Trickle Down or Crowd Out?
The Effects of Rising Demand for College Graduates on the Consumption, Housing, and Neighborhood Conditions of Less Educated Households

Ingrid Gould Ellen
Davin Reed
Michael Suher

New York University Wagner School
and
NYU Furman Center for Real Estate and Urban Policy

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In the past decade, demand for college-educated workers has risen in many cities, especially large, coastal cities. While many welcome this trend, there is growing concern about the plight of less educated workers, who have not seen the same gains; indeed, households without any college-educated adults have seen incomes decline in almost all U.S. cities. We explore whether these phenomena are related. Specifically, we explore whether increasing demand for college-educated workers has compounded the challenges of less educated households through increasing rents, increasing housing costs and pushing less educated households to lower quality neighborhoods and homes. Conversely, income growth among college graduates could also generate new opportunities for less educated households through positive labor market spillovers, improved city amenities, and increasing neighborhood economic diversity (Moretti 2011; Hartley 2013; Diamond 2016).

While previous work has analyzed skill sorting across cities, our interest lies in how less educated households who remain in cities seeing growing demand for college graduates are faring, focusing in particular on their housing and neighborhood outcomes. A growing literature shows that pecuniary and non-pecuniary moving frictions mean that a substantial number of inframarginal (stayer) households may bear the incidence of these demand shocks (Bartik 2016, Zabek 2017). We focus specifically on less educated renters, as they are more vulnerable to rising housing costs. In future drafts we will explore outcomes for all less educated individuals. We define less educated individuals as those completing a high school degree or less and college graduates those completing a bachelor's degree or more.

A few descriptive graphs suggest what this incidence might be. Figure 1 plots the real change in average rent paid by less educated renters against the real change in aggregate income earned by college graduates for the 100 largest metropolitan areas during the 1990s and the

2000s.[1] The figure makes clear that during these two decades most cities saw large increases in the total income earned by college graduates, and in the cities where those increases were largest, less educated renters saw larger increases in real housing costs.

Yet Figure 2 also highlights the fact that the residual incomes of less educated renters tended to rise most (during the 1990s) and fall least (during the 2000s) in the cities where the aggregate income of college graduates rose most. This pattern suggests that rising incomes among college graduates might not only bid up housing prices but also boost the wages of less educated renters relative to other cities, perhaps due to complementarity between low- and high-skill workers, productivity spillovers from high-skill workers, or increased demand for local, non-tradable goods (Moretti 2011, Diamond 2016, Howard 2017). That said, Figure 3, which plots changes in residual income (the difference between the average residual income of college graduates and the average residual income of less educated renters) against the growth in aggregate income of college graduates, shows that gains to the residual income of less educated renters did not translate into lower residual income inequality.

Our analysis investigates these stylized facts more formally. Specifically, we explore how the increasing relative demand for college graduates in cities affects the well-being of less educated renters in those cities along a number of dimensions, including housing costs, residual income, commuting costs, crowding, and exposure to higher human capital (college graduate) neighbors. To isolate the causal impact of shifts in labor demand for college graduates from other local factors that could simultaneously drive changes in the outcomes of less educated renters, we estimate two-stage least squares regressions using an instrumental variable strategy motivated by Bartik (1991). We separately control for exogenous shocks to demand for less educated

[1] We use metropolitan area and city interchangeably throughout but always specifically mean metropolitan area.

workers. Using a regression correction technique from Combes, Duranton, and Gobillon (2008) to adjust our metrics for observable household demographics, we also distinguish between effects on incumbent households and effects due to changes in the composition of households in a given city due to migration.

Further, in addition to exploring how increased labor demand for college graduates affects the absolute outcomes of less educated renters, we also estimate effects on less educated renters *relative to college graduate households* in the same city. This will inform whether increasing demand for college graduates is furthering within-city inequality in well-being along a number of previously unexplored dimensions.

Finally, we examine heterogeneity in these effects in a number of ways. First, we estimate grouped quantile instrumental variables models to test if effects differ at the extremes of the outcome distributions (Chetverikov et al. 2016). We also test whether effects differ for less educated renters who are black or Hispanic, given the greater constraints that they likely face in searching for housing. Finally, we test whether effects differ by the metropolitan area rental vacancy rate, as we expect rents to rise more in response to labor market demand shocks in cities with lower rental vacancy rates.

In future drafts, we will also consider the role that housing policies play in mediating these effects. Specifically, we will match restricted individual-level census data to individual-level data from the Department of Housing and Urban Development on subsidized housing receipt. We will then test whether receipt of subsidized housing (either place-based or tenant-based) helps insulate high-school-only renters from rising rents and helps them stay in improving neighborhoods as rents rise.

In brief, increased demand for college graduates is associated with higher rents, but this appears to be explained by the fact that demand for less educated workers is also more robust in those cities than it is in other cities: controlling for less educated labor demand, college graduate labor demand does not significantly increase rents paid by less educated renters. In terms of residual income, we find evidence that labor demand shocks for college graduates lead to greater residual income among high-school only renters, perhaps due to labor market spillovers, complementarity, or non-tradable goods demand. We find no effect on residual income inequality.

We also find some evidence that high-school only renters are adjusting their housing and neighborhood choices in response to rising incomes of college graduates. Specifically, increases in college graduate incomes lead to increases in household crowding among less educated renters. They also lead less educated renters to, on average, end up in neighborhoods with *relatively* lower human capital. Given the overall increase in the college-educated share in the city, high-school only renters end up living among more educated neighbors, but inequality in neighborhood human capital levels by education widens, as college graduate households see significantly larger increases in exposure to college-educated neighbors than do high-school only renters.

As for heterogeneity across renters in impacts, we see little evidence of racial differences. But quantile regressions reveal considerable variation across renters in effects. Specifically, the effects on the residual income of high-school only renters and in their exposure to college graduate neighbors are driven by the high-end of the distribution. That is, shocks to college graduates' income have little effect on less educated renters with relatively low residual incomes or low exposure to college graduates, but large effects for those with relatively high residual incomes and high exposure to college graduates. While we cannot establish the mechanisms definitively, these

results are consistent with labor market spillovers being greater for less educated renters with higher residual incomes (relative to those with lower residual incomes in the same city). They are also consistent with neighborhoods with more college graduates being more attractive to college graduates, which makes sense given established results on sorting and amenities.

Finally, we test whether vacancy rates mediate the effects of college-educated total income growth on high-school-only renters. Theoretically, high-school-only renters in housing markets with less slack should experience higher rent increases or worse relocation outcomes as the total income of college graduates rises. We stratify our sample of MSAs by whether the rental vacancy rate is high or low (above or below the median MSA in each year) and run our main IV specifications in each stratified sample. Overall, we find little evidence of differential effects in high versus low vacancy MSAs. However, results suggest that the effect on high-school-only renter exposure to college graduates is greater in higher vacancy MSAs (.05 in high vacancy MSAs vs. .017 in low vacancy MSAs), and this difference is significant at the 10% level.

Our results shed light on the distributional and welfare implications of the rising incomes of college graduates within cities. On the one hand, it appears that increasing demand for college graduates is increasing residual incomes among high-school only renters, though this is driven by the high end of the high-school-only distribution. Yet growing college graduate incomes appear to be pushing high-school-only renters to live in somewhat more crowded conditions, perhaps in response to higher rents. Further, high-skill labor demand shocks appear to be widening the differential between the human capital levels of the neighborhoods lived in by more and less educated households. In future drafts, we will explore how housing choice vouchers and other forms of subsidized housing shape these absolute and relative effects.

Literature and Theoretical Background

A growing literature explores the implications of changing labor demand in cities on the migration patterns and outcomes of different workers. Bound and Holzer (2000) find that negative labor demand shifts during the 1980s reduced the earnings and employment of less-educated and black workers. Diamond (2016) shows that increased sorting of high-skill workers into high-cost but high-amenity cities increased well-being inequality between high- and low-skill workers beyond that implied by the increase in the college wage premium alone. Notowidigdo (2013) shows that negative shocks to city labor demand lead to greater out-migration of high-skill workers than low-skill workers. Maestas, Mullen, and Powell (2013) show that city labor demand shocks increase the probability that older individuals work, decrease their probability of retirement, and increase their wages and non-wage benefits.

The existing work has yet to consider how increases in incomes among college graduates affect the housing and neighborhood outcomes of households with less educated adults. To the extent that college graduates bid up demand for housing, some high-school only households may leave the city altogether. Others may choose to remain in the city but to spend more of their incomes on housing and/or live in lower quality and more crowded homes. Similarly, in order to find lower rents, they may choose to live in homes that are further from their jobs or in neighborhoods with fewer college educated residents, minimizing their opportunity to enjoy positive spillovers to skill development from neighbors with higher human capital and richer job networks (Benabou 1993; Chetty et al. 2015).

A second and more limited literature focuses on increasing inequality within cities. Baum-Snow and Pavan (2013) show that within-city wage inequality has increased more in larger cities than in smaller cities and that this differential increase can explain 23% of the national

increase in wage variance. They do not explore the implications for inequality in housing and neighborhood conditions.

A third related literature considers the effects of "gentrification." Since the 1980s, and especially since 2000, a growing number of downtown neighborhoods are seeing increases in income and college-educated residents. There is an ongoing debate about the underlying causes, but increasing demand for college graduates likely plays a role (Hwang and Lin, 2016). Baum Snow and Hartley (2016) show that high-skill jobs have shifted to downtown areas since 2000. Of course, high-skill jobs may be following college-educated residents, who are increasingly attracted to urban amenities (Couture and Handbury, 2016).

Most of the existing literature on the consequences of gentrification focuses on the displacement of low-income residents from gentrifying neighborhoods. While these papers have used different data sets and defined gentrification in different ways, the findings have been highly consistent, showing little evidence of displacement (Ding, Hwang, and Divringi 2015; Ellen and O'Regan 2011; Freeman 2005; McKinnish, Walsh, and White 2010; Vigdor, 2002). Indeed, some recent research suggests that incumbent, low-income residents may see some economic benefits as their neighborhoods gentrify (Hartley 2013). If higher income and college-educated households are increasingly choosing to live in lower income, urban neighborhoods, economic and skill segregation should fall, at least in the short-run, and high-school only households may find themselves living in neighborhoods with more educated and higher income residents. Living in such environments may offer high-school only households improved amenities (Diamond 2016) and more opportunities for advancement (Chetty et al., 2015).

Our work builds on these three strands of research in a number of ways. First, we examine how increased demand for college graduates in cities has affected a broad set of housing and

neighborhood outcomes among high-school only households living in those cities, such as rents, residual incomes, crowding, commutes, segregation, and access to neighborhood conditions. Second, we consider effects not only on absolute outcomes but also on within-city inequality along a variety of dimensions. Third, we explore heterogeneity in outcomes, by estimating quantile regression models, separately analyzing outcomes for high-school only households by race, and stratifying results by high- and low-vacancy housing markets. Finally, in future drafts, we will test whether, and to what extent, housing vouchers and subsidized housing shape any effects.

We expect that increased demand for college graduates will have positive labor market effects for less educated workers if it leads to increased job opportunities for these workers (such as through the opening of new establishments) or productivity spillovers from college-educated workers (Moretti 2011; Diamond 2016). Our identification strategy rules out the role of confounding factors by controlling for direct changes in labor demand for workers with no more than high-school degrees, by controlling for region-specific time trends, and exploiting exogenous changes in labor demand to college educated workers that should be uncorrelated with confounding factors at the city level.

Increased demand for college graduates should also increase rents and housing values, but the magnitude of these effects for high-school only households is unclear as they tend to live in different neighborhoods than college graduates and are more likely to rent than own. Busso et al. (2013) show that effects of increased demand can differ for rents and home values. We also examine changing household sizes, crowding, and commuting time to see if high-school only households are managing higher housing costs by forming larger households and economizing on space, or locating farther from central areas.

As for neighborhood outcomes, theoretical predictions are unclear. On the one hand, an increase in demand for college graduates might reduce segregation by education level if this rising demand increases housing costs and leads a growing number of college graduates to choose to move into lower-income, urban neighborhoods that they might not have considered in less costly markets. At the same time, their in-movement might make neighborhoods less affordable to less educated and lower-income households, triggering the displacement that many fear. We use data on the neighborhood locations of high-school households to create measures of their actual access to neighborhoods with high human capital levels. We then undertake a decomposition analysis to separate overall changes in their access to neighborhood characteristics into changes due to changing characteristics (holding high-school only household location constant) and changes due to the shifting locations of high-school only households (holding characteristics constant). For all of these outcomes, we separately analyze the experience of high-school only households who are longer-term residents of these cities.

Our second key area of inquiry centers on how increasing demand for college educated workers affects the outcomes of high-school only households relative to college graduate households in the same city. We consider all the same outcomes highlighted above, but focus on differences between high- and low-education households. The results provide direct evidence on how increasing demand for college graduates might be driving within-city well-being inequality in a number of unexplored ways.

As noted, we also explore heterogeneity in all these outcomes as there are reasons to believe that certain types of households – in particular racial minorities – may face greater constraints in their ability to move and adjust to shifting prices and rents. We also examine heterogeneity across housing markets, and in particular examine how patterns differ in more supply

constrained cities, where a given high-skill demand increase should lead to greater increases in rents and home values, and potentially greater restrictions in the set of neighborhoods accessible to low-skill households (Saiz 2010). Similarly, commuting costs and crowding might be more adversely affected in more supply-constrained cities.

As for the third set of questions, we plan to examine whether high-school only households with vouchers or living in place-based subsidized housing fare better than other high-school only households as demand for college graduates increases. We hypothesize that such increases in labor demand should have a smaller effect on rent, commuting, and crowding for subsidized households, as those subsidies help shield households from rent increases. We also expect that housing subsidies enable high-school only households to reach a broader set of neighborhoods in the face of labor demand shocks. To conduct these analyses, we will use restricted, Census data that identifies whether or not surveyed households receive housing subsidies.

Data

Our sample consists of 363 Core Based Statistical Areas (CBSAs) in the years 1990, 2000, and 2010 which have data available in all years (though we re-estimate all of our analyses with the largest 100 metropolitan areas and obtain similar results). The CBSAs are metropolitan areas approximate labor and housing markets. We refer to metropolitan areas as cities throughout the paper.

Most of our variables are constructed at the metropolitan area (city) – year level using the Public Use Microdata Sample (IPUMS) versions of the 1990 Decennial Census, 2000 Decennial Census, and 2010-2014 5-year American Community Survey (ACS). We refer to the latter as 2010. The IPUMS provides individual- and household-level information on city of residence,

education level, and other exogenous characteristics such as age, sex, and race/ethnicity. It also includes labor market characteristics such as employment, income, and wages, and housing characteristics such as homeownership, rents and housing costs, household crowding (rooms per person), and commuting times. We construct high-school only renter outcomes by taking averages of individual-year outcomes by city-year, weighting by the Census-provided individual weights.

We also use the IPUMS to create our key endogenous variables and instruments for them. To construct these measures, we first restrict the sample to full-time, non-farm, non-military workers aged 25-64. Note that we do not impose these restrictions when constructing our outcomes for high-school only renters. We define high-education individuals as those completing a bachelor's degree or more and low-education individuals as those completing a high school degree or less. (We exclude middle-education individuals who have completed some college but do not have a degree.) We calculate college graduate total income as the number of employed college graduates times the average income of college graduates from wage sources, and total income for high-school only individuals analogously. These measures capture both changes in employment and changes in income to proxy for the overall change in presence and spending power of high- low-education individuals in cities.

We measure neighborhood opportunity as the exposure to college graduates in neighborhood. To construct these, we require data on the neighborhood (Census tract) of residence of both college graduates and individuals with no more than a high school degree. This is not available in the publicly available IPUMS. Instead, we use aggregate counts of individuals at the tract level from the public use Decennial 1990, Decennial 2000, and ACS 2010-2014 5-year. Note that counts by education and tenure status are not available in 1990 or 2000, so we are unable to focus specifically on high-school only renters here as we are with our other outcomes. In future

work, we will use restricted access microdata versions of these census data sets through the New York Census Research Data Center. These versions will allow us to construct detailed counts of high-school only households at the neighborhood level by tenure status and along other dimensions. They will also allow us match high-school only renters to LIHTC and public housing at the individual level, allowing for an analysis of the role of subsidized housing.

Table 1 shows the distributions of changes in four different measures of high- and low-education labor demand. Whether measured as total income from wages (our preferred measure), employment, income from wages per worker, or hourly wages, demand for college graduates has far outstripped demand for high-school only workers in almost all cities and in both the 1990s and 2000s. Figures 4 plots percentage changes in total income (from wages) for college graduates and high-school only workers by decade for the full sample of 363 metropolitan areas. The solid line is the fitted line, and the dashed line represents 45 degrees. All graphs show that total income of college graduates has been increasing faster than total income for individuals with no more than a high school education in almost all cities and in both the 1990s and 2000s.

Research Methods and Analytic Strategy 1: Well-Being of High-School Only Households

We seek to analyze how the increasing demand for college graduates and concomitant influx of college graduates to cities and increase in income earned by college graduates affects the housing and neighborhood outcomes of less educated households and shapes the inequality in those outcomes between college graduates and less educated households in the same city.

To isolate the causal impact of college graduate total income shifts from other local factors that could simultaneously drive changes in high-school only renter outcomes, we use an instrumental variable strategy motivated by Bartik (1991). Specifically, separately for each of

high- and low-education, we multiply industry-specific national changes in total income with each city's initial industrial employment composition. These high- and low-education instruments are then used in the first stage to predict actual changes in high- and low-education total income. The case for exogeneity rests on the exclusion of own city-industry total income changes: for each target city, national changes are computed by excluding changes in the target city. This means that the instruments are only picking out variation in local high- and low-education total income changes that are due to national, or even international, changes in demand for a given industry's output, rather than from any idiosyncratic success or failure of the specific firms located in a given city.

Specifically, we run a series of instrumental variables regressions of the form:

$$\Delta y_{ct}^{l} = \beta_0 + \beta_1 \widehat{\Delta E_{ct}^{h}} + \beta_2 \widehat{\Delta E_{ct}^{l}} + \beta_3 \log(households)_{ct} + d_{ct} + \varepsilon_{ct} \quad (1)$$

where Δy_{ct}^{l} is change in outcome *y* for high-school only renter households in city *c* between periods *t* and *t-1*, $\widehat{\Delta E_{ct}^{h}}$ is the predicted exogenous change in the total income of college graduates in city *c*, $\widehat{\Delta E_{ct}^{l}}$ is the predicted exogenous change in high-school only total income in city *c,* and d_{ct} is a set of fixed effects for the nine Census divisions interacted with year indicators. We also include the log of the number of households in each city. The fixed effects and city size control are included so comparisons are restricted to similar city types. We pool changes from 1990 to 2000 and from 2000 to 2010.

While others have used employment-based and wage-based Bartik instruments to proxy for exogenous changes in labor demand (Blanchard and Katz 1992; Bound and Holzer 2000; Mullen, Maestas, and Powell 2013; Notowidigdo 2013; Baum-Snow and Hartley 2015), we differ in that we construct them using total income, which combines changes in employment and

income. Total income best captures the overall relative changes that could be affecting high-school only households. We also differ from most previous work in the labor demand literature in that we construct separate instruments for increasing income for college graduates and for less educated workers. Diamond (2016) and Notowidigdo (2013) are exceptions.

Even if the demand shock to college graduate incomes is exogenous to other confounding factors at the city level, it is still possible that it is correlated with changing demand for less educated in some way. We find that high- and low-education Bartik shocks are moderately correlated in our sample of cities and periods. Therefore, when estimating equation (1) we also instrument for changes in total income of individuals with no more than high school educations. Our coefficient of interest β_1 is therefore interpreted as the spillover effect of increased demand for college-educated workers on our outcomes for less educated households isolated from shifts in these outcomes due to simultaneous exogenous changes in demand for less educated workers.

Isolating Effects on Longer-Term Residents

To better understand the distributional implications, we distinguish effects on incumbent high-school only households from effects due to changes in the composition of high-school only households in a given city due to migration. Although our data are a series of cross-sections, we account for changes in the observable characteristics of households in our sample of cities. Specifically, we run versions of equation (1) but with an adjusted version of each outcome. This version captures outcomes for incumbent workers through a regression correction technique from Combes, Duranton, and Gobillon (2008). Take, for example, high-school only residual income. A preliminary regression relates the income of each individual *i* in year *t* to a vector of individual characteristics *x* such as age, race, and occupation, as well as a city by year fixed effect δ:

$$y_{ict} = \alpha + \delta_{ct} + \beta x_{ict} + \varepsilon_{ict} \qquad (2)$$

The coefficient on the city fixed effect then becomes an income index for low-skill workers in the city that is corrected for changes in observable worker characteristics. This index or adjusted residual income then takes the place of the simple average residual income as the outcome variable in equation (1). If the estimated impact of labor demand for college graduates differs between the original regression and this adjusted version, we can discern the extent to which a changing high-school only population induced by the high-education labor demand shock is driving the estimate rather than a change in outcomes for incumbent households.

Disaggregating Changes in Neighborhood Quality

We also explore whether observed changes in high-school only households' overall exposure to neighborhood quality result more from changes in neighborhood quality (holding low-skill household location constant) or from changes in the location of high-school only households (holding neighborhood quality constant). To do this, we construct versions of the college exposure (poverty exposure) measures that 1) reweight changes in share college educated (share poverty) by the first period location of high-school only households, effectively holding high-school only household location constant, and 2) reweight changes in high-school only household location by first period neighborhood share college educated (share poverty), effectively holding neighborhood quality constant.

Research Methods and Analytic Strategy 2: Within-City Inequality

In addition to impacts on absolute well-being, we run a parallel set of analyses and sub-analyses to consider how rising incomes among college graduates affects within-city differences in outcomes between low- and high-education households. We typically calculate inequality of each outcome as the ratio of the low-education outcome to the high-education outcome. High-

school only renter household outcomes are compared against all college graduate households (renter and owner). We capture exposure to college-educated neighbors with a simple difference rather than a ratio.

Research Methods and Analytic Strategy 3: Heterogeneity

We test for heterogeneity across individuals and also across places. Specifically, we estimate quantile regressions to learn if patterns differ at different points in the distribution. We apply the approach presented in Chetverikov, Larsen, and Palmer (2016) for estimating quantile regressions with group level data. We compute the deciles of the distribution for our outcomes at the city level in each year, and then difference across the decade. These differenced deciles take the place of the difference of means outcome in equation 1, but otherwise the specification is the same. We can then see whether the impact of increases in college graduate income in a city on the distribution of a measure, like residual income, for high-school only residents of a city differs from the mean impact. The quantile outcomes are level rather than log differences and we re-estimate the mean impact in level changes as well for direct comparison. We also specifically examine whether outcomes differ by the race of the high-school only household. We do so by stratifying our core regressions by race.

As for heterogeneity across place, we test how the tightness of a housing market might mediate the effects of increasing demand for college graduates on the housing and neighborhood outcomes of less educated households. To determine whether housing market tightness contribute to worse outcomes for high-school only households in response to labor demand shocks for college graduates, we will estimate the following interacted versions of equation (1):

$$\Delta y_{ct}^{l} = \beta_0 + \beta_1 \widehat{\Delta E_{ct}^{h}} + \beta_2 \widehat{\Delta E_{ct}^{l}} + \beta_3 d_t + \beta_4 h_{ct} + \beta_5 \widehat{\Delta E_{ct}^{h}} h_{ct} + \beta_6 \widehat{\Delta E_{ct}^{l}} h_{ct} + \varepsilon_{ct} \quad (4)$$

where h_{ct} captures the rental housing vacancy rate of the metro area at the start of the decade. (We also experiment with capturing stringency of land use regulations in the city, as measured by the Wharton Residential Land Use Regulatory Index.) As before, we estimate this equation for each of our metrics of high-school only household well-being. The estimated coefficients β_5 indicate whether, along which dimensions, and by how much a low vacancy rate might lower absolute well-being of low-skill households and amplify within-city well-being inequality in cities seeing increasing demand for college graduates. As before, terms involving ΔE_{ct}^{l} are included to control for potential confounding shocks to demand for less educated workers.

Research Methods and Analytic Strategy 4: Housing Policy

Finally, in future work, we will use restricted access census data that identifies whether or not surveyed households are receiving rental subsidies to examine whether housing assistance helps to insulate high-school only households from rising rents, allowing them to earn higher residual incomes, live with fewer people, and stay in improving neighborhoods as rents rise.

Results

For all our results we focus on the outcomes of high-school only households who rent their homes or the outcomes of these households relative to those for all college graduate households. The 1990 to 2000 and 2000 to 2012 samples are pooled together. All regressions relate decadal changes in log outcomes to the contemporaneous change in education-specific log total wage income. All specifications include controls for log city size, a set of Census division by year fixed effects, and are weighted by metro area employment.

First stage results are presented in Table 2. The instruments have the expected positive effects on the total income earned by college graduates and workers with no more than a high school degree, and the F-statistics on the excluded instruments pass the standard thresholds ruling out weak instruments. Figure 5 depicts the relationship between the instruments and endogenous variables by education level and decade.

We focus on how an increase in the income earned by college graduates affects high-school only renters in the same city. In Table 3 we focus specifically on the extent to which increased high-skill demand spills over into changes in average high-school only housing costs as measured by gross rents. Column 1 shows the unadjusted association between growth in incomes earned by college graduates and high-school only housing costs. On average, cities with greater increases in college graduate incomes have not seen any greater increases in high-school only rental expenditure over this time period.

In column 2 we instrument for the change in income earned by college graduates using our national shift share instrument described above. The aim is to isolate the impact of exogenous labor demand shocks for college graduates. This shows that high-school only renters in cities with greater shocks to college graduate incomes have experienced greater increases in rent payments, with a 10% increase in income earned by college graduates leading to a 2.8% increase in rents. Column 3 controls directly for simultaneous, exogenous changes in incomes earned by high-school only workers in each city, using a similarly constructed instrument for total wage income earned by workers with no more than high school educations. As expected, these low-education shocks drive up high-school only rent payments significantly, with a 10% increase in low-education income leading to a 2.4% increase in the average rents paid by high-school only households. Once we control for low-education shocks, the apparent spillovers from college

graduates largely go away, indicating that cities seeing more demand growth for college graduates also tended to see more demand for high-school only workers (or at least smaller declines in demand). We also looked at the impact on the housing costs of all high-school only households pooling together renters and owner-occupiers (not shown). Here we do see some evidence of increased low-skill housing costs in response to greater high-skill demand growth. The interpretation is made more difficult though as incumbent owners are also receiving some capital gains.

As we expect some migration response to these demand shocks, in column 4 we consider the outcome measure adjusted for observable head of household characteristics of age, race, sex, and occupation. Because we observe only repeated cross-sections, this composition adjustment is done in a separate first step regression described above. The intent is to account for any sorting of observably different types of households induced by the demand shocks. This more closely measures the impact of increased high and low-education demand on incumbent households in the city in the base period, or at least households with observably similar demographics and occupations to the incumbent households. Accounting for this observable sorting reduces the measured direct impact of low-education demand increases on rents by about one third, but it does not alter the insignificant coefficient on demand for college graduates.

Column 5 considers relative housing costs between low and high-education households, measured as the ratio of mean high-school only gross rents to mean college graduate housing costs (for renters and owners combined). We do not see any significant changes in this ratio in response to the labor demand shocks. We investigate below why it is that increases in housing demand from college graduates did not lead high-school only households to pay higher housing costs in the same city.

In Table 4, we look at how residual income for high-school only households, measured as total household income minus annual housing costs, is impacted by these same shocks. In column 2 we see cities with bigger positive income shocks to college graduates led to higher growth in our measure of high-school only residual income. In column 3 when we directly account for exogenous changes in low-education labor demand in the same city the spillover estimate is cut in half, but is still relative large, with a 10% increase in high-education income increasing high-school only real incomes by about 2%. This spillover estimate is largely similar in column 4 accounting for changes in the composition of the high-school only population. Perhaps surprisingly, in column 5, we do not see significant increases in residual income inequality between high-school and college graduate households resulting from exogenous income growth among college graduates.

The quantile estimates are fairly revealing though regarding the impact of these labor-demand increases on the high-school only population of a city. In Figure 6, we plot the effect of a 10% increase in incomes earned by college graduates on each decile of the high-school only residual income distribution using the group-level IV quantile regression framework described above. The figure shows that the top quartile of households are accounting for the bulk of the estimated mean effect of increasing income of college graduates on high-school only incomes.

We now turn to the question of why high-school only renter households do not pay more in housing costs when incomes earned by college graduates increases. One possibility is that high and low-skill households consume housing in largely separate markets differentiated by neighborhood, housing type, quality and tenure status. Below we find that this cannot be the whole story, as increased high-skill housing demand has driven changes in the quantity of housing high-school only renters consume and the neighborhoods in which they consume it.

Table 5 looks at changes in the quantity of housing high-school only renters consume in cities with increasing incomes earned by college graduates. We use the number of rooms per person in the household as a measure of crowding. In column 3, accounting for the direct impact of changes in high-school only labor demand, we see rooms per person falling by 2.7% for a 10% increase in college graduate income. This result holds even once observed household sorting is controlled for in column 4. Column 5 looks at the change in the ratio of mean high-school only renter household rooms per person to the mean for all college graduate households, and shows that crowding for high-school only households is also deteriorating in relative terms.

In addition to consuming less housing, high-school only households could be driven to less desirable neighborhoods in terms of economic opportunity and amenities. Table 6 considers whether high-school only renters end up in neighborhoods that are more distant from employment centers. The measure we look at is the change in mean commute times for employed workers. While the OLS specification in column 1 shows that high-school only renters tend to have slightly longer commutes in cities with bigger increases in the total income earned by college graduates, we see no impact once we restrict to exogenous changes in demand.

Next we turn to the impact on the neighborhood location of high-school only households from increases in the total income earned by college graduates in a city. Because the public microdata used in the above estimations only reveals location at the relatively large PUMA geography, we turn to the neighborhood change database which uses public tabulations of Census and ACS data at the geographically much finer census tract level. The one drawback is that we can no longer distinguish high-school only renters from high-school only homeowners, and so all high-school only households are combined in the following results.

In Table 8, we consider the exposure of high-school only to college graduate households. In this table all specifications instrument for both high and low-education income changes. In column 1, consistent with the isolation results, exposure of high-school only households to households with college education is increasing with exogenous increases in income earned by college graduates in the city. A 10% increase in college graduate income leads to a 0.3 percentage point increase in the college share of the typical high-school only household's neighborhood. In Figure 7, we plot the quantile estimates for the distribution of high-school only households neighborhood share college educated. The lower quartile of high-school only households by college exposure sees no change in neighborhood college share in response to an increase in high-skill income in the city. The positive effect is present for the median high-school only household and is largest for the top decile. The influx and increased income of college graduate households is thus directed towards neighborhoods which already had a large share college.

Because such a change can result from a combination of changing tract characteristics and household relocation we next attempt to decompose the importance of each channel. In column 2, the base year location of high-school only households is held fixed and is interacted with the actual evolution in neighborhood college share. Column 3 does the opposite, fixing base year neighborhood college share and interacting it with the observed relocation patterns of high-school only households over the decade. Here we see from column 2 that the entirety of the observed increase in college exposure is driven by an increased college share in the tracts where high-school only households were previously living. Column 4 looks at the difference in exposure to college educated neighbors between college graduate and high-school only households. We see this difference tends to grow as city level high-skill income increases.

Finally, Table 8 considers the exposure of low-skill households to neighbors living in poverty and shows no significant effects on overall exposure to poverty. Notably though, when we do the same decomposition of channels described above, we see in column 3 that increases in high-skill income lead high-school only households to relocate to higher poverty neighborhoods.

Conclusion

Over the past two decades, the incomes of workers without college educations have been fairly stagnant, while housing costs have increased. As a result, residual incomes have fallen, leaving the households of these low-education workers with fewer resources to spend on necessities other than housing. We find little evidence here that this trend has been exacerbated by increases in employment and income among college graduates in particular cities. Indeed, we observe that shocks to college graduate income are boosting the residual income of high-school only households on average.

That said, high-school only households do appear to be adjusting their housing consumption to some degree, and living in more crowded homes, as the total income earned by college graduates rises– perhaps in order to keep costs down. Further, as incomes of college graduates rise, the average high-school only household appears to shift to relatively higher poverty and lower human capital neighborhoods. They end up in neighborhoods with more college graduates, but this is driven entirely by the overall increase in the college-educated share in the city. High-school only households see smaller increases than college graduates in exposure to college-educated neighbors.

As for heterogeneity across households, the observed effects on the residual income and neighborhood environments of high-school only households are driven by the high-end of the

distribution. That is, rising demand for college graduates has little effect on low percentiles of the high-school only distribution of residual income and neighborhood human capital levels.

In future drafts, we will consider the extent to which housing subsidies shape these effects. Specifically, we will examine whether high-school only households with housing subsidies are better able to benefit from labor market spillovers and amenity improvements without having to live in more crowded homes.

References

Acemoglu, D., Autor, D., Dorn, D., Hanson, G., and Price, B. 2016. Import Competition and the Great US Employment Sag of the 2000s. Journal of Labor Economics 34(S1): 141-198.

Bartik, A. W. 2016. Worker Adjustment to Changes in Labor Demand: Evidence from Longitudinal Census Data. Working paper.

Bartik, T. J. 1991. Who benefits from state and local economic development policies? Books from Upjohn Press, W.E. Upjohn Institute for Employment Research.

Baum-Snow, N., Freedman, M., and Pavan, R. 2014. Why has urban inequality increased? Working paper.

Baum-Snow, N., Hartley, D. 2016. Gentrification and Changes in the Spatial Strucure of Labor Demand. Working paper.

Baum-Snow, N. and Pavan, R. 2013. Inequality and city size. Review of Economics and Statistics 95(5): 1535-1548.

Benabou, R. 1991. Workings of a city: Location, education, and production. Quarterly Journal of Economics 108(3): 619-652.

Blanchard, O. and Katz, L. 1992. Regional evolutions. Brookings Papers on Economic Activity 23(1): 1-76.

Bound, J. and Holzer, H. 2000. Demand Shifts, Population Adjustments, and Labor Market Outcomes during the 1980s. Journal of Labor Economics 18(1): 20-54.

Busso, M., Gregory, J., and Kline, P. 2013. Assessing the incidence and efficiency of a prominent place based policy. American Economic Review 103(2): 897-947.

Chetty, R. and Hendren, N. 2015. The impacts of neighborhoods on intergenerational mobility: Childhood exposure effects and county-level estimates. Working paper.

Chetty, R., Hendren, N., and Katz, L. 2015. The effects of exposure to better neighborhoods on children: New evidence from the Moving to Opportunity experiment. NBER, Working paper no. 21156.

Chetverikov, D., Larsen, B., and Palmer, C. 2016. IV quantile regression for group-level treatments, with an application to the distributional effects of trade. Econometrica 84(2) 809-833.

Combes, P. P., Duranton, G., and Gobillon, L. 2008. Spatial wage disparities: Sorting matters!. Journal of Urban Economics 63(2): 723-742.

Couture, V., and Handbury, J. 2016. Urban Revival in America, 2000 to 2010. Working paper. Philadelphia: University of Pennsylvania.

Diamond, R. 2016. The determinants and welfare implications of US workers' diverging location choices by skill: 1980-2000." American Economic Review 106(3): 479-524.

Ding, L., Hwang, J., and Divringi, E. 2015. Gentrification and residential mobility in Philadelphia. Federal Reserve Bank of Philadelphia, Working paper.

Ellen, I.G. O'Regan, K. 2011. How neighborhoods change: Entry, exit, and enhancement. Regional Science and Urban Economics 41(2): 89-97.

Freeman, L. 2005. "Displacement or Succession? Residential Mobility in Gentrifying Neighborhoods." Urban Affairs Review 40(4).

Glaeser, E. L., and Gyourko, J. 2005. Urban decline and durable housing. Journal of Political Economy 113(2): 345.

Gyourko, J., Saiz, A., and Summers, A. 2008. A new measure of the local regulatory environment for housing markets: The Wharton Residential Land Use Regulatory Index. Urban Studies 45(3): 693-729.

Hartley, D. 2013. Gentrification and Financial Health. Economic Trends. Federal Reserve Bank of Cleveland.

Howard, G. 2017. The Migration Accelerator: Labor Mobility, Housing, and Aggregate Demand. Working paper.

Lee, S. and Lin, J. 2015. Natural amenities, neighborhood dynamics, and persistence in the spatial distribution of income. Federal Reserve Bank of Philadelphia, Working paper no. 15-46.

Maestas, N., Mullen, K., and Powell, D. 2013. The effect of local labor demand conditions on the labor supply outcomes of older Americans. RAND Working Paper Series WR-1019.

McKinnish, T., Walsh, R., and White, T.K. 2010. Who gentrifies low-income neighborhoods? Journal of Urban Economics 67(2): 180-193.

Moretti, E. 2011. Local labor markets. Handbook of Labor Economics, Volume 4, Chapter 14: 1237-1313. Elsevier.

Notowidigdo, M. 2013. The incidence of local labor demand shocks. Working paper.

Ruggles, S., Genadek, K., Goeken, R., Grover, J., and Sobek, M. Integrated Public Use Microdata Series: Version 6.0 [Machine-readable database]. Minneapolis: University of Minnesota, 2015.

Saiz, A. 2010. The Geographic Determinants of Housing Supply. Quarterly Journal of Economics: 1253-1296.

Vigdor, J. 2002. Does Gentrification Harm the Poor? Brookings-Wharton Papers on Urban Affairs. 133-182.

Zabek, M. 2017. Implications of Local Ties in Spatial Equilibrium. Working paper.

Table 1: Distributions of Changes in Different Measures of Labor Demand

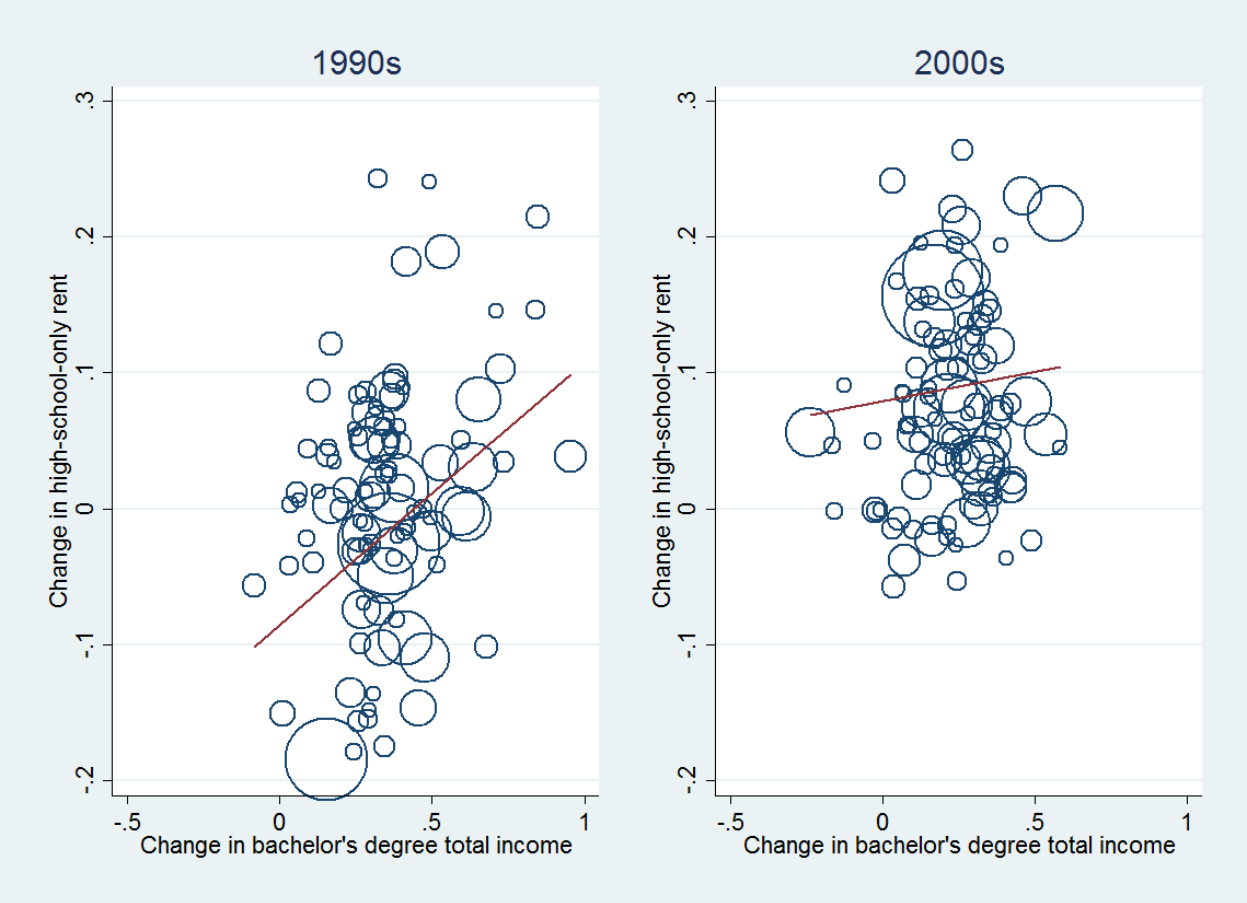
		Panel A: Change in Total income from wages		**Panel B: Change in Employment**	
		College Grads	High-School Only	College Grads	High-School Only
1990s	10th	5.9%	-15.7%	9.7%	-20.2%
	25th	19.8%	-4.2%	19.5%	-13.0%
	Median	32.9%	5.4%	26.0%	-8.9%
	75th	43.8%	26.6%	34.4%	2.0%
	90th	56.3%	45.2%	43.8%	13.7%
	Mean	31.6%	10.7%	25.9%	-6.3%
2000s	10th	-1.1%	-39.8%	12.0%	-22.2%
	25th	12.4%	-18.8%	19.7%	-11.5%
	Median	22.0%	-5.3%	24.8%	-1.0%
	75th	32.0%	16.7%	31.6%	10.2%
	90th	41.9%	26.2%	38.9%	21.4%
	Mean	21.1%	-6.1%	25.2%	-1.4%

		Panel C: Change in Income from wages per worker		**Panel D: Change in Hourly wage**	
		College Grads	High-School Only	College Grads	High-School Only
1990s	10th	5.4%	-4.5%	1.4%	-6.3%
	25th	8.5%	-0.9%	4.4%	-4.0%

	Median	12.1%	2.1%	8.0%	-1.2%
	75th	14.7%	6.1%	10.0%	2.5%
	90th	17.4%	10.2%	13.2%	5.7%
	Mean	11.8%	2.5%	7.3%	-0.6%
2000s	10th	-9.5%	-20.2%	-8.6%	-17.5%
	25th	-5.8%	-15.5%	-6.2%	-15.0%
	Median	-3.1%	-13.2%	-4.0%	-12.5%
	75th	0.2%	-8.3%	-0.3%	-8.1%
	90th	4.1%	-3.6%	3.4%	-4.3%
	Mean	-3.0%	-12.2%	-3.3%	-11.5%

Note: 363 metro areas. Non-farm, non-military, full-time workers aged 25-64. 2014 dollars.

Figure 1: Changes in College Graduate Total Income from Wages and High-School-Only Renter Paid Rent

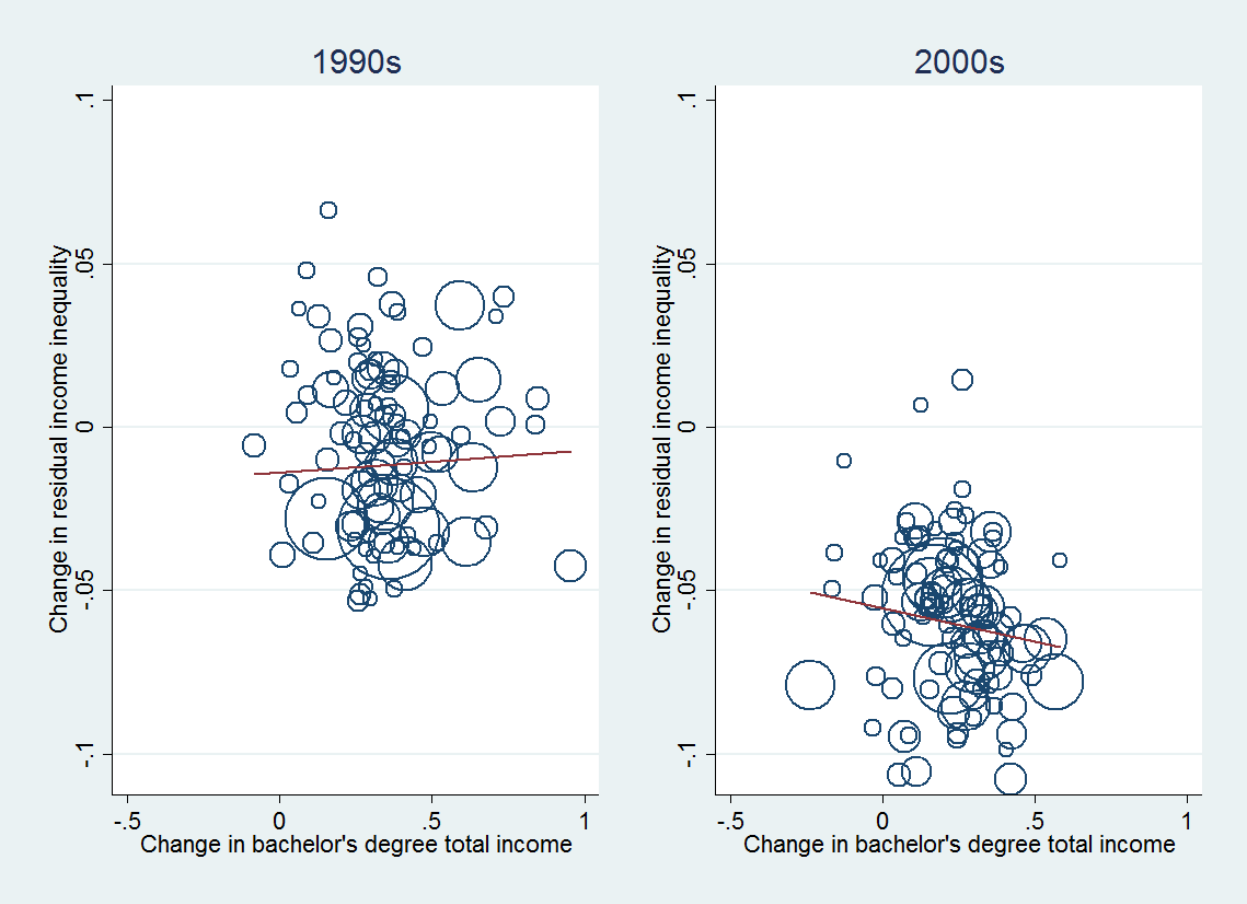


Note: Plot of Core Based Statistical Area (CBSA) decadal. 100 largest CBSAs based on 2000 employment. Source: IPUMS.

Figure 2: Changes in College Graduate Total Income from Wages and High-School-Only Renter Residual Income

Note: Plot of Core Based Statistical Area (CBSA) decadal change. 100 largest CBSAs based on 2000 employment. Source: IPUMS.

Figure 3: Changes in College Graduate Total Income from Wages and Residual Income Inequality (College Graduate Residual Income Minus High-School-Only Renter Residual Income)

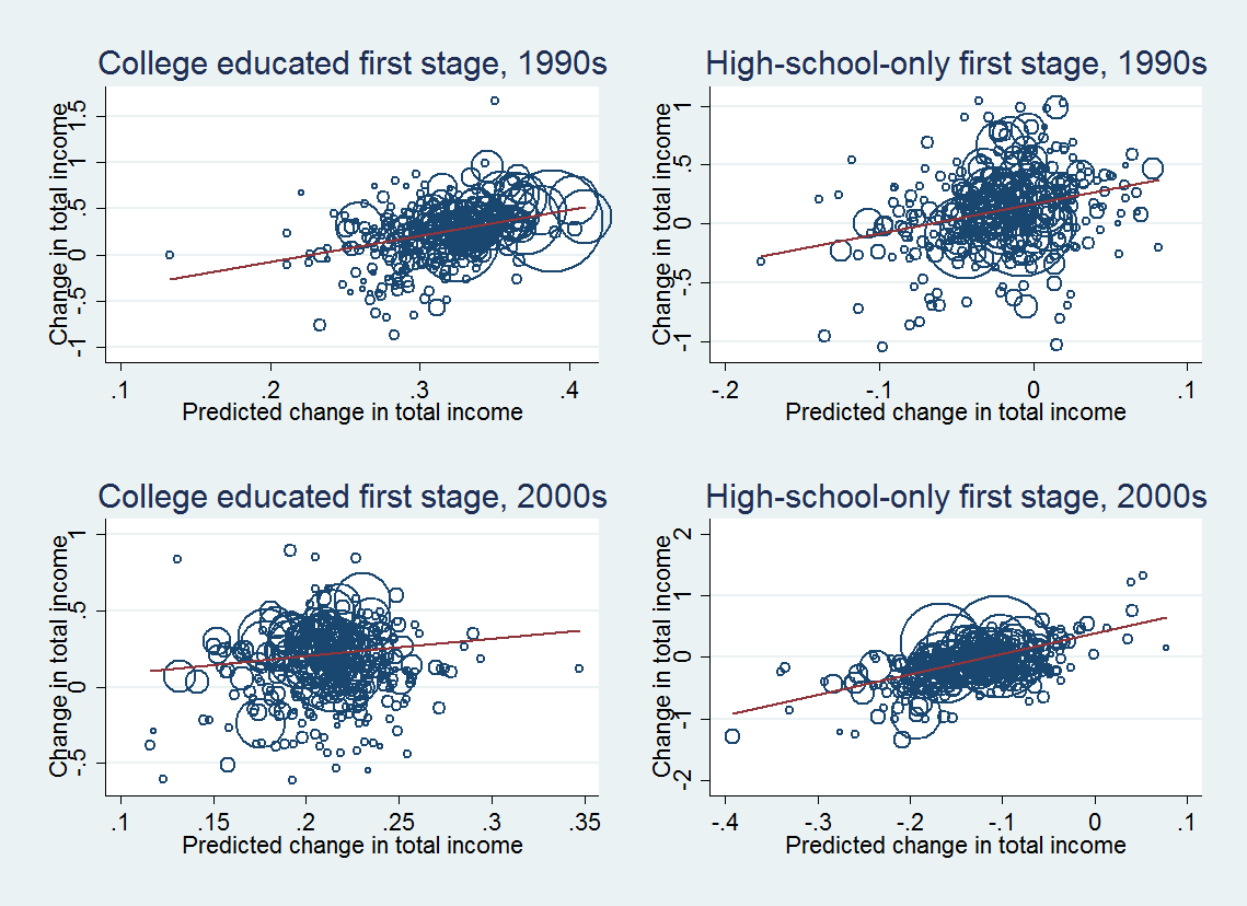


Note: Plot of Core Based Statistical Area (CBSA) decadal change. 100 largest CBSAs based on 2000 employment. Source: IPUMS.

Figure 4: College Graduate and High-School-Only Renter Changes in Total Income from Wage Sources, Full Sample

Note: 363 Core-Based Statistical Areas (CBSAs). Non-farm, non-military, full-time workers aged 25-64.

Figure 5: First Stages by Education Level and Decade, Full Sample



Note: 363 Core-Based Statistical Areas (CBSAs). Non-farm, non-military, full-time workers aged 25-64. X and Y axes are not common across graphs.

Figure 6: Quantile IV: Effect of College Graduate Total Income on High-School-Only Renter Residual Income, by Deciles of Residual Income

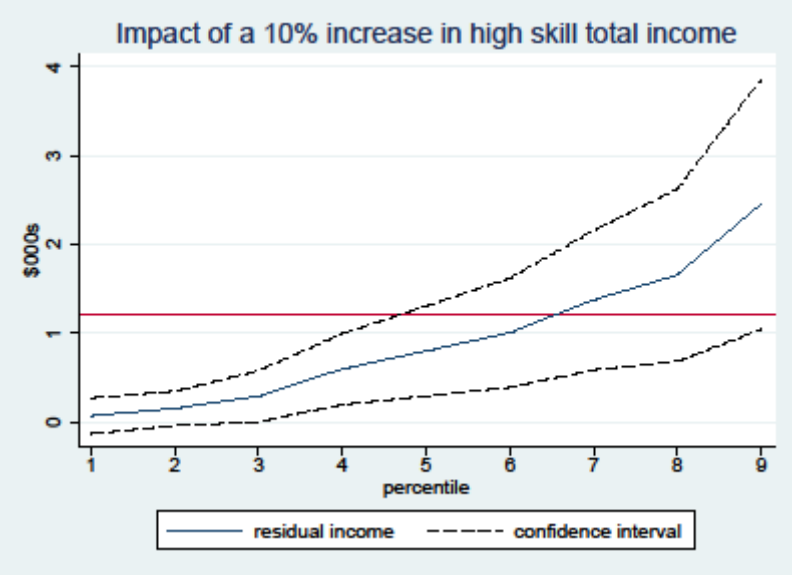


Figure 7: Quantile IV: Effect of College Graduate Total Income on High-School-Only Renter Exposure to College Graduates, by Deciles of Exposure

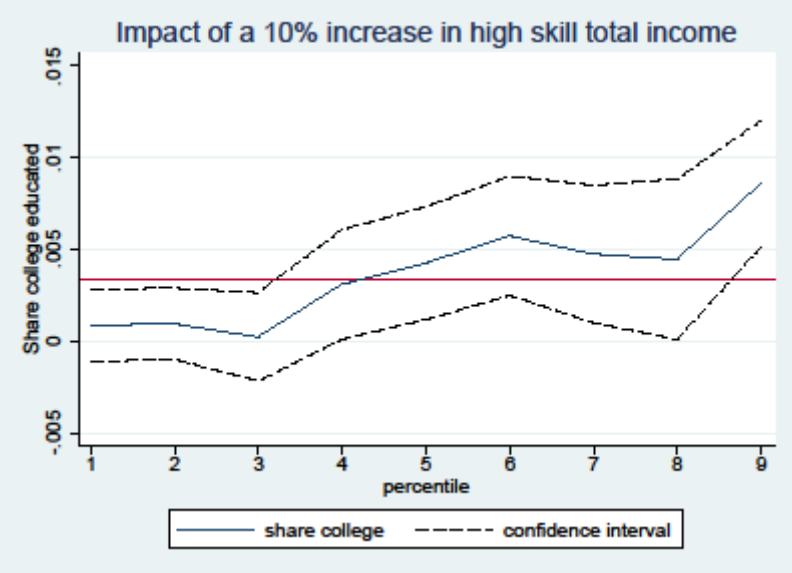


Table 2: First stage: Total income from wages

VARIABLES	(1) hs diffln_totincwage	(2) hs diffln_totincwage	(3) ls diffln_totincwage	(4) ls diffln_totincwage
hs b_diffln_totincwage	2.08***	2.34***		0.70
	(0.37)	(0.40)		(0.53)
ls b_diffln_totincwage		-0.39	2.02***	1.76***
		(0.36)	(0.23)	(0.31)
Observations	726	726	726	726
R-squared	0.331	0.334	0.548	0.550
hs F-stat	31.4	37.4		
ls F-stat			78.5	38.6

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

Weighted by metro employment. Nine Census division by year fixed effects and log city size included in all specifications. Standard errors clustered by metropolitan area.

Table 3: Low skill renters: Housing costs

VARIABLES	(1) OLS	(2) 2SLS	(3) 2SLS	(4) Comp Adjusted	(5) Inequality
hs diffln_totincwage	0.026	0.28***	0.062	0.042	0.033
	(0.026)	(0.095)	(0.074)	(0.056)	(0.024)
ls diffln_totincwage			0.24***	0.16***	0.0092
			(0.050)	(0.035)	(0.022)
Observations	726	726	726	726	726
R-squared	0.482	0.236	0.405	0.489	0.904

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

Weighted by metro employment. Nine Census division by year fixed effects and log city size included in all specifications. Standard errors clustered by metropolitan area.

Table 4: Low skill renters: Residual income

VARIABLES	(1) OLS	(2) 2SLS	(3) 2SLS	(4) Comp Adjusted	(5) Inequality
hs diffln_totincwage	0.048*	0.45***	0.21***	0.17***	-0.023
	(0.027)	(0.083)	(0.078)	(0.058)	(0.024)
ls diffln_totincwage			0.27***	0.17***	0.051***
			(0.070)	(0.054)	(0.017)
Observations	726	726	726	726	726
R-squared	0.882	0.779	0.823	0.825	0.598

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

Weighted by metro employment. Nine Census division by year fixed effects and log city size included in all specifications. Standard errors clustered by metropolitan area.

Table 5: Low skill renters: Rooms per person

VARIABLES	(1) OLS	(2) 2SLS	(3) 2SLS	(4) Comp Adjusted	(5) Inequality
hs diffln_totincwage	-0.045***	-0.22***	-0.27***	-0.25***	-0.11***
	(0.015)	(0.056)	(0.066)	(0.050)	(0.028)
ls diffln_totincwage			0.055	0.087**	0.044**
			(0.042)	(0.044)	(0.020)
Observations	726	726	726	726	726
R-squared	0.760	0.644	0.607	0.583	0.351

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

Weighted by metro employment. Nine Census division by year fixed effects and log city size included in all specifications. Standard errors clustered by metropolitan area.

Table 6: Low skill renters: Commute time

VARIABLES	(1) OLS	(2) 2SLS	(3) 2SLS	(4) Comp Adjusted	(5) Inequality
hs diffln_totincwage	0.055***	-0.072	-0.018	-0.10	-0.032
	(0.013)	(0.056)	(0.066)	(0.10)	(0.054)
ls diffln_totincwage			-0.060	-0.092	-0.052
			(0.037)	(0.060)	(0.041)
Observations	726	726	726	726	726
R-squared	0.674	0.622	0.615	0.555	0.213

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

Weighted by metro employment. Nine Census division by year fixed effects and log city size included in all specifications. Standard errors clustered by metropolitan area.

Table 7: Low-skill isolation index

VARIABLES	(1) OLS	(2) 2SLS	(3) 2SLS
hs diffln_totincwage	-0.0057	-0.0094	-0.049**
	(0.0039)	(0.014)	(0.019)
ls diffln_totincwage			0.044***
			(0.013)
Observations	726	726	726
R-squared	0.640	0.639	0.479

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

Weighted by metro employment. Nine Census division by year fixed effects and log city size included in all specifications. Standard errors clustered by metropolitan area.

Table 8: College exposure

VARIABLES	(1) ch_coll_ls_obs	(2) ch_coll_ls_consloc	(3) ch_coll_ls_conschar	(4) ch_coll_ineq_obs
hs diffln_totincwage	0.033***	0.031**	-0.00074	0.019*
	(0.011)	(0.013)	(0.0052)	(0.011)
ls diffln_totincwage	-0.0061	0.0096	-0.0084	0.0026
	(0.0058)	(0.0095)	(0.0059)	(0.0073)
Observations	726	726	726	726
R-squared	0.551	0.495	0.464	0.543

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

Weighted by metro employment. High and low skill income changes are both instrumented. Nine Census division by year fixed effects and log city size included in all specifications. Standard errors clustered by metropolitan area. Note: Columns 1-3 are exposure to share college educated. Columns 4-6 are exposure to share poverty. "obs" is the observed change combining household relocation across tracts and changing tract characteristics. "consloc" fixes start of period location but allows tract characteristics to change. "conschars" fixes start of period tract characteristics but allows household relocation.

Table 9: Poverty exposure

VARIABLES	(1) ch_pov_ls_obs	(2) ch_pov_ls_consloc	(3) ch_pov_ls_conschar	(4) ch_pov_ineq_obs
hs diffln_totincwage	0.014	0.0071	0.0077*	0.0022
	(0.017)	(0.018)	(0.0040)	(0.010)
ls diffln_totincwage	-0.071***	-0.075***	0.000099	0.025***
	(0.013)	(0.017)	(0.0051)	(0.0091)
Observations	726	726	726	726
R-squared	0.680	0.676	0.462	0.434

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

Weighted by metro employment. High and low skill income changes are both instrumented. Nine Census division by year fixed effects and log city size included in all specifications. Standard errors clustered by metropolitan area. Note: Columns 1-3 are exposure to share college educated. Columns 4-6 are exposure to share poverty. "obs" is the observed change combining household relocation across tracts and changing tract characteristics. "consloc" fixes start of period location but allows tract characteristics to change. "conschars" fixes start of period tract characteristics but allows household relocation.