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Accounting for the Decline in Homeownership among the Young

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ACCOUNTING FOR THE DECLINE IN HOMEOWNERSHIP AMONG THE YOUNG

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Abstract

This paper documents that the drop in young homeownership is more persistent among non-college graduates compared to college graduates: while some college graduates postpone home purchasing, non-college graduates are more likely to remain long-term renters. I develop a model showing that the combination of a higher share of college graduates and a widening education-driven income gap accounts for the delayed home purchasing of college graduates and the lack of purchasing among non-college graduates. Exploiting cross-city variation, I find that the mechanism can quantitatively account for the diverging ownership decisions between the two education groups from 1980 to 2019.

Keywords: Housing Tenure Choice, College Share, Household Income, Housing Prices, General Equilibrium Effects

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1 Introduction

The past four decades have witnessed a significant decline in the homeownership rate of households with "heads" aged 25-34. While the aggregate homeownership rate has been stable around 68%, young households saw a 10 percentage point drop in their ownership rate. Previous literature suggests that the drop in young homeownership rate is temporary, i.e., households are postponing the purchase of their first home (Fisher and Gervais, 2011; Anagnostopoulos, Atesagaoglu, and Carceles-Poveda, 2013). Some more recent studies highlight the impact of rising student loans on delaying home purchases by college graduates see e.g. Mezza, Ringo, Sherlund, and Sommer, 2020). I find that while some college graduates postpone buying their first home, a considerable fraction of non-college graduates have become long-term renters.

This paper proposes a mechanism that can largely account for the diverging ownership decisions between college- and non-college-educated households from 1980 to 2010. The mechanism is motivated by the observed changes in the income distribution that have been caused by (i) unbalanced income growth among college graduates; (ii) a rising share of college graduates. Specifically, college graduates have enjoyed an increase in their household income, especially among those that are middle-aged during the past several decades. Meanwhile, non-college graduates have barely seen any growth in their household income. I show these changes, when examined through the lens of a general equilibrium model, can quantitatively account for the delayed purchasing of college graduates and the lack of purchasing among non-college graduates.

An increase in the household income of college graduates drives up the aggregate housing demand for owner-occupied units. As the supply is not perfectly elastic (see e.g. Glaeser, Gyourko, and Saks, 2005), a rise in demand leads to higher equilibrium house prices. As a result, a considerable fraction of households headed by non-college graduates find owning less affordable and become long-term renters. In other words, an increase in the income gap between college and non-college graduates shifts ownership from non-college-educated households to college-educated households. Meanwhile, homeownership has shifted from young to middle-aged college graduates as the middle-aged ones have seen a larger increase in their household income. In the presence of credit constraints, i.e., down payment requirements, young college graduates postpone the purchase of their first home as their income profiles have become steeper. In addition, a growing share of college graduates results in a lower ownership rates for both college and non-college graduates by fueling house price increases, with the downward pressure on ownership for college graduates partially offset by the increase in their household income.

To illustrate the mechanism and to guide the empirical analysis, I develop a stylized three-period tenure choice model which shows that changes in income and college share can affect the ownership decisions of college and non-college graduates in different ways. My model extends the frame-work of Ortalo-Magne and Rady (2006) to allow for two types of households, College and Non-college, to capture the widening gap in their household incomes and the divergence in their ownership decisions. Within each type, households differ in preference towards owning and in the endowment streams which are described by an ability ranking. Conditional on the ability ranking and age, college graduates earn more than non-college graduates. Moreover, the lifetime earning profile for college graduates is steeper than that for non-college graduates. For all households, owning is preferred to renting. The owner-occupied units are in limited supply.

The model yields several testable implications on house prices and homeownership rates of four groups of households (henceforth "the four groups"): young college, young non-college, middle-aged college, and middle-aged non-college. The comparison between young and middle-aged households from the same educational background allows me to distinguish delaying home purchasing from switching to long-term renters. The model implies that, first, house prices are increasing in college share, while homeownership rates of all groups are declining in college share. Second, homeownership rates of non-college graduates are decreasing in the income of college graduates. Third, an increase in the income of middle-aged college graduates lowers the homeownership rate of young college graduates due to the credit constraint, i.e. households cannot borrow against their future income, and therefore are forced to delay home purchases.

To evaluate the empirical relevance of the model and to quantify the contribution of these changes on ownership decisions of college and non-college graduates, I examine cross-city variations in house prices, the share of households headed by college graduates, and homeownership rates and household incomes of the four groups for the largest 161 cities in the United States using data from Census and American Community Survey from 1980 to 2010. I regress local house prices and homeownership rates of the four groups on college share, average household income of the four groups, housing supply elasticity, total number of households and year dummies that are supposed to capture any potential aggregate trends.

Consistent with the model's predictions, I find that: a 1 percentage point increase in households headed by holders of a bachelor degree or above pushes up the average house price by 2.1-2.3 percent. For homeownership rates, a 1 percentage point increase in the share of college-educated households leads to a 0.47-0.70 percentage point drop in the homeownership rate for young non-college graduates, a 0.63-0.84 percentage point drop for young college graduates, a 0.34-0.62 percentage point drop for middle-aged non-college graduates and a 0.31-0.40 percentage point drop for middle-aged college graduates. A 1 percent increase in the average household income of college-educated households is associated with a 0.04-0.14 percentage point drop in the homeownership rate among young non-college graduates, and a 0.03-0.17 percentage point drop among middle-aged non-college graduates. Moreover, a 1 percent increase in the average income of middle-aged college graduates is associated with a 0.18-0.22 percentage point drop in the homeownership rate among young college graduates. The estimated coefficients on the college share and on the household income of the other three groups become smaller and less significant after controlling for local house prices, indicating that growing college share and changing household income of other groups affect homeownership rates mostly through their impact on local house prices, as the mechanism suggests.

Concerns with the empirical analysis include endogeneity and reverse causality of the college share. For instance, higher house prices could induce less-educated households to move to cities with low house prices, resulting in a higher college share. Therefore, I construct an Instrumental Variable (IV) for the college share, which exploits the cross-industry variations in the labor demand growth for college graduates. I construct the predicted college share by interacting the 1970 city-level industry structure with the labor demand growth for college graduates and the non-college graduates in other cities. This Instrument allows me to isolate the impact of increasing college share on local house prices and homeownership rates from alternative explanations.

Consistent with the model's predictions, I find that: a 1 percentage point increase in households headed by holders of a bachelor degree or above pushes up the average house price by 2.3 percent. For homeownership rates, a 1 percentage point increase in the share of college-educated households leads to a 0.70 percentage point drop in the homeownership rate for young non-college graduates, a 0.84 percentage point drop for young college graduates, a 0.62 percentage point drop for middle-aged non-college graduates and a 0.41 percentage point drop for middle-aged college graduates. In addition, homeownership rate of non-college graduates is decreasing in the household income of college graduates. Most importantly, the estimated coefficients on the college share and the household income of the other education group become smaller and less significant after controlling for local house prices, indicating that growing college share and changing household income of other groups affect homeownership rates mostly through their impact on local house prices, i.e. the general equilibrium effect, as the mechanism suggests.

To quantitatively evaluate the impact of the mechanism on ownership decisions for college and non-college gradates, I apply the estimated coefficients on the changes in college share and in the average household income of the four groups to project their impact on homeownership rates of the four groups for all years from 1980 to 2019 for the aggregate economy. The IV estimates do a good job in fitting the trends in homeownership rates for the four groups from 1980 to 2019, which implies that the proposed mechanism can largely account for the diverging ownership decisions between college and non-college gradates. My findings suggest that the low-income non-college graduates become long-term renters due to the high house prices caused by the changes in the income distribution, which implies that they are facing a more severe affordability problem.

This paper offers new insights into the discussion about the drop in the young homeownership rate. Unlike Fisher and Gervais (2011) and Anagnostopoulos, Atesagaoglu, and Carceles-Poveda (2013), who argue that the drop in the young homeownership rate is temporary, I find that the drop in the young homeownership rate is more persistent among less-educated households. Anagnostopoulos, Atesagaoglu, and Carceles-Poveda (2013) argue that young households postpone home purchases due to the delay in marriage and the increase in the income risk. Anagnostopoulos, Atesagaoglu, and Carceles-Poveda (2013) argue that skill-biased technological change towards experience lowers the income-to-house price ratio for the young, but increases it for the old. Consequently, it takes young households longer to save for a down payment. Most recently, Mezza, Ringo, Sherlund, and Sommer (2020) highlight the impact of rising student loans on delaying home purchases for college graduates. The empirical analysis in this paper controls for these potential aggregate trends in marriage, income risks, skill-biased technological change, and the rising student debt by introducing year dummies. My analysis suggests that, in spite of these trends, the change in income distribution caused by the increasing share of college graduates and the widening household income gap between college- and non-college-educated households can account for a large fraction of the observed dynamic in ownership rates for both college and non-college graduates. My results suggest that changes in income distribution have pushed up house prices and resulted in a housing affordability issue among low-income non-college-educated households.

The findings in this paper are consistent with previous work showing that educational attainment has an increasing impact on the propensity of owning (Gyourko and Linneman, 1996, Gyourko and Linneman, 1997, and Segal and Sullivan, 1998). This paper provides a mechanism that rationalizes the growing importance of education attainment on housing tenure choice. In the empirical part, this paper adopts a more Macro approach. I look into the cross-metropolitan variations in homeownership rates, house prices, population share of college graduates and household income. I find that homeownership rates for college graduates are less sensitive to their average household income compared to non-college graduates.

The rest of this paper is organized as follows. Section 2 presents the motivating facts. Section 3 outlines a simple OLG model that illustrates the mechanism. Section 4 describes the empirical exercise. Section 5 concludes.

2 Empirical Evidence

This section documents the stylized facts that motivate the mechanism. First, I present changes in homeownership rates by age for college- and non-college-educated households separately. Second, I provide evidence on the change in the income distribution due to the increasing share of households headed by college graduates and the widening gap in household income between college and non-college graduates.

2.1 Trends in Homeownership Rates: 1976-2015

While the aggregate homeownership rate has been relatively flat since 1976, the homeownership of households with heads aged 25-34 has decreased from 53% to 40% (Figure 1). The young homeownership rate recovered slightly during the 2001-2005 mortgage credit expansion, followed by an even sharper decline after 2006.

FIGURE 1:
U.S. Homeownership Rate by Age: 1976-2015

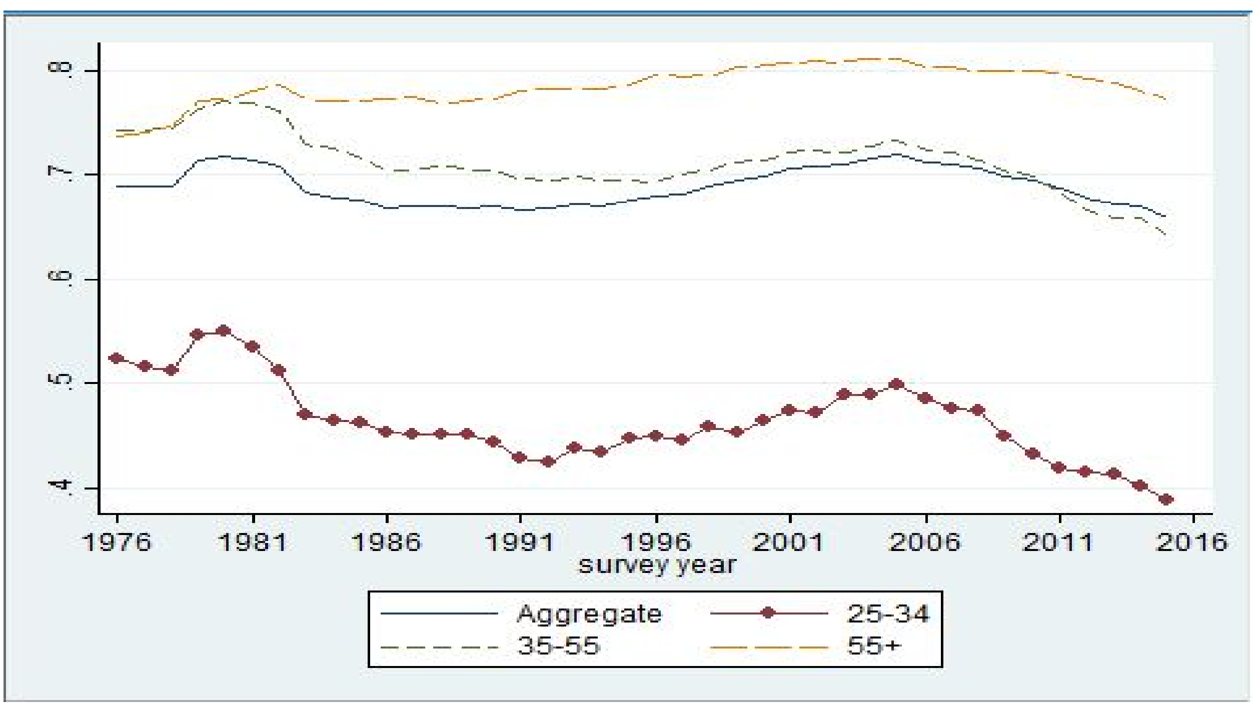


Table 1 presents the homeownership rates by age and by education of the household head. Following the Census Bureau and other researchers (e.g. Fisher and Gervais, 2011), homeownership rates are defined as the number of households living in owner-occupied dwellings divided by the total number of households. Households are identified by the age and education attainment of the household head. College graduates are defined as people who complete four years of college education.

The drop in the young homeownership rate is larger among households headed by non-college graduates. Specifically, households headed by 25-to 29-year-old college graduates see a 7 percentage points decline in their homeownership rate compared to a 15 percentage points drop experienced by households headed by non-college graduates between 1976-2015. The changes in homeownership rates for all age groups from 25-54 are negative. However, there is a noticeable difference in the levels of decline in homeownership rates between college and non-college graduates. For all age groups, the drop in the homeownership rate for non-college graduates is between 1.5 to 3 times as large as the drop for college graduates. Most importantly, 58% (4% out of 7%) of the drop in the homeownership by the young recovers when households reach middle-age (45-54) among college graduates. In contrast, only 33% (5% out of 10%) of the drop in young homeownership recovers when households hit middle-age for non-college graduates. This comparison suggests that while some college graduates postpone home purchases, a considerable fraction of non-college graduates have become long-term renters.

TABLE 1:
Change in Homeownership Rate by Age and Education

Age	25-34	35-44	45-54
Households with Non-College Educated Heads			
1976-1980	0.52	0.70	0.76
2011-2015	0.37	0.53	0.66
Change	0.15	0.17	0.10
Households with College Educated Heads			
1976-1980	0.55	0.79	0.85
2011-2015	0.48	0.73	0.82
Change	0.07	0.06	0.03

Note: Author's own calculation using data from IPUMS-CPS

The cross-sectional analysis above compares homeownership rates of different cohorts. To check the robustness of my main finding, i.e. diverging homeownership decisions between college- and non-college-educated households, I conduct a cross-cohort comparison. Figure 2 plots the age profiles of homeownership by the education of the household head calculated using the CPS data extracted from the Integrated Public Use Microdata Series (IPUMS). We see similar patterns. Among the less-educated households, homeownership profiles of newly born cohorts are flatter compared to the older generations. For households headed by college graduates, newly born cohorts catch up with the older generations in terms of ownership around age 40. The sharp contrast in the ownership profiles confirms the diverging ownership decisions between college and non-college graduates, i.e. while a large fraction of non-college-educated households become long-term renters, some college-educated households merely postpone the transition to ownership.

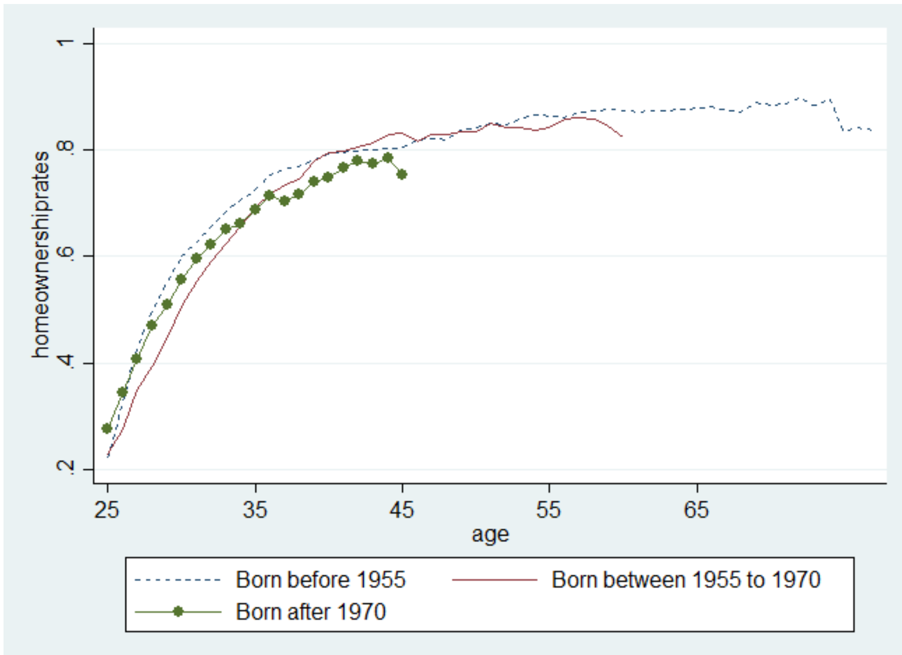
2.2 Trends in Income Distribution

This subsection documents the driving forces behind the changing income distribution. The rise in the college premium and the increase in the number of households headed by college graduates has changed the income distribution substantially since 1980 (see e.g. Goldin and Katz, 2001). As Gyourko and Linneman (1996) and Gyourko and Linneman (1997) suggest, the propensity towards owning increases with household income. Therefore, the change in the income distribution can lead to a reallocation of owner-occupied houses among education (income) and age groups through its impact on house prices.

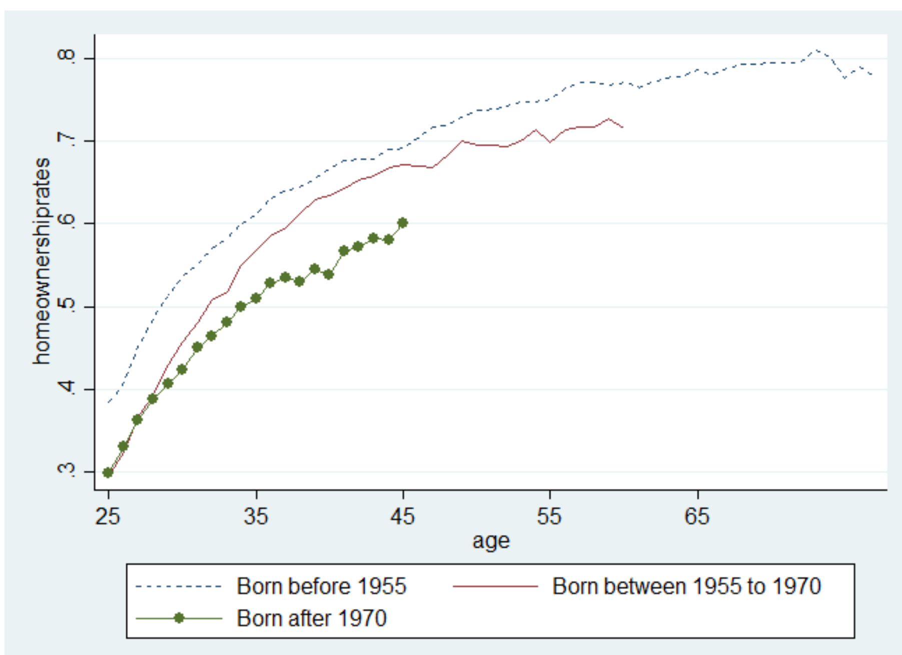
The fraction of households headed by a person with a bachelor's degree or above has more than doubled, climbing from less than 15% to 33% from 1976 to 2015.[1] Meanwhile. the gap in real average household income between college and non-college graduates has risen significantly (see Figure 3). Young households (25-34) and middle-aged households (35-54) constitute prime age buyers in housing markets. Since the household income of non-college-educated households has barely changed, the widening income gap between those with and without college education is mainly driven by the rising household income of college graduates. It is worth noting that middle-aged households headed by college graduates have experienced a larger increase in their household income compared to the young college-educated households. In the following analysis, I show that this steeper earning profile is

[1] Author's calculation using IPUMS.

FIGURE 2:
Homeownership Profile by Education of Household Head



(a) College



(b) Non-College

key to understanding the postponement of house purchases by college graduates.

3 Model

This section presents a model that I use to qualitatively illustrate the impact of the change in the income distribution documented in Section 2.2: (i) an increase in the share of college graduates, (ii) a moderate rise in the household income of young college graduates and (iii) a large increase in the household income of middle-aged college graduates; on house prices and homeownership rates of the four groups.

The model generates several testable implications: (i) an increase in the share of college graduates pushes up the equilibrium house prices and lowers homeownership rates for all groups; (ii) a rise in the household income of college graduates lowers homeownership rates for non-college graduates; and (iii) an increase in the household income of middle-aged households lowers homeownership rates for the young among college graduates. These implications guide my empirical analysis in Section 4.

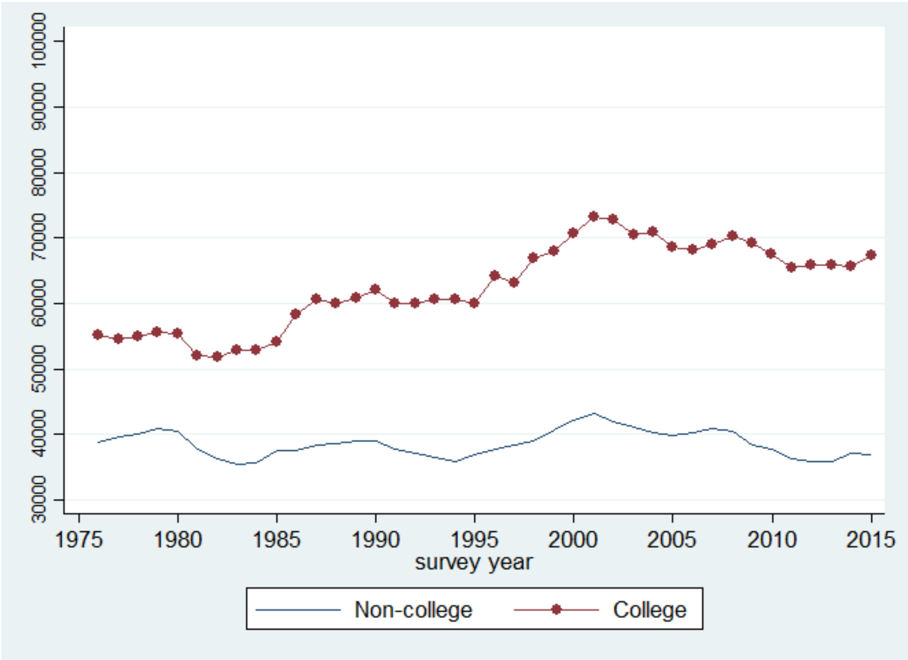
The three-period OLG model extends the framework in Ortalo-Magne and Rady (2006). The model is modified to consider two types of households, college and non-college, to capture the diverging ownership decisions and changes in household income between these two groups. In addition, it allows me to consider the impact of an increase in the fraction of households headed by college graduates. Households within each type differ in the utility premium they derive from living in an owner-occupied house and in their endowment streams, which are characterized by their ability ranking. Conditional on the ability ranking, college graduates earn more than non-college graduates, which is referred to as the "college premium". Owner-occupied houses are in limited supply.

3.1 Population

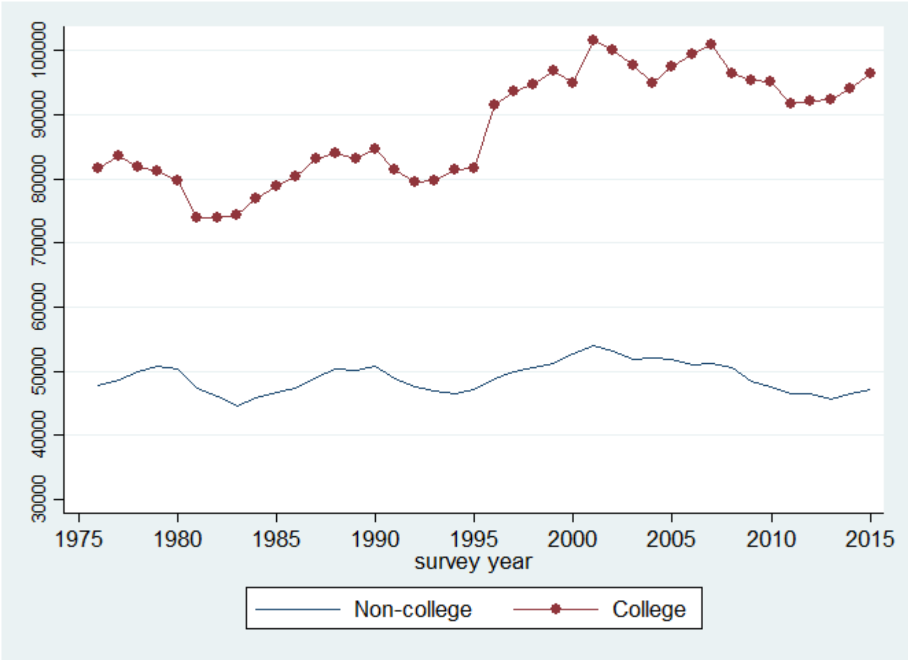
A measure one of agents is born at the start of each period. A fraction κ are college graduates (C), and the remaining $1-\kappa$ are non-college graduates (N). Each agent lives for 3 periods, so the total population in each period is 3.

Within each type (College or Non-college) of each cohort, agents are uniformly distributed

FIGURE 3:
Evolution of Household Income by Age



(a) Household Income (25-34)



(b) Household Income (35-54)

over the unit square. Each agent of type $g \in \{N, C\}$ is identified by the indices $(i, m) \in [0,1] \times [0,1]$ that determine the ability and preference towards owning, respectively. Agents learn their types and indices at the beginning of life. I assume that i is independent of m, such that households of all abilities from all educational backgrounds draw their preference towards owning from the same distribution.[2] College and non-college graduates differ in their endowment stream conditional on their ability ranking.

3.2 Commodities

There is a numeraire consumption good and S units of identical owner-occupied houses. Each house can accommodate one household only, who must own it. There are $3 - S$ units of identical rental units. Housing choices $h \in \{\emptyset, H\}$, where $\emptyset$ stands for renting, of which cost and utility are normalized to 0.

3.3 Endowment

Agents are born with no initial wealth. At age $j = 1$ and 2, agents with (i, m) of type g receive an endowment of $w_j^g(i)$ units of the numeraire goods where the mapping from ability ranking to endowment, $w_j^g : [0,1] \to R_+$, is continuous and monotonically increasing.

3.4 Preference

Following Ortalo-Magne and Rady (2006), I assume a linear utility function.

$$\sum_1^3 c_j + U(h_2, m) + U(h_3, m) \tag{1}$$

$$U(h, m) = \begin{cases} 0, & if \quad h = \emptyset \\ m \triangle & if \quad h = H \end{cases} \tag{2}$$

[2]Relaxing this independence assumption to allow for a positive correlation between ability and preference towards owning will not change my results qualitatively.

$$
\begin{aligned}
s.t. c_1 + s_1 + \mathbb{1}_{h_2=H} P^* &\le w_1^g(i) \\
c_2 + s_2 + \mathbb{1}_{h_2=\emptyset, h3=H} P^* &\le w_2^g(i) + s_1 * r \\
c_3 &\le s_2 * r + \mathbb{1}_{h3=H} P^* \\
c_t &\ge 0, \quad t \in \{1,2,3\}
\end{aligned} \tag{3}
$$

c_t represents the consumption of the numeraire good and $m\triangle$ is the additional utility derived from living in owner-occupied houses, i.e. the ownership premium. Consumption in each period has to be non-negative.

The linear utility implies that all non-housing consumption will be postponed until the last period of life. This feature keeps the model analytically tractable, particularly with respect to the equilibrium house price and the homeownership rates of different groups.

The supply of owner-occupied houses is fixed at S, so that the aggregate homeownership rate is fixed at $S/3$.[3] Households have access to a storage technology for the numeraire good that yields an exogenously given rate of interest $r > 1$.

In each period, there is a competitive market for houses with the equilibrium price P^*. There is no rental market for dwellings and no other asset markets. Households cannot borrow against their future income.

3.5 Timing

Within each period, agents first derive utility from housing. Then they receive an endowment of the numeraire good, after which, they trade in the housing market and finally, they consume the numeraire good.

Households with ability i of type g receive $w_1^g(i)$ at age 1 and $w_2^g(i)$ at age 2. At age 3, households have no labor income and consume their savings. Owners at age 3 sell their house and consume. Denote $W^g(i) = rw_1^g(i) + w_2^g(i)$ as household's lifetime income valued at age 2.

[3] Fixed supply of owner-occupied houses is not critical to my results. As long as the supply is not perfectly elastic, the results hold. It is worth noting the aggregate homeownership rate in the U.S. has been stable at 69%, which supports the fixed supply assumption.

3.6 Assumptions on Endowment Stream

- Fix the ability rank i, college graduates receive more endowments than non-college graduates $w_j^C(i) \geq w_j^N(i)$ for $j = 1, 2$.

- Households experience wage growth as they age. $w_2^g(i) \geq w_1^g(i)$. Consistent with the observation that college graduates have steeper earning profiles than non-college graduates, I assume $w_2^C(i) - w_1^C(i) \geq w_2^N(i) - w_1^N(i)$.

- Following Ortalo-Magne and Rady (2006), I adopt the following convention. Given a continuous and strictly increasing function $w : [0, 1] \rightarrow R_+$, set $w^{-1}(i) = 1 \;\; if \;\; i > w(1), \;\; and \;\; w^{-1}(i) = 0 \;\; if \;\; i < w(0)$.

3.7 Equilibrium

The independence between endowment stream and ownership premium implies that a household's preference towards owning determines whether he/she wants to buy, while the household income determines whether he/she can afford to purchase a house.

As households postpone consumption until the last period, the value of buying a house at the end of the first period and holding it until the last period is the total lifetime income valued at the end of life plus the ownership premium for two periods net of the forgone interest on the equilibrium house price for two periods.

$$V^1(i, m, g) = \begin{cases} W^g(i)r + 2m \bigtriangleup -(r^2 - 1)P^*, & if \;\; w_1^g(i) \geq P^* \\ -\infty \;\; otherwise \end{cases} \tag{4}$$

Similarly, the value of buying a house at the second period is the total life time income valued at the end of life plus the ownership premium for one period net of the forgone interest on the equilibrium price for the second period.

$$V^2(i, m, g) = \begin{cases} W^g(i)r + m \bigtriangleup -(r - 1)P^*, & if \;\; W^g(i) \geq P^* \\ -\infty \;\; otherwise \end{cases} \tag{5}$$

The value of permanent renters is simply the lifetime income valued at the end of life.

$$V^0(i,m,g) = W^g(i)r \tag{6}$$

Households that prefer buying in the first period satisfy $V^1(i,m,g) \geq V^2(i,m,g)$ and $V^1(i,m,g) \geq V^0(i,m,g)$. It implies that at the end of period 1, households with $i \geq w_1^{g^{-1}}(P^*)$ and $m \geq m_1^*$ become owners, where $m_1^* = \frac{r(r-1)P^*}{\triangle}$.

Households that postpone buying a house to the end of period 2 are characterized as $i \geq W^{g^{-1}}(P^*)$ and $m \geq m_2^*$, where $m_2^* = \frac{(r-1)P^*}{\triangle}$.

The lower income cutoff among the second-period buyers $w_1^{g^{-1}}(P^*) > W^{g^{-1}}(P^*)$ implies that some of the households postpone buying due to credit constraints. Households with $m \geq m_1^*$ always prefer to buying a house in the first period. However, households without enough endowment have to save for one more period.

Households that prefer buying a house at the end of the first period also find it optimal to hold it in the second period. As there is no uncertainty on house prices or income, owner-occupied houses are modeled as a consumption good. Thus, the cost of owning per period is simply the forgone interest on the house price. Households that buy a house are those with a high attachment to owning and therefore would prefer to hold it until the last period of life.

The model has two types of households, college and non-college, and three ages for each type. In total, I have 6 groups. Because households buy house at the end of age 1 and age 2, homeownership rates for the four groups are calculated: young college, young non-college, middle-age college, and middle age non-college.

Lemma 1 *There is a unique steady-state equilibrium. The price of houses P^* solves*

$$\begin{aligned} S =& (1-\kappa)(1-m_1^*)(1-w_1^{N^{-1}}(P^*)) + (1-\kappa)(1-m_2^*)(1-W^{N^{-1}}(P^*)) \\ & \kappa(1-m_1^*)(1-w_1^{C^{-1}}(P^*)) + \kappa(1-m_2^*)(1-W^{C^{-1}}(P^*)) \end{aligned} \tag{7}$$

Given the uniform distribution of ability and preference towards owning, steady state homeownership rates for young non-college, young college, middle-age non-college, and middle-

age college are $\{n_1^N, n_1^C, n_2^N, n_2^C\}$

$$n_1^g = (1 - m_1^*)(1 - w_1^{g^{-1}}(P^*)), \quad g \in \{N, C\} \tag{8}$$

$$n_2^g = (1 - m_2^*)(1 - W^{g^{-1}}(P^*)), \quad g \in \{N, C\} \tag{9}$$

The uniqueness of the equilibrium can be proven by showing the right-hand side of equation 7 is strictly decreasing in P^* as both m^* and $w^{g^{-1}}$ are increasing in P^*.

Proposition 1 *Holding the income of each group constant, an increase in the college share (rising* κ*) pulls up the equilibrium housing price and therefore reduces homeownership rates for all groups* $\frac{\partial P^*}{\partial k} > 0$, $\frac{\partial n_i^g}{\partial k} < 0$ *for* $i = \{1, 2\}$ *and* $g = \{N, C\}$.

Rising college share drives up the aggregate demand for owner-occupied houses for a given level of house price, because college graduates with high income are more likely to be able to afford a house. As long as the housing supply is not perfectly elastic, growing aggregate demand reflects itself through the equilibrium housing price.

Proposition 2 *Holding the share of college graduates fixed, a rise in the income of college (non-college) graduates leads to an increase in the equilibrium housing price, an increase in the homeownership rate of college (non-college) graduates and a decrease in the homeownership rate for both young and middle-aged non-college (college) graduates.*

An increase in the endowment of middle-age college-(non-college-)educated households lowers the homeownership rate for the young among college-(non-college-)graduates.

A rise in the endowment of young college- (non-college-) educated households increases the homeownership rate of themselves. The impact on the homeownership rate for middle-aged college-(non-college-)educated households is uncertain.

A rise in endowment of one type, $g \in \{N, C\}$, leads to an increase in the housing demand of that type, as a larger fraction of households from that type can afford to buy a house. Holding the housing supply unchanged, the housing price has to adjust in the presence of excess demand. As a result, the equilibrium house price increases to clear the housing market. The homeownership rate drops for the other type whose income does not change.

As the aggregate homeownership rate is fixed at $S/3$, the homeownership rate for the type that experiences an income growth increases at the expense of a drop in homeownership of the other type.

Within each type, a rise in the endowment of middle-age households pushes up the equilibrium house price. Both m_1^* and $w_1^{g^{-1}}$ increase. Because young households cannot borrow against future income, an increasing fraction of them choose to postpone house purchases.

Within one type, an increase in the endowment of young households leads to an increase in the equilibrium house price. As a result, m_2^* increases, indicating that less middle-aged households find owning attractive. Meanwhile, the life time income $W^g(i)$ increases, suggesting that owning is more affordable. The direction of overall impact depends on these two forces.

The qualitative impact of increasing college share, rising household income of young college households (YC), and an even bigger rise in household income of middle-aged college households (MC) on homeownership rates of the four groups is summarized in Table 2.[4] A combination of the three changes predicts a drop in the homeownership rate for both young and middle-aged households among non-college graduates, which indicates that some non-college graduates choose to become long-term renters. Its impact on college graduates is undetermined. When the increase in the household income of middle-aged households is large enough, we should see some college graduates postponing the purchase of their first home.

TABLE 2:
Impact of Changing Income Distribution on Homeownership Rates

Homeownership Rate	↑ College Share	↑ HH Income of YC	↑↑ HH Income of MC	Overall
Young College	↓	↑	↓	?
Young Non-College	↓	↓	↓	↓
Middle Age College	↓	?	↑↑	?
Middle Age Non-college	↓	↓	↓	↓

In the next section, I apply the model to data to quantify the impact of the change in

[4]The comparative statics mainly focuses on the change in income of college graduates as that is what we see in the data. The propositions apply for non-college graduates in the same way.

the income distribution on house prices and homeownership rates of the four groups.

4 Empirical Analysis

I use cross-city variation for the largest 161 cities in the U.S. to verify Proposition 1 and Proposition 2 and to quantify the impact of the change in income distribution on the ownership decision for college and non-college graduates.[5] I regress house prices and homeownership rates of the four groups on the share of households headed by college graduates, average household income of the four groups, local number of households, housing supply elasticity and year dummies. To control for the endogeneity issue and reverse causality, I adopt an instrumental variable that predicts share of college graduates using the city-level industry structure in the year 1970, aggregate labor demand growth, and labor demand growth for college graduates in other cities from 1980 to 2010.[6]

I find that, consistent with the propositions, cities with more college graduates tend to have higher house prices and lower homeownership rates for the four groups. The homeownership rate of one type (College or Non-college) is increasing in its own household income and decreasing in the household income of the other type. Moreover, an increase in the household income of middle-age households lowers the homeownership rate for the young among college graduates.

I apply the estimates to quantify the impact of the changes in college share and household income of the four groups on aggregate homeownership rates for the four groups. I find that these changes can largely account for the diverging ownership decisions: delayed home purchasing of college graduates and the switch towards renting by non-college graduates.

[5] Appendix A.1 provides a full list of the cities in OLS and IV estimation.

[6] I use cross-city variation instead of cross-time variation to conduct the empirical analysis due to the concern that the economy was not in a steady state during the past several decades. For instance, a considerable fraction of middle-aged households in 1990s bought houses in 1980s. As a result, the change in homeownership rate of middle-aged households from 1990 to 2000 may partially reflect housing price change from 1980 to 1990, which could be problematic as housing prices display mean reversion in the long-run (Glaeser and Nathanson, 2017).

4.1 Data Description

I use data from the 1970, 1980, and 1990 waves of the Census and the 2000 and 2010 waves of the American Community Survey (ACS), taken from Integrated Public Use Microdata Series (IPUMS)-USA, aggregated to the metropolitan area level.[7] I obtain information on the mean/median house values of owner-occupied houses, household income, age and education of household heads, and the geographic location of residence. All dollar values are converted into constant 1999 dollars using the Consumer Price Index (CPI). For the analysis across metropolitan areas, I use a sample of the largest 161 cities that have at least 30 observations in each of the four groups for every year for the OLS estimation and 108 cities for the IV estimation.[8]

The average self-reported house value in a city is used as the representation of local house prices in the main analysis. To check the robustness of the results, two other measurements of housing prices are used: the median local house price that is self-reported and the Freddie Mac Conventional Mortgage Home Price Index that is based on repeated sales.

4.2 Summary Statistics

Table 3 presents the summary statistics of the 161 metropolitan areas for 1980 and 2010. During this period, the (unweighted) average share of college-educated households increased from 20.5% to 31%, with a standard deviation that increased from 0.058 to 0.074. The average house price went up, as did the cross-city variation in mean house prices. Similar to the aggregate economy, we can see a larger and more persistent drop in homeownership rates among the non-college graduates compared to college graduates. While non-college graduates experienced a decline in their average household income, college graduates enjoyed an increase in their average household income, especially among the middle-aged ones.

[7] Census 1970 is used to construct the Instrumental Variable.

[8] To calculate the homeownership rate of one group, I need enough observations for each group. So I exclude cities with less than 30 observations in a group for at least one year. I conduct robustness using metropolitan areas with more than 40 (20) households in each group. Despite ending up with fewer (more) areas, I obtain similar results.

TABLE 3:
Summary Statistics

		1980		2010	
Variable	Obs	Mean	Std. Dev	Mean	Std. Dev
Fraction of college educated households	161	0.205	0.058	0.314	0.0739
Homeownership rate YNC	161	0.510	0.081	0.360	0.090
Homeownership rate YC	161	0.584	0.082	0.542	0.118
Homeownership rate MNC	161	0.747	0.061	0.627	0.073
Homeownership rate MC	161	0.842	0.042	0.810	0.061
Ln Average HH income YNC	161	10.56	0.093	10.30	0.137
Ln Average HH income YC	161	10.82	0.098	10.85	0.158
Ln Average HH income MNC	161	10.86	0.10	10.67	0.117
Ln Average HH income MC	161	11.27	0.071	11.34	0.129
Ln Total Number of HHs	161	11.92	0.99	12.46	0.96
Ln Average House price	161	11.76	0.253	12.03	0.370
Saiz's supply elasticity	161	2.13	1.099		

4.3 Verification of Propositions

I estimate the following regressions using the panel of 161 metropolitan areas over four decades from 1980 to 2010.

$$log(P_{j,t}) = \beta_0 + \beta_1 \kappa_{j,t} + \sum_g \beta_2^g log(I_{j,t}^g) + \beta_3 E_j + \beta_4 log(N_{j,t}) + \delta_t + \epsilon_{j,t} \tag{10}$$

$$OR_{j,t}^g = \alpha_0^g + \alpha_1^g \kappa_{j,t} + \alpha_2^g log(I_{j,t}^g) + \sum_{g' \neq g} \alpha_{3,g'}^g log(I_{j,t}^{g'}) + \alpha_4 E_j + \alpha_5 log(N_{j,t}) + \delta_t + \epsilon_{j,t} \tag{11}$$

Equation 10 and 11 detail the primary specification used in testing Proposition 1 and Proposition 2 from the model. Equation 10 focuses on the equilibrium house price, and Equation 11 is for homeownership rates of the four groups. $P_{j,t}$ is the real average house price in metropolitan area j at time t. $OR_{j,t}^g$ stands for the homeownership rate of group g in metropolitan j at time t. $\kappa_{j,t}$ is the share of households headed by someone with a college degree or above in metropolitan j at time t. $I_{j,t}^{g}$ is the real average household income of group g in metropolitan area j at year t. I examine four groups defined by age and education of the household head: young college-educated household (YC), young non-college-educated household (YNC), middle-aged college-educated household (MC), and middle-aged non-college-educated household (MNC). $N_{j,t}$ is the total number of households in metropolitan area j at time t. δ_t is a year dummy that is supposed to capture any potential aggregate shocks, such as a drop in the marriage rate, an increase in the income volatility, an expansion of mortgage credit, a change in consumer confidence, and/or a trend. E_j is local housing supply elasticity provided by Saiz (2010), which also contains information on amenities and regulations.

4.3.1 OLS

Table 4 reports the OLS results. Consistent with Proposition 1, cities with a higher share of households headed by college graduates tend to have higher house prices and lower homeownership rates for all groups. The homeownership rate of one type is generally positively correlated with the average income of its own group and negatively correlated with the average income of the other type, as Proposition 2 suggests. Moreover, an increase in the household income of middle-age households lowers the homeownership rate for the young within the same type. In addition, cities with high housing supply elasticity tend to have lower house prices and higher homeownership rates.

The mechanism suggests that holding the household income fixed for non-college graduates, rising college share and increasing household income of college graduates affect homeownership rate of non-college graduates through the general equilibrium effect, i.e. their impact on the equilibrium house prices. To test the importance of the general equilibrium effect, I introduce the city-level average house price into the homeownership rate regressions in columns (6)-(9). The estimates on the share of college-educated households become smaller in magnitude and less significant, as do the estimates on the average household income of other groups. In other words, the rising share of college graduates and the increasing household income of college graduates affect homeownership rates of non-college graduates through their impact on local house prices, as the model suggests.

TABLE 4:
OLS Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$log(P)$	OR^{YNC}	OR^{YC}	OR^{MNC}	OR^{MC}	OR^{YNC}	OR^{YC}	OR^{MNC}	OR^{MC}
κ	2.053***	-0.474***	-0.632***	-0.335***	-0.311***	-0.00809	-0.353***	0.0661	-0.0733*
	(0.142)	(0.0515)	(0.0608)	(0.0429)	(0.0345)	(0.0510)	(0.0690)	(0.0427)	(0.0396)
$log(I^{YNC})$	0.434***	0.222***	0.0352	-0.0304	-0.0118	0.321***	0.0943*	0.0544	0.0384
	(0.141)	(0.0505)	(0.0528)	(0.0387)	(0.0277)	(0.0438)	(0.0544)	(0.0366)	(0.0316)
$log(I^{YC})$	0.355***	-0.0402	0.330***	-0.0494	-0.0343	0.0403	0.378***	0.0199	0.00679
	(0.0792)	(0.0324)	(0.0408)	(0.0300)	(0.0224)	(0.0268)	(0.0388)	(0.0251)	(0.0206)
$log(I^{MNC})$	0.585***	0.0495	0.126**	0.276***	0.133***	0.182***	0.205***	0.390***	0.201***
	(0.135)	(0.0576)	(0.0621)	(0.0454)	(0.0351)	(0.0512)	(0.0617)	(0.0401)	(0.0342)
$log(I^{MC})$	0.0196	-0.117**	-0.222***	-0.134***	0.0714**	-0.112***	-0.219***	-0.131***	0.0737***
	(0.117)	(0.0502)	(0.0552)	(0.0407)	(0.0311)	(0.0413)	(0.0501)	(0.0326)	(0.0279)
$log(P)$						-0.227***	-0.136***	-0.195***	-0.116***
						(0.0128)	(0.0207)	(0.0115)	(0.0127)
$log(N)$	-0.0144	-0.00824**	-0.00954**	-0.00952**	-0.00598**	-0.0115***	-0.0115***	-0.0123***	-0.00764***
	(0.0120)	(0.00417)	(0.00459)	(0.00371)	(0.00303)	(0.00310)	(0.00404)	(0.00287)	(0.00250)
Elasticity	-0.115***	0.0223***	0.0217***	0.0174***	0.0104***	-0.00382	0.00599*	-0.00505**	-0.00291
	(0.00897)	(0.00304)	(0.00335)	(0.00235)	(0.00210)	(0.00292)	(0.00343)	(0.00225)	(0.00194)
1990.year	-0.0908***	-0.0388***	-0.0801***	-0.0391***	-0.0384***	-0.0594***	-0.0925***	-0.0568***	-0.0489***
	(0.0238)	(0.00928)	(0.00860)	(0.00760)	(0.00519)	(0.00743)	(0.00840)	(0.00607)	(0.00469)
2000.year	-0.0682***	-0.00175	-0.0238**	-0.0120	-0.0119*	-0.0172*	-0.0331***	-0.0253***	-0.0198***
	(0.0249)	(0.0109)	(0.0118)	(0.00862)	(0.00618)	(0.00912)	(0.0112)	(0.00725)	(0.00567)
2010.year	0.251***	-0.0157	0.0687***	-0.0231*	0.0211**	0.0412***	0.103***	0.0259**	0.0501***
	(0.0374)	(0.0163)	(0.0175)	(0.0126)	(0.00932)	(0.0146)	(0.0173)	(0.0120)	(0.00960)
Constant	-3.236***	-0.476	-2.024***	0.267	-0.799***	-1.211***	-2.465***	-0.365	-1.174***
	(1.065)	(0.395)	(0.424)	(0.295)	(0.238)	(0.312)	(0.393)	(0.239)	(0.215)
Observations	644	644	644	644	644	644	644	644	644
R-squared	0.734	0.491	0.487	0.476	0.295	0.669	0.544	0.672	0.452

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To account for potential correlations across the error terms in the ownership equation estimation, I also run Seemingly Unrelated Regressions (SUR). The results are quantitatively similar to regular OLS results and are represented in Appendix A.2.

4.3.2 IV Results

Standard OLS regression could be subject to the omitted-variable bias or reverse causality. For instance, higher house prices could induce less educated households to move to other cities, resulting in a higher college share (Gyourko, Mayer, and Sinai, 2013). In this case, the OLS estimator could be downward biased in the price equation estimation.

I control for these possibilities using an instrumental variable (IV), in which I use the industry structure in the year 1970, total labor demand growth and the labor demand growth for college graduates in other cities to project the college share in one city for 1980-2010. The instrumental variable exploits the cross-industry variations in the labor demand growth for college graduates. It requires that the industry structure in 1970 is independent of the housing market conditions in the following years.

The instrumental variable is constructed in two stages. In the first stage, I use Equation 12 to construct the predicted local labor demand for college graduates $Z_{j,t}$

$$Z_{jt} = \sum_{h}^{41} n_{h,j,1970} \times (n_{h,-j,t}/n_{h,-j,1970}) \tag{12}$$

Where $n_{h,j,t}$ is the number of college-educated workers in industry h, city j, year t, $n_{h,-j,t}$ is the number of college workers in industry h and year t, excluding city j. The first stage uses the change in the number of college workers in other cities adjusted by local industrial college employment in the base year to predict the local labor demand for college graduates in other years.

Predicted total local labor demand $L_{j,t}$ is constructed in a similar way in the second stage.

$$L_{jt} = \sum_{h}^{41} l_{h,j,1970} \times (l_{h,-j,t}/l_{h,-j,1970}) \tag{13}$$

Where $l_{h,j,t}$ is the number of workers, including both college and non-college graduates, in industry h, city j, year t, $l_{h,-j,t}$ is the number of workers in industry h and year t, excluding city j.

The Bartik Instrument is defined as the predicted college share, i.e. the ratio between predicted local demand for college graduates and predicted aggregate local labor demand.

$$B_{jt} = \frac{Z_{jt}}{L_{jt}} \tag{14}$$

I use two-stage estimation. In the first stage, I regress the share of college-educated households on the instrument, the average household income of all groups, housing supply elasticity, the number of households, and year dummies. The first-stage regression result is reported in the last column of Table 5. In the second stage, I regress the variables of interest, i.e., local house prices and homeownership rates of the four groups, on the predicted fraction of college-educated households, average household income of the four groups, housing supply elasticity, the number of households, and year dummies.

As the construction of the Instrument variable requires the industry structure in 1970. I use the 1-in-100 national random sample of the population of which the smallest identifiable geographic units are metropolitan areas. In order to construct the employment of different industries for both college and non-college graduates, cities without enough observations in all of the 41 industries for both education groups are dropped. Therefore, I end up with a smaller sample size in the IV estimation. To make the OLS results and IV results more comparable, I use the sample of 107 cities to run the OLS regressions. Appendix A.3 reports the results. The estimates are quantitatively similar to the ones presented in Table 4.

The IV results are reported in Table 5. The first-stage estimation result is reported in the last column. The F statistic is 713.485, rejecting the weak instrument null hypothesis. For the price equation, the IV estimates are similar to the OLS estimates. A 1 percentage point increase in the share of college-educated households leads to a 2.3% increase in average local house prices. In terms of the ownership estimations, IV estimators are larger in magnitude than the OLS estimators, especially for college-educated households. A 1 percentage point increase in the share of college-educated households leads to a 0.70 percentage point drop in homeownership rate among young non-college-educated households, a 0.84 percentage point drop in homeownership rate for young college-educated households, a 0.62 percentage point drop in homeownership rate for middle-aged non-college-educated households, and a 0.41 percentage point drop in homeownership rate among middle-aged college-educated households.

In the ownership rate regressions, estimated coefficients on the average income of the other type are negative and the estimated coefficient on the household income of its own group is positive, which is consistent with Proposition 2. For instance, a 1 percent increase in the household income of young college graduates lowers the ownership of young non-college graduates by 0.145 percentage point and middle-aged non-college graduates by 0.177 percentage point. In addition, a 1 percent increase in the household income of middle-aged college graduates lowers the ownership of young college graduates by 0.177 percentage point.

A comparison of the coefficients on income of college and non-college households reveals that in general, homeownership rates of college graduates are less sensitive to the change in their current income, which suggests the impact of household income on ownership rate might not be linear, most likely due to the down payment requirement.

Some of the year fixed effects are significant, suggesting the existence of time trends. The estimated coefficients on year dummies differ across groups, indicating that the trends vary across groups. For the two time-related factors that are well-discussed in the literature, declining marriage rates and mortgage credit expansion, previous studies suggest that changes in these two factors may differ across groups. For instance, Goldin and Katz (2001) argue that marriage is increasingly becoming a province of the most educated women. For the impact of changes in credit conditions, Mian and Sufi (2009) suggest that the mortgage credit expansion is concentrated in subprime ZIP codes with sharply declining relative income growth. Although they do not divide households by the education of the household head, research on the skill-biased technological change (see, Katz, Autor, Ashenfelter, and Card, 1999, for example) indicates that households with negative income growth are likely to be less educated.

Declining marriage rates and credit expansions have opposite impacts on homeownership rates. Declining marriage rates lower homeownership rates Fisher and Gervais (2011).[9]

[9] The cross-sectional variation in marriage rates is not big enough to test the impact of changing marriage

Meanwhile, relaxing credit constraints boosts homeownership. The negative impact dominates through 1990 to 2000. From 2000 to 2010, the positive impact takes over as we see a significant positive coefficient on the 2010 year dummies on the homeownership rates.

Note that in the price equation estimations, the IV estimate on college share is larger than the OLS estimate, which suggests that the omitted variable is negatively correlated with the college share. One possible explanation is that higher house prices could induce less educated households to move to other cities, resulting in a higher college share (Gyourko, Mayer, and Sinai, 2013).

4.4 Robustness

In addition to the average house prices, two measurements of housing prices are commonly used: the median house price reported by owners and the Freddie Mac Conventional Mortgage Home Price Index (CMHPI).[10] Compared to the mean house price, the median house price is less likely to be affected by extreme values but it may overlook the increasing demand in the high quality market. According to Goodman and Ittner (1992), the self-reported house value is subject to measurement errors. Therefore, I also run the regressions using CMHPI based on repeated sales to approximate house prices. It controls for quality by holding constant property type and location, but it may overlook the price of newly built houses. To check the robustness of the results and to investigate the impact of changing income distribution across markets with different housing qualities, I run the price regression using the median house price and CMHPI. Table 6 reports the OLS and IV results.

The impact of increasing college share on local house prices is robust with respect to different measurements of house prices. It is worth noting that the increasing college share has a similar impact on local median price compared to local average house price. Its impact on the CMHPI is significantly smaller. A 1 percentage point growth in college share increases CMHPI by 1.94%, 17% lower than its impact on the median or mean house price. As CMHPI

rates on homeownership rates. Meanwhile, the change in marriage rates over time can be largely captured by the time dummies. When I regress marriage rates on time dummies, I find more than 70% of variation in the marriage rate can be explained.

[10]CMHPI is combined with the median single-family home values from the 2000 Census to make the cross metropolitan areas comparison possible.

TABLE 5:
IV Regression Results

	$log(P)$	OR^{YNC}	OR^{YC}	OR^{MNC}	OR^{MC}	κ
κ	2.312***	-0.700***	-0.843***	-0.621***	-0.405***	
	(0.237)	(0.0907)	(0.0966)	(0.0784)	(0.0598)	
Bartik						0.652***
						(0.0255)
I^{YNC}	0.442***	0.277***	0.0908	-0.00849	-0.0266	-0.0383
	(0.164)	(0.0628)	(0.0669)	(0.0543)	(0.0414)	(0.0268)
I^{YC}	0.550***	-0.145***	0.158***	-0.177***	-0.100***	-0.0780***
	(0.126)	(0.0483)	(0.0515)	(0.0418)	(0.0319)	(0.0197)
I^{MNC}	0.604***	0.0872	0.161**	0.335***	0.154***	0.138***
	(0.198)	(0.0759)	(0.0809)	(0.0657)	(0.0501)	(0.0309)
I^{MC}	-0.0374	-0.0744	-0.177***	-0.0215	0.111***	0.114***
	(0.160)	(0.0612)	(0.0652)	(0.0529)	(0.0404)	(0.0247)
N	-0.0297**	-0.00304	0.00159	-0.00457	-0.00318	0.00424**
	(0.0123)	(0.00469)	(0.00500)	(0.00406)	(0.00310)	(0.00197)
Elasticity	-0.135***	0.0301***	0.0335***	0.0228***	0.0173***	0.00100
	(0.00912)	(0.00349)	(0.00372)	(0.00302)	(0.00230)	(0.00151)
1990.year	-0.0903***	-0.0178*	-0.0498***	-0.0223**	-0.0255***	-0.00120
	(0.0282)	(0.0108)	(0.0115)	(0.00934)	(0.00712)	(0.00466)
2000.year	-0.0938***	0.0261**	0.00574	0.00696	-0.000569	0.00239
	(0.0340)	(0.0130)	(0.0139)	(0.0112)	(0.00858)	(0.00557)
2010.year	0.239***	0.0366*	0.119***	0.0246	0.0360***	0.0439***
	(0.0495)	(0.0190)	(0.0202)	(0.0164)	(0.0125)	(0.00727)
Constant	-4.825***	-0.847*	-1.761***	-0.517	-0.627*	-1.545***
	(1.338)	(0.512)	(0.546)	(0.443)	(0.338)	(0.192)
Observations	428	428	428	428	428	428

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

only measures housing price based on repeated sales, it may overlook the price of newly built houses. The results indicate that college graduates with high lifetime incomes may prefer newly built houses with better quality. In other words, the impact of an increasing college share on housing prices is not uniform across markets with different housing qualities. It has a larger impact on newly built houses of better qualities.

TABLE 6:
Robustness Check

	CMHPI-OLS	CMHPI-IV	Median House Price-OLS	Median House Price-IV
κ	1.914***	2.088***	2.070***	2.417***
	(0.202)	(0.272)	(0.196)	(0.261)
I^{YNC}	0.629***	0.649***	0.412**	0.451**
	(0.192)	(0.190)	(0.177)	(0.181)
I^{YC}	0.598***	0.638***	0.525***	0.604***
	(0.136)	(0.146)	(0.125)	(0.139)
I^{MNC}	0.790***	0.732***	0.933***	0.816***
	(0.227)	(0.229)	(0.206)	(0.219)
I^{MC}	-0.109	-0.159	-0.204	-0.304*
	(0.194)	(0.185)	(0.173)	(0.176)
N	-0.0508***	-0.0537***	-0.0357**	-0.0416***
	(0.0170)	(0.0141)	(0.0178)	(0.0135)
Elasticity	-0.145***	-0.145***	-0.144***	-0.143***
	(0.0111)	(0.0106)	(0.0110)	(0.0101)
1990.year	-0.0293	-0.0352	-0.0589*	-0.0706**
	(0.0333)	(0.0326)	(0.0314)	(0.0311)
2000.year	-0.0105	-0.0181	-0.0909***	-0.106***
	(0.0363)	(0.0392)	(0.0320)	(0.0375)
2010.year	0.250***	0.228***	0.257***	0.213***
	(0.0553)	(0.0570)	(0.0464)	(0.0546)
Constant	-8.386***	-7.824***	-5.954***	-4.830***
	(1.421)	(1.540)	(1.323)	(1.476)
Observations	424	424	428	428
R-squared	0.717		0.733	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.5 Effects of Changing Income Distributions on Homeownership Rates

4.5.1 Decompostion

I use the IV estimates to project the impact of increasing college share and widening gap in the household income between college- and non-college-educated households that occurred between 1980 to 2010 on the homeownership rates of the four groups. Specifically, I apply the estimated coefficients from the IV estimation to the change in college share and changes in the average household income of the four groups to project their impact on homeownership rates since 1980 on the national level.[11]

Table 7 presents the results. The increasing share of households headed by bachelors can account for over half of the observed changes in homeownership rates for all groups. Rising income partially alleviates the downward pressure on homeownership among college graduates. The increasing share of college graduates combined with the changes in household income tend to over-predict the drop in homeownership rates, indicating the possibility that relaxing mortgage credit constraints mitigates the downward pressure on homeownership rates caused by the change in the income distribution.[12]

4.5.2 Projections: 1980 to 2019

In this section, I extend the projection to all years from 1980 to 2019. I use the IV estimates to project the impact of the change in income distribution caused by increasing college share and changing income of college- and non-college-educated households on the homeownership rates of the four groups for each single year from 1980 to 2018 on the national level. Note that in the empirical analysis, I only use data for four years (1980, 1990, 2000, and 2010). Therefore this exercise includes both in-sample and out-of-sample projections.

The data used in this section comes from the Current Population Survey (CPS). CPS provides household level data on household income, ownership status, and age and education

[11]Coefficients not statistically significant are treated as 0.

[12]Recall that I include time dummies to capture potential time trends in the regression. Time dummies are not applied to the decomposition.

TABLE 7:
Effects of Changing Income Distribution on Homeownership Rates

	Observed			Predicted by the model			
	1980	2010	△ 2010-1980	↑ college share	Own Income Change	Income Change Other	Total
Young Non-College	0.51	0.36	-0.15	-0.084	-0.061	-0.0145	-0.16
Young College	0.55	0.50	-0.061	-0.10	0.016	-0.049	-0.13
Middle Age Non-College	0.73	0.62	-0.11	-0.075	-0.054	-0.018	-0.15
Middle Age College	0.82	0.79	-0.02	-0.05	0.0144	-0.035	-0.07

of the household head.[13] For each year, I compute the homeownership rates, the average household income of each of the four groups, and the share of households headed college graduates.

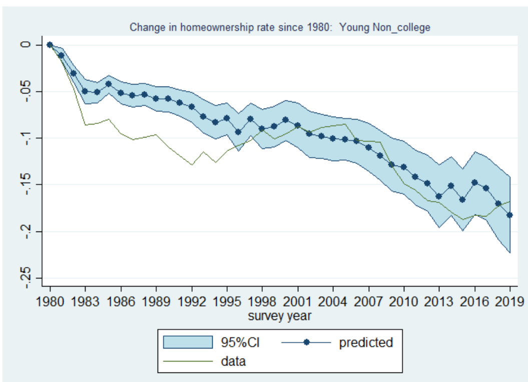
Figure 4.5.2 presents the results. Overall, the model captures the trends in homeownership rates of the four groups both for in-sample test and for the out-of-sample projection, which suggests that changes in the income distribution can account for the observation that while college graduates postpone home purchases, a large fraction of non-college graduates have become long-term renters as owning becomes less affordable. In general, the model over-predicts homeownership rates for all groups between 1980 and 1990 and under-predicts homeownership rates at the beginning of the 2000s. One possible explanation is that the high inflation rate at the beginning of 1980s made owning more attractive (see, e.g. Poterba, 1984). The following adjustments in the inflation rate lowered homeownership rates for all groups. Meanwhile, the mortgage credit expansion in the early 2000s reduced the cost of mortgage for households and led to an increase in homeownership rates for all groups. The large spikes in the observed homeownership rates for young college graduates suggest that their housing tenure choice decisions are more vulnerable to macroeconomic conditions.

5 Conclusion

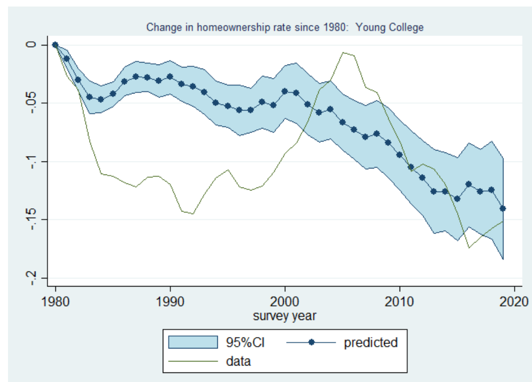
This paper finds that the drop in young homeownership rate is more persistent among less-educated households. While a considerable fraction of college-educated households are postponing home purchases, many non-college-educated households find owning less attractive and remain as long-term renters. My analysis suggests that the changing income distribution caused by a growing numbers of college graduates and the rising household income of college graduates can account for the diverging ownership decisions between these two groups. The changing income distribution pushes up house prices and lowers homeownership rates for all groups. The increasing college premium partially alleviates the decline in homeownership rate among the college graduates, while non-college graduates without any income growth

[13] The sample size in CPS is much smaller than that in the Census and ACS. That is the main reason that I only use CPS to do aggregate analysis.

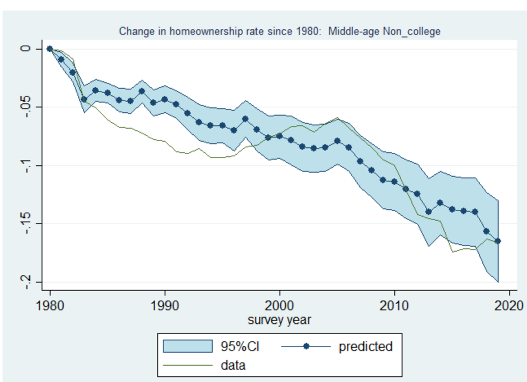
FIGURE 4:
Projected Homeownership Rates: 1980-2019



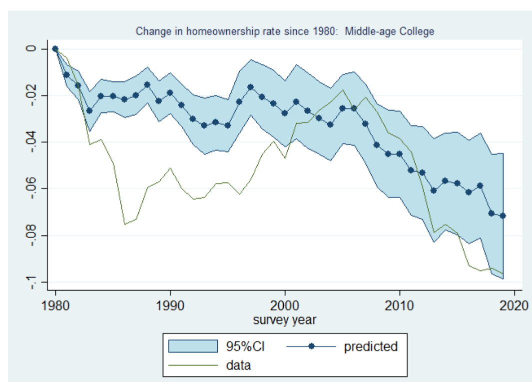
(a) Homeownership Rate: Young Non-college



(b) Homeownership Rate: Young College



(c) Homeownership Rate: Middle Age Non-college



(d) Homeownership Rate: Middle Age College find owning less affordable.

My results add to the studies which argue the drop in the homeownership rate among young households is temporary. This paper points out that in the presence of rising income inequality and limited housing supply, owning has become less affordable for the low income, less-educated households. As owner-occupied houses provide a hedge against fluctuations in rents (Sinai and Souleles, 2005) and constitute a major part of the household investment portfolio (Flavin and Yamashita, 2002), reducing access to homeownership among non-college graduates might aggravate wealth and welfare inequality.

In terms of policy implications, my findings suggest that in the presence of rising income inequality, policies that disproportionately favor homeowners could have resulted in an even larger increase in the wealth inequality. One example is the mortgage interest deduction, which allows owners with more mortgage to collect more after-tax savings. As argued in Sommer and Sullivan (2018), eliminating the mortgage interest deduction will lead to a decline in house prices and an increase in homeownership. My findings imply that such a policy modification could be the solution to the affordability problem experienced by the low-income, less educated households.

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MSA	MSA
Akron, OH (IV)	Charlotte-Gastonia-Rock Hill, NC/SC (IV)
Albany-Schenectady-Troy, NY (IV)	Chattanooga, TN/GA (IV)
Albuquerque, NM (IV)	Chicago, IL (IV)
Allentown-Bethlehem-Easton, PA/NJ (IV)	Chico, CA
Amarillo, TX	Cincinnati-Hamilton, OH/KY/IN (IV)
Ann Arbor, MI	Cleveland, OH (IV)
Appleton-Oshkosh-Neenah, WI (IV)	Colorado Springs, CO
Atlanta, GA (IV)	Columbia, MO
Atlantic City, NJ	Columbia, SC (IV)
Austin, TX (IV)	Columbus, OH (IV)
Bakersfield, CA (IV)	Corpus Christi, TX (IV)
Baltimore, MD (IV)	Dallas-Fort Worth, TX (IV)
Baton Rouge, LA (IV)	Davenport, IA - Rock Island-Moline, IL (IV)
Beaumont-Port Arthur-Orange, TX (IV)	Dayton-Springfield, OH (IV)
Billings, MT	Daytona Beach, FL
Biloxi-Gulfport, MS	Denver-Boulder, CO (IV)
Binghamton, NY (IV)	Des Moines, IA (IV)
Birmingham, AL (IV)	Detroit, MI (IV)
Bloomington-Normal, IL	Duluth-Superior, MN/WI (IV)
Boise City, ID	Erie, PA (IV)
Boston, MA/NH (IV)	Eugene-Springfield, OR
Brownsville-Harlingen-San Benito, TX	Fayetteville, NC
Buffalo-Niagara Falls, NY (IV)	Fayetteville-Springdale, AR
Canton, OH (IV)	Fort Collins-Loveland, CO
Cedar Rapids, IA	Fort Lauderdale-Hollywood-Pompano Beach, FL (IV)
Champaign-Urbana-Rantoul, IL	Fort Myers-Cape Coral, FL
Charleston-N. Charleston, SC (IV)	Fort Wayne, IN (IV)

A Appendix

A.1 List of Sample Cities

This section lists the 161 Metropolian areas used in the OLS estimation alphabetically. The one followed by (IV) are also used in the IV estimation.

A.2 SUR Regression

This section presents the SUR regression results.

MSA
Philadelphia, PA/NJ (IV)
Phoenix, AZ (IV)
Pittsburgh, PA (IV)
Portland, OR/WA (IV)
Providence-Fall River-Pawtucket, MA/RI (IV)
Provo-Orem, UT
Raleigh-Durham, NC
Reading, PA (IV)
Reno, NV
Richland-Kennewick-Pasco, WA
Richmond-Petersburg, VA (IV)
Riverside-San Bernardino, CA (IV)
Roanoke, VA
Rochester, NY (IV)
Rockford, IL (IV)
Saginaw-Bay City-Midland, MI
St. Louis, MO/IL (IV)
Salem, OR
Salinas-Sea Side-Monterey, CA (IV)
Salt Lake City-Ogden, UT (IV)
San Antonio, TX (IV)
San Diego, CA (IV)
San Francisco-Oakland-Vallejo, CA (IV)
San Jose, CA (IV)
Santa Barbara-Santa Maria-Lompoc, CA (IV)
Santa Cruz, CA
Santa Rosa-Petaluma, CA

MSA
Sarasota, FL
Savannah, GA
Scranton-Wilkes-Barre, PA (IV)
Seattle-Everett, WA (IV)
South Bend-Mishawaka, IN (IV)
Spokane, WA (IV)
Springfield, MO
Springfield-Holyoke-Chicopee, MA (IV)
State College, PA
Stockton, CA (IV)
Syracuse, NY (IV)
Tacoma, WA (IV)
Tampa-St. Petersburg-Clearwater, FL (IV)
Toledo, OH/MI (IV)
Trenton, NJ (IV)
Tucson, AZ (IV)
Tulsa, OK (IV)
Utica-Rome, NY (IV)
Ventura-Oxnard-Simi Valley, CA (IV)
Visalia-Tulare-Porterville, CA
Washington, DC/MD/VA (IV)
West Palm Beach-Boca Raton-Delray Beach, FL (IV)
Wichita, KS (IV)
Wilmington, DE/NJ/MD (IV)
York, PA (IV)
Youngstown-Warren, OH/PA (IV)

TABLE A1:
SUR Regression Results

	(1) OR^{YNC}	(2) OR^{YC}	(3) OR^{MNC}	(4) OR^{MC}
κ	-0.474***	-0.632***	-0.335***	-0.311***
	(0.0530)	(0.0564)	(0.0441)	(0.0338)
$log(I^{YNC})$	0.222***	0.0352	-0.0304	-0.0118
	(0.0437)	(0.0466)	(0.0364)	(0.0279)
$log(I^{YC})$	-0.0402	0.330***	-0.0494*	-0.0343
	(0.0328)	(0.0349)	(0.0273)	(0.0209)
$log(I^{MNC})$	0.0495	0.126**	0.276***	0.133***
	(0.0491)	(0.0523)	(0.0409)	(0.0313)
$log(I^{MC})$	-0.117***	-0.222***	-0.134***	0.0714**
	(0.0436)	(0.0464)	(0.0363)	(0.0278)
$log(N)$	-0.00824**	-0.00954**	-0.00952***	-0.00598**
	(0.00367)	(0.00391)	(0.00305)	(0.00234)
elasticity	0.0223***	0.0217***	0.0174***	0.0104***
	(0.00277)	(0.00295)	(0.00231)	(0.00177)
1990.year	-0.0388***	-0.0801***	-0.0391***	-0.0384***
	(0.00889)	(0.00946)	(0.00739)	(0.00566)
2000.year	-0.00175	-0.0238**	-0.0120	-0.0119*
	(0.0103)	(0.0110)	(0.00857)	(0.00656)
2010.year	-0.0157	0.0687***	-0.0231**	0.0211**
	(0.0137)	(0.0146)	(0.0114)	(0.00872)
Constant	-0.476	-2.024***	0.267	-0.799***
	(0.375)	(0.399)	(0.312)	(0.239)
Observations	644	644	644	644
R-squared	0.491	0.487	0.476	0.295

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

A.3 OLS Regression with 107 Cities

This section presents the OLS estimations using the same sample as the IV estimations.

TABLE A2:
OLS Regression Results with 107 Cities

	(1) $log(P)$	(2) OR^{YNC}	(3) OR^{YC}	(4) OR^{MNC}	(5) OR^{MC}	(6) OR^{YNC}	(7) OR^{YC}	(8) OR^{MNC}	(9) OR^{MC}
κ	2.092***	-0.575***	-0.718***	-0.434***	-0.334***	-0.0983	-0.429***	0.00541	-0.0588
	(0.171)	(0.0691)	(0.0721)	(0.0563)	(0.0416)	(0.0671)	(0.0796)	(0.0559)	(0.0454)
I^{YNC}	0.417**	0.291***	0.105	0.0127	-0.0186	0.386***	0.163**	0.100*	0.0363
	(0.167)	(0.0634)	(0.0749)	(0.0548)	(0.0417)	(0.0624)	(0.0803)	(0.0511)	(0.0437)
I^{YC}	0.499***	-0.116**	0.186***	-0.134***	-0.0840**	-0.00278	0.255***	-0.0290	-0.0183
	(0.115)	(0.0466)	(0.0644)	(0.0484)	(0.0345)	(0.0365)	(0.0602)	(0.0393)	(0.0305)
I^{MNC}	0.678***	0.0452	0.119	0.272***	0.130**	0.200***	0.213**	0.414***	0.219***
	(0.205)	(0.0772)	(0.0917)	(0.0668)	(0.0523)	(0.0721)	(0.0924)	(0.0572)	(0.0455)
I^{MC}	0.0263	-0.111*	-0.213***	-0.0757	0.0903**	-0.105**	-0.209***	-0.0702	0.0938**
	(0.158)	(0.0647)	(0.0723)	(0.0596)	(0.0424)	(0.0475)	(0.0658)	(0.0447)	(0.0379)
$log(P)$						-0.228***	-0.139***	-0.210***	-0.132***
						(0.0168)	(0.0271)	(0.0145)	(0.0163)
N	-0.0259	-0.00518	-0.000540	-0.00777	-0.00438	-0.0111***	-0.00413	-0.0132***	-0.00779**
	(0.0158)	(0.00569)	(0.00656)	(0.00528)	(0.00458)	(0.00398)	(0.00542)	(0.00357)	(0.00338)
Elasticity	-0.136***	0.0304***	0.0338***	0.0232***	0.0175***	-0.000556	0.0150***	-0.00527*	-0.000391
	(0.0105)	(0.00373)	(0.00404)	(0.00326)	(0.00270)	(0.00358)	(0.00421)	(0.00280)	(0.00219)
1990.year	-0.0828***	-0.0220**	-0.0540***	-0.0287***	-0.0279***	-0.0409***	-0.0655***	-0.0460***	-0.0388***
	(0.0282)	(0.0109)	(0.0102)	(0.00961)	(0.00652)	(0.00866)	(0.00976)	(0.00749)	(0.00576)
2000.year	-0.0841***	0.0206	0.000221	-0.00135	-0.00369	0.00147	-0.0114	-0.0190**	-0.0148**
	(0.0298)	(0.0126)	(0.0132)	(0.0110)	(0.00774)	(0.0106)	(0.0126)	(0.00915)	(0.00726)
2010.year	0.266***	0.0210	0.103***	0.00120	0.0272**	0.0816***	0.140***	0.0571***	0.0622***
	(0.0445)	(0.0189)	(0.0210)	(0.0163)	(0.0120)	(0.0176)	(0.0215)	(0.0146)	(0.0117)
Constant	-5.537***	-0.443	-1.358***	0.0905	-0.399	-1.703***	-2.124***	-1.071***	-1.129***
	(1.170)	(0.467)	(0.483)	(0.376)	(0.282)	(0.393)	(0.469)	(0.304)	(0.261)
Observations	428	428	428	428	428	428	428	428	428
R-squared	0.774	0.572	0.494	0.539	0.351	0.724	0.553	0.727	0.528

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1