THE EFFECTS OF HOUSING WEALTH ON EDUCATION AND OTHER ESSAYS IN EMPIRICAL MICROECONOMICS

A Dissertation

Presented to

The Faculty of the Department

of Economics

University of Houston

In Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

By

Ryan Ruddy

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Abstract

This dissertation is composed of three essays. The first essay, *Family Resources and Secondary Education Investment: Evidence From the Housing Boom* uses plausibly exogenous home price increases during the housing boom in the late 1990's and early 2000's to identify the effect of family resources on investment in secondary education. Exploiting the large spatial and timing variation of home price changes during this period, I find the average home price increase lowered the probability of dropping out of high school by age 19 by 1 percentage point, a 10% reduction. Consistent with an increased expectation of ability to pay for college, home price increases also raised the probability of completing a college preparatory curriculum and attending college. Students who reported low grades in eighth grade respond the strongest to home price increases suggesting that merit-based scholarship programs might be less beneficial than scholarship programs which are not contingent on ability. Black students of all ability levels are more likely to remain in high school in response to a home price increase. A mean change in home price decreased the probability of black students dropping out by 20%.

The second chapter, *The Effect of Housing Wealth on Labor Market Outcomes and Behavior*, expands on the findings of Chapter 1 and previous literature that found a link between housing wealth and education by examining the impact of home wealth on adult labor market outcomes and behavior. Using the NLSY97, I measure the effect of a change in home price while in high school on income at age 26, job industry, criminal behavior, and community participation. I find evidence that home wealth shocks increase the probability of holding white collar jobs, increase wages, and positively impact behavior outcomes. These effects are likely manifesting

through the increased education found in previous work.

The final chapter examines the effect of the introduction of Sildenafil (Viagra) on marriage rates for elderly men in the United States. I exploit the sudden introduction and rise of Viagra use along with the difficulty in obtaining Viagra prescriptions for men with heart problems or history of stroke in a difference in difference framework to find the effect of Viagra on marriage rates. I find that men physically able to take Viagra which married prior to the introduction of Viagra were more likely to remain in their current marriage or enter a new marriage after Viagra's introduction. Furthermore, I find no evidence that the marital behavior of women was altered by health conditions at the time of Viagra's introduction.

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Chapter 1

Family Resources and Secondary Education Investment: Evidence From The Housing Boom

1.1 Introduction

Parental resources are highly correlated with education attainment. In 2009, students in the lowest quartile of household income were about five times more likely than those from the highest quartile to drop out of high school.[1] When low-income students graduate high school and transition to college they are less successful than their high income counterparts. Only 70% of college freshman whose family income is in the lowest quartile complete their college education, while 83% of their peers

[1] *Trends in High School Dropout and Completion Rates in the United States: 1972-2009 Compendium Report* National Center of Education Statistics http://nces.ed.gov/pubs2012/2012006.pdf

in the highest household income quartile earn a college degree.[2] These positive associations do not necessarily have a causal interpretation. There are many variables correlated with both parental resources and educational outcomes. For example, higher parental ability affects both family resources and student outcomes, leading to upward bias when parental ability (which is difficult to measure) is omitted from an estimation of the effect of family resources on educational outcomes. In order to identify the causal impact of family resources on student outcomes, an exogenous shock to family resources is needed.

The housing boom which began in the late 1990s and early 2000s provides a plausibly exogenous shock to family resources. Housing is the largest asset for the majority of American families and home equity loans were prevalent for credit constrained households in the early 2000s (Mian and Sufi 2014). A positive shock to home value is a shock to household wealth and an easing of household credit constraints. Students during this time experienced a mean home price increase of $32,790 from age 14 to age 18 and there was large variation in the timing of such increases across metropolitan statistical areas (MSAs). I exploit the large spatial and timing variation in home price changes to estimate the impact of changes in family home price on various measures of high school performance available in the National Longitudinal Study of Youth - 1997 cohort (NLSY97).

I find that the mean home price increase of $32,790 for an NLSY97 respondent increased the probability of earning a high school diploma by 1.3 percentage points,

[2]College Board http://trends.collegeboard.org/education-pays/figures-tables/completion-rates-family-income-and-parental-education-level

a 1.5% increase. The same price change lowered the probability of dropping out by 1 percentage point, a 10.1% decrease. Additionally, students experiencing an increase in home wealth take more rigorous courses. The probability of completing an Academic Specialist curriculum[3] increases by 2.91 percentage points, a 7.1% increase, following a mean home price increase. Consistent with previous work by Lovenheim (2011), I show that a change in home price increases the probability of attending college. Increased ability to pay for college is a possible mechanism through which home prices affect high school performance.

I explore heterogeneity in the effects of home price changes on high school outcomes by both ability and race. Using grades in eighth grade (the period just prior to the measured home price changes) as a baseline measure of an individual's prior school performance, I find that previously low performing students stay in school and take more difficult courses. There is no effect on dropout rates for A and B students, a small effect on C students, and relatively large effects for students who received D's or below in eighth grade. Students earning D's and F's move from being dropouts to college prep students. The only group that did not take more rigorous courses was those who earned all A's in eighth grade. I also show that the same group of low performing students are driving the college attendance result found by Lovenheim (2011). The results are consistent with students performing better in high school (via taking more rigorous courses) when they have higher expectations of attending college.

[3]4 English credits; 3 math credits of Algebra I or higher; 2 credits in biology, chemistry , or physics; 2 credits in social studies, at least 1 of which is world history; 2 credits in a foreign language

Previous literature on consumption and home prices suggests that the realization of home price increases is likely through increased access to credit (Mian and Sufi 2014). Black families may face harsher credit constraints (Ross and Yinger 2002)[4], so I separately estimate the effects of home price changes on black students. I find a significantly larger effect of home price increases for black students. The mean home price change for black students in the NLSY97 was only $17,904, but a mean home price change increases the probability of graduation by 4.85 percentage points, a 6% increase, and decreases the probability of dropping out by 2.86 percentage points, a 21% decrease. The effect on black students is nearly twice that of the entire sample. Racial differences in effects are not driven by baseline performance differences. Even black students who report earning all A's in eighth grade have increased probability of completing high school after a positive home price shock. Only white students who report D's and F's in eighth grade are affected at the dropout margin, but a broader group of white students responds strongly on the intensive (course taking) margin.

Using an MSA level home price index from Freddie Mac, I show that children of non-home-owning families do not respond positively to housing price shocks. These results demonstrate that positive effects of home price changes on the high school performance of children in home-owning families are not confounded by correlated shocks in local employment markets or school quality, building assurance that the effects for children of home-owning families are driven by increased family resources.

[4]Additional literature exists on credit constraints by race. For a thorough discussion see Ross and Yinger(2002)

The effects of home price shocks on high school performance are consistently positive for home owners across multiple specifications. Probit estimations show that an individual with mean level control variables will increase the probability of completing high school by 0.009 in response to a $10,000 increase in family home value. Logit estimates are nearly identical.

The findings in this paper have significant policy implications. I show that youths experiencing a shock to family wealth increase their secondary school investment in human capital. The increased investment in high school is driven by students who performed poorly in school prior to the home price increase. These are the same students that drive the college attendance increase found by Lovenheim (2011), suggesting that their weak historical performance may be at least in part a product of their perceived opportunities and expectations that they can afford college. The response of academically weaker students suggests that merit-based scholarship programs might be less beneficial than scholarship programs which are not contingent on ability.

The remainder of this paper proceeds as follows. Section Two reviews related literature. Section Three describes the NLSY97 data, home price data, and the construction of variables. Section Four details the estimation methods. The Fifth section will discuss results, the Sixth section robustness, and section Seven concludes.

1.2 Related Literature

An extensive literature exists on the role of family resources in education attainment. Becker (1962) notes that in the absence of credit constraints individuals will invest in education until the return on education is equal to the market rate of interest. Family resources should not affect educational attainment. However, borrowing for education is especially difficult, loans are not easily collateralized. Thus, empirical work on family resources and education is often concerned with credit constraints.

Recently, Lovenheim (2011) and Lovenheim and Reynolds (2013) used the housing boom of the late 1990s and early 2000s to examine the link between parental resources and college attendance, finding evidence that credit constrained families sent their children to college in response to home equity increases. Lovenheim (2011) found that a $10,000 increase in home equity could increase the probability of college attendance by as much as 5.7 percentage points. Lovenheim and Reynolds (2013) explored the effects of home equity on the intensive margin (college quality) of college attainment. A positive shock to home equity increased the probability of a student attending a private college or the state flagship university in lieu of community college and lower cost public universities. This paper expands on their work by demonstrating that a shock to home equity not only affects the transition from high school to college, but also increases human capital investment made while in high school.

Cameron and Heckman (1998, 2001) and Cameron and Tabor (2000) argued against credit constraints as a major factor in racial differences in college going rates. Developing a structural model for grade transition, Cameron and Heckman

(2001) found that lack of resources throughout a child's life played a larger role in the college enrollment racial gap. However, work utilizing more recent data by Belley and Lochner (2007, 2011) found that the role of family resources in education decisions increased substantially for cohorts younger than those analyzed by Cameron and Heckman (1998, 2001). For the younger cohorts, family resources account for a much larger portion of the education gap between low and high income families.

This paper adds to the handful of papers that identify the causal impact of family resources using variation provided by the housing boom of the late 1990s and early 2000s. Other papers have used this housing boom to gain insight about the causal impact of family resources on various other outcomes: college going (Lovenheim(2011), Lovenheim and Reynolds (2013), fertility (Lovenheim and Mumford (2013), Dettling and Kearney (2014)), and household consumption patterns (Mian and Sufi (2014)). A useful feature of housing price shocks is that they are experienced broadly in the population, and not limited to, say, families with students of high academic ability. This contrasts with variation in family wealth/college affordability generated by state merit aid programs, which would be experienced only by high performing students or geographically limited. This permits me to examine heterogeneity in impacts of family resource by student academic ability.

One possible mechanism through which housing prices could increase investment in high school education is the expectation of college affordability. When college becomes affordable, the potential returns from taking a college preparatory curriculum are higher. A branch of literature has found evidence that programs increasing

college accessibility have a positive effect on secondary outcomes. Henry and Rubenstein (2002) found that the Georgia Hope[5] program increased GPAs and SAT scores of African American students. Bartik and Lachowska (2012) found that the Kalamazoo Promise [6] increased the GPAs of black students and increased credit earning of black students by 9%. Home price shocks differ from these programs, because they are not merit-based or limited in geographical area.

1.3 Data

Individual level data for this analysis comes from the National Longitudinal Survey of Youth- 1997 cohort (NLSY97). Home prices are not available for every year and are estimated using the Freddie Mac Home Price Index (FMHPI). This section will discuss these data sources.

1.3.1 NLSY97

The data used for this analysis is the restricted use National Longitudinal Survey of Youth 1997 (NLSY97)[7]. The NLSY97 is a nationally representative sample of youths born between 1980 and 1984. Parents and youths were both interviewed in the original 1997 survey and youths were interviewed on an annual basis following the initial round. The NLSY97 provides a plethora of controls and outcomes including

[5]Georgia Hope is a merit-based program which gives substantial college scholarships to Georgia residents that meet GPA and or standardized testing minimums.

[6]Kalamazoo Promise is a scholarship program which paid tuition for students that had been in the Kalamazoo district for at least four years prior to graduation.

[7]The restricted data is needed to match individuals to their MSA for home price estimations and MSA fixed effects.

estimated home value, household income, parental education, high school transcripts, and several non-cognitive outcomes.

A drawback of the NLSY97 is missing data. For example, 14% of respondents did not supply father's education. Following Lovenheim and Reynolds (2013), I use multiple imputed chained equations to impute missing control variables. No outcomes or home price variables are imputed.[8] A more detailed description of the imputation process can be found in the appendix.

Summary statistics for control variables are located in Table 1.[9] Data is reported by home ownership status. The main results only use home owners, but some estimations in the robustness section will include the response to home price increases within MSA by non-home owners. Splitting data into home owners and non-home owners also illustrates the correlation between family resources and educational outcomes, since home owners have higher family resources on average. Column 1 displays mean values for the entire sample with standard deviations in parentheses. Columns 2 and 3 display summary statistics for home owners and non-home owners respectively.

Home owning families have a higher mean household income than non-home owning families. This higher level of family resources is correlated with performance in eighth grade and parent's education highlighting the need for an exogenous source of variation in family resources.

To account for changes in opportunity cost of living in a home, I have also included changes in the fair market rent as provided by the U.S. Department of Housing and

[8]Results without imputed data are similar and available upon request.

[9]The NLSY97 oversamples minorities, so data in Table 1 is weighted using the NLSY custom weights found at https://www.nlsinfo.org/weights/nlsy97.

Urban Development (HUD).[10] HUD compiles rental data within MSA. I use the published fair market rent for three bedroom apartments. Fair market rent is the 45th percentile of rental rates within an MSA.[11]

Outcome variables are found in Table 2. As before, column 1 includes all observations, column 2 includes home owners, and column 3 includes non-home owners. Several outcomes are missing observations and outcome variables were not included in the imputation process. Therefore, the number of observations varies by outcome. The number of observations is in brackets. Education level at age 19 is available for most respondents. Course taking variables have fewer observations.[12]

Outcomes are clearly correlated with home ownership. There is a 26 percentage point gap in the probability of completing a high school diploma by the year in which youths turn 19 between home owners and non-home owners. Fewer than 10% of youths from home owning families drop out of high school, while over 30% of their non home owning peers dropout. Students from home owning households are also more likely to attend college. 68% of home owners report ever attending college by age 20, while only 38% of non-home owners attend.

The remainder of the outcome variables are drawn from high school transcripts. Transcripts in the NLSY97 have been coded in the manner outlined by the National Center for Education Statistics (NCES) *Procedures Guide for Transcript Study*. Credits refer to *Carnegie* credits. A class which meets for one hour a day for an entire

[10] http://www.huduser.org/portal/datasets/fmr.html

[11] I have also used two bedroom apartment rent. All estimates are nearly identical.

[12] The probability of missing data is not predicted by changes in home price. This is addressed in the appendix.

school year is one Carnegie credit.

Academic Specialist and Academic Concentrator are categories defined by the NCES transcript guide. The Academic Specialist has completed 4 English credits; 3 math credits of Algebra I or higher; 2 credits in biology, chemistry , or physics; 2 credits in social studies, at least 1 of which is world history; 2 credits in a foreign language; and does not meet the requirements of a vocation specialist or concentrator. The requirements of an Academic Specialist are the same as those defined by the bureau of education's *Preparing Your Child For College: 2000 Edition*.[13] Academic Concentrator is a less demanding requirement. An Academic Concentrator is a student that earns at least: 4 English credits; 3 math credits; 3 science credits; 3 social studies credits; and is not categorized as a vocational specialist or concentrator. Students can be classified as both Academic Concentrator and Academic Specialist.

Total math and science credits refer to Carnegie credits. Academic math is any math course pre-Algebra or above. Literature on the returns to curriculum has found that math courses have high returns (Altonji 1995, Goodman 2009, Rose and Betts 2004) and increase probability of college attendance (Aughinbaugh 2012).

The new basic curriculum is the minimum recommendation of the National Commission on Excellence in Education. Percent New Basic refers to the percent of new basic requirements that have been filled. These requirements include 4 years of English, 3 years of math, 3 years of science, 3 years of social science, and 1 semester of computer science. These requirements are similar to the minimal requirements for

[13]https://www2.ed.gov/pubs/Prepare/pt2.html

graduation imposed by many state governments.[14]

While the main analysis uses the sample described in Tables 1 and 2, which has one observation per individual, some supplementary analysis uses longitudinal data. The longitudinal data is structured to include each individual while they are under 20 years old and have yet to complete high school. The summary statistics of the data in panel form can be found in the appendix.

1.3.2 Housing Data

The explanatory variable of interest is the change in family home price from age 14 to age 18. The NLSY97 did not collect home price in every period. The first round of parental questions in 1997 includes the parent's estimated value of their current home. Subsequent home values are estimated using the Freddie Mac Housing Price Index (FMHPI). The FMHPI is based on repeated sales of homes with conventional mortgages[15] with average appreciation rates calculated by MSA each month. I assign the mean of monthly values for each year's home price index. The FMHPI uses data on all homes whose loans were purchased by either Freddie Mac or Fannie Mae.[16] Home prices are estimated by multiplying the 1997 home price by the ratio of the current year's home price index to the 1997 price index, as follows:

$$\widehat{P_{i,m,t}} = P_{i,m,1997} * \frac{FMHPI_{m,t}}{FMHPI_{m,1997}} \qquad \textbf{(1)}$$

where i is the individual, m is MSA, and t is the year. $P_{i,m,1997}$ is the reported 1997 home price, while $\frac{FMHPI_{m,t}}{FMHPI_{m,1997}}$ is the ratio of home price indexes. For example,

[14]Based on data from the NCES.
[15]Conventional mortgages include single family homes under $417,000 in 2014.
[16]From 1975 to 2014, the FMHPI includes over 25 million paired transacitions.

consider a respondent from the Ann Arbor, Michigan MSA reporting a home value of $150,000 in 1997. The Freddie Mac home price index for Ann Arbor is 77.60 in 1997 and 103.57 in 2001. The respondent's estimated home value in 2001 would be: $\$150,000 * \frac{103.57}{77.60} = \$200,200$. This method of approximating home price is the same as used by Lovenheim and Reynolds (2013).[17]

Variation in home prices changes comes from variation in the initial home price, variation within year across MSAs, and variation across time within MSAs. Table 3 shows the large variation in home prices and home price changes. All home prices are displayed in $10,000 increments. Column 1 displays mean and column 2 shows standard deviation. Column 3 is the mean standard deviation within MSA and column 4 is the mean standard deviation within birth cohort. Rows 2 through 5 of Table 3 show information on price changes. 4 year Δ HP at 18 is the price change between ages 14 and 18. This is the independent variable in the main specification. The mean change in home price from the age 14 to age 18 is $32,790.[18] Rows three and four of Table 3 present the mean change in home price for the 2 years prior to turning 18 and two years prior to turning 16. The mean change in home price is 65% larger in the last two years prior to turning 18. Since 30 states had a compulsory

[17]Lovenheim and Reynolds used the Conventional Mortgage Home Price Index (CMHPI) which was formerly published by Freddie Mac. The CMHPI was replaced by the FMHPI in 2011 and is no longer available. The main difference in the two indices is the treatment of appraisals. The FMHPI accounts for the possibility that appraisal values differ systematically from sales.

[18]It should be noted that Lovenheim & Reynolds (2013) have a substantially larger mean $53,310 home price change. The difference is driven by the sample selected for analysis and the treatment of inflation. Their sample is limited to college bound students, which have a higher home value. They difference home prices without adjusting for inflation and then scale the difference into 2007 dollars. Using the same sample and method as Lovenheim & Reynolds (2013) , I get a mean home price change of approximately $50,000, not statistically different from theirs.

schooling age of 16 at the time of this survey[19], it is important to note that the large change in home prices is occurring at a time in which students can legally dropout. This is also the time period at which the most difficult courses are likely to be taken.

Decomposing the home price change helps to better understand the variation:

$$\Delta HP_{i,c,m} = HP^{18}_{i,c,m} - HP^{14}_{i,c,m}$$

$$\Delta HP_{i,c,m} = \frac{P_{i,m,1997}}{FMHPI_{m,1997}}(FMHPI_{m,18} - FMHPI_{m,14}) \qquad \textbf{(2)}$$

Home price changes are the change in Freddie Mac indices between the year the youth turned 18 and the year they turned 14 multiplied by the price of their home relative to the index in their MSA. There is variation across time within MSA because different cohorts reach 18 at different times. Estimations with MSA fixed effects will rely heavily on variation within MSA across cohort. The mean standard deviation of four year price change within MSA is \$24,440. Variation across MSA within time occurs because the housing boom took place in different cities at different times. This is scaled by relative home value. The scaling is necessary because families with more expensive homes will receive a larger increase in equity when home prices rise. The 1997 home price causes all of the variation within MSA and time. Household income is used as a control in all estimates. Conceptually, the change in $\Delta HP_{i,c,m}$ due to the initial home price is caused by families with the same income buying a more expensive home. The variation in home prices can be seen in Figure 1. Each map in Figure 1 represents a birth year cohort. The darker MSAs indicate a larger mean change in home price from age 14 to age 18. Variation within MSA is depicted

[19]National Center of Education Statistics

by the same MSA having different shades in each map. For example, youths from San Francisco in the 1984 cohort have a much larger change in home price than those born in 1980.

There is considerable within-MSA variation in housing price changes and this will permit me to identify effects of housing price changes while controlling for MSA-level time invariant characteristics. I discuss this empirical strategy next.

1.4 Empirical Methodology

This paper estimates the effect of family resources in the form of housing wealth on children's secondary educational attainment and performance. My identifying assumption treats a change in home price as an exogenous shock to family resources. An increase in home price constitutes both a positive shock to household wealth and an easing of credit constraints. Any equity which the household has accrued may be extracted by either borrowing against the equity in the home or selling the home. The aim of this paper is not to determine the mechanism through which wealth is extracted, but rather to examine the effects of wealth and credit access. Previous literature on consumption and home prices (Mian and Sufi 2014, Campbell and Cocco 2008, Hurst and Stafford 2002) found consumption changes due to home equity are the result of credit constrained families extracting equity through home equity loans.

There are two potential ways that an increase in home price could improve high school outcomes. First, a shock to home price can increase household expenditures

while in high school, stabilizing household finances and making it easier to finish school. Second, the shock to wealth can change the expectation of ability to pay for college thereby increasing the returns to high school. These potential mechanisms are not mutually exclusive and I cannot distinguish between them. An increase in family resources could decrease high school outcomes for some students. Increased resources could mean that students no longer need to vie for competitive scholarships and they respond to increases in family resources with decreased effort in academics. Ultimately the effect of home prices on educational outcomes is an empirical question. I estimate the effect of a home price shock on high school outcomes with the following specification:

$$Y_{i,c,m} = \beta(\Delta HP_{i,c,m}) + X_{i,c,m}\Pi + \omega_m + \psi_c + \epsilon_{i,c,m} \quad \textbf{(3)}$$

$Y_{i,c,m}$ represents a high school outcome of individual i, from birth cohort c, and from MSA m. ω_m captures any time invariant effects of living in a given MSA and ψ_c captures any effects specific to each youth's birth cohort. $\Delta HP_{i,c,m}$ is the estimated home price change from age 14 to age 18 for individual i in \$10,000 increments. The coefficient of interest is β, which is the change in $Y_{i,c,m}$ in response to a \$10,000 change in home price.

X contains all of the controls displayed in Table 2. Household income controls for changes in family resources caused by potential endogenous labor market outcomes. Grades in eighth grade are used as a control for ability. Performance in eighth grade is a strong indicator of success in high school. Grades capture knowledge prior to entering high school and also encapsulate the non cognitive skills necessary to succeed

in school. To further account for ability and household importance of education, I also include the education level of biological parents.[20]

Equation 3 treats home price changes as an exogenous shock to wealth, conditional on controls. For estimates of equation 3 to produce upwardly biased estimates of the effect of home price changes on high school outcomes, the home price change would have to be correlated with some unobserved aspect of families that increases both home prices and high school outcomes positively. In section 5, I will show that children from non-home owning families are not positively affected by home price increases within their MSA, providing evidence that results are not confounded by other MSA/time omitted variables affecting all students. A handful of other works have also treated home price increases as exogenous. (Lovenheim 2011, Lovenheim & Reynolds 2013, Dettling & Kearney)

The results from equation 3 are robust to several alternative specifications including logit, probit, higher order polynomials, log home prices, and individual fixed effects. Some of these specifications are presented in the robustness section, while others have been relegated to an appendix.

1.5 Results

The results section is comprised of four parts. I begin by discussing the main results. Shocks to home price increase both high school completion and course rigor. Next,

[20]The NLSY97 also provides the Armed Services Vocational Aptitude Battery (ASVAB). This is similar to the AFQT in the 1979 NLSY. The ASVAB is given to most respondents during the initial interview. For many respondents, they are taking the ASVAB during their estimated home price change, meaning ASVAB scores are an outcome. I do not use ASVAB scores in any reported estimates. All estimates maintain their significance and sign when using the ASVAB as a control.

I explore heterogeneity in the results. In subsection two, I show that the effects of a shock to family resources varies by grades in eighth grade. The third subsection shows that black students are reacting on the dropout margin, while white students are on the course rigor margin. Lastly, I discuss individual fixed effects estimations and effects of home price changes within MSA on non-home owners.

1.5.1 Main Results

I begin by estimating the effect of home price changes on high school completion with Equation 3. Estimates can be found in Table 4. The first column shows the effect of home price changes on the probability of earning a high school diploma by the year in which the youth turns 19. The second column is an estimation of the probability of dropping out of school by age 19. Column 3 displays the effect of a home price change on ever attending college by age 20. In addition to the covariates shown in Table 4, all regressions include MSA level fixed effects. Standard errors are robust and clustered at the MSA level.

Home price changes are in $10,000 increments. In Column 1, the coefficient of 0.00401 indicates that a $10,000 home price increase increases the probability of finishing high school by 0.4 percentage points. The mean change in home price is $32,790 and 87.1% of students from home owning households are earning their high school diploma. So, a mean change in home price increases the probability of completing a high school diploma by 1.5%.[21] This effect is statistically significant at a 5% level.

[21] 0.401*3.279/0.871=1.5

The effect of home price changes on the probability of earning a high school diploma seems small, but it is important to consider that a very high percentage of children from home owning families will be graduating high school no matter what. In Column 2, I examine dropout behavior.[22] The estimated coefficient for the housing price variable is -.00303 and is significant at the 5% level. An individual experiencing a mean home price change lowers their probability of dropping out of high school by 1 percentage point. Considering the mean dropout rate for home owners is only 9.83%, this effect is relatively large. A mean change in home price decreases the probability of dropping out by 10%.[23]

The third column is the effect of a home price increase on college attendance. A $10,000 change in home price causes an increase in college going of 1.14 percentage points. This effect is statistically significant at the 10% level and the 95% confidence interval includes the effect size of 0.7 percentage points found by Lovenheim (2011). It is useful to establish that using my sample I replicate Lovenheim's result, because college affordability is a possible mechanism for the impact of home price on high school performance.

Results in Table 4 show that a positive shock to family resources while in high school increases the probability of earning a high school diploma. The role of family finances in educational attainment is not limited to the transition from high school to college.

[22]Some students who have not received a high school diploma by age 19 are not necessarily high school dropouts, but are still enrolled in high school.

[23]To ensure that results were not driven by the linear probability specification, these estimates were repeated in both a probit and a logit with similar results.

If these results are driven by an increase in college affordability I would also expect to see an increase in college preparation. Results in Table 5 provide evidence that students do respond to home price increases by completing a more rigorous curriculum. The response of a four year home price change in Equation 3 on various measures of curriculum completed is shown in Table 5. Positive home price shocks increase the probability of completing an Academic Specialist path, Academic Concentrator path, percent of new basic curriculum completed, and highest grade completed.[24]

The Academic Specialist path is a college preparatory curriculum.[25] A home price increase of $10,000 caused an increase of the probability of being an Academic Specialist of 0.89 percentage points. 39.7% of children from home owning households were Academic Specialists, so a mean change of home price during a youth's high school years caused a 7.4% increase in the probability of completing the Academic Specialist path. This result supports the theory that youth are preparing for college.

The Academic Concentrator path is similar, but less rigorous, than the Academic Specialist path. 50% of children in home owning families complete the requirements necessary to be denoted as an Academic Concentrator. A $10,000 home price increase leads to a 1 percentage point increase in the probability of completing the requirements. The average home price change led to a 6.5% increase in the probability of completing the requirements of an Academic Concentrator.

There are also statistically significant increases in the percent of the new basic

[24]See data section for definitions of dependent variables.

[25]Students must complete 4 credit hours of English, 3 credits of math (Algebra I or higher), 2 credits from Biology, Chemistry, and Physics; 2 social studies credits including world history, and 2 foreign language credits. These are the same credits recommended by the department of education's *Preparing Your Child For College: 2000 Edition.*

curriculum completed and highest grade completed. The magnitude of this effect is relatively small. The effect on high school grade point average is also positive but not statistically significant. The theoretical effects of home price changes on grades are ambiguous. Grade point average should be increasing in effort and decreasing in course difficulty. Additionally, grades are only observed for enrolled students. Marginal students remaining in school and students taking more difficult courses should decrease gpa, but students investing more in their high school education should increase their gpa.

Table 6 further examines the course taking effects of a home price change, by investigating the effect of a change in home price on types of course credits. Outcomes include math credits, science credits, academic math credits (pre-Algebra or higher), percent of credits in advanced courses, and cumulative credits. Students experiencing a positive home price shock take more math and science courses. Math credits are of particular interest. Several papers in the education literature (Goodman 2009, Rose and Betts 2004, Aughinbaugh 2012, Altonji 1995, and others) find that taking math courses in high school, particularly high level math courses, have higher returns than other coursework and increase the probability of attending college. A $10,000 shock to home prices causes an increase of 0.0235 math credits. The results for science courses are similar. The increase in math credits appears to be driven by students taking academic math (pre-Algebra or higher). The magnitude of the increase in academic math courses is larger than the magnitude of the increase for all math credits. This could either be caused by students that were dropping out now taking academic math or students that were already in school taking academic math in lieu

of basic math classes. A $10,000 home price increase led to a 0.0356 increase in academic math credits. Students are responding to home price increases by taking the classes which prepare them for college.

These findings show that an increase in family resources improves children's high school education, both in terms of quantity (dropout rates are lower) and quality (more academic-track courses are taken). While the decrease in high school dropout rate might be consistent with a story in which greater financial stability for the family frees up time for the student to complete high school, that would not necessarily involve a change in courses taken. A change in the expectation of ability to pay for college is consistent with greater high school completion and selection of college prep courses. Henry and Rubenstein (2002) and Bartik and Lachowska (2012) have also found, in the context of college scholarship programs, that greater college affordability improves high school performance. Since home price shocks were not merit-based or confined to a limited geographical area, I can further explore my results to find which students are responding.

1.5.2 Effects by Baseline Ability

The impact of family resources on high school performance is likely to have different effects by student academic ability. High performing students are unlikely to be on the margin of dropping out regardless of family resources, but lower ability students' dropout behavior may be sensitive to family resources. Course taking and performance may be driven by mid-level students trying to improve their college prospects, while the highest and lowest ability students may not adjust their behavior because

the top students are already taking the most rigorous courses and the bottom students may not have expectations of attending college regardless of parental resources. Because the housing boom generates shocks to families of all types, not only families of students with a particular ability level, it is possible to assess heterogeneous effects by baseline student ability. The baseline student ability measure I use is grades in 8th grade. I adjust Equation 3 to allow effects to differ by grades as follows:

$$\begin{aligned} Y_{i,c,m} = {} & \gamma_1(D/FStudent) * (\Delta HP_{i,c,m}) + \gamma_2(C's \text{ and } D's) * (\Delta HP_{i,c,m}) \\ & + \gamma_3(A's \text{ and/or } B's) * (\Delta HP_{i,c,m}) + \gamma_4(allA's) * (\Delta HP_{i,c,m}) \\ & + X\Pi + \omega_m + \psi_c + \epsilon_{i,c,m} \end{aligned} \quad \textbf{(4)}$$

The results from estimating Equation 4 are found on Table 7. Coefficients are plotted in Figure 2. The solid line indicates the estimates of home price effects on outcomes by eighth grade grades. The dashed lines are 95% confidence intervals. The students that performed the worst in 8th grade are the most affected by an increase in home price. Students who received D's and F's in eighth grade had a 1.64 percentage point increase in the probability of earning a high school diploma for a $10,000 increase in home price. Students that earned all A's did not have a statistically significant response to a home price change. High School completion and dropout rate effects are driven by students that performed poorly in eighth grade.

The estimated effects of home price changes on Academic Specialist are found in Column 3 of Table 7. These results are also driven by low level students, but students that reported A's and B's are also affected. A and B students could be preparing for college by fulfilling the Academic Specialist requirement. Results in

column 4 show that the probability of attending college is increased by all but the top students. Students that may not be helped by merit-based scholarships are responding to home price increases.

Results in Table 8 indicate the same pattern in course taking with the largest effects for low performing students. Column 1 shows that home price increases led to a statistically significant increase in the number of math courses taken for D/F students and A/B students. Similar results are found with science and academic math credits. All of the previously measured outcomes are estimated with equation 4 with similar results. [26] There is a consistent pattern of low performing students finishing high school and taking more difficult courses in response to a positive shock to family resources. This finding suggests that lack of family resources may be dampening the performance of some students in high school. Even students with low grades in eighth grade, who are typically at high risk to drop out of high school, can be induced to graduate high school when family resources are increased.

1.5.3 Effects by Race

The main findings of this paper are that a positive shock to housing wealth improves high school performance. In this section I explore whether the effects of housing wealth are heterogeneous by race. Blacks may face greater credit constraints than whites (Ross and Yinger (2002))[27] and loans secured by the house may be one of the only reliable ways for blacks to relax credit constraints. Thus, if the observed findings

[26] Any outcomes not found in tables 7 or 8 can be found in the appendix.

[27] Additional literature exists on credit constraints by race. For a thorough discussion see Ross and Yinger(2002)

are driven by a relaxation of credit constraints I might expect greater response from black students. The results of this subsection will show that increasing home price has a larger affect on high school completion for blacks. White students appear more responsive on the course taking margin but differences are not statistically significant. While average grades for black students are lower, I show that low performing blacks are not driving the observed racial differences. Even high performing black students respond on the drop out margin.

Table 9 reports the results of estimating Equation 3 separately for blacks and whites. [28] The positive effect of home price changes on earning a high school diploma are larger for black students. The mean change in home price among black students is $17,904 and the graduation rate of black students from home owning families is 80%. The increase in diploma completion rate from a $10,000 home price increase is 0.027. This is a 6% increase in high school completion among black students in response to a mean change in home price. A $10,000 home price change does not have a statistically significant impact on white students. The difference between coefficients is statistically significant. [29]

The effect of home prices on dropout rates is also larger for black students. Black students probability of dropping out is decreased by 0.016 by a $10,000 home price change. The dropout rate of blacks from home owning families is .135. This result

[28] The results for Hispanics and other races are not shown. Those samples are relatively small. Point estimates for Hispanic students are similar to those found for whites.

[29] The 95% confidence interval for black students ranges from 0.011 to 0.044. For white students, the same confidence interval ranges from -0.001 to 0.008.

constitutes a 20% reduction in dropout rate for black students. The dropout coefficient for the black group is larger, but not statistically different from the coefficient found for white students.

I repeat all of the previous estimates separately for blacks and whites. Tables 10 and 11 show the effect of home price changes on course taking. Course selection of black students does not appear to be affected by home price changes. Standard errors on estimates for black students are relatively large. The point estimate on the probability of completing the Academic Specialist path is negative and not statistically significant. The estimates for whites are similar to the results for the entire sample. White students are likely to complete a college prep curriculum in response to family resource shocks but the differences are not statistically significant. The sample for black students is about one fourth the size of the sample for whites and standard errors are relatively large.

The effect of housing shocks by baseline ability for black students are shown in Table 12. Estimates for white students are similar to the whole sample and are reported in the appendix. Columns 1 and 2 show that black students of all ability levels are affected by family resources on the dropout margin. Even high performing students are affected by a shock to family resources.

To summarize, I find that housing price shocks affects both blacks and whites but in different ways. First, only blacks have a statistically significant response on the margin of high school dropout, with a $17,904 change reducing the probability of dropping out by 21%. The impact on dropout probability for the overall sample in section 4.1 is driven by the impacts on blacks. Second, whites are more responsive

on the margin of course-taking although the difference is not statistically significant. Black dropout rates are higher than whites and black families tend to be poorer on average. The marginal black student therefore differs from the marginal white student and it appears from these results that, as far as the high school dropout decision is concerned, white students on the margin of dropping out are driven by other reasons besides family resources.[30]

1.5.4 Robustness

The estimates presented in the previous sections consistently show that youth experiencing a family housing wealth shock are more likely to finish high school, more likely to take college preparatory curriculum, and complete more math and science courses. One possible concern is that other MSA/time level variations may be driving the results. For example, school funding is increased, leading to better schools and higher real estate prices. In this section, I will show that non-home owning students are not affected by increases in MSA level home prices. The effects of home price changes on secondary education outcomes were estimated in a linear specification. In this section, I show that results are robust several alternative specifications.

The restricted data from the NLSY97 allows me to match youth from non-home owning families to the Freddie Mac home price index within their MSA. I estimate Equation 3 for students in non-home owning families, replacing change in home price

[30]Additional estimates by household income quadrant and mother's education have also been estimated. There are not statistically significant differences by mother's education. The results by income level are similar to comparing whites to blacks. However, splitting by race and income level shows that differences by income level are driven by race.

with change in Freddie Mac Home Price Index. The results are found in table 13. The Home Price Index change does not have a statistically significant affect on high school completion or curriculum completion variables. For all but the Academic Specialist curriculum, the point estimates indicate worse outcomes for students from non-home owning families. This implies that non other MSA/time level variation is biasing my results.

Possible mechanisms through which home price changes affect high school outcomes include wealth effects and alleviation of credit constraints. In both of these mechanisms, it is intuitive that high school outcomes are a concave function of home price changes. The first $10,000 in home price changes may be just enough to cover tuition. A family experiencing a relatively large increase of $90,000 would already be in position to use equity to pay for college and an additional $10,000 change would have a smaller effect. I allow equation 3 to have a more flexible functional form by including squared and cubed terms:[31]

$$Y_{i,c,m} = \beta_1 \Delta HP_{i,c,m} + \beta_2 \Delta HP^2_{i,c,m} + \beta_3 \Delta HP^3_{i,c,m} + X\Pi + \omega_m + \psi_c + \epsilon \qquad \textbf{(5)}$$

In Equation 5 the marginal effect of a $10,000 change in home price is $\beta_1 + 2\beta_2 \Delta HP_{i,c,m} + 3\beta_3 \Delta HP^2_{i,c,m}$. Table 14 shows results from estimating Equation 5 on high school completion, high school dropout, and completion of the academic specialist curriculum. As expected β_1 is positive and β_2 is negative. The estimation results show that completing a high school diploma is a concave function of home

[31] Additional specifications were performed with larger degree polynomials. Results consistently showed high school outcomes as a concave function of home price changes and polynomials of power higher than 3 were seldom statistically significant.

price changes in the range $(-\infty, 10.79)$. This range includes 94.7% of observations. Students respond more to the first $10,000 change than an increase in home price change from $90,000 to $100,000. For example, the home price change at the 25th percentile is $9,071. The marginal effect of home price increases at the 25th percentile is 0.0197, indicating that a $10,000 increase in home price for a student at the 25th percentile in home price changes would increase the probability of completing high school by 1.97 percentage points. At the 75th percentile the home price increase is $37,424. The marginal effect of a $10,000 home price increase at the seventy fifth percentile is 0.0124, indicating that a $10,000 home price increase would increases the probability of completing high school by 1.24 percentage points. Estimates of the probability of completing an academic specialist curriculum in column 3 have a similar pattern where β_1 is positive and β_2 is negative. Column 2 shows the effect of home price changes on the probability of dropping out of high school. Again, the effect is the largest when the home price change is smallest.

Equation 5 was also estimated for credits and college attendance. Those results are shown in Table 15. Estimates of Equation 5 show a consistent pattern of concave effects (for most ranges of home price changes). A $10,000 change in home price has the largest effect on the probability of completing high school or a college preparatory curriculum at lower levels.

The completion of a high school diploma by age 19 is a binary outcome and 87% of the children in home owning families have completed their high school diploma. Linear probability models can provide inaccurate estimations, particularly when the mean outcome is near 0 or 1. To alleviate this concern, Equation 3 was estimated

via probit and logit. The probit and logit estimations assume a latent variable Y^* where:

$$Y^* = \beta(\Delta HP_{i,c,m}) + X\Pi + \omega_m + \psi_c + \epsilon_{i,c,m} \qquad \textbf{(6)}$$

$$\begin{cases} Y_{i,c,m} = 1 \quad if\ Y^* > 0 \\ Y_{i,c,m} = 0 \quad if\ Y^* \leq 0 \end{cases}$$

The probit estimation assumes Y^* is distributed normally, while the logit assumes logistic distribution.

Coefficients from Equation 6 are not meaningful, so the marginal effects from the probit estimation calculated at the mean of all independent variables is shown in Table 16.[32] At the mean home value change, a $10,000 price increase in home value increases the probability of completing a high school diploma by 0.009 and decreases the probability of dropping out by 0.006. Increases in home price also increase the probability of completing the academic specialist curriculum and attending college by age 20. Each marginal effect displayed in table 16 is statistically significant and consistent with the results found in the linear probability model.

Table 17 displays marginal effects from the logit estimation. [33] Logit estimates are also consistent with the linear probability model. At the mean home price change, a $10,000 home price change increase will raise the probability of completing high

[32]Marginal effects from the probit are calculated as: $\frac{\delta E[Y_{i,c,m}|\bar{X}]}{\delta \Delta HP} = \phi(\beta'\bar{X})\beta$, where $\bar{X}$ is the mean value of each x and β is from Equation 6.

[33]Marginal estimates for logits are estimated as $\frac{\delta E[Y_{i,c,m}|\bar{X}]}{\delta \Delta HP} = \Lambda(\beta'\bar{X})[1 - \Lambda(\beta'\bar{X})]\beta$, where $\bar{X}$ is the mean value of each x and β is from Equation 6.

school by 0.009 and decrease the probability of dropping out of high school by 0.006. All outcomes have statistically significant responses with the expected sign.

Additional specifications including log home price changes and panel regressions with individual fixed effects are also consistent with previously reported results. These estimates can be found in the appendix.

Several specifications have been used to test the effect of home price changes on secondary education outcomes and the results are consistent. An increase in family home price increases the probability that a student will graduate high school and increases the probability that student will complete a college preparatory curriculum.

1.6 Conclusion

Family resources influence high school education on both the intensive and extensive margins. Students experiencing a positive shock to family home value are more likely to complete their high school diploma and take more difficult courses in the process. Students whose parents own their home are 1.5% more likely to earn a high school diploma when they experience an average home price shock of $32,790 during the housing boom. The dropout rate is decreased by 10% for the same shock. Students experiencing the $32,790 home price increase were also 7.1% more likely to complete a college preparatory curriculum and completed more math and science courses. These results are consistent with an increase in college affordability, and therefore greater expectations of attending high school for credit constrained families, significantly improving high school performance.

I find largest change in high school performance among students with low baseline academic performance. On average, a positive shock to housing wealth increases high school completion for students on the low end of the baseline academic performance distribution and raises rigor of courses taken for students at the middle and low end. High performing students are not affected, which is not surprising since they are typically not on the margin of dropping out and they are already taking academic-track courses. These previously low performing students are also driving the increased college attendance that was shown in previous literature (Lovenheim 2011 and Lovenheim and Reynolds 2013).

I find that the effects are especially pronounced for black students. The increase in high school completion in the overall sample is primarily driven by blacks. The effect of a home price shock on white students does not have a statistically significant effect on high school completion. The shift to more rigorous course taking is driven by white students. The black-white education gap has been a subject of considerable attention by academics and policymakers, and this paper shows that family resources have a causal role to play. Positive shocks to family resources decrease the high school dropout rate of blacks but not for whites, which could explain part of the racial education gap.

The impact of family resources on educational attainment is not limited to the transition from high school to college. This paper shows that family resources are an important factor in high school completion and course taking. Policies that increase the affordability of college could raise educational attainment and reduce educational inequality. Merit-based scholarship programs, while increasing college affordability

for higher performing students, may miss the gains from raising opportunity to attend college for weaker students. Student effort responds to opportunity, and low grades may partly be a response to a low perception of opportunity, so it is important to not count weaker students out when thinking about policies to reduce high school dropout and raise college-going.

1.7 Tables

Table 1.1: Summary Statistics: Control Variables

	All	Children of Home Owners	Children of Non-Owners
Household Income 1997	56020.3	68315.3	30572.5
	(47588.4)	(49259.3)	(31143.1)
Eighth Grade At Least Half D's	0.126	0.0973	0.186
	(0.332)	(0.296)	(0.389)
Eighth Grade No D's some C's	0.348	0.314	0.417
	(0.476)	(0.464)	(0.493)
Eighth Grade A's and or B's	0.359	0.389	0.297
	(0.480)	(0.488)	(0.457)
Eighth Grade All A's	0.158	0.192	0.0890
	(0.365)	(0.394)	(0.285)
Mother Less Than HS Diploma	0.135	0.0786	0.251
	(0.341)	(0.269)	(0.433)
Mother HS Diploma	0.492	0.481	0.514
	(0.500)	(0.500)	(0.500)
Mother Associates Degree	0.119	0.127	0.103
	(0.324)	(0.333)	(0.305)
Mother Bachelor's Degree	0.254	0.313	0.132
	(0.435)	(0.464)	(0.339)
Father Less Than HS Diploma	0.158	0.0986	0.281
	(0.365)	(0.298)	(0.450)
Father HS Diploma	0.478	0.465	0.504
	(0.500)	(0.499)	(0.500)
Father Associates Degree	0.0844	0.0932	0.0663
	(0.278)	(0.291)	(0.249)
Father Bachelor's Degree	0.280	0.344	0.149
	(0.449)	(0.475)	(0.356)
Female	0.479	0.473	0.493
	(0.500)	(0.499)	(0.500)
Black	0.165	0.102	0.295
	(0.371)	(0.302)	(0.456)
Hispanic	0.150	0.110	0.231
	(0.357)	(0.313)	(0.422)
Mixed Race	0.0119	0.0119	0.0119
	(0.108)	(0.108)	(0.108)
White	0.674	0.776	0.461
	(0.469)	(0.417)	(0.499)
MSA Fair Market Rent 1997	1208.3	1185.7	1255.1
	(291.7)	(287.2)	(295.5)
Observations	5961	3579	2382

Means are displayed. Standard errors are in parentheses. Summary statistics are weighted using NLSY97 custom weights.

Table 1.2: Summary Statistics: Outcome Variables

	All	Home Owners	Non-Owners
Has HS Diploma at 19	0.789	0.871	0.617
	(0.408)	(0.335)	(0.486)
	[5268]	[3181]	[2087]
Has Dropped Out at 19	0.165	0.0983	0.304
	(0.371)	(0.298)	(0.460)
	[5268]	[3181]	[2087]
Enrolled in College by 20	0.586	0.681	0.382
	(0.493)	(0.466)	(0.486)
	[5337]	[3238]	[2099]
Academic Specialist	0.358	0.423	0.201
	(0.479)	(0.494)	(0.401)
	[3873]	[2468]	[1405]
Academic Concentrator	0.456	0.525	0.290
	(0.498)	(0.499)	(0.454)
	[3798]	[2428]	[1370]
Total Math Credits	3.084	3.251	2.669
	(1.207)	(1.092)	(1.370)
	[3932]	[2545]	[1387]
Academic Math Credits	2.885	3.068	2.396
	(1.276)	(1.190)	(1.368)
	[3641]	[2425]	[1216]
Total Science Credits	2.780	2.969	2.301
	(1.208)	(1.136)	(1.252)
	[3874]	[2527]	[1347]
Percent of New Basic Requirements Fulfilled	82.18	87.08	70.48
	(26.31)	(21.04)	(33.07)
	[4060]	[2580]	[1480]
Cumulative Credits at 19	19.27	20.62	16.06
	(7.024)	(5.836)	(8.431)
	[4061]	[2580]	[1481]
Total GPA	2.882	2.967	2.669
	(0.610)	(0.589)	(0.610)
	[3925]	[2546]	[1379]

Means are displayed. Standard errors are in parenthesis. Observations are in brackets. Summary statistics are weighted using NLSY97 custom weights.

Table 1.3: Home Price Variance

	Mean	Standard Deviation	Mean Standard Deviation Within MSA	Mean Standard Deviation Within Cohort
1997 Home Price ($10,000)	12.57	8.65	6.57	8.648
4 Year Δ HP at 18	3.279	4.350	2.444	3.756
2 Year Δ HP at 16	1.235	1.898	1.126	1.516
2 Year Δ HP at 18	2.044	2.660	1.409	2.436
4 Year Δ HPI at 18	1.846	1.090	0.687	0.814

There are 5961 observations for all variables referring to home price index (HPI) and 3569 for all variables referring to housing price (HP).

Table 1.4: Effect of Home Price Changes on High School Completion and College Attendance

	H.S. Diploma at 19	H.S. Dropout at 19	Attend College by 20
4 Year Δ HP at 18	0.00401**	-0.00303*	0.0114***
	(0.00178)	(0.00154)	(0.00265)
Log HH Income at 18	0.00300	-0.00250	0.0100***
	(0.00264)	(0.00236)	(0.00272)
Eighth Grade At Least Half D's	-0.219**	0.186**	-0.262**
	(0.101)	(0.0873)	(0.110)
Eighth Grade No D's some C's	0.0515	-0.0431	0.00202
	(0.0996)	(0.0857)	(0.113)
Eighth Grade A's and B's	0.156	-0.128	0.201*
	(0.0979)	(0.0855)	(0.113)
Eighth Grade All A's	0.176*	-0.134	0.320***
	(0.0973)	(0.0855)	(0.115)
Mother HS Diploma	0.185***	-0.167***	0.0897**
	(0.0362)	(0.0376)	(0.0409)
Mother Associate's Degree	0.185***	-0.165***	0.166***
	(0.0377)	(0.0382)	(0.0490)
Mother Bachelor's Degree	0.189***	-0.168***	0.171***
	(0.0387)	(0.0396)	(0.0458)
Father HS Diploma	0.0534**	-0.0438	0.0949***
	(0.0259)	(0.0300)	(0.0293)
Father Associate's Degree	0.0889***	-0.0717**	0.183***
	(0.0304)	(0.0349)	(0.0395)
Father Bachelor's Degree	0.109***	-0.0930***	0.224***
	(0.0283)	(0.0303)	(0.0322)
Female	0.0336***	-0.0250**	0.0705***
	(0.0118)	(0.0109)	(0.0144)
Black	0.0123	-0.0376**	0.0430*
	(0.0187)	(0.0175)	(0.0258)
Hispanic	-0.00469	-0.0152	-0.0441
	(0.0253)	(0.0246)	(0.0343)
Mixed Race	0.0425	-0.0418	0.00136
	(0.0569)	(0.0556)	(0.0932)
4 Year Δ Fair Rent *100	-0.00338	0.00419	-0.0115*
	(0.00374)	(0.00357)	(0.00654)
Born 1980	0.0217	-0.0163	0.00686
	(0.0193)	(0.0196)	(0.0283)
Born 1981	0.0169	-0.00845	0.0767***
	(0.0218)	(0.0208)	(0.0272)
Born 1982	0.00169	-0.0131	0.00851
	(0.0191)	(0.0180)	(0.0261)
Born 1983	-0.0232	0.0206	-0.0288
	(0.0195)	(0.0188)	(0.0251)
Observations	3124	3124	3179

Standard errors are in parentheses.
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$
Each regression includes MSA fixed effects. Robust errors are clustered at the MSA level. All regressions are weighted using the NLSY97 custom weights. The omitted category for eighth grade grades is "other". Parent's education dummies are relative to no high school diploma, and white is the omitted race variable.

Table 1.5: Effect of Home Price Changes on Course Taking and Performance

	Academic Specialist	Academic Concentrator	% New Basic Curriculum by 19	Highest Grade Completed at 19	H.S. GPA
4 Year Δ HP at 18	0.0089***	0.0104**	0.2260*	0.0100*	0.00149
	(0.0026)	(0.0047)	(0.1380)	(0.0061)	(0.0038)
N	2426	2387	2537	3108	2504
Dependent Variable Mean	0.3957	0.5006	85.846	12.108	2.921

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression includes controls for grades in eighth grade, household income, parent's education, race, cohort fixed effects, sex, and MSA fixed effects. Robust errors are clustered at the MSA level. All regressions are weighted using the NLSY97 custom weights.

Table 1.6: Effect of Home Price Changes on Credits Earned

	Math Credits	Science Credits	Academic Math Credits	% Credits Advanced	Cumulative Credits at 19
4 Year Δ HP at 18	0.0235***	0.0190**	0.0356***	0.0195	0.0486
	(0.0074)	(0.0077)	(0.0106)	(0.0564)	(0.0336)
N	2502	2486	2384	2502	2537
Dependent Variable Mean	3.214	2.8934	3.007	7.242	20.25

Standard errors are in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression includes controls for grades in eighth grade, household income, parent's education, race, cohort fixed effects, sex, and MSA fixed effects. Robust errors are clustered at the MSA level. All regressions are weighted using the NLSY97 custom weights.

Table 1.7: Effects by Grades in 8th Grade

	H.S. Diploma at 19	H.S. Dropout at 19	Academic Specialist	Ever College at 20
D's and F's * Δ HP	0.0164***	-0.0125**	0.0255***	0.0245***
	(0.0056)	(0.0050)	(0.0041)	(0.0047)
No D's some C's * Δ HP	0.0064**	-0.0048**	0.0079**	0.0189***
	(0.0028)	(0.0023)	(0.0037)	(0.0040)
B's and Some A's * Δ HP	0.0012	-0.0004	0.0094**	0.0106***
	(0.0017)	(0.0013)	(0.0043)	(0.0027)
All A's * Δ HP	0.0009	-0.0011	0.0029	0.0035
	(0.0018)	(0.0016)	(0.0058)	(0.0035)
Observations	3102	3102	2412	3157

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.8: Effects of Home Price Changes on Courses Taken by Grades in Eighth Grade

	Math Credits	Science Credits	Academic Math Credits	Percent Advanced Credits
D's and F's * Δ HP	0.0874***	0.0536***	0.1000***	-0.0189
	(0.0172)	(0.0183)	(0.0206)	(0.1180)
No D's some C's * Δ HP	0.0071	0.0236	0.0087	-0.0330
	(0.0183)	(0.0162)	(0.0185)	(0.0845)
B's and Some A's * Δ HP	0.0278***	0.0216**	0.0415***	0.0976
	(0.0077)	(0.0083)	(0.0116)	(0.0792)
All A's * Δ HP	-0.0008	0.0020	0.0132	-0.0546
	(0.0105)	(0.0136)	(0.0123)	(0.1400)
Observations	2489	2473	2371	2489

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.9: Home Price Change Effects on High School Completion by Race

	Black H.S. Diploma at 19	Black Dropout at 19	White H.S. Diploma at 19	White Dropout at 19
4 Year Δ HP at 18	0.0271***	-0.0160**	0.0037	-0.0026
	(0.0082)	(0.0078)	(0.0023)	(0.0019)
Log HH Income	0.0056	-0.0039	0.0010	-0.0015
	(0.0057)	(0.0050)	(0.0035)	(0.0032)
At Least Half D's	0.360	-0.0182	-0.328**	0.244**
	(0.290)	(0.230)	(0.124)	(0.122)
No D's some C's	0.633**	-0.227	-0.0629	0.0264
	(0.280)	(0.216)	(0.122)	(0.119)
B's and Some A's	0.710**	-0.268	0.0521	-0.0675
	(0.281)	(0.218)	(0.121)	(0.119)
Mostly A's	0.714**	-0.255	0.0705	-0.0741
	(0.279)	(0.219)	(0.121)	(0.119)
Mother HS Diploma	0.103	-0.127	0.242***	-0.220***
	(0.0778)	(0.0783)	(0.0590)	(0.0591)
Mother Associate's Degree	0.205**	-0.186**	0.232***	-0.213***
	(0.0812)	(0.0778)	(0.0607)	(0.0596)
Mother Bachelor's Degree	0.112	-0.123	0.243***	-0.218***
	(0.102)	(0.0917)	(0.0618)	(0.0616)
Father HS Diploma	0.122*	-0.0907	0.0141	-0.0250
	(0.0681)	(0.0725)	(0.0403)	(0.0461)
Father Associate's Degree	0.111	-0.0145	0.0573	-0.0654
	(0.0792)	(0.0852)	(0.0420)	(0.0510)
Father Bachelor's Degree	0.200***	-0.136	0.0682*	-0.0734
	(0.0748)	(0.0827)	(0.0390)	(0.0452)
4 Year Δ FMR * 100 at 18	-0.0154	0.0155	-0.00581	0.00420
	(0.0255)	(0.0183)	(0.00434)	(0.00385)
Observations	589	589	1919	1919

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression also includes MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.10: Effects on Course Taking for Blacks

	Academic Specialist	Academic Concentrator	% New Basic Curriculum by 19	High Grade at 19	Total GPA
4 Year Δ HP at 18	-0.0129	-0.00220	0.0762	0.0316	-0.0309*
	(0.0108)	(0.0146)	(0.786)	(0.0201)	(0.0167)
Observations	450	443	470	586	451
	Math Credits	Science Credits	Academic Math Credits	% Advanced % AdvancedCredits	Cumulative Credits
4 Year Δ HP at 18	0.0101	-0.0351	0.0816*	-0.481	-0.0311
	(0.0539)	(0.0571)	(0.0485)	(0.339)	(0.199)
Observations	454	452	434	451	470

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.11: Effects on Course Taking for Whites

	Academic Specialist	Academic Concentrator	% New Basic Curriculum by 19	High Grade at 19	Total GPA
4 Year Δ HP at 18	0.0097***	0.0088*	0.190	0.0108	0.0033
	(0.0028)	(0.0048)	(0.153)	(0.0074)	(0.0047)
Observations	1515	1488	1594	1912	1590
	Math Credits	Science Credits	Academic Math Credits	% Advanced Credits	Cumulative Credits
4 Year Δ HP at 18	0.0227***	0.0185**	0.0309***	0.0033	0.0398
	(0.0078)	(0.0090)	(0.0103)	(0.0650)	(0.0358)
Observations	1583	1576	1519	1588	1595

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.12: Effects on Blacks by Grades in Eighth Grade

	H.S. Diploma at 19	H.S. Dropout at 19	Academic Specialist	Ever College at 20
D's and F's * Δ HP	0.0316	0.0019	-0.0582**	-0.0577***
	(0.0284)	(0.0256)	(0.0221)	(0.0205)
No D's some C's * Δ HP	0.0226***	-0.0154*	-0.0125	0.0048
	(0.0083)	(0.0089)	(0.0107)	(0.0158)
B's and Some A's * Δ HP	0.0180	-0.0010	-0.0245	0.0002
	(0.0122)	(0.0097)	(0.0255)	(0.0155)
All A's * Δ HP	0.0270*	-0.0180*	-0.0222	-0.0056
	(0.0141)	(0.0092)	(0.0153)	(0.0123)
Observations	585	585	448	587

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.13: Effects of Home Price Index Changes on Students From Non-Home Owning Families

	H.S. Diploma at 19	H.S. Dropout at 19	Academic Specialist	Academic Concentrator	Math Credits
4 Year Δ HPI at 18	-0.00438	0.00731	0.00690	-.015213	-.0451568
	(0.0229)	(0.0218)	(0.0185)	(.0184021)	(.0641752)
Observations	2087	2087	1405	1370	1387

Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.14: Effects of Home Price Changes Squared and Cubed

	H.S. Diploma at 19	H.S. Dropout at 19	Academic Specialist
4 Year Δ HP at 18	0.0223 ***	-0.0116 *	0.0117
	(0.00696)	(0.00605)	(0.0138)
ΔHP^2	-0.00147 ***	0.000708 *	-0.000138
	(0.000526)	(0.000416)	(0.00110)
ΔHP^3	0.0000270 **	-0.0000134	0.000000805
	(0.0000110)	(0.00000826)	(0.0000208)
Observations	3124	3124	2426

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.15: Effects of Home Price Changes Squared and Cubed

	Math Credits	Science Credits	Academic Math Credits	Attended College by 20
4 Year Δ HP at 18	0.0590 **	0.0246	0.0959 ***	0.0327 ***
	(0.0257)	(0.0261)	(0.0327)	(0.0108)
ΔHP^2	-0.00380 *	-0.000995	-0.00577 **	-0.00180 **
	(0.00215)	(0.00198)	(0.00249)	(0.000804)
ΔHP^3	0.0000895 *	0.0000298	0.000126 **	0.0000352 **
	(0.0000472)	(0.0000399)	(0.0000533)	(0.0000163)
Observations	2502	2486	2384	3179

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.16: Marginal Effects of Probit

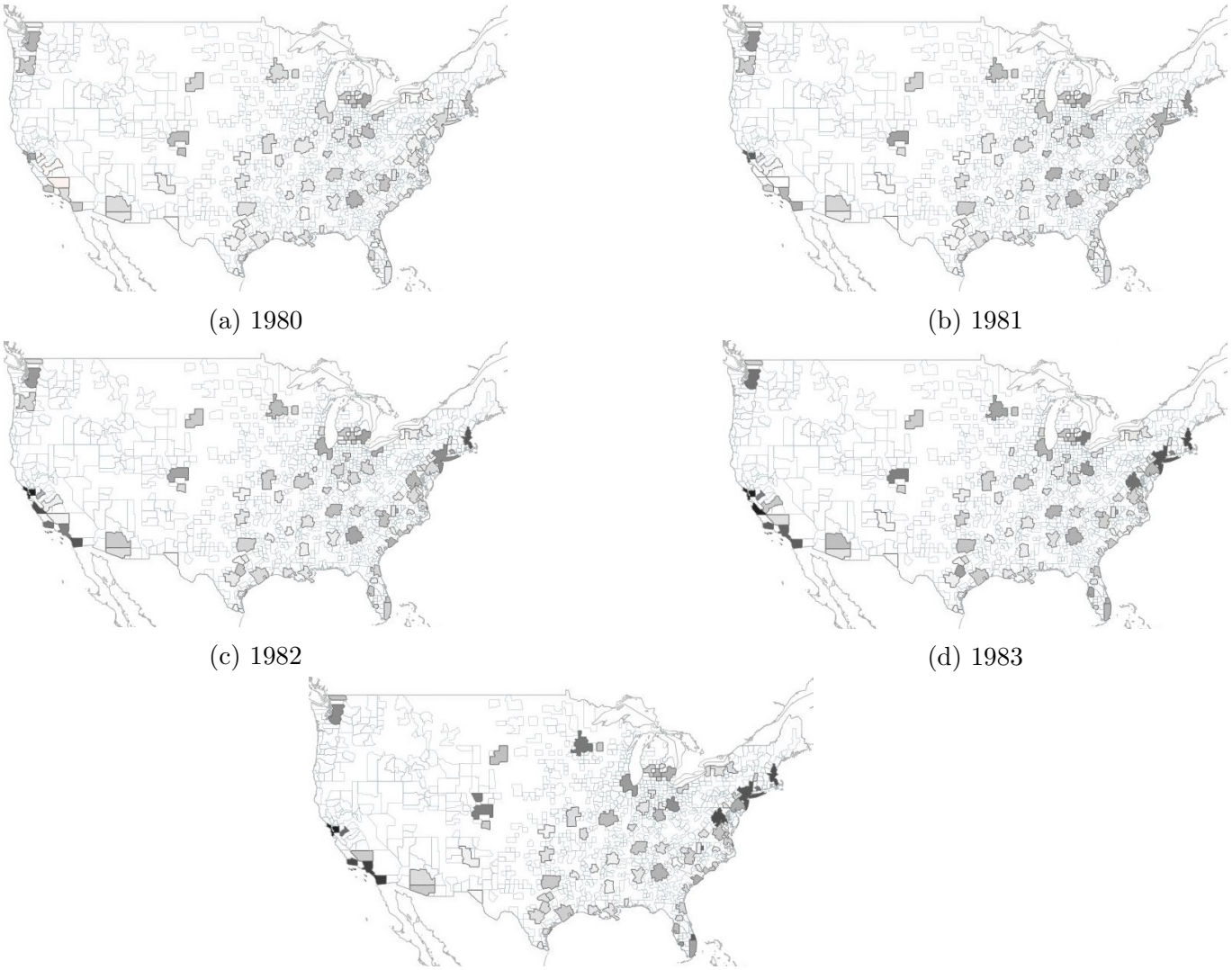
	H.S. Diploma by 19	H.S. Dropout at 19	Academic Specialist	Attend College by 20	Academic Concentrator
4 Year Δ HP at 18	0.00901 **	-0.00627 **	0.00863 ***	0.0185 ***	0.0103 **
	(0.00379)	(0.00298)	(0.00271)	(0.00408)	(0.00477)
Observations	3067	3004	2409	3167	2362

Robust standard errors clustered at MSA level are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.17: Marginal Effects of Logit

	H.S. Diploma by 19	H.S. Dropout at 19	Academic Specialist	Attend College by 20	Academic Concentrator
4 Year Δ HP at 18	0.00886 **	-0.00562 *	0.00889 ***	0.0190 ***	0.0110 **
	(0.00397)	(0.00308)	(0.00275)	(0.00436)	(0.00513)
Observations	3067	3004	2409	3167	2362

Robust standard errors clustered at MSA level are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



(a) 1980

(b) 1981

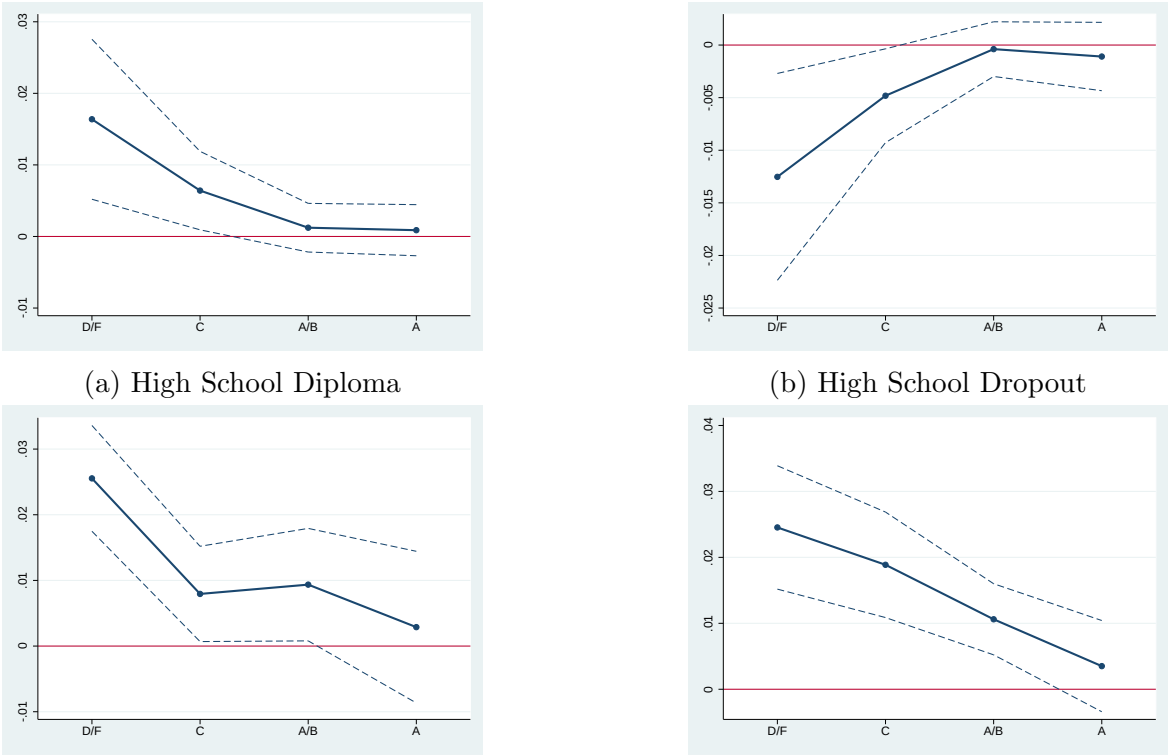
(c) 1982

(d) 1983

(e) 1984

Figure 1.1: Four Year Home Price Changes by Birth Cohort
Darker areas indicate larger change

1.8 Figures



(a) High School Diploma

(b) High School Dropout

(c) Academic Specialist

(d) Ever Attend College

Figure 1.2: Effects of Home Price Changes by Grades in Eighth Grade

1.9 Appendix

1.9.1 Data

Respondents must answer questions on home ownership and live in a defined MSA to be included in my work. There are 6,019 youths which answered the home ownership question and lived in an MSA. Of those 3,621 were members of home owning families, while 2.398 were members of non- home owning families. 3,511 individuals gave home price information. The data does provide a rich set of controls, but several of these controls are missing as well. For example, 11% of respondents are missing their father's education level. Several respondents are missing the ASVAB score and household income as well. Additionally, only 70% of the transcripts were acquired.

Following Lovenheim and Reynolds, I use the multiple imputation by chained equations (MICE) originally developed by Van Buren, Boshuizen, and Knook (1999). Like Lovenheim and Reynolds, I utilized the STATA module ICE (Royston 2004). First each missing data point is randomly filled using the distribution of existing data. Next each variable is estimated using all available data. OLS is used for continuous variables, while an ordinal logit estimates categorical variables. Data points that were originally missing are replaced by their predicted values from estimation. Then the process is repeated. This process is completed ten times. Following Loveheim and Reynolds (2013). Data is only imputed for control variables. Outcomes and housing prices are not used in the imputation process.

Outcome variables were not imputed, so there is a concern that missing data could influence results. Appendix table 1 shows that home price changes are uncorrelated

with missing data. Equation 3 was estimated with a dummy variable for missing as the independent variable. For example, column one shows the effect of home price on the probability that high school completion data is unavailable for a student. Home price changes are not correlated with any missing data.

1.9.2 Individual Fixed Effects Estimations

The longitudinal aspect of the NLSY97 allows for specifications with individual fixed effects. Including individual fixed effects controls for any time invariant factors, such as ability or parent's involvement in education. Many outcomes cannot be measured on a yearly basis. For example, the Academic Specialist track is a cumulative group of courses, there is not a logical way to divide it across years.

The sample for the panel regressions includes all youths that are under 20 years old and have yet to complete a high school diploma. After they complete their diploma or turn 20 they move out of the sample. This creates an unbalanced sample, but I cannot estimate high school outcomes for those that have completed high school. I estimate the following equation:

$$Y_{i,m,t} = \alpha + \beta \Delta HPi, m, t + X_{i,m,t}\Pi + \psi_c + \delta_i + \epsilon_{i,t} \quad \textbf{(8)}$$

where δ_i is the individual fixed effect, ψ_c is a cohort fixed effect, and $X_{i,h,t}$ includes family income and fair market rent. $\Delta HPi, m, t$ is the yearly home price in \$10,000 increments and β represents the student response to a contemporaneous home price change. Table 3 reports the results of estimating equation 7 on the probability of advancing a grade in a given year and credits acquired in a given year. Column 1

shows that even with the inclusion of individual fixed effects a $10,000 home price increase raises the probability of completing a grade by 0.007.

A remaining concern, even with individual fixed effects, is the possibility of some MSA-level change that occurs concurrently with home price shocks. For example, as housing prices are increase, tax revenue increases, which improves school quality. To address this possibility, I add non-home owners to the analysis. These students are subject to these same MSA-time changes, but do not experience changes in housing wealth because their family does not own a home. As such they can be used to control for MSA-time effects that do not operate through housing wealth. To do this, I perform the following difference-in-differences estimation (including the individual FE to control for individual time-invariant characteristics):

$$Y_{i,m,t} = \alpha + \beta_1 HPI_{m,t} * Own_i + \beta_2 HPI_{m,t} + X_{i,m,t}\Pi + \psi_c + \delta_i + \epsilon_{i,t} \quad \textbf{(8)}$$

Equation 8 uses the individual fixed effects specification to identify the difference in treatment for non-home owners and home owners. β_1 is the difference in the effect of a change in home price for home owners and non-home owners. This estimation loses a great deal of home price variation for home owners. The only within MSA variation from earlier estimates comes from initial home prices. Since non-home owners do not have a home price, all variation is within MSA and across cohort or within cohort and across MSA.

Results are shown in Table 4. Consistent with home price shocks having a positive effect on home owners MSA level home price increases have a relatively larger effect on earning a high school diploma and advancing a grade. The β_2 coefficient is

the mean effect of home price index increases for the non-home owning population. Results in Table 14 indicate that increases in home prices, lower MSA-level high school completion for non-home owners. This result is consistent with recent work by Charles et al (2014), who argue that marginal students left school to pursue construction jobs in MSAs experiencing housing booms.

Table 1.1: The Effect of Home Price Increases on Probability of Data Missing

	H.S. Diploma at 19	H.S. Dropout at 19	Academic Specialist	Academic Concentrator	Percent New Basic	Hi Grade at 19
4 Year Δ HP at 18	0.00279	0.00279	-0.000791	-0.00283	-0.000726	0.00221
	(0.00280)	(0.00280)	(0.00391)	(0.00394)	(0.00388)	(0.00272)
N	3511	3511	3511	3511	3511	3511
	Attend College by 20	Math Credits	Science Credits	Academic Credits	Percent Adv. Credits	Total GPA
4 Year Δ HP at 18	0.00212	-0.000192	-0.00128	0.0000465	-0.00103	-0.00137
	(0.00235)	(0.00349)	(0.00363)	(0.00310)	(0.00362)	(0.00372)
N	3511	3511	3511	3511	3511	3511

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

1.10 Appendix Tables

Table 1.2: Longitudinal Summary Statistics for Individuals under 20 Without a HS Diploma in Previous Year

	All	home owners	Non- home owners
Acquired H.S. Diploma	0.222	0.250	0.166
	(0.416)	(0.433)	(0.372)
Dropped Out	0.116	0.0746	0.198
	(0.320)	(0.263)	(0.398)
Advanced at least 1 Grade	0.883	0.928	0.793
	(0.322)	(0.259)	(0.405)
Newly Acquired Credits	4.697	5.068	3.854
	(2.345)	(2.047)	(2.731)
GPA for Year	2.857	2.964	2.585
	(0.805)	(0.733)	(0.910)
Percent of New Basic Requirements Added	17.48	18.63	14.87
	(12.04)	(11.64)	(12.53)
Math Credits	0.686	0.713	0.621
	(0.523)	(0.507)	(0.558)
Science Credits	0.619	0.655	0.531
	(0.547)	(0.546)	(0.539)
Academic Math Credits	0.642	0.671	0.556
	(0.520)	(0.510)	(0.537)
Academic Science Credits	0.571	0.610	0.468
	(0.545)	(0.547)	(0.526)

Means are shown with standard errors in parentheses.
Summary Statistics are weighted using the NLSY97 custom weights.

Table 1.3: Panel Regressions with Individual Fixed Effects

	Advanced a Grade	Credits Acquired in Year
Home Price	0.0074***	0.0182
	(0.0016)	(0.0184)
Observations	10777	6221

Table 1.4: Effects of Housing Price Shocks for home owners Relative to Non-Owners on School Advancement

	Advanced a Grade	Credits Acquired for Year
HPI*Own	0.0639***	-0.0767
	(0.0060)	(0.0637)
HPI	-0.0449***	0.0390
	(0.0077)	(0.0836)
Observations	18588	10120

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression includes controls for household income, fair market rent, age fixed effects and year fixed effects. All regressions are weighted using the NLSY97 custom weights.

Table 1.5: Effects on Blacks Course Taking by Grades in Eighth Grade

	Math Credits	Science Credits	Academic Math Credits	Percent Advanced Credits
D's and F's * Δ HP	0.0428	-0.0553	0.0399	0.584
	(0.110)	(0.0579)	(0.0948)	(0.393)
No D's some C's * Δ HP	-0.0146	-0.0403	0.0734	-0.290
	(0.0725)	(0.0658)	(0.0463)	(0.280)
B's and Some A's * Δ HP	0.0568	-0.104**	0.0847	-2.032***
	(0.0560)	(0.0430)	(0.0699)	(0.525)
All A's * Δ HP	0.0394	-0.00607	0.0796	-1.386**
	(0.0816)	(0.0719)	(0.0832)	(0.554)
Observations	452	450	432	449

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.6: Effects by Grades in 8th Grade White Students

	H.S. Diploma at 19	H.S. Dropout at 19	Academic Specialist	Ever College at 20
D's and F's * Δ HP	0.0162***	-0.0133**	0.0302***	0.0312***
	(0.00593)	(0.00556)	(0.00464)	(0.00638)
No D's some C's * Δ HP	0.00598	-0.00490*	0.0104**	0.0205***
	(0.00411)	(0.00266)	(0.00492)	(0.00546)
B's and Some A's * Δ HP	0.000811	0.000381	0.00975**	0.0104***
	(0.00223)	(0.00158)	(0.00451)	(0.00348)
All A's * Δ HP	0.0000323	-0.000177	0.00225	0.00601
	(0.00238)	(0.00206)	(0.00686)	(0.00369)
Observations	1906	1906	1507	1962

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.7: Effects on Whites Course Taking by Grades in Eighth Grade

	Math Credits	Science Credits	Academic Math Credits	Percent Advanced Credits
D's and F's * Δ HP	0.108***	0.0616***	0.113***	-0.0893
	(0.0143)	(0.0205)	(0.0151)	(0.127)
No D's some C's * Δ HP	0.000958	0.0242	-0.00315	-0.0679
	(0.0168)	(0.0202)	(0.0189)	(0.0985)
B's and Some A's * Δ HP	0.0274***	0.0200**	0.0382***	0.101
	(0.00909)	(0.00920)	(0.0118)	(0.0922)
All A's * Δ HP	-0.00802	0.00473	0.00206	-0.0830
	(0.0131)	(0.0151)	(0.0163)	(0.174)
Observations	1575	1568	1511	1580

Standard errors are in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Each regression also includes household income, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 1.8: Course Taking for Blacks

	Academic Specialist	Academic Concentrator	Math Credits	Science Credits	Academic Math Credits	Attend College by 20
4 Year Δ HP at 18	-0.0129	-0.00220	0.0101	-0.0351	0.0816*	0.0011
	(0.0108)	(0.0146)	(0.0539)	(0.0571)	(0.0485)	0.0135
Observations	450	443	454	452	434	590

Table 1.9: Course Taking for Whites

	Academic Specialist	Academic Concentrator	Math Credits	Science Credits	Academic Math Credits	Attend College by 20
4 Year Δ HP at 18	0.0097***	0.0088*	0.0227***	0.0185**	0.0309***	0.0129***
	(0.0028)	(0.0048)	(0.0078)	(0.0090)	(0.0103)	0.0033
Observations	1515	1488	1583	1519	1519	1975

Table 1.10: Effects of ΔHP^2&ΔHP^3

	Academic Concentrator	% New Basic at 19	High Grade Completed at 19
4 Year Δ HP at 18	0.0138	0.976 **	0.0468 **
	(0.0153)	(0.436)	(0.0192)
ΔHP^2	-0.0000593	-0.0742 **	-0.00223
	(0.00139)	(0.0306)	(0.00166)
ΔHP^3	-0.00000330	0.00166 **	0.0000263
	(0.0000301)	(0.000664)	(0.0000359)
Observations	2387	2537	3108

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.11: Effects of Log(ΔHP)

	H.S. Diploma at 19	H.S. Dropout at 19	Academic Specialist
Log 4 Year Δ HP	0.0132 **	-0.00910 *	0.00517
	(0.00552)	(0.00519)	(0.00848)
Observations	3124	3124	2426

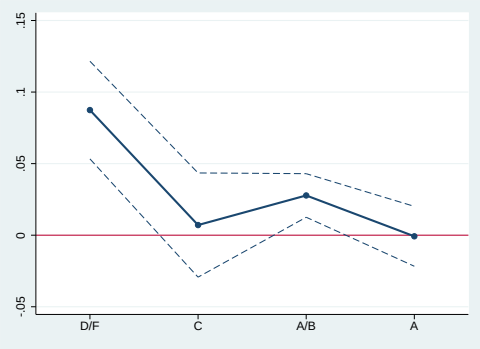
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.12: Effects of Log(ΔHP)

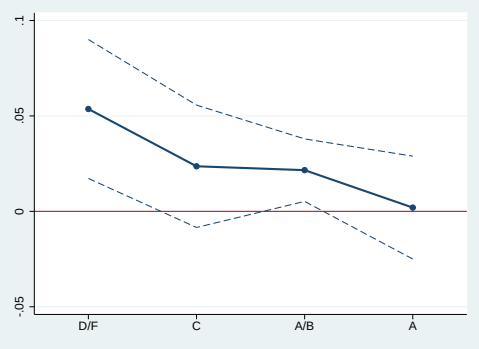
	Math Credits	Science Credits	Academic Math Credits	% Advanced Credits	Attend College by 20
Log 4 Year Δ HP	0.0548 **	0.0129	0.0495	-0.0671	0.0246 ***
	(0.0209)	(0.0194)	(0.0340)	(0.203)	(0.00862)
Observations	2502	2486	2384	2502	3179

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

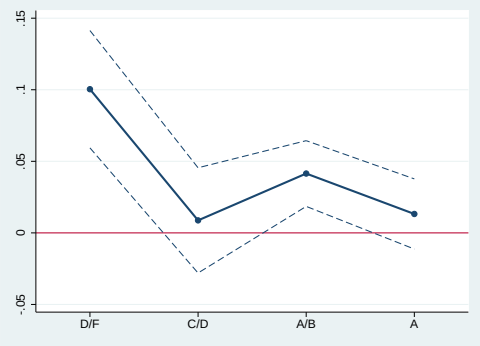
1.11 Appendix Figures



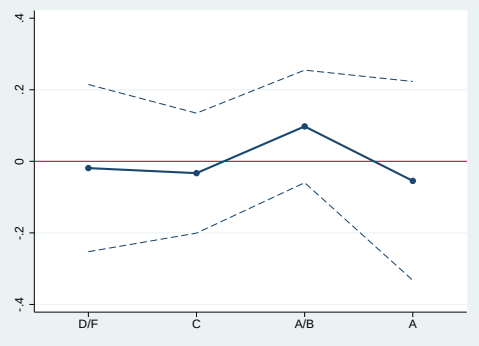
(a) Math Credits



(b) Science Credits



(c) Academic Math Credits



(d) Percent Credits Advanced

Figure 1.1: Effects if Home Price Changes by Grades in Eighth Grade

Chapter 2

The Effect of Housing Wealth on Labor Market Outcomes and Behavior

2.1 Introduction

The previous chapter demonstrated that youth whose family experienced an increase in home wealth during the housing boom increased educational outcomes in both quantity and quality. High school students who experienced a home price increase were more likely to complete high school, take more math and sciences courses, and were more likely to complete a college preparatory curriculum. Previous literature also showed that students exposed to home price increases were also more likely to enroll in college (Lovenheim 2011) and more likely to attend better colleges (Lovenheim & Reynolds 2013). This paper expands on those findings by examining the longer run impact of these home wealth shocks.

Since shocks to home value have increased both quantity and quality of education,

labor market outcomes should also be affected. This paper uses a reduced form approach, measuring the effect of home price changes while in high school on labor market outcomes at age 26. I find that a $10,000 increase in home value between age 14 and 18 leads to a 2% increase in income at age 26. The probability of working in white collar industries [1] is also increased.

I further explore the effects of home price changes on behavior outcomes. I find evidence that home price shocks decrease the probability of males participating in criminal activity and increase participation in the community as an adult.

Since my previous work found larger impacts on education for black youths and previously low performing students, I also examine heterogeneity in results by race and underlying baseline ability. The results are consistent with earlier findings, but I cannot show that outcomes have statistically significant differences by group.

The remainder of this paper will proceed as follows. Section 2 will discuss data from the NLSY97 and the home price estimation using data from the Freddie Mac Home Price Index. Section 3 will establish the empirical methodology. The fourth section discusses results. Subsections of the results section will explore heterogeneity by race and baseline ability level. The final section concludes.

2.2 Data

Individual level data for this analysis comes from the National Longitudinal Survey of Youth- 1997 cohort (NLSY97). Home prices are available for the initial survey

[1] Information and Communication; Finance, Insurance, and Real Estate; Professional Services; Education, Health, and Social Services; or Public Administration

year and estimated using the Freddie Mac Home Price Index (FMHPI) for other years. This section will discuss these data sources.

2.2.1 NLSY97

The data used for this analysis is the restricted use National Longitudinal Survey of Youth 1997 (NLSY97)[2]. The NLSY97 is a nationally representative sample of youths born between 1980 and 1984. The survey was released annually through 2011, allowing for labor market outcomes as late as 26 years old. There are a plethora of controls and outcomes available including household income as a youth, parental education, high school transcripts, and several behavior outcomes.

Potential drawbacks of the NLSY97 are missing data and survey attrition. Following the previous chapter and Lovenheim & Reynolds (2013), I use multiple imputed chained equations to impute missing control variables. No outcomes or home price variables are imputed.[3] Survey attrition does not affect the results and will be addressed in the results section.

Summary statistics for control variables are located in Table 1.[4] Column 1 shows means and standard deviations for all respondents and column 2 is limited to home owners. The main results use only the children of home owners, but I will also estimate the response to home price increases within MSA by non-home owners.

[2]The restricted data is needed to match individuals to their MSA for home price estimations and MSA fixed effects.

[3]Results without imputed data are similar and available upon request. A further discussion of the imputation process can be found in the appendix of chapter one.

[4]The NLSY97 oversamples minorities, so data in Table 1 is weighted using the NLSY custom weights found at https://www.nlsinfo.org/weights/nlsy97.

Home owning families have a higher mean household income, better grades, and more educated parents than their non-home owning counterparts. The variables in Table 1 are the same control variables used in the previous chapter.

To account for changes in opportunity cost of living in a home, I have also included changes in the fair market rent as provided by the U.S. Department of Housing and Urban Development (HUD).[5] HUD compiles rental data within MSA. I use the published fair market rent for three bedroom apartments. Fair market rent is the 45th percentile of rental rates within an MSA.[6]

A summary of labor market variables are found in Table 2. Column 1 displays means and standard deviations for all respondents, Column 2 shows means for black respondents, and the third Column displays outcomes for white respondents. One of the ways that home price shocks could effect schooling is through increased access to credit. Since black families may have difficulty accessing credit markets (Ross & Yinger 2002), black families may have a different response to home price shocks. My previous work found that home price changes had a large, positive effect on high school completion for black youths. Black students may also have different returns to schooling. I also show separate results by race.

Earned income is the response to the question: "During (year), how much income did you receive from wages, salary, commissions, or tips from all jobs, before deductions for taxes or for anything else?" The mean earned income at age 26 is $30,180.50. White collar industries include Information and Communication; Finance, Insurance,

[5]http://www.huduser.org/portal/datasets/fmr.html

[6]I have also used two bedroom apartment rent. All estimates are nearly identical.

and Real Estate; Professional Services; Education, Health, and Social Services; or Public Administration. 88% of respondents reported that they earned some income in the past year and only 15.6% were enrolled in school. MSA level unemployment rate at age 26 is used as a control for all labor market outcomes. Row 6 shows that the mean MSA level unemployment rate for the NLSY97 respondents at age 26 was 7.53%.

Table 3 summarizes the substance use and delinquency outcomes, The data is split into males and females, because some of the estimates will look at results for males only. The probability of females committing crimes is much lower that of males, so they are less likely to be on the margin. For example, males are nearly 3 times as likely (0.199 to 0.067) to be arrested.

2.2.2 Housing Data

The explanatory variable of interest is the change in family home price from age 14 to age 18. The NLSY97 did not collect home price in every period. The first round of parental questions in 1997 includes the parent's estimated value of their current home. Home values in other years are estimated using the Freddie Mac Housing Price Index (FMHPI). The FMHPI is based on repeated sales of homes with conventional mortgages[7] with average appreciation rates calculated by MSA each month. I assign the mean of monthly values for each year's home price index. The FMHPI uses data on all homes whose loans were purchased by either Freddie Mac or Fannie Mae.[8]

[7]Conventional mortgages include single family homes under $417,000 in 2014.
[8]From 1975 to 2014, the FMHPI includes over 25 million paired transacitions.

Home prices are estimated by multiplying the 1997 home price by the ratio of the current year's home price index to the 1997 price index, as follows:

$$\widehat{P_{i,m,t}} = P_{i,m,1997} * \frac{FMHPI_{m,t}}{FMHPI_{m,1997}} \qquad \textbf{(1)}$$

where i is the individual, m is MSA, and t is the year. $P_{i,m,1997}$ is the reported 1997 home price, while $\frac{FMHPI_{m,t}}{FMHPI_{m,1997}}$ is the ratio of home price indexes. For example, consider a respondent from the Ann Arbor, Michigan MSA reporting a home value of \$150,000 in 1997. The Freddie Mac home price index for Ann Arbor is 77.60 in 1997 and 103.57 in 2001. The respondent's estimated home value in 2001 would be: $\$150,000 * \frac{103.57}{77.60} = \$200,200$. This method of approximating home price is the same as used by Lovenheim and Reynolds (2013) and also in chapter 1 of this work.[9]

Variation in home prices changes comes from variation in the initial home price, variation within year across MSAs, and variation across time within MSAs. Table 4 shows the large variation in home prices and home price changes. All home prices are displayed in \$10,000 increments. Column 1 displays mean and column 2 shows standard deviation. Column 3 is the mean standard deviation within MSA and column 4 is the mean standard deviation within birth cohort. The mean home value in 1997 was \$125,700. Rows 2 and 3 of Table 4 show information on price changes. 4 year Δ HP at 18 is the price change between ages 14 and 18. This is the independent variable in the main specification. The mean change in home price from the age 14

[9]Lovenheim and Reynolds used the Conventional Mortgage Home Price Index (CMHPI) which was formerly published by Freddie Mac. The CMHPI was replaced by the FMHPI in 2011 and is no longer available. The main difference in the two indices is the treatment of appraisals. The FMHPI accounts for the possibility that appraisal values differ systematically from sales.

to age 18 is $32,790.[10] Row 3 shows the four year change of Freddie Mac Home Price index.

There is considerable within-MSA variation in housing price changes and this will permit me to identify effects of housing price changes while controlling for MSA-level time invariant characteristics. I discuss this empirical strategy next.

2.3 Empirical Methodology

This paper estimates the effect of a shock to home wealth on adult labor market outcomes and behavior. Home wealth increases have been shown to increase both quantity and quality of education. A shock to home wealth increased the probability of finishing high school, completing college preparatory curriculum, attending college, and attending a private or state flagship college. I expect that the increased quantity and quality of education would lead to better labor market outcomes and higher behavior skill measures.

The previous literature treated a home price change as an exogenous shock to family resources. The shock to home wealth may be extracted by either borrowing against the equity in the home or selling the home. Previous literature on consumption and home prices (Mian and Sufi 2014, Campbell and Cocco 2008, Hurst and Stafford 2002) found consumption changes due to home equity are the result of credit

[10]It should be noted that Lovenheim & Reynolds (2013) have a substantially larger mean $53,310 home price change. The difference is driven by the sample selected for analysis and the treatment of inflation. Their sample is limited to college bound students, which have a higher home value. They difference home prices without adjusting for inflation and then scale the difference into 2007 dollars. Using the same sample and method as Lovenheim & Reynolds (2013) , I get a mean home price change of approximately $50,000, not statistically different from theirs.

constrained families extracting equity through home equity loans.

Two potential ways that an increase in home price could improve high school outcomes include complimentary consumption making it easier to finish high school and an increase in the expectation of ability to pay for college. Increased college quantity and quality could be effected through the alleviation of credit constraints. These potential mechanisms are not mutually exclusive and I cannot distinguish between them. Neither am I able to show that changes in labor market outcomes or behavior measures are caused by increased education. The aim of this paper is to find the reduced form effect of home price shocks on long run outcomes, not identify the precise method through which the effects are operating.

The increased education should cause better labor market outcomes and may also lead to increased non-cognitive skills. Changes in home prices do increase the years of education, but using the home price change as an instrument for years of schooling would not be appropriate though. Since both quantity and quality of education are increased, an IV estimation using home price increases to instrument for years of education would not meet the exclusion restriction. Thus estimates are done in reduced form. I estimate the effect of a home price shock on labor market and behavior outcomes with the same specification used in the previous chapter to identify the effects of home price on high school outcomes:

$$Y_{i,c,m} = \beta(\Delta HP_{i,c,m}) + X_{i,c,m}\Pi + \omega_m + \psi_c + \epsilon_{i,c,m} \qquad \textbf{(2)}$$

$Y_{i,c,m}$ represents a high school outcome of individual i, from birth cohort c, and from MSA m. ω_m captures any time invariant effects of living in a given MSA and ψ_c

captures any effects specific to each youth's birth cohort. $\Delta HP_{i,c,m}$ is the estimated home price change from age 14 to age 18 for individual i in \$10,000 increments. The coefficient of interest is β, which is the change in $Y_{i,c,m}$ in response to a \$10,000 change in home price.

X contains all of the controls displayed in Table 2. Household income controls for changes in family resources caused by potential endogenous labor market outcomes. Grades in eighth grade are used as a control for ability. Performance in eighth grade capture knowledge prior to the measured home price change and may also encapsulate the non cognitive skills necessary to succeed in school. To further account for ability and household importance of education, I also include the education level of biological parents.[11]

Equation 2 treats home price changes as an exogenous shock to wealth, conditional on controls. For estimates of equation 2 to produce upwardly biased estimates of the effect of home price changes on outcomes, the home price change would have to be correlated with some unobserved aspect of families that increases both home prices and outcomes positively. In the results section, I will show that children from non-home owning families are not positively affected by home price increases within their MSA, providing evidence that results are not confounded by other MSA/time omitted variables affecting all students. A handful of other works have also treated home price increases as exogenous (Lovenheim (2011), Lovenheim & Reynolds (2013)

[11]The NLSY97 also provides the Armed Services Vocational Aptitude Battery (ASVAB). This is similar to the AFQT in the 1979 NLSY. The ASVAB is given to most respondents during the initial interview. For many respondents, they are taking the ASVAB during their estimated home price change, meaning ASVAB scores are an outcome. I do not use ASVAB scores in any reported estimates. All estimates maintain their significance and sign when using the ASVAB as a control.

, Dettling & Kearney (2014)).

2.4 Results

The results section consists of three parts. I begin with the main results, estimates of equation 2 for the entire home owning sample. I find that youths that experienced an increase in family home price between ages 14 and 18 earn higher incomes and are more likely to work in white collar industries. I also the effect of home price changes on youths in non-home owning families. I find evidence that a positive home price change may increase behavior measures, but the results are not consistent. In the remaining subsections, I further explore the labor market results. Since my previous work found differing effects by race and baseline ability on education outcomes, I explore the same heterogeneous effects for labor market outcomes. The second subsection discusses results by race and the third subsection discusses the effects of home price changes on labor market outcomes by 8th grade performance.

2.4.1 Main Results

I expect home price increases to affect labor market outcomes and behavior skills through increased quality and quantity of education. The previous chapter showed that a $10,000 increase in home price decreased the probability of dropping out of high school by 0.003, increased the probability of completing high school by age 19 by 0.004, and increased the probability of attending college by 0.011. I also found that home prices increased the probability of completing a college preparatory curriculum. The labor market outcomes are taken nine years later, so there is some

survey attrition. In order to alleviate concerns that attrition could drive the labor market results, I begin by estimating the effect of home price changes on education outcomes, restricting the sample to only individuals with both education data and data on income at age 26. Those results are displayed in Table 5.

Each regression uses household income as an adolescent, parents' education, race, sex, and fair market rent as controls. MSA and cohort fixed effects are also included and robust standard errors are clustered at the MSA level. The first column shows the effect of home price on completing high school by age 19. The estimate is nearly identical to that found in the previous chapter. A $10,000 increase in home price causes an increase in the probability of completing high school of 0.004. While this effect seems small, it is important to remember that over 90% of the children in home owning families are graduating high school. The dropout rate is also similarly affected for my restricted sample. I also find positive effects on the probability of completing the academic specialist[12] and academic concentrator curricula. The probability of attending college by age 20 is also increased. The point estimates for each estimation are nearly identical to those found in the previous chapter, but statistical significance is lost for some estimates.

Column 6 in Table 5 shows the increase in highest grade attained by 2011 (the final year of the survey). A $10,000 home price increase raises the average education level by 0.0482 years. The mean home price increase is $32,790, so a mean home price increase adds approximately 0.15 years of education. The results in Table 5 and

[12]4 English credits, 3 math credits of Algebra I or higher, 2 credits of biology, chemistry , or physics, 2 credits in social studies, and 2 credits in a foreign language

previous literature indicate that home price increases lead to both increased quantity and increased quality of education.

The final column in Table 5 addresses attrition directly. "Attrition" is a binary variable equal to 1 if high school education data is available and income at age 26 is not available. Survey attrition is positively associated with home price increases, but it is not statistically significant.

I next estimate Equation 2 on the labor market outcomes, those estimates are found in Table 6. The first column shows the effect of home price increases on the log of earned income. I find that a $10,000 increase in home price increases adult earned income by 2.03%. The second column is level income. A $10,000 home price increase raises earned income at age 26 by $1,036.40. The mean home price change is $32,790 so a mean change in home price increases income at age 26 by approximately $3,398, 10% of the mean.

Column 3 shows the estimates for holding a job in a white collar industry.[13] I find that a home price increase raised the probability of working in these industries by 1.31 percentage points per $10,000 home price increase.

The fourth column reports the estimated effect of home price changes on the probability of reporting a non- zero income at age 26. I find that an increase in home price, decreases the probability of reporting a job that pays salary or income. This result is counter intuitive to the education and income results. Those areas that were exposed to increased home prices in the late 1990s and early 2000s were also

[13]Information and Communication; Finance, Insurance, and Real Estate; Professional Services; Education, Health, and Social Services; or Public Administration

exposed to adverse economic conditions between 2006 and 2010, the years that labor market outcomes are measured. But the MSA level unemployment rate at age 26 is used as a control. One possibility is that increased education creates an increased reservation wage. The increase in reservation wage would cause both the positive results found in column 1 and the negative result in column 4.

Column 5 shows the effect of home price increases on hours worked in a year. The home price increase has a small, statistically insignificant effect on hours worked.

There could be concern that some of the survey respondents have yet to complete their human capital investment in education. 15% of the sample was still enrolled in school at age 26. The last three columns show the effect of home price changes on enrollment probability, log income with students dropped, and the probability of reporting any income with students omitted from the sample. The results for income are consistent. There is still a statistically significant increase in log of earned income in response to a home price change. The probability of reporting earnings remains negative, but loses its statistical significance indicating that the negative effect found in column 4 was at least partially driven by respondents that were still enrolled in school.

Given the results from previous work and estimates in Table 5, one mechanism through which home prices could affect income is through education. Since home price changes increase years of schooling, one possibility would be an instrumental variable approach. However, the results in Table 5 show that home price increases also changes the quality of education. Thus the exclusion restriction is violated. In an unreported estimate, I found that the IV approach gives a coefficient of 0.564 on

years of schooling, implying that each year of schooling leads to an income 56.4% greater. This coefficient seems implausibly large, but it is feasible that a local average treatment effect at the high school graduation margin is very large.

To further explore the pathway through which home prices are affecting income, I repeated estimations of Equation 2 with education controls. The third column of Table 7 shows the same results as Table 6. When years of schooling is added in column 2, the coefficient on home price shrinks, but remains significant. In column 1, I have controlled for completing a high school diploma by age 19, enrolled in college by age 20, and completing the academic specialist curriculum. These controls reduce the magnitude of the coefficient by half and the effect on home price is no longer statistically significant. The results in Table 7 are consistent with the story that home price changes are affecting income through education quantity and quality.

One possible concern is that these results are driven by some other macroeconomic component that causes both home price increases and changes in school quality or local labor markets. To address this concern, I estimate the effect of home price increases on labor market outcomes for respondents from non- home owning families. in lieu of home price changes, I use MSA level changes in home price from the FMHPI. These results are displayed in Table 8. None of the estimations find a statistically significant effect of MSA level home prices on labor market outcomes for non- home owners.

There is a statistically significant effect of MSA level home price changes on enrollment for non-home owners. This result could indicate that youths that do not receive the housing wealth boom as teens are delaying their education investment.

Next, I examine the effect of home price changes on behavior outcomes. I begin by looking at crime and delinquency. I concentrate on the male population.[14] The summary statistics in Table 3 showed that females exhibited a very low likelihood to commit crimes. Males are much more likely to be on the margin of committing a crime. Table 8 shows the estimated effects of home price increases on committing various crimes by age 18. If access to education increases behavior outcomes, I would expect to find negative effects. This holds for most outcomes, however a home price increase does have a positive, statistically significant effect on the probability of being arrested. I also find a positive, although near zero, point estimate for the probability of stealing something worth less than $50. As expected, an increase in home price has a negative point estimate for most other outcomes. The probability of joining a gang, destroying property, and committing assault all have statistically significant results. Home price increases appear to have a positive effect on crime outcomes.

There are additional behavior outcomes available in the NLSY97 and I have performed estimates on many additional outcomes. There appears to be a pattern of positive effects from home price changes, but very few estimates have statistically significant results.

Finally, I look at the effects on community participation. Educated voters and community participation are potential positive externalities of education. If home price increases education level, I would also expect home price to increase community participation. I estimate the effect of home price changes on voting, interest in

[14]Estimates for the entire population and for teen pregnancy on girls can be found in the appendix tables.

government, attendance at community meetings, volunteer work, and donations. These results are shown in Table 10. These questions are not available every year. I choose to look at the last available year for each outcome. All outcomes were in 2010 or 2011.

I find that home price increases had a positive effect on the probability of voting in 2010 (a non- presidential election year). A home price index of $10,000 while in high school increased the probability of voting by 1.32 percentage points. This result is statistically significant with a p-value less than 0.01. A positive change in home value also resulted in increased interest in government (column 2). I also find that home price increases raised the probability of attending a community meeting. I find a positive point estimate on the probability of volunteering as well. Donating to charity is the only negative point estimate. This evidence points strongly to an increase in community participation as a result of a positive home price shock.

The results for labor market outcomes were particularly strong with a mean home price increase causing a 6% increase in income at age 26. Respondents were also more likely to work in fields that typically require higher education. In my previous work, I found that home price shocks had particularly large education effects on black students and students that performed poorly in eighth grade. The following subsections will explore that same heterogeneity for labor market outcomes.

2.4.2 Effects by Race

One of the possible mechanisms through which home price increases could increase education outcomes is an easing of credit constraints. There is evidence that black

families may experience harsher credit constraints (Ross & Yinger 2002). In the previous chapter, I found that black students had significantly larger effects on high school completion. For example, a mean home price change for a black family decreased the dropout probability by 20%. If education is the channel through which home prices affect labor market outcomes, I expect that black respondents will also exhibit different effects in labor market outcomes.

Table 11 addresses heterogeneous results by race. The estimates at the top of Table 11 are for white respondents and those on the bottom are estimates for black respondents. The white respondents have results nearly identical to those of the entire sample. As column shows, a $10,000 increase in home price leads to a 2.20% increase in income. The estimate for the entire sample was 2.03%. White respondents are more likely to work in professional industries also.

The results for black respondents are surprising. I do not find any statistically significant results and many of the coefficients are of the opposite sign of those for the entire sample.

2.4.3 Results by Baseline Ability

My previous work also found different effects in education outcomes by grades reported in eighth grade, the time just prior to the measure home price increase. I found that the students that performed poorly in eighth grade had the largest effect of home price increases on educational attainment. Since education is the likely channel through which home price increases are affecting labor market outcomes, I examine the effects of home price on labor market outcomes by grades in eighth

grade. I estimate the following equation:

$$Y_{i,c,m} = \gamma_1(D/FStudent) * (\Delta HP_{i,c,m}) + \gamma_2(C's\ and\ D's) * (\Delta HP_{i,c,m}) + \gamma_3(A's\ and/or\ B's) * (\Delta HP_{i,c,m}) + \gamma_4(allA's) * (\Delta HP_{i,c,m}) + X\Pi + \omega_m + \psi_c + \epsilon_{i,c,m} \quad \textbf{(3)}$$

γ_1 is the estimated effect of a \$10,000 home price change for students that reported D's and F's on outcome $Y_{i,c,m}$. Results from estimation of Equation 3 are shown in Table 12. The point estimates are higher for low performing students, but estimates are not statistically significant. For example, the estimates on log income (column 1) indicate that a home price increase of \$10,000 increased income at age 26 by 2.84% for the lowest performing students and 1.71% for the previously high performing students, but the estimates are not statistically different. The students that performed poorly in eighth grade are also more likely to be employed in a professional industry.

Column 4 shows an unexpected result. The previously low performing students are less likely to have received any income if they experienced a positive home price shock while in high school. This result is counter intuitive.

The trend found in log wages and white collar jobs is similar to those found in the previous chapter. There is evidence that youths who were performing poorly in school prior to the measured home price increase were the largest benefactors of the increased home wealth. The results for reporting any income are the opposite though. Table 12 indicates that low performing youth earn more, are more likely to have white collar jobs, but are more likely to be unemployed.

2.5 Conclusion

The run up of the housing bubble in the late 1990s and early 2000s was shown to increase educational attainment for those youths whose family owned a home and experienced a shock to home wealth. This paper has presented evidence that the increased education also increased labor market outcomes later in life. A $10,000 home price shock increased wages at age 26 by over 2%. Youths from home- owning families that experience home price increases were more likely to work in white collar industries as well.

The labor market results are interesting and should be further explored. Labor market outcomes were measured at age 26, which occurred during the heart of the financial crisis, between 2006 and 2010 for the NLSY97 participants. While controls are included for MSA level unemployment rate, additional controls for current labor market conditions could aid in providing a better understanding of the results, particularly the decrease in the probability of earning wages or salary.

Marriage market decisions also provide an additional avenue for further research. Increased college attendance likely increases exposure to high quality matches for those on the margin of attending college.

2.6 Tables

Table 2.1: Summary Statistics

	(All)	(Home Owners)	(Non- Home Owners)
HH Income at 18	56,020.3	68,315.3	30,572.5
	(47,588.4)	(49,259.3)	(31,143.1)
Eighth Grade At Least Half D's	0.115	0.0907	0.168
	(0.319)	(0.287)	(0.374)
Eighth Grade No D's some C's	0.344	0.309	0.421
	(0.475)	(0.462)	(0.494)
Eighth Grade A's and or B's	0.368	0.392	0.315
	(0.482)	(0.488)	(0.465)
Eighth Grade Mostly A's	0.165	0.202	0.0839
	(0.372)	(0.402)	(0.277)
Mother HS Diploma	0.480	0.467	0.508
	(0.500)	(0.499)	(0.500)
Mother Bachelor's Degree	0.272	0.328	0.147
	(0.445)	(0.470)	(0.354)
Father HS Diploma	0.472	0.457	0.504
	(0.499)	(0.498)	(0.500)
Father Bachelor's Degree	0.300	0.358	0.170
	(0.458)	(0.480)	(0.376)
Female	0.470	0.465	0.481
	(0.499)	(0.499)	(0.500)
Black	0.154	0.0989	0.277
	(0.361)	(0.299)	(0.448)
White	0.685	0.777	0.478
	(0.465)	(0.416)	(0.500)
Observations	4173	2592	1581

Mean coefficients; SD in parentheses

All summary stats are weighted using NLSY97 custom weights. Additional parental education dummies include less than H.S. diploma and Associates Degree. Other races not shown include Hispanic, mixed, and other.

Table 2.2: Summary Statistics Labor Market Outcomes

	All Respondents	Black Respondents	White Respondents
Earned Income at age 26	30189.5	23333.9	31874.9
	(24696.9)	(23907.7)	(25284.1)
Log Earned Income at Age 26	10.167	9.948	10.210
	(0.862)	(0.9347)	(0.855)
White Collar Job at 26	0.485	0.503	0.485
	(0.500)	(0.500)	(0.500)
Reported Earned Income	0.883	0.804	0.897
	(0.322)	(0.397)	(0.305)
Enrolled in School at age 26	0.156	0.155	0.161
	(0.363)	(0.362)	(0.367)
Unemployment Rate at 26	7.53	6.89	7.56
	(3.01)	(2.69)	(2.98)
Observations	3087	608	1859

Mean coefficients; SD in parentheses

Summary statistics are weighted using NLSY97 custom weights. Each variable is measured in the year in which the respondent turns 26.

Table 2.3: Summary Statistics Substance Use, Criminal Activity, and Behavior

	All Respondents	Male Respondents	Female Respondents
Ever Smoked by 18	0.613	0.614	0.612
	(0.487)	(0.487)	(0.487)
Ever Smoke Marijuana by 18	0.458	0.481	0.433
	(0.498)	(0.500)	(0.496)
Ever Use Hard Drugs by 18	0.142	0.146	0.138
	(0.349)	(0.353)	(0.345)
Ever Carry a Gun by 18	0.148	0.240	0.0478
	(0.355)	(0.427)	(0.213)
Ever Join a Gang by 18	0.0628	0.0939	0.0289
	(0.243)	(0.292)	(0.168)
Ever Steal <$50 by 18	0.424	0.471	0.374
	(0.494)	(0.499)	(0.484)
Ever Steal >$50 by 18	0.124	0.161	0.0840
	(0.330)	(0.368)	(0.278)
Ever Destroy Property by 18	0.131	0.202	0.0529
	(0.337)	(0.402)	(0.224)
Ever Assault by 18	0.246	0.320	0.165
	(0.431)	(0.467)	(0.371)
Ever Sell Drugs by 18	0.165	0.203	0.123
	(0.371)	(0.403)	(0.328)
Ever Arrested by 18	0.136	0.199	0.0677
	(0.343)	(0.399)	(0.251)
Ever been Pregnant by 18	0.178	N/A	0.178
	(0.382)	N/A	(0.382)
Observations	3258	1699	1559

Means are displayed. Standard deviations are in parentheses. Summary statistics are weighted using NLSY97 custom weights. Each variable is taken in the year in which the respondent turns 18.

Table 2.4: Home Price Variance

	Mean	Standard Deviation	Mean Standard Deviation Within MSA	Mean Standard Deviation Within Cohort
1997 Home Price ($10,000)	12.57	8.65	6.57	8.648
4 Year Δ HP at 18	3.279	4.350	2.444	3.756
4 Year Δ HPI at 18	1.846	1.090	0.687	.814

There are 5961 observations for all variables referring to home price index (HPI) and 3569 for all variables referring to housing price (HP).

Table 2.5: Education Outcomes & Survey Attrition

	H.S. Diploma by 19	H.S. Dropout by 19	Academic Concentrator	Academic Specialist	Attend College by 20	High Grade Ever	Attrition
4 yr ΔHP	0.00378*	-0.00279	0.00804	0.00425	0.0109***	0.0482***	0.00215
	(0.00209)	(0.00184)	(0.00519)	(0.00367)	(0.00232)	(0.0163)	(0.00306)
Observations	2741	2741	2039	2074	2761	2900	3124

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 2 with only β reported. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. Each regression also includes household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 2.6: Labor Market Outcomes

	Log Income from Salary & Wages	Income from Salary & Wages	White Collar Job	Reported any Earned Income	Hours Worked in year	Enrolled in School	Log Income without students	Earned Income without students
4 yr ΔHP	0.0203***	1036.4***	0.0131**	-0.00661**	-0.637	-0.00308	0.0171*	-0.00372
	(0.00700)	(278.9)	(0.00501)	(0.00252)	(5.119)	(0.00283)	(0.00934)	(0.00338)
Observations	2344	2344	2431	2697	2665	2798	2008	2284

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 2 with only β reported. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. All outcomes are the year in which the respondent turns 26 years old. Columns 7 and 8 do not use respondents that reported enrollment in school. Each regression also includes MSA level unemployment rate, household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 2.7: Labor Market Outcomes with Education Controls

	Log Income	Log Income	Log Income
4 yr ΔHP	0.00907	0.0193***	0.0203***
	(0.0121)	(0.00674)	(0.00700)
Has HS Diploma at 19	0.278***		
	(0.0974)		
Enrolled in College by 20	0.190**		
	(0.0750)		
Academic Specialist	0.0470		
	(0.0561)		
Highest Grade Ever Completed		0.0293***	
		(0.00883)	
MSA Unemployment	-0.0285*	-0.0402***	-0.0411***
	(0.0156)	(0.0124)	(0.0126)
Log HH Income at 18	0.0198*	0.0162*	0.0174*
	(0.0106)	(0.00971)	(0.00971)
No D's some C's	0.00320	0.155*	0.203**
	(0.0820)	(0.0812)	(0.0817)
A's and or B's	0.115	0.264***	0.356***
	(0.0883)	(0.0899)	(0.0907)
Mostly A's	0.175*	0.388***	0.520***
	(0.101)	(0.0957)	(0.0942)
Mother Bachelor's Degree	0.0584	0.168*	0.205**
	(0.100)	(0.0858)	(0.0900)
Father Bachelor's Degree	-0.0240	-0.00908	0.0254
	(0.0908)	(0.0830)	(0.0787)
Female	-0.328***	-0.291***	-0.278***
	(0.0502)	(0.0415)	(0.0407)
Black	-0.117	-0.0867	-0.0675
	(0.0730)	(0.0605)	(0.0615)
Observations	1620	2332	2344

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 2. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. Each regression includes birth year fixed effects and MSA fixed effects. Additional parental education categories were omitted for space. Coefficients on Bachelor's Degree are relative to high school dropout. Each regression has robust errors clustered at the MSA level.

Table 2.8: Labor Market Outcomes for Non- Home Owners

	Log Income from Salary & Wages	Income from Salary & Wages	White Collar Job	Reported any Earned Income	Hours Worked in year	Enrolled in School	Log Income without students	Earned Income without students
4 Year ΔHPI at 18	0.0190	-608.8	-0.0331	0.00264	-12.50	0.0187*	0.0172	0.0165
	(0.0510)	(1400.5)	(0.0288)	(0.0168)	(47.81)	(0.00993)	(0.0520)	(0.0171)
Observations	1450	1450	1564	1896	1872	1955	1275	1667

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This sample includes only children that were not from home owning families. Estimates are of Equation 2 with 4 yr ΔHP replaced by 4 yr ΔHPI, the change in MSA level home price index between the year in which the respondent turns 14 and the year they turn 18. Each regression also includes household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 2.9: Crime and Behavior Outcomes

	Delinquency Index	Ever Arrested	Crime Index	Stole < $50	Stole > $50
4 yr ΔHP	-0.0313	0.00558*	-0.0210	0.000142	-0.00187
	(0.0420)	(0.00295)	(0.0149)	(0.00662)	(0.00342)
Observations	965	1671	1669	1671	1670

	Ever Carry Gun	Ever in Gang	Ever Destroy Property	Ever Assault	Ever Sell Drugs
4 yr ΔHP	-0.00170	-0.00761**	-0.00550*	-0.0104***	-0.00330
	(0.00322)	(0.00316)	(0.00326)	(0.00346)	(0.00595)
Observations	1669	1672	1672	1671	1671

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 2. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. All outcomes are measured at 18 years old. Each regression also includes household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 2.10: Community Participation Outcomes

	Voted 2010	Interest in Govt	Volunteer	Attend Community Meetings	Donate to Charity	Community Participation Index
4 yr ΔHP	0.0132***	0.0356***	0.00291	0.0104*	-0.00116	0.0386**
	(0.00358)	(0.00908)	(0.00993)	(0.00609)	(0.00344)	(0.0149)
Observations	2204	2849	2767	2781	2794	1997

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 2. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. All outcomes are in 2010 or 2011. The final column is an index composed of the principle eigenvector of the previous columns. Each regression also includes household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 2.11: Labor Market Outcomes By Race

	Log Income from Salary & Wages	Income from Salary & Wages	White Collar Job	Reported any Earned Income	Hours Worked in year	Enrolled in School	Log Income without students	Earned Income without students
White Respondents								
4 yr ΔHP 4 yr ΔHP	0.0220**	1120.5***	0.0134**	-0.00664**	1.088	-0.00258	0.0163	-0.00302
	(0.00956)	(360.5)	(0.00582)	(0.00308)	(6.733)	(0.00345)	(0.0128)	(0.00426)
Observations	1461	1461	1488	1638	1621	1701	1245	1373
Black Respondents								
4 yr ΔHP	0.00113	-527.2	0.0158	-0.0248	-71.44	-0.0193	-0.0185	-0.0276
	(0.0459)	(1180.1)	(0.0184)	(0.0180)	(53.61)	(0.0203)	(0.0511)	(0.0179)
Observations	422	422	461	526	516	546	360	442

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 2. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. Each regression also includes household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 2.12: Labor Market Outcomes by Grades in 8th Grade

	Log Income from Salary & Wages	Income from Salary & Wages	White Collar Job	Reported any Earned Income	Hours Worked in year	Enrolled in School	Log Income without students	Earned Income without students
D's & F's * Δ HP	0.0284	1917.9	0.0206*	-0.0204***	2.376	0.00283	0.0206	-0.0192**
	(0.0395)	(1543.2)	(0.0108)	(0.00677)	(15.53)	(0.00805)	(0.0484)	(0.00736)
C's & D's * Δ HP	0.0158	657.1*	0.0120*	-0.0108**	-10.55	-0.00549	0.00540	-0.00887**
	(0.0108)	(385.4)	(0.00694)	(0.00415)	(13.60)	(0.00485)	(0.0111)	(0.00427)
A's & B's * Δ HP	0.0224**	1188.8***	0.0114*	-0.00331	2.109	-0.00268	0.0155	-0.000346
	(0.00857)	(329.8)	(0.00631)	(0.00236)	(5.880)	(0.00223)	(0.0116)	(0.00325)
All A's * Δ HP	0.0171*	875.9***	0.0121***	-0.00241	2.631	-0.00564	0.0197**	-0.00377
	(0.00926)	(288.3)	(0.00424)	(0.00369)	(10.51)	(0.00434)	(0.00930)	(0.00464)
Observations	2333	2333	2416	2679	2648	2780	2008	2284

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 4. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. The grades indicate self reported grades in eighth grade. So row 1 is the affect of home price changes on youth that earned D's and F's in eighth grade. Each regression also includes household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

2.7 Appendix Tables

Table 2.1: Community Participation Variables

Variable (Variable Description)	Mean (SD)
Vote in 2010 (0,1)	0.446 (0.497)
Interest in Govt 2010 (1 to 4, 1=Never 4=Most of the Time)	2.507 (1.096)
Volunteered in 2011 (1 to 4, 1=Never 4=12+ times)	1.688 (0.923)
Attend Community Meetings 2011 (1 to 4, 1=Never 4=12+ times)	1.303 (0.659)
Donated in last 12 months? 2011 (0,1)	0.315 (0.465)
Observations	3016

Means are reported with standard deviations in parentheses. Variable coding is defined underneath the variable names. All summary statistics are weighted using NLSY97 custom weights.

Table 2.2: Labor Market Outcomes Men Only

	Log Income from Salary & Wages	Income from Salary & Wages	White Collar Job	Reported any Earned Income	Hours Worked in year	Enrolled in School	Log Income without students	Earned Income without students
4 yr ΔHP	0.0183	1052.0**	0.0166***	-0.00977***	-0.738	0.0150	1070.1*	-0.00705*
	(0.0121)	(480.7)	(0.00516)	(0.00301)	(12.08)	(0.0132)	(558.7)	(0.00360)
Observations	1227	1227	1276	1396	1377	1070	1070	1200

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 2. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. All outcomes are at 26 years old. Columns 7 and 8 do not use respondents that reported enrollment in school. Each regression also includes MSA level unemployment rate, household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 2.3: Labor Market Outcomes Marital Status Controls

	Log Income from Salary & Wages	Income from Salary & Wages	White Collar Job	Reported any Earned Income	Hours Worked in year	Enrolled in School	Log Income without students	Earned Income without students
4 yr ΔHP	0.0209***	1056.2***	0.0126**	-0.00645**	-0.876	0.0182*	1046.9***	-0.00349
	(0.00695)	(281.0)	(0.00501)	(0.00254)	(5.202)	(0.00927)	(349.2)	(0.00332)
Observations	2310	2310	2426	2652	2566	1980	1980	2245

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 2. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. All outcomes are at 26 years old. Columns 7 and 8 do not use respondents that reported enrollment in school. Each regression also includes MSA level unemployment rate, household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Table 2.4: Crime Outcomes

	Delinquency Index	Ever Arrested	Crime Index	Stole < $50	Stole > $50
4 yr ΔHP	-0.0523**	0.00161	-0.0194	-0.00453	-0.00397
	(0.0260)	(0.00214)	(0.0123)	(0.00458)	(0.00246)
Observations	1578	2660	2635	2657	2659

	Ever Carry Gun	Ever Pregnant	Ever Destroy Property	Ever Assault	Ever Sell Drugs
4 yr ΔHP	0.000451	-0.00401	-0.00140	-0.00826***	-0.00102
	(0.00233)	(0.00358)	(0.00212)	(0.00231)	(0.00441)
Observations	2657	1406	2660	2659	2660

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Estimates are of Equation 2. The 4 yr ΔHP is the change in home price between the year in which the respondent turns 14 and the year they turn 18. All outcomes are at 18 years old. The ever pregnant sample is women only. Each regression also includes household income as adolescent, parental education, sex, MSA and cohort fixed effects. Robust standard errors are clustered at the MSA. All regressions are weighted using the NLSY97 custom weights.

Chapter 3

Stimulating Marriage: The Effect of Viagra on Marriage Rates

3.1 Introduction

In 1998, Pfizer released the first ever oral treatment of erectile dysfunction, Sildenafil (Viagra). Viagra became the fastest selling prescription drug in history with over 300,000 prescriptions written in the first month. It is still widely used and highly profitable, but we know little of it's social consequences. This paper attempts to fill that gap. I exploit the sudden introduction and fast uptake of Viagra, along with the fact that some men were not medically able to use the drug, to measure the affect of Viagra on marriage rates via a difference in differences strategy. I find that men whom were married prior to Viagra's release are 3.7 percentage points more likely to be married after Viagra's release if they are medically able to take Viagra.

Viagra affected a substantial portion of adult men. Erectile dysfunction (ED), the persistent inability to achieve or maintain an erection sufficient for satisfactory sexual

performance, was estimated to affect up to 30 million American men (Goldstein et al 1998). Clinical trials of Viagra were very successful, allowing 69% of men to perform sexually and demand for Viagra quickly became apparent. Over fifteen million prescriptions were filled in the first year and a half (Keith 2010).

Sociology literature has shown that decreased sexual activity is associated with unhappy marriages, marital infidelity, and divorce (Liu 1998). The introduction of Viagra provides a positive shock to the marriage surplus of up to 30 million matches. Simultaneously, Viagra also changes the value of options outside of marriage, increasing potential utility from dating or alternative matches. Since the effects of Viagra are theoretically ambiguous, measuring these effects is an empirical exercise.

I begin by using medical literature to identify a group of men likely to suffer from ED. ED is age associated, with an estimated prevalence of 39% at 40 years of age and 67% at 70 years old (Goldstein et al 1998). I utilize the University of Michigan Health and Retirement Study (HRS). The HRS is a longitudinal panel with a nationally representative sample of Americans over the age of 50. I follow medical literature to identify those most likely to suffer from erectile dysfunction. I am also able to identify individuals that are less likely to be given a prescription due to pre-existing medical conditions.

With a sample of men likely to suffer from erectile dysfunction, I use a difference in differences estimation strategy to approximate the effects of Viagra on marriage. The first difference is the abrupt release and immediate adoption of Viagra. In April of 1998 within weeks of its FDA approval, Pfizer introduced Viagra with tremendous success. The sudden availability and quick adoption of Viagra provides a clear time

difference before and after its release. The second difference is the health conditions permitting Viagra use. These conditions are quickly recited by the narrator of every Viagra commercial: "Ask your doctor if your heart is healthy enough for sex. Do not take Viagra if you take Nitrates for chest pain, as this may cause an unsafe drop in blood pressure..." This legalese was backed by clinical tests and additional medical research at the time of Viagra's release (Goldstein et al 1998, Cheitlin et al 1999, Pfizer labs 1998). Men with heart problems, recent strokes, and heart attacks could not take Viagra. I estimate the change in the difference of marriage rates before and after Viagra's release for men with and without access to Viagra.

For men married in 1994, I find the change marriage likelihood after Viagras release was .0369 greater for men able to take Viagra than those whose health conditions prevented them from taking Viagra. These results are driven by married men staying in their current marriage and the results are robust across several adjustments to specification. I will also show that women were not differently affected by Viagra under the same set of pre- existing conditions.

Economists have long been interested in marriage markets. Marital markets have major implications for population growth, labor force participation, and household resource allocation (Becker 1974). The majority of research has focused on first marriages and family decisions made by young and middle aged workers (Stevenson and Wolfers 2007, Becker et al 1977, and several others). Research on marriage decisions of elderly Americans is much scarcer.

An additional branch of literature has examined the effects of pharmaceutical and medical innovations on marriage markets. The majority of this research has been

concerned with oral contraceptives and female labor supply decisions (Goldin and Katz 2002, Bailey 2006, and others). To my knowledge, there is no literature on the effects of medical innovations on late in life marriages.

The American population is getting older. Between the 2000 and 2010 census, the number of Americans between 45 and 64 years old increased by 31.5%, while the overall population increased by only 9.7%. The median age in the 2010 census was 37.2 years old. Older Americans are active in the marriage market as well. In 2008 men aged 45 and older accounted for 19.8% of newly married men and 39.6% of male divorces (census.gov). Understanding the marriages of elderly Americans is important. ED is an age associated disorder (Goldstein et al 1998) and Viagra provides us a shock to marriages targeted at older Americans.

In addition to the interest in marriage markets, there is also interest in the value of Viagra. In 2000, roughly half of U.S. insurance plans reimbursed members for at least some Viagra pills (Keith 2000). Many insurance plans decided not to include coverage for Viagra after its initial release. California's Department of Corporations, which regulates state health plans, forced Kaiser Permanente to cover Viagra prescriptions for its members after Kaiser's initial denial of coverage (Keith 2000). Knowing the effects of Viagra on marriage is a step toward understanding the value of ED drugs.

This paper is organized as follows: section 2 will provide the reader with a brief history and background on Viagra; section 3 will discuss the theoretical effects of Viagra on marriages; section 4 will discuss the difference in difference identification strategy; section 5 will discuss the Health and Retirement Survey (HRS) data; section 6 will discuss the main results, section 7 will expand on the results and include a

series of robustness checks; and section 8 will conclude.

3.2 How We Got the Little Blue Pill

Viagra was somewhat of an accident. From 1989 to 1994, Pfizer researchers were conducting clinical tests for Sildenafil (Viagra), hoping to provide a treatment for angina. The drug was unable to successfully increase blood flow to the heart, but participants in the trials were able to benefit from a side effect of the drug. Sildenafil increased blood flow to the genitals, allowing men to achieve erections. Study participants requested to stay on the drug and were reluctant to return unused pills, despite limited effectiveness in relieving angina (Loe 2004).

Pfizer saw the potential and began a new type of clinical trials. From 1994 to 1997 Pfizer conducted clinical trials for Viagra as a treatment for erectile dysfunction. Pfizer patented Sildenafil as a treatment for erectile dysfunction in 1996. In March of 1998, the FDA approved Viagra as a treatment for erectile dysfunction. A few weeks after approval, Viagra was available for prescription.

Prior to 1987, the term erectile dysfunction didn't even exist. The 1987 Massachusetts Male Aging Study (MMAS) was the first federally funded study on impotence (Loe 2000) and the first to use the term ED. The MMAS identified the demographics of men suffering from the condition, finding that 52% of men aged 40-70 had some form of erectile dysfunction. The main associated variable with ED was age. Chronic medical conditions associated with ED included hypertension, diabetes, treated heart disease, and smoking (Levy 1994). This identifies the group

most likely to be effected by Viagra: men 40-70 years old with hypertension, diabetes, heart disease, or smokers.

Viagra works. In clinical trials, 69% of attempts at sexual intercourse were successful for men taking Viagra. Those taking the placebo had a success rate of 22%. (The high rate of success for placebo recipients is often cited as evidence that erectile dysfunction is often a psychological problem.) Men in the clinical trials included individuals with ED from both physical and psychological causes. Men with varying degrees of ED were also included. Men that were able to perform marginally without Viagra saw vast improvements with Viagra (Goldstein et al 1998). Note that there is no evidence that Viagra increases sexual desire, clinical trials found that the drug causes an erection only in response to sexual stimulation (Goldstein et al 1998). So the men taking Viagra wanted to have sex, but were physically unable to perform.

Prior to the release of Viagra, treatment for ED was much more intrusive and expensive. The main competitors of Viagra at its inception were Muse, a transurethral suppository, and Caverject, a penile injection (Kieth 2000). In addition to the obvious discomfort of these treatments, they were also much more expensive. In 1998, Viagra had an average wholesale price of $8.75 per pill. Meanwhile, the two alternate treatments cost $20-$30 per each (Kieth 2000). Understandably, prior to the release of Viagra only 14% of men suffering from erectile dysfunction visited a doctor about their problem. This increased by 75% in 1998. Viagra absorbed 92% of the erectile dysfunction treatment market within the year. And this market quadrupled in size (Kieth 2000). [1]

[1]Pfizer's Viagra was the sole FDA approved oral erectile dysfunction drug until 2003, when

Viagra's introduction and saturation of the market happened quickly. The initial sales growth of Viagra was faster than any other pharmaceutical product in history (Keith 2010). There were over 300,000 prescriptions written in the first month of its release. More than $400 million worth of Viagra was sold in its first quarter on the U.S. market. In the first year and a half, 15.6 million prescriptions were filled (Kieth 2010). Pfizer has marketed Viagra to a wide variety of demographics. Former Republican presidential candidate Bob Dole appeared in early Viagra advertisements. Pfizer has employed Nascar star Mark Martin, baseball star Rafeal Palmeiro, and Brazilian soccer star Pele to appear in Viagra ads as well (Loe 2000). Americans have become accustomed to television advertisements of products offering male enhancement

Viagra was not a blessing to all men with ED, as some men wishing to take Viagra were not able to do so. According to the advertisements regularly seen on television, Viagra is intended for men "whose heart is healthy enough for sex." Pfizer's Viagra prescription information (the sheets of paper that you receive whenever you pick up a prescription) warns, "Patients taking Nitrates are not to be prescribed Viagra." Pfizer also warns that for patients with preexisting cardiovascular disease, physicians should carefully consider the combination of the vasodilatory effects of Viagra combined with sexual activity. Additional warnings are given for stroke and heart attack patients, patients with angina, and patients with hypertension or hypotension. Also, some kidney and liver diseases could make processing the drug difficult

Levitra and Cialis entered the market. My analysis will end with 2002, eliminating the complication of 3 slightly different erectile dysfunctions medicines.

(Pfizer 1998). In January of 1999, Melvin Cheitlin et. al. published "Use of Sidenafil (Viagra) in Patients with Cardiovascular Disease" in *Circulation* [2] to "appropriately caution doctors in prescribing Viagra to patients with heart disease. The authors warn that Viagra should never be prescribed to patients receiving any form of Nitrate therapy. Other patients in whom Viagra use is potentially hazardous include those with coronary ischemia; those with congestive heart failure and low blood pressure status; and those with complicated multi-drug, anti-hypertensive therapy regimes. Additionally, authors warn against prescriptions to stroke patients and a continued list of heart conditions until further studied (Cheitlin et al 1999).

Over half of men aged 40-70 suffer from some degree of ED. Viagra met a demand for erectile dysfunction relief and it works. Viagra was introduced as quickly as possible and the immediate uptake was huge, providing a clear before and after period. Not everyone that wanted to take Viagra was able to do so. Doctors were advised against prescribing Viagra to patients with heart problems and strokes.

3.3 Theoretical Effects of Viagra

The theoretical effect of Viagra on marriages is ambiguous. Assuming people enjoy sex and marriage provides access to sex, the introduction of Viagra provides a positive shock to marriages. The Viagra shock does not solely affect the existing marriage though; the utility of the outside option, the pursuit of another marriage or the dating market, is also affected.

[2]The Journal of the American Heart Association

Marital sex declines sharply after 50 years of age and a decline in sexual activity is highly correlated with unhappy marriages (Liu 2000, Jasso 1985). Interestingly, Jasso (1985) found marital coital frequency was decreasing in husband's age, but not in wife's age. As mentioned in the previous section, over half of men over forty years old have some degree of ED. If sex within a marriage is declining due to physical limitations, Viagra can slow or stop the decline. The increase in sexual frequency increases happiness within the marriage, leading to a decline in divorces.

If a newly virile man chooses to pursue sex outside of the marriage, he must pay both the cost of ending his current marriage (or risk this cost if he pursues an extramarital affair) and any costs associated with matching frictions in the current dating market. Incurring these additional costs, a married man may be more likely to remain married. Should a married man divorce, he has already shown a proclivity to marriage and is likely to remarry.

Married and unmarried men have displayed different revealed preferences in regard to marriage. Additionally, they face different costs for pursuing new marriages or dating. So, men that were unmarried at the introduction of Viagra should be analyzed separately. Unmarried men will not have to incur any costs associated with dissolving a current marriage. Unmarried men may pursue marriage, pursue sex outside of marriage, or remain single. The expected response for unmarried men is even less than that of married men.

There is no theoretically clear response of marriages to the introduction of Viagra. Understanding the effects of Viagra on marriage is an empirical exercise. The next section will discuss the empirical strategy which I use to test the effect of Viagra on

marriage.

3.4 Identification Strategy

I estimate the difference in the differences of marriage rates for men with and without access to Viagra before and after Viagra's release. This requires a clear before and after period, as well as groups with and without access to Viagra. This section uses the institutional background provided in section 2 to establish the difference in differences estimation strategy.

The introduction and adoption of Viagra happened quickly. In March of 1998, Viagra was yet to receive FDA approval and was unavailable. In April, 300,000 prescriptions were written (Keith 2000). The May 4th edition of Time magazine pictured a man taking a Viagra pill with the caption "The Potency Pill: Yes, Viagra works!..." April 1998 provides a clear cut in before and after periods.[3]

Comparing the difference in marriage rates for men over 50 before and after Viagra's introduction does not imply causation. Attitudes about sex and marriage have changed over time. Comparing 50 year olds in 1992 to 50 year olds in 2002 could be problematic without some sort of control group. As a comparison group, I use men who were not able to take Viagra for health reasons. Men with angina or taking Nitrates are immediately eliminated from taking Viagra. Additionally, Viagra use is potentially hazardous for men with heart conditions or strokes (Cheitlin et al 1999). I define the absence of heart problems (including angina) and strokes as access to

[3]Section 2 provides a more extensive discussion on the quick market saturation of Viagra.

Viagra.

Table 3.1: Groups

Access (Meets all of these conditions)
No Strokes
No Heart Problems
No Angina
No Angina Medications

Heart problems and strokes can be associated with lifestyle choices. In order to avoid endogenous selection into the access group, I define access using health conditions reported in 1994 (the year clinical trials of Viagra as an ED drug began) and do not allow variation over time.

I estimate the likelihood of marriage as a function of access to Viagra ($Access_i$), the introduction of Viagra ($After_t$), and the interaction ($After_t * Access_i$). The coefficient on $After_t * Access_i$ is the difference in the change of marriage likelihood for men with access to Viagra and without access to Viagra after Viagra's release. I use the following equation to identify the effects of Viagra on marriage:

$$Married_{i,t} = \beta_1 After_t * Access_i + \beta_2 After_t + \beta_3 Access_i + \beta_4 X_{i,t} + \epsilon_{i,t} \quad (1)$$

$Married$ is a binary variable equal to one when the individual is married. $After_t$ indicates whether the time period is before or after the advent of Viagra. $Access_i$ indicates whether the individual has access to Viagra. Table 1 displays all of the conditions that could prevent access. X contains controls for birth year, race, and

education level. β_1 represents the change in the difference of the likelihood of marriage for men with and without access to Viagra before and after Viagra's introduction in April of 1998. The conditions preventing access to Viagra are correlated with age. Additionally, attitudes toward sex and marriage have evolved over time. To account for age effects, I use birth year fixed effects. There are also racial differences in marriage and in health conditions, so race will be included in controls. Education level can capture differences in knowledge of the availability of Viagra and is also included in all regressions. Equation 1 assumes parallel trends in marriage rates by health groups. Figure 1 shows that the trends in marriage rates were the same before Viagra's release.

3.5 Data

I use data from the University of Michigan Health and Retirement Study (HRS). The HRS is a longitudinal panel study that surveys a representative sample of more than 26,000 Americans over the age of 50 every two years. [4] The survey includes several questions pertaining to health care and income. Data collection began in 1992 and data is currently available through 2010. In 2003, the FDA approved two additional ED medications, Levitra and Cialis. The additional medications give doctors more options and pose difficulty in identifying access groups. So, I limit the sample to 1992-2002.

The data set is narrowed to men most likely to suffer from erectile dysfunction.

[4]Data was obtained at https://ssl.isr.umich.edu/hrs/files2.php . The HRS Core Fat Files were used.

As discussed in previous sections, ED is correlated with age. (Goldstein et al 1998, Rowland et al 2005) The HRS surveys Americans over fifty and their spouses. To further isolate the effects of Viagra, men with co-morbidities that have been shown to be positively correlated with erectile dysfunction are identified. In the Massachusetts Male Aging Study, men with diabetes, hypertension, and treated heart disease were more likely to suffer from erectile dysfunction. Additionally, smoking was found to be correlated with erectile dysfunction. (Levy 1994, Rowland et al 2005) Hypertension, diabetes, and smoking are used to define the group of people likely to suffer from erectile dysfunction. Treated heart disease is not used in the identification of the likely group. While treated heart disease is correlated with erectile dysfunction, individuals with treated heart disease are more likely to be denied a prescription for Viagra and thus are placed in the group without access. Table 2 includes the co-morbidities which identify the likely group. In order to be considered likely to have ED, a man must have at least one of the co-morbidities.

Table 3.2: Groups

Likely (Meets any of these conditions)
Diabetes
Hypertension
Smoking

The HRS asks if each individual is married and places respondents into 6 categories: Married, Partnered, Separated, Divorced, Widowed, Never Married. Those reporting to be coupled are treated as married. Since partnered are living in the same household, their partnership has a structure similar to marriage. Separated,

Divorced, Widowed, and Never Married are classified as not married.

This paper's main results narrow the sample those most likely to have ED prior to 1994 and define access to Viagra as the absence of heart problems or strokes in 1994. Table 3 contains a summary of these conditions by access. By construction, individuals with access do not have heart problems, strokes, or angina.[5] As seen in column 2, the access group is driven by heart problems. Only 11% of the access group reports no heart problems. These respondents are individuals who have suffered a stroke, but did not report heart problems in 1994. The final 3 rows of Table 3 describe the inclusion in the likely group. 83.5% of the individuals without Viagra access report hypertension. Access is defined by heart problems, which correlate with hypertension. There are more smokers in the access group than the no access group, which is unexpected.

Additional summary statistics for men likely to have ED are found in Table 4. Men without access to Viagra are less healthy by definition. Health is negatively correlated with education and income. As expected, the individuals without access to Viagra look slightly worse. They have less income, are less likely to be initially married, are less educated, and slightly older. The identification relies on parallel trends, not levels.[6]

The main result of this paper is that men that were married before Viagra and had access to Viagra have a larger relative probability of being married than those without access. Marriage rates for married men by access group can be seen in Table

[5]Angina is a subset of heart problems.

[6]Additional summary statistics are available in appendix tables, including comparisons across the likely group and statistics for female observations

5. The difference in difference estimator using only means is: $(0.842 - 0.977) - (0.808 - 0.978) = 0.035$. Men with access to Viagra have a change in the probability of marriage 0.035 more than men without access to Viagra. Regression results in the next section show that this holds when controlling for age, race, and education level.

3.6 Results

Table 6 displays estimates of equation 1 separately for men married in 1994 and men that were unmarried in 1994. The sample includes only men *Likely* to have ED; men with at least one of the following: hypertension, diabetes, or smokers. $After$ is defined as after April of 1998. *Access* is defined as reporting none of the following: heart problems, strokes, angina, and angina medications. As discussed in the identification section, access and likely group assignment uses responses from 1994. Standard errors are clustered at the individual level. The regressions include fixed effects for birth cohort, race, and education level.

Column 1 shows that men who were married in 1994 are 3.69 percentage points more likely to be married after the release of Viagra if they have access relative to those without access. This estimate is statistically significant. I do not find an effect for men that were not married in 1994.

Marriage rates by access group are depicted in Figure 1. Men surveyed in 1998 before the introduction of Viagra are coded as 1998, while those surveyed after are coded as 1998.1. The dashed line is the marriage rate for men without access to Viagra, while the solid line is marriage rates for men with access to Viagra.

The sample includes men that were married in 1994 and are likely to have ED, as defined by their 1994 health conditions. The marriage rates look similar prior to the introduction of Viagra, when a clean break is made and men without access to Viagra are less likely to be married.

The second column in Table 6 shows that men that were single in 1994 were not affected by Access to Viagra. Single men do not have to incur the cost of ending their marriage if they want to pursue multiple or new sexual partners. Single men likely benefited from Viagra, but the results indicate that they did not choose to marry.

The driving force behind Viagra increasing the probability of marriage was men staying in their current marriage. Figure 2 depicts the marriage survival rate for men married in 1992.[7] Men without Viagra access are represented by the dashed line, while men that do not have health conditions preventing Viagra access are represented by the solid line. In Figure 2, we see a clear break in the marriage survival rate, consistent with men staying in their current marriages.[8]

Table 7 includes a difference in differences estimate of the marriage survival rate for those married in 1992. The β_1 coefficient is positive, but not statistically significant. So some of the results shown in Table 6 are also influenced by men ending current marriages and getting remarried.

[7]Men surveyed in 1998 before the introduction of Viagra are coded as 1998, while those surveyed after are coded as 1998.1

[8]Men that die out of their marriage or are widowed during the sample period are eliminated from the sample.

3.6.1 Effects of Viagra on Women

Viagra only affects men's sexual performance. There is an effect on women though. Marriages are formed in a matching market. So a change in the surplus of some marriages would affect women's marriage choices as well. However, the introduction of Viagra should not have different effects across women's health concerns allowing access to Viagra. I find that women are not differentially affected by health status allowing access to Viagra.

Table 8 shows estimates of equation 1 for men and women. Since placement in *Access* and *Likely* groups could be correlated with lifestyle choices, controls for spouse's access and whether the spouse is likely to have ED are included. I was unable to match approximately 1% of observations with their spouses. Standard errors are clustered at the individual level.

As expected, the estimates of β_1 for men are statistically significant when access is defined as the lack of a heart problem or stroke. The estimated β_1 for women is near zero (0.005) and not statistically significant. Figure 3 shows the marriage rates for women by access. Unlike figures 1 and 2, there is no distinct difference before and after Viagra for women. Columns 3 and 4 of Table 8 show results without controlling for spouse conditions. Again the medical ability to take Viagra does differentially affect women's marriages.

These results show that I am not picking up some other aspect of the timing and the health conditions that affects both sexes. For the statistically significant results to be spurious, there would have to be some other phenomenon that affects only

married men with heart problems or strokes in 1998.

3.6.2 Additional Robustness

Next, I show that these estimates are not picking up on some other exit from the marriage. There is the possibility of leaving the sample. In order to ensure that those exiting the survey are not driving results, the sample is narrowed to only those individuals that appear in every time period. Table 9 shows estimates of equation 1 with only individuals that appear in every survey year. The coefficient on β_1 is nearly identical and still statistically significant. Table 10 repeats this exercise, omitting those that exit marriage through being widowed. The β_1 coefficient is still positive and significant. The point estimate is smaller. This implies that widowers were more likely to get remarried if they had access to Viagra, which is consistent with my theory presented earlier.

Table 11 displays results for married men broken down by the definition of likely. The three conditions that could place a man in the group likely to suffer from ED were: diabetes, hypertension, and smoking. As shown in the summary statistics, hypertension was the condition that placed the most individuals into the likely category. The β_1 estimate for hypertension is nearly identical to the estimate for the entire likely sample at 0.0379. The β_1 estimate for only individuals with diabetes is much larger, 0.712, which is intuitive since diabetes is a better predictor of ED (Levy 1994).

Column 6 displays results without conditioning on *Likely*. The results are similar to table 6 and statistically significant. As discussed in the introduction and theory

sections, medical literature has shown that ED is associated with age. (Goldstein et al 1998, Levy 1994 , Feldman et al 1998). Since the data is from men over 50 years of age, we would expect a high prevalence of ED throughout the group. Narrowing to the likely categories does give us a slightly larger estimate in each instance, which implies that these likely groups are more likely to suffer from ED.[9]

Table 13 breaks down results by access categories. Recall from the summary statistics, over 83% of the individuals categorized as no access to Viagra had heart problems. If the access group is narrowed to only people with a heart problem, the results are nearly identical, the β_1 estimate is 0.369. Column 2 shows individuals with strokes. The estimates are small and insignificant. According to the medical literature, angina is the largest constraint and specifically medications for angina. However, there are only 76 men with angina likely to have ED that are married in 1994 and no more than 11 of these men are unmarried in subsequent years. The standard errors become large when narrowing to such small groups. Results using angina as the sole barrier of access are found in column 3 of Table 13. The results are not statistically significant.

Finally, Table 12 repeats estimates of equation 1 with the after period changed to 1996 and 2000. Both specifications still have positive estimates of β_1, but neither is significant. The β_1 coefficients should still be positive, because in both cases the after period includes some time with Viagra availability and the before period

[9]Regressions were run for a triple difference with likely as the third group and running the whole sample with the DD estimator interacted with likely. The DDD results are not significant. The estimation with likely with the DD estimator and dummy variables is very similar to previous results. These tables are available upon request

includes some time without Viagra availability. Both coefficients are smaller than the correct specification as well. This indicates that the break in marriage rates occurs at the release of Viagra. The figures presented in the previous section also indicate that the introduction of Viagra provided the change in marriage rates.

3.7 Conclusion

This paper explores the effects of Viagra on marriage rates for elderly men. Married men with access to Viagra had an increase in the likelihood of being married relative to men unable to take Viagra after Viagra's release. Point estimates range from 0.037 to 0.07. The results are consistent across several specifications and stand up to many robustness tests.

The effects of Viagra on marriage rates were estimated by comparing the change in the difference of marriage rates for men with and without access to Viagra before and after Viagra's release.Viagra was the fastest growing pharmaceutical product in history. Viagra's debut provided a clear before and after period. Every Viagra commercial ends by warning the viewer, "Viagra is not to be taken with Nitrates and individuals should consult their doctors to see if their heart is healthy enough for sex." Men with health problems preventing the use of Viagra provide the second difference.

The results held up across a series of robustness tests. The β_1 estimates are consistent, measuring between 0.025 and 0.07 for differing measures of likely and access. The most striking robustness test is the measurement of Viagra effects on

women's marriage probability. Marriage rates for women are not differently affected by health conditions preventing Viagra access.

This identification strategy could be used to find the effect of Viagra on several additional outcomes. Viagra increased sexual activity and likely increased the incidence of STI's among the senior population. There may also be an effect on the mental well-being of senior citizens. Preliminary analysis on well-being shows little effect, but needs to be investigated further.

3.8 Tables

Table 3.3: Summary of Conditions for Individuals likely to have ED by 1994 Access

	(1) With Access to Viagra	(2) Without Access to Viagra
No Heart Problem in 1994	1	0.111
	(0)	(0.314)
No Stroke in 1994	1	0.792
	(0)	(0.406)
No Angina in 1994	1	0.826
	(0)	(0.379)
Has Co-Morbidities of ED in 1994	1	1
	(0)	(0)
Has Diabetes in 1994	0.167	0.336
	(0.373)	(0.473)
Has Hypertension in 1994	0.665	0.835
	(0.472)	(0.371)
Smoker in 1994	0.416	0.293
	(0.493)	(0.455)

mean coefficients; sd in parentheses

Table 3.4: Summary Statistics for Individuals likely to have ED by 1994 Access

	(1) With Access to Viagra	(2) Without Access to Viagra
Married in 1994	0.704	0.624
	(0.456)	(0.484)
Age	58.74	59.97
	(6.357)	(6.055)
Widowed in Sample Period	0.245	0.264
	(0.430)	(0.441)
Household Income	42977.7	33051.3
	(54452.4)	(48929.6)
White	0.730	0.667
	(0.444)	(0.471)
Black	0.204	0.268
	(0.403)	(0.443)
Indian	0.00392	0.00433
	(0.0625)	(0.0657)
Asian	0.00367	0.00163
	(0.0605)	(0.0403)
Hispanic	0.0357	0.0314
	(0.186)	(0.174)
Other Race	0.0217	0.0265
	(0.146)	(0.161)
Less than High School Education	0.311	0.435
	(0.463)	(0.496)
High School Diploma	0.381	0.351
	(0.486)	(0.477)
Some College	0.183	0.138
	(0.387)	(0.345)
College Graduate	0.0592	0.0344
	(0.236)	(0.182)
Post College	0.0660	0.0409
	(0.248)	(0.198)

mean coefficients; sd in parentheses

Table 3.5: Summary of Marital Status for by Access and After for Men Married in 1994

	(1) Before With Access	(2) After With Access	(3) Before No Access	(4) After No Access
Married	0.977	0.842	0.978	0.808
	(0.150)	(0.365)	(0.148)	(0.394)
Divorced	0.00808	0.0385	0.00973	0.0474
	(0.0895)	(0.192)	(0.0982)	(0.213)
Widowed	0.0128	0.110	0.00823	0.122
	(0.112)	(0.313)	(0.0904)	(0.327)

mean coefficients; sd in parentheses

Table 3.6: Effects of Viagra on Likelihood of Marriage for Individuals Most Likely to Have ED

	Married in 1994	Not Married in 1994
After*Access	0.0369**	-0.0177
	(0.0188)	(0.0129)
After	-0.170***	-0.00442
	(0.0173)	(0.0112)
Access	-0.00804	0.0109
	(0.00552)	(0.00817)
Observations	13411	6059

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.7: Effects of Viagra on Marriage Survival for Individuals Most Likely to Have ED

	Married in 1992
After * Access	0.0249
	(0.0153)
After	-0.0828***
	(0.0143)
Access	0.00680
	(0.00723)
Observations	11549

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.8: Effects of Viagra on Women

	Men Spouse Controls	Women Spouse Controls	Men no Spouse Controls	Women No Spouse Controls
After * Access	0.0353*	0.00546	0.0352*	0.00580
	(0.0187)	(0.0126)	(0.0188)	(0.0126)
After	-0.168***	-0.0791***	-0.168***	-0.0796***
	(0.0172)	(0.0112)	(0.0173)	(0.0112)
Access	-0.00711	0.00953**	-0.00487	0.0110***
	(0.00629)	(0.00424)	(0.00632)	(0.00412)
Spouse Access	0.0540***	0.0409***		
	(0.00944)	(0.00896)		
Spouse Likely	-0.0420***	-0.0000171		
	(0.00725)	(0.00570)		
Observations	13278	14393	13417	14543

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.9: Effects of Viagra on Likelihood of Marriage for Ommitting Survey Exiters

	Married in 1994	Not Married in 1994
After*Access	0.0376*	-0.0116
	(0.0202)	(0.0153)
After	-0.165***	-0.0102
	(0.0187)	(0.0136)
Access	-0.00821	0.00220
	(0.00648)	(0.0116)
Observations	10745	4620

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.10: Effects of Viagra on Likelihood of Marriage for Ommitting Widowers

	Married in 1994	Not Married in 1994
After*Access	0.0234*	-0.0158
	(0.0131)	(0.0206)
After	-0.0584***	0.0134
	(0.0121)	(0.0181)
Access	0.00294	0.0155
	(0.00481)	(0.0109)
Observations	11418	3212

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.11: Effects of Viagra on Likelihood of Marriage by Likely Definition

	Diabetes	Hypertension	Smoker	Diabetes or Smoker	Diabetes or Hypertension	No Likely Distinction
After*Access	0.0712*	0.0379*	0.0522	0.0373	0.0425**	0.0325**
	(0.0362)	(0.0204)	(0.0420)	(0.0275)	(0.0200)	(0.0147)
After	-0.181***	-0.158***	-0.221***	-0.191***	-0.164***	-0.148***
	(0.0321)	(0.0184)	(0.0401)	(0.0254)	(0.0181)	(0.0139)
Access	-0.00802	-0.00735	-0.00618	-0.0111	-0.00698	-0.00502
	(0.0121)	(0.00591)	(0.0129)	(0.00844)	(0.00561)	(0.00432)
Observations	2546	9168	5125	7273	10025	24916

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.12: Falsification Test Changing After Period

	After 1996	After 2000
After * Access	0.0219	0.0316
	(0.0152)	(0.0198)
Access	-0.00689	-0.00246
	(0.00438)	(0.00682)
After 1996	-0.140***	-0.165***
	(0.0138)	(0.0184)
Observations	13411	13411

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.13: Effects of Viagra for Married Men by Access Definition

	Heart Problems	Stroke	Angina	Angina Medication
After*Access	0.0369*	0.00854	0.0415	0.0300
	(0.0201)	(0.0325)	(0.0479)	(0.0507)
After	-0.170***	-0.147***	-0.180***	-0.168***
	(0.0187)	(0.0318)	(0.0474)	(0.0503)
Access	-0.00503	-0.0258***	-0.00281	-0.00559
	(0.00570)	(0.00988)	(0.0139)	(0.0154)
Observations	13411	13411	13405	13411

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.9 Figures

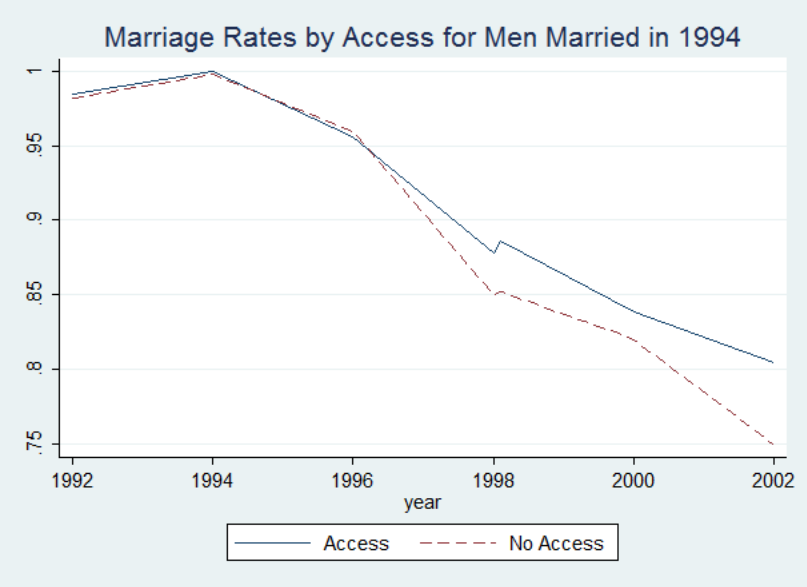


Figure 3.1: Men's Marriage Rates

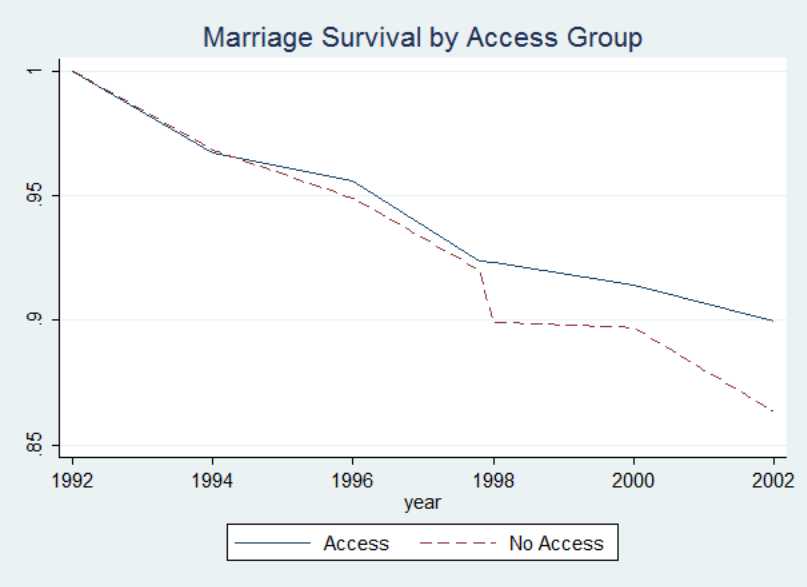


Figure 3.2: Men's Marriage Survival Rate

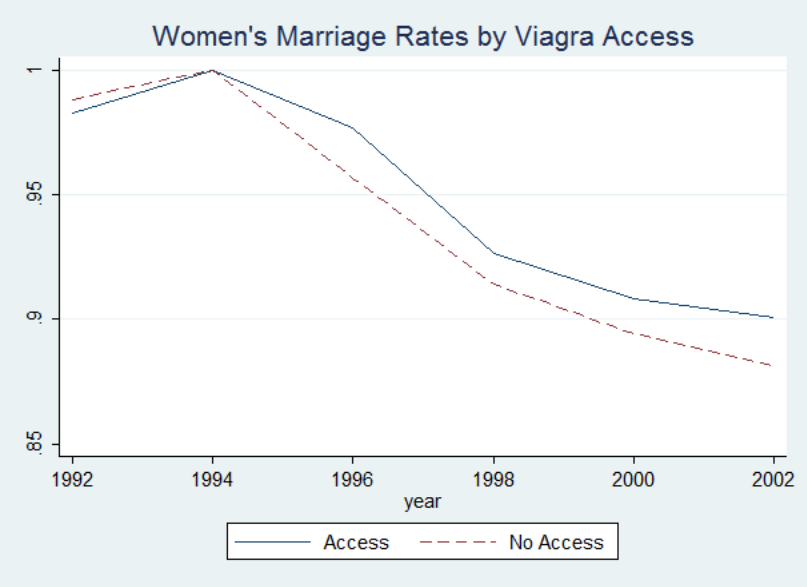


Figure 3.3: Women's Marriage Rates

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