress, (6) whether the parents are allowed to help in decisions about the child's schooling, (7) teaching students right from wrong, and (8) ability to maintain order and discipline.

an overall school quality measure. The mother-reported school assessment raises some concern over endogeneity between the school quality score and child outcomes. The mother may be more likely to report that teachers are skillful and caring if her child is doing well in school, and she may be more likely to grade the school poorly if her child is struggling academically or having behavioral problems at school. However, this is the best measure of school quality available in the NLSY79 data.

4.5. Other control variables

Housing is only one of many factors that affect child development, and it is important to control for as many other factors as possible to avoid attributing the associations between other variables and youth outcomes to housing. We control for a number of household and child/youth characteristics (X_i). These include gender (female = 1), age, location of residence (central city or not), and the number of children in each of six age-sex categories (0–4, 5–11, 12–17) in the family. They also include the mother's characteristics such as age, race, ethnicity, marital status, immigration status, her parent's education, and her Armed Forces Qualification Test (AFQT) score. The AFQT score is the sum of scores from the arithmetical reasoning, word knowledge, paragraph comprehension, and numerical operations sections of the Armed Services Vocational Aptitude Battery, administered in 1980. The AFQT is similar although not identical to an IQ test. It has been widely used in analyses of adult earnings (e.g. Heckman et al., 2006) and as a predictor of cognitive development of children (e.g. Todd and Wolpin, 2003; Bernal and Keane, 2011). It provides a measure of maternal cognitive ability and achievement that is strongly correlated with child cognitive development, and is therefore a very useful control variable. Because AFQT rises with age, we adjust the variable for age at the time of test administration. Marital status categories include married, cohabiting, divorced, separated, single, and widowed. While marital status and the number of children in various age categories are characteristics of the household, they also help control for the amount of parental time inputs. The more parents and the fewer children the parents' time must be divided across in the household, the more attention any one child is likely to receive.

Finally, in some specifications we include county fixed effects as well as a set of time-varying county characteristics (listed in note 17). This may help mitigate bias from unobserved neighborhood characteristics, but it is unlikely to be a good substitute for neighborhood characteristics or fixed effects measured at a finer geographic level such as census tract or zip code. Thus, as noted above, our estimates are probably biased upward and are best interpreted as upper bounds on the true effects.

5. Results

Table 2 presents results for five young adult outcomes. The baseline OLS regression relates youth outcomes to the average of childhood housing characteristics, controlling for other inputs and characteristics described above (Eq. (1)). We then include childhood-average cognitive skill and behavioral problems, in order to test for an indirect relationship between childhood housing and young adult outcomes (Eq. (2)). Next we add county dummy variables and variables that characterize the county's socio-economic profile. Finally, we include our proxies for goods inputs to child outcomes— childhood averages of income, non-housing assets and home equity.

We then present in Table 3 estimates of the production functions for cognitive skill and behavioral problems (Eq. (3)). We report results estimated by OLS, child fixed effects, and mother fixed effects. If housing is associated with child outcomes, and child outcomes affect young adult outcomes, then part of the association between housing and youth outcomes occurs through this indirect pathway.

5.1. Young adult outcomes

Table 2 displays selected coefficients from OLS estimates of the production function specification for five young adult outcomes measured by age 20 (Panels A to E)[20]: high school completion, college attendance, ever convicted of a crime, teen pregnancy, and ever being on welfare.[21] Panel A shows that homeownership is positively associated with high school completion, with a statistically significant coefficient estimate of 0.11 to 0.13 depending on the specification. This is a large coefficient estimate: growing up from birth through age 14 in a dwelling owned by one's parents is associated with a 13.4 percentage point increase in the likelihood of graduating from high school relative to the mean graduation rate of 76%. The association is quite robust across specifications, declining by less than 20% in the richest specification in column 5 relative to the column 1 estimate.

The dwelling characteristics are not associated with high school graduation at conventional levels of statistical significance. The signs of the parameters indicate that more bedrooms per person is associated with a lower graduate rate, contrary to what we expected. The estimate in column 1 of −0.062 implies that increasing the number of bedrooms from one for every two inhabitants to one for each inhabitant (i.e. from 0.5 to 1.0) is associated with a 3.1 percentage point decline in high school graduation (0.5×-0.062). The column 5 estimate implies a decline of 1.7 percentage points. Living in a newer dwelling is associated a higher high school graduation rate, and living in a mobile home is associated with a lower high school graduation rate. The parameter estimates on mobile home are quite large in columns 3–5: a 9 percentage point reduction in the graduation rate. The coefficient on living in a multi-family dwelling is very small. The interviewer's observation of home quality is not associated with high school graduation. (We discuss the coefficient estimates on the child outcome variables below).

The results for ever attending college in Panel B are qualitatively similar to the results for high school graduation. The magnitudes of the coefficient estimates on homeownership and bedrooms per person are quantitatively similar as well. However, the coefficients on living in a multi-family dwelling and year built are much larger, and the latter is statistically significant. The association between growing up in a mobile home and college attendance are also larger. The parameter estimate on year built of 0.08 in column 5 implies that living in a dwelling that is 25 years newer is associated with a 2 percentage point higher rate of college attendance (0.25×0.08). In column 5, the parameter estimate on multi-family dwelling is 0.063, a large association, and the parameter on mobile home is −0.165, much larger than the corresponding parameter of −0.09 in Panel A.

Panels C, D, and E present results for non-normative behaviors (crime, welfare, and early pregnancy). The results indicate negative associations between homeownership and all three outcomes, with similar magnitudes, all significantly different from zero. Bedrooms per person is associated with increases in crime, welfare, and early pregnancy, with statistically significant estimates for crime. The coefficient of 0.092 in column 5 implies a 2.2 percentage point change per standard deviation increase in residential density. Year built has a negative and statistically significant association with welfare receipt, with the coefficient estimate of −0.084 in column 5 implying a 2.1 percentage point lower rate of welfare receipt per 25 year increase in year built (-0.084×0.25). The estimates for living in a multi-family dwelling and interviewer's assessment of home quality are all small. The estimate for mobile home is positive for crime but negative for welfare and early pregnancy.

[20] Teen pregnancy is measured by age 19.

[21] The full set of coefficients for these regressions are available from the authors. The results for college attendance are presented in Appendix B, except for the birth year and county dummy variables.

Table 2
Select coefficients from OLS model for young adult outcomes[a].

Panel A: High school graduation by age 20	(1)	(2)	(3)	(4)	(5)
Home Ownership	0.134***	0.117***	0.121***	0.120***	0.113***
	[0.026]	[0.026]	[0.027]	[0.028]	[0.029]
Year Built/100	0.015	−0.004	0.036	0.051	0.051
	[0.031]	[0.030]	[0.031]	[0.032]	[0.033]
Bedrooms/Person	−0.062	−0.066	−0.033	−0.027	−0.035
	[0.055]	[0.054]	[0.054]	[0.054]	[0.056]
Multi-family Building	0.002	−0.012	0.005	0.005	0.005
	[0.054]	[0.051]	[0.056]	[0.055]	[0.056]
Mobile Home	−0.065	−0.080	−0.093	−0.095	−0.094
	[0.234]	[0.219]	[0.231]	[0.235]	[0.234]
Interv. Obs. Home Score/100	0.005	0.015	−0.019	−0.009	−0.009
	[0.073]	[0.072]	[0.074]	[0.075]	[0.076]
PIAT-Math/10		0.018***	0.015***	0.015***	0.015***
		[0.005]	[0.005]	[0.005]	[0.005]
PIAT-Reading Recognition/10		0.012*	0.013**	0.013**	0.013**
		[0.006]	[0.006]	[0.006]	[0.006]
PIAT-Reading Comp./10		0.004	0.005	0.005	0.005
		[0.006]	[0.007]	[0.007]	[0.007]
Behavior Problems Index/10		−0.021***	−0.019***	−0.019***	−0.019***
		[0.003]	[0.004]	[0.004]	[0.004]
County Dummies			Yes	Yes	Yes
County Characteristics				Yes	Yes
Income/Wealth					Yes
R^2	0.191	0.222	0.278	0.284	0.284
Sample Size	3148	3148	3148	3148	3148

Panel B: Ever attend college by age 20	(1)	(2)	(3)	(4)	(5)
Home Ownership	0.129***	0.112***	0.094***	0.096***	0.076***
	[0.027]	[0.025]	[0.026]	[0.026]	[0.028]
Year Built/100	0.099***	0.072**	0.074**	0.085***	0.080**
	[0.032]	[0.030]	[0.031]	[0.032]	[0.032]
Bedrooms/Person	−0.068	−0.076	−0.032	−0.036	−0.067
	[0.052]	[0.050]	[0.051]	[0.051]	[0.052]
Multi-family Building	0.061	0.047	0.063	0.063	0.063
	[0.052]	[0.050]	[0.056]	[0.055]	[0.055]
Mobile Home	−0.213	−0.217	−0.175	−0.183	−0.165
	[0.149]	[0.142]	[0.155]	[0.162]	[0.162]
Interv. Obs. Home Score/100	−0.075	−0.047	−0.054	−0.063	−0.061
	[0.070]	[0.067]	[0.069]	[0.070]	[0.070]
PIAT-Math/10		0.032***	0.029***	0.030***	0.029***
		[0.005]	[0.005]	[0.005]	[0.005]
PIAT-Reading Recog./10		0.013**	0.014**	0.014**	0.016**
		[0.006]	[0.006]	[0.006]	[0.006]
PIAT-Reading Comp./10		0.010*	0.011*	0.010	0.010
		[0.006]	[0.006]	[0.006]	[0.006]
Behavior Problems Index/10		−0.014***	−0.013***	−0.013***	−0.012***
		[0.003]	[0.004]	[0.004]	[0.004]
County Dummies			Yes	Yes	Yes
County Characteristics				Yes	Yes
Income/Wealth					Yes
R^2	0.284	0.327	0.36	0.366	0.367
Sample Size	3817	3817	3817	3817	3817

Panel C: Ever convicted by age 20	(1)	(2)	(3)	(4)	(5)
Home Ownership	−0.066***	−0.059***	−0.068***	−0.067***	−0.062***
	[0.021]	[0.021]	[0.022]	[0.022]	[0.023]
Year Built/100	−0.008	−0.002	−0.002	0.003	0.003
	[0.025]	[0.025]	[0.027]	[0.027]	[0.027]
Bedrooms/Person	0.093**	0.090**	0.103**	0.095**	0.092**
	[0.040]	[0.040]	[0.043]	[0.043]	[0.044]
Multi-family Building	0.004	0.010	0.012	0.011	0.013
	[0.042]	[0.041]	[0.045]	[0.044]	[0.044]
Mobile Home	0.134	0.139	0.167	0.170	0.169
	[0.176]	[0.172]	[0.165]	[0.164]	[0.164]
Interv. Obs. Home Score/100	0.017	0.056	0.034	0.020	0.033
	[0.057]	[0.045]	[0.058]	[0.058]	[0.058]
PIAT-Math/10		0.004	0.003	0.003	0.003
		[0.004]	[0.004]	[0.004]	[0.004]
PIAT-Reading Recog./10		−0.001	−0.001	−0.000	−0.001

(*continued on next page*)

Table 2 (*continued*)

Panel C: Ever convicted by age 20	(1)	(2)	(3)	(4)	(5)
		[0.005]	[0.005]	[0.005]	[0.005]
PIAT-Reading Comp./10		−0.006	−0.006	−0.006	−0.005
		[0.005]	[0.005]	[0.005]	[0.005]
Behavior Problems Index/10		0.014***	0.014***	0.014***	0.014***
		[0.003]	[0.003]	[0.003]	[0.003]
County Dummies			Yes	Yes	Yes
County Characteristics				Yes	Yes
Income/Wealth					Yes
R^2	0.129	0.136	0.171	0.174	0.174
Sample Size	4149	4149	4149	4149	4149
Panel D: Ever pregnant by age 19	(1)	(2)	(3)	(4)	(5)
Home Ownership	−0.098***	−0.095***	−0.084***	−0.085***	−0.090***
	[0.030]	[0.030]	[0.032]	[0.032]	[0.034]
Year Built/100	0.005	0.009	0.010	0.004	0.005
	[0.035]	[0.035]	[0.036]	[0.037]	[0.037]
Bedrooms/Person	0.051	0.056	0.024	0.012	0.013
	[0.054]	[0.054]	[0.057]	[0.057]	[0.060]
Multi-family Building	−0.034	−0.029	−0.045	−0.044	−0.044
	[0.061]	[0.060]	[0.064]	[0.064]	[0.064]
Mobile Home	−0.050	−0.049	−0.126	−0.161	−0.160
	[0.194]	[0.196]	[0.218]	[0.223]	[0.223]
Interv. Obs. Home Score/100	0.007	0.009	0.045	0.030	0.029
	[0.088]	[0.088]	[0.093]	[0.094]	[0.095]
PIAT-Math/10		−0.002	−0.001	−0.001	−0.001
		[0.006]	[0.006]	[0.006]	[0.006]
PIAT-Reading Recog./10		0.005	0.005	0.006	0.006
		[0.007]	[0.008]	[0.008]	[0.008]
PIAT-Reading Comp./10		−0.019***	−0.018**	−0.019**	−0.019**
		[0.007]	[0.008]	[0.008]	[0.008]
Behavior Problems Index/10		0.008*	0.007*	0.008*	0.007*
		[0.004]	[0.004]	[0.004]	[0.004]
County Dummies			Yes	Yes	Yes
County Characteristics				Yes	Yes
Income/Wealth					Yes
R^2	0.248	0.255	0.324	0.328	0.328
Sample Size	2013	2013	2013	2013	2013
Panel E: Ever on welfare by age 20	(1)	(2)	(3)	(4)	(5)
Home Ownership	−0.090***	−0.083***	−0.075***	−0.076***	−0.072***
	[0.025]	[0.024]	[0.026]	[0.026]	[0.028]
Year Built/100	−0.095***	−0.087***	−0.096***	−0.084***	−0.084***
	[0.029]	[0.029]	[0.030]	[0.030]	[0.030]
Bedrooms/Person	0.057	0.060	0.048	0.050	0.050
	[0.046]	[0.045]	[0.049]	[0.049]	[0.051]
Multi-family Building	−0.005	−0.001	0.019	0.023	0.025
	[0.053]	[0.053]	[0.054]	[0.054]	[0.054]
Mobile Home	−0.107	−0.098	−0.161	−0.158	−0.161
	[0.133]	[0.133]	[0.137]	[0.136]	[0.136]
Interv. Obs. Home Score/100	0.047	0.042	0.048	0.038	0.038
	[0.073]	[0.072]	[0.072]	[0.073]	[0.074]
PIAT-Math/10		−0.009**	−0.007	−0.007	−0.007
		[0.004]	[0.005]	[0.005]	[0.005]
PIAT-Reading Recog./10		0.004	0.002	0.002	0.002
		[0.005]	[0.005]	[0.005]	[0.005]
PIAT-Reading Comp./10		−0.009	−0.010*	−0.011*	−0.011*
		[0.008]	[0.006]	[0.006]	[0.006]
Behavior Problems Index/10		0.007**	0.006*	0.006*	0.006*
		[0.003]	[0.003]	[0.003]	[0.003]
County Dummies			Yes	Yes	Yes
County Characteristics				Yes	Yes
Income/Wealth					Yes
R^2	0.221	0.226	0.275	0.278	0.278
Sample Size	3323	3323	3323	3323	3323

[a] *Note:* Other variables in the regression are the average for a child during the spell of ages 0–14 to the extent they are included in the data set. The variables are the same as in Table 2 with the addition of the birth year and county. The sample for Panel D is only female children.

Table 3
Selected coefficients from models for child outcomes[a].

Panel A	PIAT-Math			PIAT-Reading recognition		
	(1) OLS	(2) Mother FE	(3) Child FE	(1) OLS	(2) Mother FE	(3) Child FE
Home Ownership	0.714 (0.635)	−0.992 (1.343)	0.118 (1.419)	0.248 (0.601)	−0.644 (1.384)	−0.138 (1.276)
Bedrooms/Person	2.503 (1.324)*	1.131 (2.957)	2.567 (3.041)	−1.397 (1.235)	0.563 (2.646)	2.703 (2.941)
Year Built	0.012 (0.008)	−0.005 (0.026)	0.019 (0.030)	0.006 (0.007)	−0.021 (0.024)	−0.004 (0.028)
Multi-family Building	−0.373 (0.776)	−1.474 (1.644)	−1.185 (1.918)	0.565 (0.959)	1.082 (1.774)	0.089 (2.070)
Mobile Home	−0.631 (3.908)	3.583 (4.956)	−0.338 (5.410)	5.278 (3.889)	6.060 (6.678)	5.162 (5.262)
Interviewer-Observed Home Score	−0.000 (0.011)	−0.005 (0.014)	−0.003 (0.017)	0.034 (0.011)***	0.019 (0.015)	0.012 (0.013)
Adjusted R^2	0.48	0.10	0.06	0.61	0.26	0.01
Sample Size	7576	7576	7576	7534	7534	7534
# Mothers		1901			1897	
# Children			3745			3738

Panel B	PIAT-Reading comprehension			Behavioral problems index		
	(4) OLS	(5) Mother FE	(6) Child FE	(7) OLS	(8) Mother FE	(9) Child FE
Home Ownership	0.696 (0.690)	−1.675 (1.544)	−1.922 (1.626)	−2.116 (0.443)***	−0.634 (1.095)	0.074 (1.157)
Bedrooms/Person	0.864 (1.156)	1.626 (3.168)	2.176 (4.174)	2.421 (1.216)**	2.520 (2.607)	0.852 (2.756)
Year Built	0.022 (0.009)**	0.016 (0.032)	0.020 (0.034)	−0.030 (0.008)***	−0.022 (0.020)	−0.022 (0.026)
Multi-family Building	−1.251 (1.045)	−2.411 (2.562)	−1.821 (3.879)	−1.101 (0.986)	−0.132 (1.733)	−0.226 (2.280)
Mobile Home	2.620 (4.610)	4.430 (10.263)	8.842 (8.701)	3.181 (3.274)	4.092 (6.372)	3.970 (6.960)
Interviewer-Observed Home Score	0.012 (0.013)	−0.017 (0.016)	−0.020 (0.023)	−0.016 (0.013)	−0.010 (0.015)	−0.001 (0.016)
Adjusted R^2	0.49	0.15	0.17	0.44	0.10	0.03
Sample Size	6078	6078	6078	8424	8424	8424
# Mothers		1798			2014	
# Children			3395			3986

[a] *Note:* The dependent variables are measured in percentile points, ranging from 0 to 100. Other variables in the OLS regression are: indexes of cognitive stimulation, emotional support, and dummy variables for missing values of these indexes; child's age, gender, birth order; mother is immigrant; mother's hours of work, age at child's birth, marital status (5 categories), education; number of boys ages 0–4, 5–11, and 12–17 in family, number of girls ages 0–4, 5–11, and 12–17 in family; maternal grandmother's and grandfather's education; father's education; biological father lives with child, number of visits per year and days per visit with absent biological father, and an indicator for living in central city. In the fixed effects regression, time invariant variables are omitted.

The most striking finding in Table 2 is the consistently positive association between living in an owner-occupied home during childhood and young adult outcomes. Homeownership has positive associations with the two measures of educational attainment and negative associations with crime, welfare receipt, and teenage pregnancy. The parameter estimates are 10–15% smaller after controlling for childhood cognitive achievement, behavior problems, county characteristics, and financial variables. These results are not surprising in view of the generally positive associations between homeownership and youth outcomes found in the literature; however, the set of controls used in our analysis is more extensive than in previous studies. In particular, these associations are present even when dwelling characteristics, youth cognition and the behavior problems index are controlled. Regarding the latter, their associations with youth outcomes are generally as expected. Increased PIAT-Math levels are associated with a greater likelihood of completing high school and attending college. Higher PIAT-Reading Recognition is associated with a higher likelihood of graduating from high school and attending college and a higher PIAT-Reading Comprehension is associated with a lower likelihood of teen pregnancy. An increase in the Behavioral Problems Index during childhood is associated with a lower likelihood of graduating from high school and attending college, and increased likelihood of being convicted and being on welfare.

Another possible explanation for the relationship of homeownership with young adult outcomes is that homeownership is positively associated with financial resources, and financial resources have positive effects on the outcomes. Financial resources would presumably be used to finance expenditure on children, and as discussed above, we do not have a measure of expenditures on children. This omission makes it plausible that homeownership could be picking up the effects of financial resources. We examined this possibility when we added measures of financial resources to the production function (compare the fifth column to prior ones). The measures include net worth, divided into home equity and other assets, and total household income. We find no evidence for this hypothesis as, surprisingly, the financial variables are not statistically significant in any of the youth outcome models (results not shown), and the coefficients on the housing variables are virtually identical (compare columns 4 and 5).

For college enrollment, homeownership could be a proxy for a different variable: credit constraints. If homeowners are able to draw on their current home equity to help finance college costs, this could account for the positive association between home ownership and college enrollment (Lovenheim, 2011). To test for this possibility, we added a measure of home equity at the time when the child was of college entry age (17–19) to the model. The results (not shown), do not support this hypothesis. The homeownership association with college attendance is only modestly affected, and the effect of home equity when age 17–19 is small and not statistically significant.

The fact that we consider five different young adult outcomes raises some concern over multiple hypothesis testing.[22] In order to address this, we report adjusted *p*-values in Appendix C for homeownership, the only housing variable that is statistically significant across the outcomes.[23] We implement three common *p*-value correction methods: Bonferroni, Sidak, and the step-down Holm method (see Appendix C for a discussion of these methods). Overall, we find the statistical inference

[22] Testing a single hypothesis at the 5-percent significance level ($\alpha = 0.05$) means there is a 5-percent chance of making a type I error (i.e., rejecting a true null hypothesis). Thus, if we were to test 20 outcomes, even if the null hypothesis is true for all cases, we might expect to reject the null hypothesis and incorrectly find a statistically significant effect in one out of 20 outcomes. See Gibson et al. (2011) for an example of correcting for multiple hypothesis testing.

[23] We report the adjusted p-values for the specification reported in column 5 of Table 2, which includes the largest set of control variables (county characteristics, county dummy variables, and measures of income/net worth).

for homeownership in all five young adult outcome models is unchanged. Homeownership remains statistically significant at the 5-percent level using adjusted *p*-values. The only exception is ever being on welfare by age 20, for which homeownership just misses statistical significance at the 5-percent level under the most stringent, Bonferroni correction. These results help confirm the validity of our estimates across a variety of young adult outcomes.

5.2. Child outcomes

Above we find that selected child outcomes are associated with youth outcomes. We next determine whether there is an association of house characteristics with contemporaneous child outcomes. Table 3 reports selected coefficient estimates from OLS, mother fixed effects, and child fixed effects estimation of Eq. (3), using PIAT test scores and the BPI as the outcomes.[24] The results indicate that the number of bedrooms per person is positively associated with math and reading achievement in all but one of the specifications. The mean PIAT-Math score is 54 and the mean bedrooms per person is 0.73 with a standard deviation of 0.24. The Child FE estimate of about 2.5 indicates that a one standard deviation increase in bedrooms per person is associated with an increase in PIAT-Math of about 0.6 percentile points, or 1%, using the mean. The Child FE estimates for bedrooms per person are of the same order of magnitude in the PIAT reading models, and these coefficients are larger in the fixed effects models than in the OLS model. Most of the estimates are imprecise, with standard errors larger than the coefficients. The results are qualitatively different for Behavior Problems (BPI), with positive coefficients indicating that more bedrooms per person are associated with higher behavior problems. The Child FE estimate is much smaller than the OLS and Mother FE estimate.

Homeownership has small and imprecisely estimated associations with cognitive outcomes. To illustrate, the standard deviation of the PIAT-Math score is 28, so the coefficient of 0.71 in column 1 indicates that home ownership is associated with a 2.5% of a standard deviation higher math achievement score. Several of the estimates are negative but none are significantly different from zero. The largest estimated coefficient on homeownership is −2.1 in the OLS estimate for BPI. This is equivalent to 4% of a standard deviation and is precisely estimated, but the mother and child fixed effect estimates are much smaller.

The year of construction of the dwelling has very small associations with cognitive test scores. The OLS estimate for BPI indicates that residing in more recently built structures is associated with fewer behavioral problems. The coefficient estimate of −0.03 translates to 1% of a standard deviation per decade. The survey interviewer's observation about the quality of the dwelling's interior has very small coefficient estimates in all cases.

We find evidence that building type is associated with child cognition, consistent with previous literature. Living in a multi-family dwelling is negatively associated with math and reading comprehension achievement, relative to living in a single family home, the omitted category. The child FE coefficients of −1.2 and −1.8 imply magnitudes of 4.3 and 6.4% of a standard deviation; however, the coefficients are not statistically different than zero. Living in a mobile home has large positive associations with reading achievement, contrary to expectations, but the estimates are very imprecise. The association between living in a mobile home and behavior problems is positive but again very imprecisely estimated.

Overall, the small and often wrong-signed coefficients on homeownership and housing characteristics in models of childhood outcomes, in conjunction with the small (albeit precisely estimated) magnitudes of the associations between child cognition, behavior problems and young adult outcomes shown in Table 2, indicates that any indirect associations between homeownership and housing characteristics on young adult outcomes are very small. To illustrate, consider the association between homeownership and high school graduation operating through the cognitive and behavioral outcomes in childhood. Using the OLS estimates in Table 3, the coefficients on homeownership are 0.714, 0.248, 0.696, and −2.116 for PIAT-Math, PIAT-Reading Recognition, PIAT Reading Comprehension, and Behavior Problems Index, respectively. The coefficients on the child outcomes in the high school graduation model in column 5 of Table 2, Panel A are 0.0015, 0.0013, 0.0005, and −0.0019, respectively. Multiplying and summing yields an indirect association between homeownership and high school graduation of 0.0057, compared to the direct association of 0.113 in Table 2, Panel A, column 5. Using the mother fixed effect and child fixed effects estimates instead of the OLS estimates yields smaller and often wrong-signed indirect associations.

5.3. Discussion

We offer two potential explanations for the puzzling finding that home ownership has positive associations with young adult outcomes, despite having modest relationships with childhood outcomes. One is unobserved heterogeneity – omitted characteristics of parents and children that are positively associated with homeownership and young adult outcomes. As noted above, the within family (mother fixed effects) estimates for young adult outcomes were uninformative due to insufficient variation across siblings in the key housing inputs experienced during childhood, including homeownership. Thus, family-specific unobserved characteristics such as perseverance, patience, diligence and so forth could explain the findings. This possibility is consistent with the fact that when we apply mother and child fixed effects estimators to the child outcome models, the coefficient estimates on homeownership become much smaller and/or switch signs.

The second potential explanation is that homeownership has positive associations with other child outcomes that we do not observe, and it is through such unobserved child outcomes that the positive associations between homeownership during childhood are correlated with young adult outcomes. We do not have any direct evidence to offer on this point, but a similar pattern has been observed in the effects of compensatory preschool programs such as Head Start. For example, the experimental Head Start Impact Study reports little or no effects of Head Start on childhood outcomes measured in first grade, while other studies show consistently positive long run effects (e.g. Carneiro and Ginja, 2014; Garces et al., 2002; Deming, 2009; Ludwig and Miller, 2007). The latter studies are nonexperimental and therefore may not be directly comparable to the HSIS, but the consistency of their findings across samples and study design suggests that long run effects may operate via as yet unknown mechanism. Heckman et al. (2013) note that similar results have been found for the experimental Perry Preschool Program (PPP), a very intensive early intervention for highly disadvantaged preschoolers. There were large positive adult impacts of the treatment despite short run beneficial impacts on early childhood cognitive skills that quickly faded away. Heckman et al. (2013) exploited very rich data on personality characteristics gathered as part of the PPP evaluation to demonstrate that changes in personality characteristics could account for a significant share of the estimated adult effects. A possible example of this form of mechanism is reported by Grinstein-Weiss et al. (2010) who found a positive relationship between homeownership and “engaged parenting practices.” They noted that, controlling for other factors, home-owning parents organized structured activities for their children more so than renters, and their children spent less time watching television and playing video games.

5.4. Other specifications[25]

The linear specification is based on the assumption of no

[24] Results for the other regressors are in Appendix D.

[25] Results for many of the nonlinear specifications are not reported in the paper, but are available from the authors upon request.

diminishing returns to inputs, but it is plausible that some inputs would experience a decrease in marginal productivity at high values. However, we find no evidence of diminishing returns to the number of bedrooms per person when we add a quadratic term to the model.

Cunha and Heckman (2008) and others have reported evidence that the productivity of investment in child development differs according to the age of the child at the time of investment. We examine whether there are "sensitive periods" with respect to housing investments by allowing the coefficients on homeownership in models of young adult outcomes to differ by age at the time of investment: 0–5, 6–10, and 11–14. The evidence reported in Appendix E indicates that the positive associations between homeownership and young adult outcomes are not age specific. Many of the coefficient estimates on homeownership become statistically insignificant in this model. We find some evidence that the negative coefficient estimates on living in a mobile home are larger in absolute value in early and late in childhood (ages 0–5 and ages 11–14) for attending college. In contrast, living in a mobile home at ages 6–10 is positively associated with attending college. These positive associations at ages 6–10 and negative associations between living in a mobile home at ages 11–14 also hold for attaining a high school degree. However, age sensitivity is not apparent across other outcomes and housing characteristics.

We examine whether the associations between housing inputs and youth outcomes differ by race, ethnicity, and cognitive skill of the mother (AFQT). Interaction terms between these maternal characteristics and all housing inputs show little evidence of differential associations, and the main coefficient estimates on homeownership and housing characteristics remain largely unchanged from those reported in Table 2.

Finally, we consider Aaronson's (2000) argument that the homeownership is associated with child and young adult outcomes via their common association with mobility. Homeowners move less often than renters, and if mobility is disruptive then ownership will be associated with better outcomes. We added the number of moves between counties (both intra and interstate) during childhood to the young adult regressions.[26] In no case was the coefficient estimate on moves statistically significant at the 10% level, and the homeownership coefficient is estimated to be 5 to 15% larger than the baseline regression.

6. Conclusion

Understanding which factors influence young adult outcomes is important. Our focus is on measuring the association between childhood housing conditions and these outcomes. A justification for this focus is the large number of public policies targeting housing quality, the density of living arrangements, and the tenure status of residents (own or rent). Further, specific housing policies target specific outcomes. For example, Federal Housing Authority programs target homeownership; HUD's housing choice vouchers target the quantity of housing consumed and thus residential density and housing quality; and public housing targets quality and density.[27] Thus, understanding which housing characteristics are associated with young adult outcomes is important for guiding public policy.

Our study makes a number of contributions to research on the relationship between housing and young adult outcomes. Our data set is a relatively large national panel that follows young individuals through their childhood into young adulthood. 1) We use data on four childhood outcomes and five young adult outcomes, a larger set of outcome variables than in other studies. These data also allow us to contrast the associations between housing and childhood outcomes to those for young adults. 2) The data set contains a large set of time varying control variables describing both the individual and parents. 3) We are among the first to be able to test for the separate associations between youth outcomes and a set of housing characteristics, which include an indicator for homeownership, a measure of residential density (bedrooms per person), two measures of quality of the dwelling (year built and an interviewer's opinion of interior quality), and type of structure (single family, multifamily, mobile home). Other studies typically focused on only a single dwelling characteristic (often only residential density or homeownership status). Our more comprehensive approach was feasible because we matched addresses in the NLSY79 to publicly available information about dwelling characteristics. 4) Our empirical framework takes advantage of the panel structure of the data by including the lagged values of the dependent variable in the child outcomes regressions, resulting in a value added specification. In the young adult regressions, we include the set of childhood cognitive and behavioral outcomes, which is possible because of the long panel that we study. We also measure housing conditions throughout childhood, not just at one point in time.

Multiple studies have found that homeownership is positively associated with child and young adult outcomes. However, with one recent exception, these studies did not control for other dwelling characteristics due to the lack of data. We find no consistent evidence that residence in an owned dwelling has positive associations with child cognition or behavior, conditional on characteristics of the dwelling. This is a plausible finding as it is difficult to envision a mechanism whereby ownership would be positively associated with child outcomes, once building type and residential density are controlled. However, we find consistent evidence of relatively large positive associations of parental homeownership during a youth's childhood with the youth's educational attainment. Also, living in an owner-occupied home is associated with a lower likelihood of being convicted of a crime, being on welfare, and teen childbirth, with all of these associations being relatively large. Thus, we find that parental homeownership has an independent association with positive economic and social outcomes for young adults. One possible causal mechanism is that a child learns particular behaviors from parents who are homeowners, such as social skills, long term planning, and adopting a low discount rate. Whether homeownership causes the parents to have these characteristics, which are then transmitted to their children, or there is selection such that adults with these characteristics become homeowners is an important avenue for future research.

An important limitation of our analysis is omission of neighborhood characteristics measured at a relatively fine geographic level such as census tract or zip code. As a result of this omission, our estimates are likely to be upper bounds on the true effects of homeownership and dwelling characteristics. Controlling for neighborhood characteristics is another high priority for future research.

Declarations of interest

None.

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[26] However, this information is only available beginning in 2000.

[27] The size of the assigned public housing unit varies with family size.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jhe.2019.04.003.

Appendix A. OLS estimation of renter's bedrooms/person, American Housing Survey

Variables		Variables	
Income-1st Quartile	−0.0303**	Married	−0.1423***
	[0.0129]		[.0134]
Income-3rd Quartile	0.0457***	Single	−0.0639***
	[0.0130]		[0.0132]
Income-4th Quartile	0.0698***	North	−0.11658***
	[0.0165]		[0.0201]
Age	−0.0006**	Midwest	−0.0627***
	[0.0003]		[0.0167]
Number of Children	−0.1054***	West	−0.0367**
	[0.0075]		[0.0183]
Dummy: Children > 0	−0.22243***	2007	−0.0136
	[0.0165]		[0.0090]
Number of Adults	−0.2288***	Income*Age	0.00002***
	[0.0070]		[0.000003]
		Income*Number of Children	0.0002*
Adjusted R^2	0.273		[0.1137]
Sample size	12,983		

Significance levels: * = 0.10; ** = 0.05, *** = 0.01. Also included in the regression are a full set of MSA dummy variables. The income quartiles are: less than $12,000, $12,000–$25,500, $25,500–48,000, and above $48,000.

Appendix B. Additional coefficient estimates from OLS estimation of college attendance

Variables	Ever attend college by age 20 Coefficient [Standard Error]
Non-home Net Worth	0.010 [0.007]
Home Net Worth	0.022 [0.021]
Total Income	0.000 [0.000]
Mom Knows Who Child is With	0.006 [0.049]
School Quality Score	−0.005 [0.004]
Immigrant	0.087*** [0.031]
Maternal Grandfather Education	−0.001 [0.002]
Maternal Grandmother Education	−0.001 [0.002]
Lives with Biological Dad	0.014 [0.033]
Visits Per Week with Absent Dad	−0.009 [0.008]
Days Per Visit with Absent Dad	−0.001 [0.002]
County Crime Rate	−0.000 [0.001]
County Unemployment Rate	0.024*** [0.006]
County Teen Pregnancy Rate	−2.410* [1.464]
County Population Density	−0.004 [0.003]
County Percent Black	−0.039 [0.160]
County Percent Hispanic	0.143 [0.151]
County Female-Headed Household Poverty Rate	0.059 [0.319]
County Female Labor Force Participation Rate	0.693 [0.536]
County Percent Urban	−0.028 [0.094]
Cognitive Stimulation Score	0.001** [0.001]
Emotional Support Score	0.001 [0.001]
Mother's Hours of Work Per Week	0.001** [0.001]
Female	0.114*** [0.017]
Birth Order	−0.013 [0.012]
Black	0.133*** [0.025]
Hispanic	−0.018 [0.027]
Number of Boys Age 0–4	−0.031 [0.034]
Number of Boys Age 5–11	0.011 [0.026]
Number of Boys Age 12–17	−0.053 [0.036]
Number of Girls Age 0–4	−0.065** [0.029]
Number of Girls Age 5–11	−0.014 [0.023]
Number of Girls Age 12–17	0.010 [0.037]
Mom's AFQT Score	0.000 [0.000]
Central City Location	0.036 [0.034]
Mother's marital status	
Never married	0.013 [0.098]
Married	0.029 [0.100]
Separated	0.034 [0.104]
Divorced	0.071 [0.101]

Widowed	−0.071 [0.103]
Constant	1.743** [0.786]
County Dummy Variables	Yes
Birth Cohort Dummy Variables	Yes
Observations	3817
R-squared	0.367

Note: This table provides a full set of regression results for the specification that corresponds with Column (5) of Table 2. The regression also includes dummy variables for missing values of county characteristics, whether the mom knows who the child is with, and school quality score.

Appendix C. Homeownership *p*-Values corrected for multiple hypothesis testing

Outcome	Single outcome (unadjusted) *p*-value	Adjusted *p*-value for multiple outcomes		
		Bonferroni	Sidak	Holm
High School Grad by Age 20	0.0001	0.0005	0.0005	0.0005
Ever College by Age 20	0.0067	0.0334	0.0329	0.0267
Ever Convicted by Age 20	0.0071	0.0353	0.0348	0.0267
Ever on Welfare by Age 20	0.0102	0.0509	0.0498	0.0267
Ever Pregnant by Age 19	0.0082	0.0408	0.0401	0.0267

Notes: We report adjusted *p*-values for homeownership, the only housing variable that is consistently statistically significant across our 5 different outcomes. We report the *p*-values from our main specification that includes all standard controls, child outcomes, county characteristics, county dummy variables, and measures of income and net worth (column 5 from each panel in Table 2). Using three of the most common *p*-value adjustment techniques, we find that homeownership remains statistically significant at the 5-percent level for almost all outcomes after adjusting for multiple hypothesis testing (the only exception is of ever on welfare, which just misses the 5-percent level under the most stringent Bonferonni correction). The Holm adjusted p-values are all the same due to the small differences in the unadjusted p-values for the latter four outcomes. There are pros and cons to each of the methods. The Bonferroni correction is the most stringent, rejecting the null hypothesis for $p_i \leq \alpha/h$, where h is the number of hypotheses being tested. As such the adjusted p-value becomes $p_i{*}h \leq \alpha$. This guarantees that the type I error rate across the entire family of hypotheses tests is less than α, which is usually set at 0.05. However, this Bonferroni method "over-corrects" the *p*-values and increases the likelihood of type II errors (failing to reject a false null hypothesis). The Sidak correction is slightly less stringent, rejecting the null hypothesis if $p_i \leq 1-(1-\alpha)^{1/h}$, which implies a type I error rate of exactly α for h independent hypothesis tests. Finally, the step-down Holm method is the least stringent, thereby reducing the likelihood of type II errors. This method (sometimes also referred to as the Holm-Bonferroni correction) ranks the *p*-values from smallest to largest across all hypotheses. The null hypothesis associated with the smallest *p*-value is rejected at a *p*-value of $p_i \leq \alpha/h$, the next smallest at a value of $p_i \leq \alpha/(h-1)$, and so forth. If the adjusted *p*-value is ever larger than the next one in the step-down process, that larger adjusted *p*-value is used for all subsequent hypothesis tests (e.g., if $p_i \leq p_k$ and $p_i{*}(h-1) \geq p_k{*}(h-2)$ then $p_i{*}(h-1)$ is used as the adjusted *p*-value for the remaining hypotheses.) Given the trade-offs across correction methods, we report all three and show the results are qualitatively similar. See Savin (1984) and Shaffer (1995) for a discussion of these correction methods. Newer, less stringent methods that allow for correlation among the outcomes have been developed (see Westfall and Young, 1993, Romano and Wolf, 2005, and Kling et al., 2007), but our results remain statistically significant with these simpler corrections that hold under arbitrary dependence in the joint distribution of *p*-values.

Appendix D. Additional coefficient estimates from OLS estimation of baseline PIAT-Math

	PIAT-Math (1)
Lagged Dependent Variable	0.530 (0.013)***
Cognitive Stimulation Score	0.044 (0.011)***
Emotional Support Score	−0.002 (0.010)
Presence of Biological Father	−0.281 (0.803)
Number of Visits with Biological Father	0.055 (0.147)
Days Per Visit with Biological Father	0.079 (0.048)
Mother Immigrant	0.302 (1.194)
Education of Grandfather	−0.001 (0.052)
Education of Grandmother	0.112 (0.079)
Mother Knows Child's Friends	1.689 (0.726)**
School Quality Score	0.125 (0.062)**
Age	−0.816 (0.136)***
Female	−2.907 (0.626)***
Birth Order	−0.354 (0.363)
Black	−3.287 (0.649)***
Hispanic	−1.445 (0.795)*
Number of Boys Ages 0–4	−0.351 (0.443)
Number of Boys Ages 5–11	0.589 (0.418)
Number of Boys Ages 12–17	−0.661 (0.624)
Number of Girls Ages 0–4	0.303 (0.608)
Number of Girls Ages 5–11	0.735 (0.369)**
Number of Girls Ages 12–17	−0.331 (0.555)
Age of Mother at First Birth	0.377 (0.081)***
Mother's AFQT Score	0.150 (0.011)***
Mother's Hours of Work	0.005 (0.011)
Lives in Central City	0.542 (0.680)
Married	1.417 (1.058)
Separated	2.228 (1.228)*

Divorced	−0.777 (0.951)
Widowed	−6.080 (1.854)***
Cohabiting	−0.511 (1.174)
Missing Mom Knows Child's Friends	4.642 (2.544)*
Missing School Quality Score	4.182 (1.764)**
Missing Interviewer-Observed Home Score	−0.508 (1.006)
Missing Cognitive Stimulation Score	0.912 (1.486)
Missing Emotional Support Score	1.879 (0.877)**
Constant	−20.131 (17.532)
Observations	7576
R-squared	0.480

Appendix E. Select coefficients from OLS model for young adult outcomes with housing characteristics experienced at various ages[a]

	(1) High school grad by age 20	(2) Ever college by age 20	(3) Ever convicted by age 20	(4) Ever on welfare by age 20	(5) Ever pregnant by age 19
Beds/Person Ages 0–5	0.087	0.007	0.198***	0.001	0.100
	[0.079]	[0.083]	[0.059]	[0.058]	[0.070]
Beds/Person Ages 6–10	−0.097	−0.153	−0.133*	0.047	−0.162
	[0.091]	[0.101]	[0.073]	[0.076]	[0.110]
Beds/Person Ages 11–14	0.052	0.052	0.022	−0.107*	0.029
	[0.070]	[0.069]	[0.055]	[0.056]	[0.079]
Homeownership Ages 0–5	0.023	−0.035	−0.019	0.006	−0.075
	[0.041]	[0.043]	[0.032]	[0.033]	[0.046]
Homeownership Ages 6–10	0.047	0.082*	−0.003	−0.016	0.009
	[0.048]	[0.049]	[0.038]	[0.038]	[0.053]
Homeownership Ages 11–14	0.046	0.016	−0.029	−0.058	−0.056
	[0.046]	[0.044]	[0.034]	[0.037]	[0.049]
Year Built/100 Ages 0–5	0.001	0.000	−0.000	0.000	−0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Year Built/100 Ages 6–10	−0.001	−0.002	0.001	−0.000	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Year Built/100 Ages 11–14	−0.000	0.002**	−0.000	−0.000	−0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Multi–family Building Ages 0–5	−0.018	−0.007	−0.110*	−0.014	−0.116
	[0.079]	[0.068]	[0.059]	[0.072]	[0.094]
Multi–family Building Ages 6–10	0.095	0.007	0.178**	−0.002	0.120
	[0.075]	[0.081]	[0.071]	[0.082]	[0.108]
Multi–family Building Ages 11–14	−0.086	−0.017	−0.065	0.029	−0.072
	[0.077]	[0.081]	[0.064]	[0.075]	[0.107]
Mobile Home Ages 0–5	0.451*	−0.868***	−0.256	−0.166	0.326
	[0.237]	[0.257]	[0.199]	[0.140]	[0.425]
Mobile Home Ages 6–10	0.992***	0.763***	−0.149	0.370**	−0.152
	[0.302]	[0.246]	[0.195]	[0.167]	[0.368]
Mobile Home Ages 11–14	−0.554***	−0.351**	0.074	−0.080	−0.229
	[0.175]	[0.155]	[0.229]	[0.085]	[0.153]
R^2	0.288	0.425	0.175	0.212	0.178
Sample Size	776	1154	1293	840	653

[a]*Note:* Other variables in the regression are the average for a child during the spell of ages 0–14 to the extent they are included in the data set. The variables are the same as in the note to Table 3 with the addition of the birth year. The sample for the final column is only female children.

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