



House prices and female labor force participation



William R. Johnson

Department of Economics, University of Virginia, P.O. Box 400182, Charlottesville, VA 22904, United States

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ABSTRACT

Is there a causal connection between house prices and labor force participation of married women? The simple correlation between house prices and married women's labor force participation across U.S. metro areas is positive. Plausible, informal arguments have been advanced to support causation in either direction: prices raising participation (negative income effects of higher house prices lead more married women to work) or participation raising prices (richer two-earner households bid up the price of scarce housing). I construct an equilibrium model of location, labor supply and real estate (land) prices within a metro area which predicts that (1) metro areas with exogenously less buildable land will have higher house prices and more labor force participation of married women, while (2) metro areas with married women exogenously more prone to work will have higher house prices. Using geographic instruments for housing supply, I find little evidence of a positive effect of house prices on married women's labor force participation, but a somewhat greater possibility that house prices raise their earnings. Likewise, an instrument for married women's labor supply reveals no consistent significant causal effect of two earner households on housing prices, although the possibility of a positive effect cannot be ruled out.

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1. Introduction

Two salient changes over the past four decades have been the rising labor force participation of married women (LFPMW) and an increase in the real price of housing. This paper examines the possible links between the two phenomena. A plausible argument can be made for causation in either direction. Warren and Tyagi (2003) have argued that the higher relative cost of housing induces households to supply more labor to the market by sending two earners into the labor market. But an equally plausible case could be made for the causation running in the opposite direction. In Frank and Cook (1995), the rise of two-earner families bids up the price of land thereby raising the relative price of housing. This direction of causation is consistent with the findings of Gyourko et al. (2010, 2013) who identify increasing national income inequality as a force creating “superstar cities” with markedly higher relative housing costs as the housing demands of an expanding number of high-income households collide with housing supply constraints in certain cities. Although Gyourko, Mayer and Sinai do not explicitly mention the rise of two-income households as a cause of increasing income inequality, other studies have found that assortative mating and a greater tendency for well-educated wives to pursue careers exacerbates income

inequality across households. Moretti (2013) shows that high wage, college educated workers are increasingly drawn to cities with high housing costs because they can earn more there but he does not argue that the high housing prices are caused by this sorting.

This paper tries to untangle the direction of causation between house prices and LFPMW using data on a cross-section of US metropolitan areas. The simple cross-section relation between real house prices and LFPMW is positive – high-priced housing markets are associated with greater LFPMW. This could arise because (1) high house prices induce women to work; (2) more working women bid up housing prices; or (3) a third variable is correlated with both house prices and LFPMW. My empirical results suggest that higher house prices do not raise LFPMW but there is some likelihood that LFPMW increases house prices.

A simple model of labor supply and residential location within a metropolitan area motivates both directions of causation. Assuming a monocentric city in which all employment occurs at the center, households with two earners will have a greater incentive to save on commuting costs by locating close to the city center, bidding up the price of close-in land and raising the overall cost of housing. Consequently, other things equal, cities with more two-earner households will have higher land prices. Labor supply choices are made in the standard way, balancing the value of non-market time against the purchased goods foregone by not

E-mail address: wjohnson@virginia.edu

working, but the household also takes into account the cost of housing and commuting. With reasonable assumptions about preferences and positive assortative mating, the model shows that high wage households will choose to send two earners into the labor market and will reside in high priced housing close to the city center. Lower wage households will have only one earner and will live on the periphery in lower priced housing.¹

The model can generate differences in labor supply and house prices across metropolitan areas. Cities may differ geographically in the capacity to build housing close to the city center; the model captures that with a parameter which represents the fraction of land that is buildable. These geographic factors will affect the price of land across metropolitan areas and, indirectly, labor supply since the decision to work depends on housing costs and commuting times.²

Metro areas might also differ in exogenous factors that affect women's labor force participation. If preferences for purchased goods relative to non-market time differ across cities, that would be reflected both in labor supply behavior and, in equilibrium, in land prices. To instrument for female labor force participation, I use a measure of the fraction of the city's males who served in the military during World War II, a variable which has been found to be causally related to female labor force behavior by Acemoglu et al. (2004).

The model generates some empirical implications that are confirmed by the data. House prices are higher and commuting times are longer in metropolitan areas with less close-in buildable land. Married women are less likely to work in cities with longer commuting times.

The hypothesis that house prices cause LFPMW can be probed by instrumenting for endogenous house prices to estimate the extent to which exogenous variations in house prices across metropolitan areas affect LFPMW. The instruments are measures of the topographic characteristics of metropolitan housing markets which may affect both the supply of close-in land, the cost of building on that land, and the desirability of the location. The results show no significant positive effect of house prices on labor supply, though possibly an effect on women's earnings. The reverse direction of causation is examined by instrumenting for LFPMW in an equation explaining house price variation across metro areas using the fraction of the city's males who served in the military during World War II as an instrument. While I cannot reject the null hypothesis of no effect of LFPMW on house prices, a substantial positive effect also cannot be ruled out.

2. The empirical puzzle

The rise in the labor market activity of women, especially married women with children, is well known and has been a central focus of research attention by labor economists. The fraction of married women in the labor market has essentially doubled in the past half century, rising from 31.9% in 1960 to 61.0% in 2010. Economic explanations for this increase have centered on the rising relative wages of women, the availability of effective contraception, and the changing structure of labor demand. Non-economic explanations have relied on what economists term changes in tastes or what sociologists call "norms".

¹ This paper focuses on two adult households with some attachment to the labor market. Married-couple family households are only 48% of all households and 35.9% of those have at least one person 60 years of age or above, so a majority of housing units in the US are not occupied by the type of household that is the focus of this paper.

² The role of commuting time in explaining cross metro area differences in women's labor force participation is highlighted in the work of Black et al. (2014).

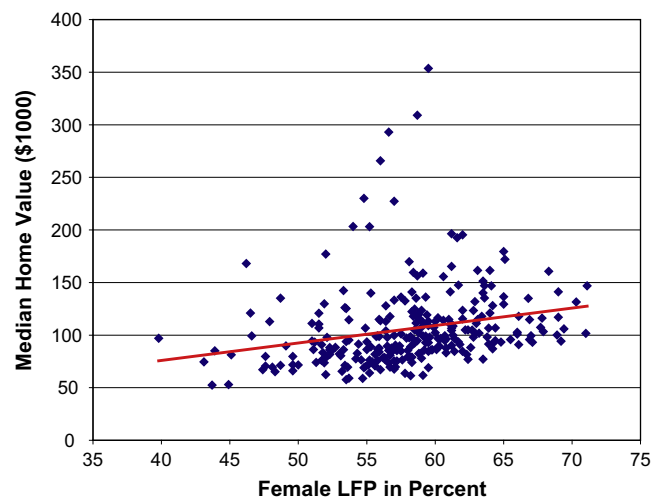


Fig. 1. Median home value and married women's labor force participation across us metro areas: 2000 Census.

The second time-series observation is the rising relative price of housing in the United States. Although the housing market is cyclic and localized, quality-adjusted house prices nationally have risen on average faster than overall inflation over the past 35 years despite the recent sharp decline in house prices. From 1975 to 2010, an index of house prices, based on repeat purchases of the same house, has risen 72.6% relative to the GDP deflator and 40% relative to the CPI.³

Cross-section evidence also points to a possible relation between house prices and women working. Housing markets and labor markets in the US are usually identified by metropolitan areas. House prices vary widely by metro area, with the highest prices in California, New York and New England. Less well known is the fact that LFPMW varies substantially across metro areas with the highest rates in the upper Midwest.⁴ The cross metro area relationship between LFPMW and housing prices is significantly positive. In Fig. 1, each additional percentage point of LFPMW in 2000 Census data is associated with \$2000 extra in median house prices across metropolitan areas. So, the crude cross-section data agree with the time-series evidence.⁵

Empirical associations between house prices and LFPMW would not be worth pursuing were there not a plausible theory linking the two. In this case, there are at least two theories. First, it is argued that higher housing prices are the cause of LFPMW. For example, a recent popular book entitled *The Two Income Trap* Elizabeth Warren and Amelia Tyagi argue that housing has become so expensive that married women must work (in the paid labor force) to maintain the standard of living that households achieved in the 1950s with only one earner. This is essentially an

³ The time period is from the first quarter of 1975 to the first quarter of 2010. See US Housing Finance Agency, http://www.fhfa.gov/webfiles/15762/1q10hpi_reg.txt. Much of this increase occurred in the northeastern and western regions of the country.

⁴ Black, Kolesnikova, and Taylor (2014) highlight the variation in married women's labor force participation across metro areas and conclude that commuting costs drive some of the variation. They find no correlation between LFPMW with housing cost differences but their analysis uses only 50 large MSAs. The analysis here uses over 200 MSAs. When I restrict my estimates to Black et al's smaller sample of metro areas, I, too, find no correlation between housing cost and LFPMW.

⁵ Median house value conflates the price per unit of housing and the quantity of housing. The statistical analyses below use only pure housing price indices. The cross-metro correlation between LFPMW and each of two house price indices is positive. Simple regressions of price indices on LFPMW show significantly positive coefficients implying that an extra percentage point of LFPMW raises house prices by roughly .03 standard deviations.

argument based on falling real wages of husbands, a trend which is not evident in the aggregate data, so it would be hard to produce the time series pattern from this theory. To be sure, if house price inflation has been so intense in certain markets that the real earnings of men in those markets had decreased, that might have boosted LFPMW in those markets. The reverse would be true in other housing markets, so this theory could be consistent with the cross-section evidence but not with the time series trends.

Using Canadian data, Fortin (1995) finds that mortgage debt raises female labor force participation, an effect she ascribes to the rules of mortgage lenders restricting mortgage borrowing to a proportion of household income. Mortgage debt is related to housing value which in turn is the product of the quantity of housing chosen by the household and a price per unit of quantity. In Fortin's model, however, housing choices and mortgage debt are exogenous, so the direction of causation implied by her empirical results is unclear.

The other theoretical story reverses the direction of causation. Here some external cause sends more women into the labor market, raising household money incomes and setting off a bidding war for goods like housing that may be in relatively inelastic supply when location is accounted for. In the extreme form of this argument, with an absolutely fixed supply of housing, the households with the most income will get the best house, and so on down the line. The house a household attains will depend on its income relative to the income of other households. This is the mechanism in the popular book, *The Winner-Take-All Society* by economists Frank and Cook (1995). When some households send wives into the labor market that makes the remaining single-earner households worse off because the two-earner households now bid up the price of housing to get the best houses. In this scenario, we would expect that over time, more married women working would lead to higher relative house prices, and that house prices will be higher in metro areas with many married women working.

One reason that LFPMW might differ across metro areas could be the effect of transitory demand shocks to local labor markets, as summarized in Moretti (2011). Bartik (1991) and Topel (1986) show that because labor is somewhat immobile, demand shocks to local labor markets affect local labor market outcomes for several years after the shock. Bartik finds that positive demand shocks increase labor force participation and housing prices. This mechanism would generate a positive cross section correlation between labor force participation and housing prices. Alternatively, the instrument for LFPMW used in this paper tries to capture more permanent differences across metro areas in some fundamental determinant of LFPMW.

3. A model of housing and labor force participation

In this section, I sketch a simple model in which location choices and LFPMW are both endogenous at the individual level and the land market clears at the level of the metropolitan area. I need a tractable model in which more labor force participation drives up land prices and vice versa, and chose one which is driven by the greater willingness of two-earner couples to pay a premium to live close to the center of the metro area in order to save on commuting cost. Models of urban location often center on commuting cost. Glaeser et al. (2008) show that in traditional models of location in monocentric cities with exogenous household income, location patterns by income depend on the relative strength of two effects: how much commuting cost rises with income and the income elasticity of the demand for land. They argue that access to public transportation helps explain why the poor often live closer to the center than higher income households. Although the model outlined below yields an equilibrium in which higher income two-earner couples pay a premium to live closer to the

center than lower income one-earner couples, an equilibrium which seems to contradict the pattern found in many US cities, the data on location of households by numbers of earners is not clear and is complicated by significant deviations in all US cities from the simple model's assumption of a single employment center, as well as variation in school quality which affects location decisions for households with children. Alternatively, I could have made special assumptions about preferences such as well-located residential land being a complement with other purchased goods but a substitute for leisure to generate the greater demand for that land by two-earner couples. It would not be enough to note that housing is a normal good and that two earner couples have more money income since money income depends on an endogenous labor supply decision in this model.

The model is static, the number of households in a metro area is fixed, and each worker's wage rate is fixed. In other words, the metropolitan area labor market clears, trivially, because labor demand is assumed to be perfectly elastic. One could endogenize wages at some cost of complicating the model, but the main conclusions of the analysis remain. Because the model is intended to explain cross section data, it focuses on causes of long-run differences among metro areas. Interregional trade in goods and services implies that the supply of non-housing consumption and housing structures (excluding land) is perfectly elastic to each metro area in the long run, hence prices do not vary across cities. Variation in quality-adjusted house prices within and across metro areas arises then solely from land prices which can persist in the long run under certain conditions.

Consider a metropolitan area in isolation. The area consists of a central place of employment, a point with no area, surrounded by undifferentiated land on which housing can be built. Every worker who is employed must commute to the center from his house; a worker's commuting costs are proportional to the distance to the center and to the opportunity cost of his time, his wage rate. Every household consists of two adults; every husband works, but wives can choose whether or not to work. The labor supply choice is a binary one. Households with two earners and those with high wages will have a greater incentive to live close to the center to reduce commuting costs, creating a price premium for land close to the center. Households simultaneously choose where to live and whether the wife works, taking into account the equilibrium land prices for different locations.

Within a metro area, households are differentiated only by wages; they have identical preferences over leisure, housing structures, and non-housing consumption. Each household must rent one unit of land for its house, the only decision being where to locate. Allowing density to vary would complicate the model substantially. The land rent, R , will depend in equilibrium on location as close-in locations are desirable because they save on commuting costs.

3.1. Household choices

Each household consists of two adults, with wages w^m and w^f . Wages differ across households, but assortative mating implies that w^m and w^f are positively correlated. Denoting H as a $(0, 1)$ indicator of whether the wife works and recalling that all husbands work, household income is $w^h + H \cdot w^f$. Household income is spent on non-housing consumption, housing (excluding land rent), land rent, and commuting costs. Recall that each housing unit requires one unit of land and that all land is assumed homogeneous except for location. The household takes the land rent function $R(r)$ as given and chooses a location, r . The center is $r = 0$.

Commuting costs are assumed to be proportional to the distance from the center, r , and the wage rates of the commuters in the household. Specifically, suppose that commuting costs per period are $\alpha(w^h + H \cdot w^f)r$, where α is a parameter which depends

negatively on the speed of commuting.⁶ The participation constraint, which is assumed to be satisfied, requires commuting costs to be low enough so that even the lowest wage husband will want to work, living at the boundary of the city.

The two crucial decisions for the household are the labor supply decision and the location decision. Households are assumed to have preferences over purchased goods (consumption plus housing structures excluding land rent) and household non-market time. A convenient utility function is one successfully fit to recent US data on female labor supply by [Attanasio et al. \(2008\)](#).

$$U(H, c) = \frac{c^{1-\gamma}}{1-\gamma} \cdot \exp(\psi_1 H) - \psi_2 H \quad (1)$$

where c represents purchased consumption (which includes housing structure), and γ , ψ_1 , and ψ_2 are preference parameters. The household budget constraint says that consumption is earnings less land rent and commuting cost:

$$c = w^m + w^f H - R(r) - \alpha r(w^m + w^f H) \quad (2)$$

Besides labor supply, the household must choose location. The first order condition for optimal r balances the cost of commuting against the higher cost of land closer in:

$$R'(r) = -\alpha(w^m + w^f H) \quad (3)$$

Eq. (3) says that two-earner households will choose a location such that the rent gradient equals α times the sum of wages, while one-earner households choose a location where the slope of the land rent gradient equals the husband's wage. Or, in terms of bid-rent functions (see [Alonso \(1964\)](#)), (3) gives the slope of a household's bid rent. Higher wage and two-earner households will offer more to live closer to the center to save on commuting costs.

Now consider the labor supply decision. The household opts for two earners when utility with two earners exceeds utility with one earner, or the following condition is met:

$$\begin{aligned} & \frac{[(w^m + w^f)(1 - \alpha r_1) - R(r_1)]^{1-\gamma}}{1 - \gamma} \cdot \exp(\psi_1) - \psi_2 \\ & > \frac{[(w^m)(1 - \alpha r_0) - R(r_0)]^{1-\gamma}}{1 - \gamma} \end{aligned} \quad (4)$$

In (4), r_1 and r_0 represent the optimal location choice if the household has two earners or only one earner, respectively.

Using the estimated parameters from [Attanasio et al. \(2008\)](#), as well as the positive empirical correlation between wife's wage rate and husband's wage rate estimated by [Hyslop \(2001\)](#), it can be shown that inequality (4) is more likely to hold the greater is the wife's wage. In other words, the substitution effect of the wife's wage rate outweighs the income effect of the wife's wage and the associated income effect of the correlated husband's wage. Wives with higher wage rates will, on average, have higher wage husbands and be more likely to work.

Spatial equilibrium will be characterized by higher wage two-earner households choosing to live within a circle closest to the city center to save on commuting costs while the one earner households live in the ring surrounding this central circle. Among the two-earner households, the highest wage households will live nearest the center and the lowest wage households will live at the outer boundary of the inner ring. Among the one-earner households, the highest wage households will live at the inner boundary of the outer ring and the lowest wage households at the outer boundary of the outer ring (and the city).

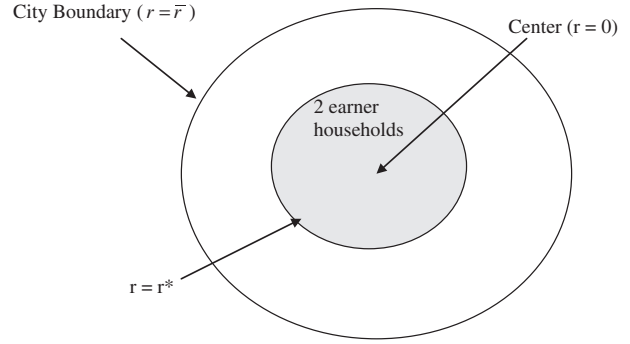


Fig. 2. The circular city.

3.2. Market equilibrium

Now consider a metropolitan area composed of N households. To simplify the exposition, I now assume that the husband's wage and wife's wage are equal.⁷ We can identify each household by the common wage rate of both adults. The number of households with wage w is given by the function $f(w)$, with support $[w, \bar{w}]$. Land can either be used for housing or for some non-housing activity (such as agriculture) with opportunity cost, a . I assume that every household in the city can have positive income net of land rent and commuting costs; this is a participation constraint for the existence of the city's population. The households with the lowest wages will have only one earner and low commuting costs so they will locate at the edge of the city on the boundary with undeveloped land. Denote the edge of the city by \bar{r} . Since each household requires one unit of land for housing, \bar{r} is determined by $N = \pi \bar{r}^2$, or $\bar{r} = \sqrt{N/\pi}$. Fig. 2 depicts the circular city.

Land rent at the edge of the city must equal its non-housing value, a , so the total land rent and commuting costs of a one-earner household living on the edge of the city will equal $w\alpha\sqrt{N/\pi} + a$. The participation constraint is that the wage income net of housing and commuting costs of that household be positive, or

$$w(1 - \alpha\sqrt{N/\pi}) - a > 0 \quad (5)$$

The participation constraint puts an upper limit on the population of the city

$$N < \left(\frac{\pi}{\alpha^2}\right) \left(1 - \frac{a}{w}\right)^2 \quad (6)$$

which will be assumed to hold. This in turn puts an upper limit on the geographic size of the city, \bar{r} :

$$\bar{r} < \frac{1}{\alpha} \left(1 - \frac{a}{w}\right) \quad (7)$$

Depending on the parameters, the city might be composed entirely of one-earner households, entirely of two-earner households, or a mixture of one and two earner households. The last case is the most interesting case, so I focus on that. Since households differ only in wages and since a higher wage makes it more likely that a household will have two earners, if there are both one-earner and two-earner households in the city, there must be a w^* , $\underline{w} < w^* < \bar{w}$, such that all households with $w > w^*$ choose $H = 1$ and all households with $w < w^*$ choose $H = 0$. The labor force participation rate of wives will equal the fraction of households with $w > w^*$, or

⁶ By normalizing units of land area such that one unit is required for each housing unit, distance, r , is measured in the square root of the area unit, and α is the time required to travel a distance equal to the square root of the required lot size.

⁷ The results derived below are substantively similar if husband and wife's wages are positively correlated but not necessarily equal.

$$\text{LFPMW} = \frac{1}{N} \cdot \int_{w^*}^w f(w) dw \quad (8)$$

LFPMW is a decreasing function of w^* .

We can now derive the equilibrium land rent function R . The lowest wage households live at the urban boundary, where $r = \bar{r}$ and $R(\bar{r}) = a$. The highest wage households live at the center where $r = 0$. For any r between 0 and \bar{r} , the fraction of the city's land area that is closer to the center than r is given by the ratio of the areas of two circles with radii r and \bar{r} , or $\pi r^2 / \pi \bar{r}^2$. Since all N households in the city live within a circle of area $\pi \bar{r}^2$, and each household uses one unit of land, $N = \pi \bar{r}^2$ and the ratio above becomes $\pi r^2 / N$. Hence, the fraction of households living closer than r is $\pi r^2 / N$. If households with wage w live at r , then the fraction living closer than r is the fraction with wages greater than w , implying that $1 - F(w) = \pi r^2 / N$, or $F(w) = 1 - \pi r^2 / N$, an equation which defines the mapping of wages, w , to location, r . Inverting this mapping, we have the household's wage as a function of its location or, $w(r) = F^{-1}(1 - \pi r^2 / N)$.

Using the results in (3), which imply that the bid rent gradient is $\alpha w(r)$ for single earner households, and $2\alpha w(r)$ for two earner households, the land rent at the center is the integral of the rent gradient from the boundary of the city to the center, or:

$$R(0) = a + \alpha \int_{\bar{r}}^r \left[F^{-1} \left(1 - \frac{r^2 \pi}{N} \right) \right] dr + 2\alpha \int_0^r \left[F^{-1} \left(1 - \frac{r^2 \pi}{N} \right) \right] dr \quad (9)$$

To understand (9), consider each term separately. The first term is a , the opportunity cost of land which would be the land rent at the outer boundary of the city where $r = \bar{r}$. The second term captures the effect on land rent of moving toward the center through the outer ring ($w < w^*$; $r > r^*$) where only single earner households live and the rent gradient is αw . Likewise, the third term represents moving toward the center through the inner ring ($w > w^*$; $r < r^*$) where the rent gradient is $2\alpha w$. Eqs. (8) and (9) together imply that, holding constant the opportunity cost of land, a , and the distribution of wages, $f(w)$, the lower is w^* (and hence the higher is r^*), the higher will be LFPMW and also $R(0)$, land rents at the center. In other words, housing (i.e., land) costs and LFPMW are thus simultaneously determined in the model.

As Fig. 2 illustrates, the model predicts that two-earner households will live closer to the center of employment than one-earner households. The model neglects complicating factors such as multiple employment centers, limited public transportation networks and variation in local public school quality, all of which are important for location decisions in the US context.⁸ For example, Rosenthal and Strange (2012) find that female entrepreneurs are less likely to locate in the city center than are male entrepreneurs. Likewise, Glaeser et al. (2008) emphasize the role of limited public transportation systems in inducing the poor to locate near the city center in many US metro areas. Despite the fact that the model predicts a pattern of residential location seemingly at odds with reality in many US metro areas, the validity of the empirical tests only requires that the two-earner household be willing to pay more for desirable land than the one earner household, whether desirability is based on proximity to employment or location in a high quality school district, and that the supply of that desirable land is affected by the geographical instruments.

⁸ However, the pattern predicted by the model may be seen in some cities. Rouwendal and van der Straaten (2003) argue that dual earner couples in the Netherlands are willing to pay a premium to live close to major employment centers in order to reduce joint commute times. Abe (2011) finds that in the Tokyo metro area, commuting cost is a deterrent to married women's labor force participation, so that couples living closer to the center are more likely to have two earners rather than one.

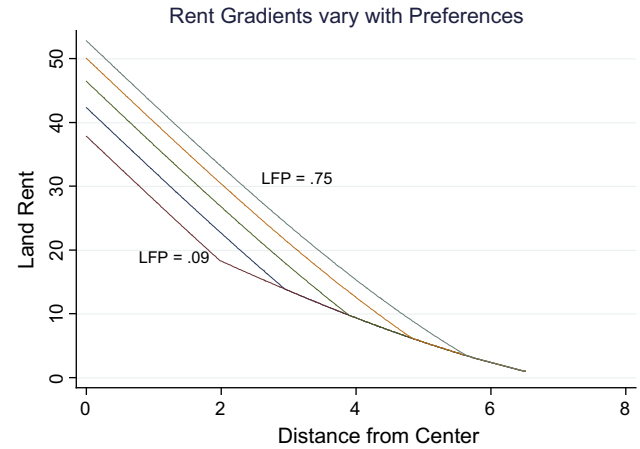


Fig. 3. Rent gradients for five values of the taste parameter ψ_2 . Notes: a numerical example in which $a = 1$, $\alpha = .05$, $\theta = .75$, $N = 100$, and the wage distribution is uniform over (50,100). The taste parameters, γ and ψ_1 are fixed at the values estimated by Attanasio et al. (2008), -1.5 and $.038$ respectively. The five rent gradients correspond to five values of the remaining taste parameter, ψ_2 , which yield female labor force participation rates of .09, .20, .36, .55 and .75. The highest rent gradients are associated with the highest labor force participation rates. The kinks in gradients occur at r^* , the boundary between the one-earner households and the two-earner households. The city boundary occurs at 6.514).

3.3. Comparative statics across metropolitan areas

To this point, the model has focused on one metropolitan area. Now I consider a number of metropolitan areas, each with a fixed and equal population.⁹ The model is intended to explain differences in land values and labor supply across metro areas. On the housing supply side, metro areas may differ in the availability of close-in land for building both because of geography or because of legal restrictions on building. The model can reflect unbuildability by adding a parameter θ representing the fraction of land that can be used for building.¹⁰ For simplicity, θ is taken to be constant across all distances from the center.

Introducing the new parameter, θ , alters the expression for the edge of the city to $\bar{r} = \sqrt{N/\theta\pi}$. Clearly, for a metro area with some unbuildable land ($\theta < 1$), the city must be built farther out to accommodate the same population, N .

The key endogenous variable in this model is w^* , the boundary wage between two-earner households, who live close to the city center, and one-earner households, who live farther away. Households with a wage of w^* are indifferent between sending one and two earners into the market; in other words, w^* is defined by the value of w which makes (4) an equality. The location of this borderline household, r^* , is given by an expression which equates the demand for land closer than r^* , which is the population with wages greater than w^* , and the supply of land closer than r^* , which is just the buildable fraction θ times the area of a circle with radius r^* .

$$r(w^*) = \sqrt{\frac{N[1 - F(w^*)]}{\theta\pi}} \quad (10)$$

⁹ At this stage, the model makes the unrealistic assumption that all metro areas must accommodate the same population. Implicitly, the model does not allow migration between metro areas, although I argue below that allowing costly migration would not alter the direction of the comparative statics effects derived here.

¹⁰ Rose (1989) finds that both natural geographic restrictions on building and legally imposed restrictions affect urban land prices. Saiz (2010) shows that topographic variables affect housing supply elasticity. Glaeser and Gyourko (2003) argue that legal restrictions are an important cause of differences in house prices across metro areas.

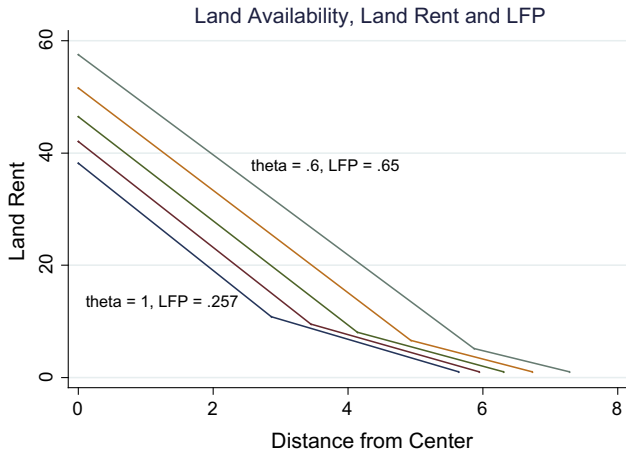


Fig. 4. Rent gradients for five values of the land availability parameter, θ . Notes: a numerical example in which $a = 1$, $\alpha = .05$, $N = 100$, and the wage distribution is uniform over $(50, 100)$. The taste parameters, γ and ψ_1 are fixed at the values estimated by Attanasio et al. (2008), -1.5 and $.038$ respectively, while $\psi_2 = .075$. Five values of the land availability parameter, θ , are illustrated $(1, 0.9, 0.8, 0.7, 0.6)$. The lowest value of θ (0.6) yields a female labor force participation rate of .650 and the highest rent gradient. The highest value of θ (1) yields a female labor force participation rate of .257 and the lowest rent gradient. The kinks in gradients occur at r^* , the boundary between the one-earner households and the two-earner households. The city boundary occurs further out the lower the value of θ .

The land rent at r^* can be found by solving the differential equation implied by the bid rent (3) along with the boundary condition that rent at the edge of the city is a .

$$R(r^*) = a + \alpha \int_{r^*}^{\bar{r}} F^{-1} \left(1 - \frac{\theta \pi r^2}{N} \right) dr \quad (11)$$

Variations across metro areas in the labor supply preference parameters, ψ_1 and ψ_2 , and in the amount of buildable land, θ , result in variation in both land rents and female LFP. Comparative statics of the system (10), (11), and (4) with respect to the parameters can be illustrated with figures representing specific numerical solutions to the land rent function. Fig. 3 shows the how rent gradients and female LFP vary with the preference parameter ψ_2 . High values of ψ_2 signify greater loss of household utility when a second adult works, and yield equilibria with less female LFP and with lower land rents. Higher ψ_2 pushes in r^* , the boundary between the two-earner and one-earner households. The land rent for all land within the r^* circle falls because the steeper part of the rent gradient, where $R'(r) = -2\alpha w$ begins farther in.

The effects of variation across metro areas in the parameter θ , the buildable land parameter, are illustrated by Fig. 4. A decrease in θ pushes the city boundary outward to gain enough buildable land to accommodate the fixed population. This raises commuting costs because the typical household must live farther away from the center. Because close-in land is now scarcer, the rent on land at any distance from the center also rises. The net result of these two effects is to raise female LFP. The income effect of higher land prices outweighs the effect of greater commuting times in raising the cost of working.

This model suggests the following results. First, lower values of ψ_2 , one of the preference parameters, raises LFP and pushes out the boundary between the two income and one income households, thereby increasing land rents for all close-in land. An increase in buildable land, represented by a higher value of θ , reduces both land rents and LFP. Note that variations in either ψ_2 or θ generate a positive correlation between land values and LFP. Hence the model allows for both directions of causality – higher house prices can “cause” higher LFP while labor

supply can also “cause” house prices. In both cases, the model predicts that the sign of the causal effect is positive.

3.4. Effects of migration, agglomeration economies, and amenities

The model above assumes that there is no migration between cities. What would equilibrium look like if movement were possible? Recall that in the basic model there is no amenity difference between cities, nor is there any labor market difference. In that model, a household can earn the same wage no matter where it locates. The only difference between cities relevant to individuals is the price of land as a function of distance from the center. Cross-metro area variations in the land rent function would be caused either by differences across cities in land availability (θ) or in the preferences of households in the metro area (ψ_2). Perfectly costless mobility leads households to move between cities seeking the cheapest land (adjusting for distance) until in equilibrium every city has the same housing prices as a function of distance from the center. Moreover, in equilibrium each city would have the same LFP. Cities with less buildable land (lower θ) would be smaller in population (but identical in maximum distance from the center, \bar{r}). To sustain differences in LFP across cities in this model, any migration must be less than costless.

If labor markets differ across cities, the model resembles the models of Rosen (1974) and Roback (1982) in which equilibrium establishes compensating differentials in wages and land rents. For example, suppose agglomeration economies raise the level of wages in cities with large populations compared to smaller cities. In equilibrium, higher wages in large cities will be offset by higher land rents. With the additional assumptions of the model developed above, larger cities would have higher LFP and also would attract migrating high wage couples from smaller cities. This agglomeration effect would produce a positive correlation between land rents and LFP across cities of varying sizes, but not across cities of the same size. Although agglomeration economies are a plausible mechanism connecting land rents and labor supply, including population size as a proxy for agglomeration economies does not materially change the empirical results reported below.

Amenity differences across cities could also conceivably generate a positive cross-section relation between LFP and house prices but it would require special (and untestable) restrictions on preferences. The most obvious mechanism would be a positive relation between the taste for amenities and the taste for goods relative to leisure. Besides being untestable, this assumption is somewhat counterintuitive since a priori one might expect leisure and amenities to be stronger complements than goods and amenities. If amenities were luxury goods, then there would be migratory sorting of households with high wage households migrating toward high amenity cities bidding up the price of land there. However, Gyourko et al. (2013) show that their “superstar” cities with high house prices actually experience lower population growth than other cities.

4. Empirical tests

4.1. Data and empirical strategy

To confront the model with data, I perform two types of instrumental variable estimation. In the first, I use geographical characteristics at the level of the US metro area to instrument for endogenous metro area average commute times and housing prices. The geographic characteristics are intended to represent the parameter θ in the theoretical model. I then use those metro area instruments in regressions on individual data on married

Table 1
Descriptive statistics.

Metro area variables	Mean (std. dev.)	Individual level variables for married women (N = 203,974)	Mean (std. dev.)
Rosenthal–Chen house price index standardized (N = 297)	0 (1)	High School	.257 (.44)
Olsen house price index standardized (N = 329)	0 (1)	Some College	.301 (.46)
Fraction of buildable land (N = 283)	.925 (.158)	College	.306 (.46)
Fraction of land with slope greater than 20% (N = 93)	.087 (.111)	Labor force participation	.679 (.46)
Mean travel to work time (min) (N = 295)	22.5 (3.7)	Number of children under five	.30 (.60)
Female labor force participation (%) (N = 277)	58.0 (5.4)	Other family income (thousands of dollars)	63.76 (66.57)
Median full-time male earnings (1000\$) (N = 275)	36.4 (4.7)	Wage income (wives) (thousands of dollars)	20.97 (29.19)
Median full-time female earnings (1000\$) (N = 275)	25.7 (3.4)	Metro area unemployment rate, April 2000	3.62 (1.64)
World War II male mobilization rate (N = 348)	.454 (.068)		

Notes: Rosenthal index from [Chen and Rosenthal \(2008\)](#). Index is $(Q_H + Q_B)/2$. Olsen index from unpublished estimates by Edgar Olsen as described in [Olsen et al. \(2005\)](#). Fraction of buildable land and 20% slope variables are author's calculations using Census maps. Mobilization rates from [U.S. Selective Service System \(1948\)](#). Climate variables from NOAA. Other variables from US Census 2000 and Census 2000 PUMS

Table 2
Effects of geography on cross-metro area differences in commute times and house prices.

	(1) Mean commute time	(2) Rosenthal–Chen house price index	(3) Olsen house price index
Fraction of buildable land	–4.61*** (1.20)	–1.93*** (.45)	–1.96*** (.39)
Fraction of sloped land	2.21 (2.46)	3.51*** (.86)	2.97*** (.93)
F-statistic	$F(3, 254) = 36.8$	$F(7, 250) = 21.2$	$F(3, 279) = 20.5$
Number of observations	258	254	283

Notes: Dummy for missing slope data is also included. Robust standard errors in parentheses.

** 5% Significance.

*** 1% Significance.

women to explain labor force participation and earnings to see if metro area commute times and housing prices “cause” married women’s labor force behavior. The second set of estimations goes in the opposite direction. I instrument for married women’s labor force participation rates at the metro area level with a variable intended to represent “tastes” for work (the parameter ψ_2 in the model) and then use instrumented labor force participation to explain metro area level housing price indices.

[Table 1](#) shows the descriptive statistics for the data used in estimation. The variables in left hand panel of [Table 1](#) are measured at the level of the metro area, while the variables in the right hand panel are measured at the level of the household.

4.2. Geographical instruments

One empirical implication of the model is that across cities, more buildable land reduces commuting times. In column 1 of [Table 2](#), I explain average commuting times across metro areas in the US with variables representing the fraction of land not covered by water or by land outside the United States and land with more than a 20% slope within a 25 mile radius of the city center.¹¹ These variables are intended to be empirical counterparts of the parameter

θ in the model above. The results in column 1 show that metro areas with less buildable land and more steep slopes have longer commuting times, although the slope variable is not significant.

A second implication of the model is that house prices are higher in metro areas with less buildable land. I use two quality-adjusted house price indices constructed by [Chen and Rosenthal \(2008\)](#) and by Edgar Olsen as described in [Olsen et al. \(2005\)](#). While each house price index uses a different methodology, they both attempt to control for housing quality differences across metro areas and are quite highly correlated. I standardize these indices so that a unit represents one standard deviation in house price variation across metro areas.

[Saiz \(2010\)](#) studies the effect of topography and land use regulations on the elasticity of housing supply and finds that the fraction of land covered with water or steeply sloped makes the supply of housing less elastic, which implies higher prices in the face of demand shocks. In columns 2 and 3 of [Table 2](#), I regress the two house price indices on the geographic variables. These variables might also be picking up amenities, as much of the non-buildable land is water and proximity to water is a valued amenity. Moreover, steeply sloped land allows for views which may also be an amenity. The prediction is that a low fraction of buildable land and more sloped land increases house prices. Columns 2 and 3 shows that this prediction is confirmed with both geographic variables strongly significant in the predicted direction. Increasing the fraction of land not under water by ten percentage points reduces house prices by .2 standard deviations, while

¹¹ This statistic was calculated using mapping technology that neglects small bodies of water, so the variation is driven by large bodies of water like oceans and large lakes and by proximity to international borders, where the assumption is that the land in another country is not a perfect substitute for land within the borders of the U.S.

Table 3A

Labor force participation of married women: linear probability models.

	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) IV
High school	17.6*** (.7)	17.5*** (.74)	17.4*** (.78)	17.5*** (.73)	17.5*** (.76)
Some college	26.4*** (.66)	26.1*** (.66)	26.1*** (.68)	26.2*** (.65)	26.1*** (.70)
College	32.8*** (.69)	32.8*** (.72)	32.8*** (.68)	32.8*** (.71)	32.9*** (.71)
Kids under 5	−13.9*** (.32)	−13.9*** (.34)	−13.9*** (.33)	−13.9*** (.33)	−13.9*** (.33)
Other family income	−.10*** (.005)	−.09*** (.006)	−.09*** (.005)	−.09*** (.006)	−.09*** (.005)
Metro area unemployment rate	−.98*** (.23)	−.86*** (.22)	−.89*** (.23)	−.82*** (.21)	−.93*** (.26)
Rosenthal–Chen house price index		.097 (.44)	−1.05* (.62)		
Olsen house price index				.51 (.38)	−1.33 (.91)
Mean travel time		−.26** (.11)	−.047 (.24)	−.36*** (.12)	.076 (.31)
F-test of excluded instruments (house price)			F = 11.11 p = .000		F = 4.74 p = .004
F-test of excluded instruments (travel time)			F = 2.56 p = .06		F = 2.56 p = .06
Test of overidentifying restrictions: p value of Hansen's J			.85		.97
Number of observations	202,829	196,831	192,295	196,831	192,295

Notes: 2000 Census data. IV estimates are GMM. Standard errors in parentheses, clustered on metro areas. Coefficients and Standard errors multiplied by 100 for clarity. Other included covariates are age, age squared, and race. House prices and mean travel times are instrumented with topographical variables.

reducing the fraction of sloped land by ten percentage points reduces prices by about .3 standard deviations.

4.3. Are household labor supply decisions caused by house prices?

Does house price variation across metro areas affect married women's labor supply? Using the 2000 Census Public Use Micro Sample (PUMS) sample of households, I select a one percent sample of married women, aged 21–65, with spouse present in the household, living in metro areas. This yields a sample size of roughly 200,000 women, which is described in the right panel of Table 1. Table 3A examines labor supply behavior with linear probability estimates of LFP and Table 3B estimates probits on LFP. Column (1) in both Tables 3A and 3B sets a baseline regression showing the importance of education, young children, the metro

area unemployment rate, and other family income, including husband's earnings. Columns (2) and (4) in Tables 3A and 3B add house prices as well as mean commuting times within the metro area. Adding the metro area variables shows that even when we consider individual data and control for household and other metro area determinants of labor supply, house prices exert a positive effect on labor force participation although neither coefficient is significant. Black et al. (2014) emphasize the role of commute times in generating cross metro area differences in married women's labor supply. That finding is echoed here where the estimated coefficient implies that 3–4 min more in commute time reduces LFP by a percentage point.

Since house prices and mean travel times are endogenous to labor supply behavior in the metro area, we need to uncover whether the positive relation between house prices and labor

Table 3B

Labor force participation of married women: probit models.

	(1) Probit	(2) Probit	(3) IV Probit	(4) Probit	(5) IV Probit
High school	.465*** (.019)	.461*** (.020)	.457*** (.009)	.462*** (.019)	.460*** (.010)
Some college	.725*** (.017)	.717*** (.017)	.716*** (.008)	.720*** (.017)	.717*** (.012)
College	.937*** (.017)	.936*** (.017)	.936*** (.010)	.936*** (.017)	.938*** (.011)
Kids under 5	−.403*** (.01)	−.405*** (.011)	−.405*** (.005)	−.404*** (.011)	−.405*** (.006)
Other family income ($\times 10^{-6}$)	−2.74*** (.16)	−2.70*** (.17)	−2.68*** (.05)	−2.71*** (.17)	−2.68*** (.05)
Metro area unemployment rate	−.029*** (.007)	−.025*** (.006)	−.026*** (.002)	−.024*** (.006)	−.027*** (.002)
Rosenthal–Chen house price index		.002 (.013)	−.032*** (.004)		
Olsen house price index				.015 (.012)	−.041*** (.006)
Mean travel time		−.008** (.003)	−.002 (.002)	−.011*** (.004)	−.002 (.004)
Number of observations	202,829	196,831	192,295	196,831	192,295

Notes: 2000 Census data. IV estimates use Newey's two step procedure. Standard errors in parentheses. Standard errors are clustered on metro areas for columns (1), (2) and (4). Bootstrapped standard errors for columns (3) and (5). Other included covariates are age, age squared, and race. House prices and mean travel times are instrumented with topographical variables.

Table 4A

Labor Earnings of Married Women: Linear Models.

	(1) OLS	(2) OLS	(3) IV	(4) OLS	(5) IV
High school	5.92*** (.24)	6.35*** (.27)	6.2*** (.27)	6.27*** (.26)	6.19*** (.25)
Some college	11.30*** (.33)	11.7*** (.36)	11.6*** (.35)	11.6*** (.34)	11.6*** (.33)
College	24.10*** (.82)	24.2*** (.81)	24.4*** (.76)	24.1*** (.78)	24.4*** (.75)
Kids under 5	−4.0*** (.16)	−4.07*** (.17)	−4.1*** (.16)	−4.08*** (.17)	−4.05*** (.16)
Other family income	−.0046 (.00457)	−.0074 (.0046)	−.007* (.0039)	−.0075 (.0046)	−.0069* (.0040)
Metro area unemployment rate	−.25 (.25)	−.35*** (.11)	−.37*** (.11)	−.33*** (.09)	−.35*** (.10)
Rosenthal–Chen house price index		1.13*** (.26)	.48 (.35)		
Olsen house price index				1.31*** (.20)	.58 (.39)
Mean travel time		.24*** (.07)	.28* (.15)	.15** (.70)	.23 (.16)
F-test of excluded instruments (house price first stage)			F = 11.11 p = .000		F = 4.74 p = .004
F-test of excluded instruments (travel time first stage)			F = 2.56 p = .06		F = 2.56 p = .06
Test of overidentifying restrictions: p value of Hansen's J			.28		.19
Number of observations	202,829	192,277	192,295	196,831	192,295

Notes: 2000 Census data. IV estimates are GMM estimates. Robust standard errors in parentheses, clustered on metro areas. Other included covariates are age, age squared, and race. House prices and mean travel times are instrumented with topographical variables.

Table 4B

Labor earnings of married women: Tobit models.

	(1) Tobit	(2) Tobit	(3) IV Tobit	(4) Tobit	(5) IV Tobit
High school	12.85*** (.62)	13.3*** (.67)	13.3*** (.25)	13.2*** (.66)	13.3*** (.26)
Some college	20.9*** (.89)	21.2*** (.94)	21.4*** (.29)	21.19*** (.92)	21.44*** (.27)
College	35.9*** (1.49)	35.9*** (1.51)	36.4*** (.37)	35.85*** (1.5)	36.45*** (.30)
Kids under 5	−8.05*** (.28)	−8.13*** (.30)	−8.15*** (.17)	−8.14*** (.30)	−8.15*** (.14)
Other family income ($\times 10^{-3}$)	−.028*** (.006)	−.031*** (.006)	−.031*** (.002)	−.031*** (.0058)	−.031*** (.003)
Metro area unemployment rate	−.603*** (.272)	−.702*** (.168)	−.737*** (.06)	−.662*** (.16)	−.741*** (.06)
Rosenthal–Chen house price index		1.10*** (.39)	−.02 (.14)		
Olsen house price index				1.44*** (.271)	−.043 (.17)
Mean travel time		.023** (.009)	.377*** (.08)	.097 (.09)	.39*** (.09)
Number of observations	202,829	196,831	192,295	196,831	192,295

Notes: 2000 Census data. IV estimates use Newey's two step method. Standard errors in parentheses. Standard errors are clustered on metro areas for columns (1), (2) and (4). Bootstrap standard errors for columns (3) and (5). Other included covariates are age, age squared, and race. House prices and mean travel times are instrumented with topographical variables. Coefficients are in thousands of dollars.

supply reflects causality from house prices to labor supply. To do this, I repeat the labor supply estimates of columns (2) and (4) in both [Tables 3A and 3B](#), except that I instrument for both house prices and mean travel times with the geographical determinants of housing prices used in [Table 2](#). These estimates, in columns (3) and (5) of each table, show that when instrumented, neither variations in the Rosenthal–Chen house price index nor in the Olsen index appear to increase married women's labor supply. Indeed, the estimated coefficients switch from positive to negative in all cases. For the IV probit estimates in [Table 3B](#) we can soundly reject the hypothesis of a positive effect of house prices on female labor supply, while for the linear probability estimates in [Table 3A](#), the standard errors are large enough that we cannot rule out a positive response of labor supply to higher house prices. Looking

at 95% confidence bounds, the most positive effect of house prices on LFP is given by the estimate in column (5) of [Table 3A](#). That upper bound estimate implies that a standard deviation increase in house prices would raise the probability of working by .005, which is a quite small effect. It is very unlikely that house prices exert a substantial positive effect on LFP.

The IV estimates in [Tables 3 and 4](#) rely on the instruments used in [Table 2](#). Although the *F*-tests reported in [Table 2](#) show that the excluded geographic instruments explain a significant amount of the variance in MSA-level house price indices and average commute times, the *F*-tests of excluded instruments reported in [Tables 3 and 4](#) meet the standard criteria of [Stock and Yogo \(2005\)](#) only for the Rosenthal–Chen price index. Hansen's *J*-statistic fails to

Table 5

IV estimates of cross-metro area differences in house prices.

	(1) Rosenthal–Chen Index	(2)	(3) Olsen index	(4)
Female labor force participation rate	.024 (.077)	–	–.077 (.067)	–
Median female earnings	–	.051 (.157)	–	–.173 (.186)
Median male earnings	.086** (.037)	.073 (.074)	.124*** (.032)	.169** (.08)
Fraction of buildable land	–1.98** (.87)	–1.82*** (.40)	–1.11* (.66)	–1.64*** (.38)
Slopes above 20%	2.75*** (.63)	2.52*** (.49)	1.76*** (.63)	2.48*** (.64)
Number of observations	231	231	257	257

Note: Estimates are GMM estimates with robust standard errors. Instruments for female labor supply and female earnings are World War II male mobilization rates.

* 10% Significance.

** 5% Significance.

*** 1% Significance.

reject the null hypothesis that the overidentifying exclusion restrictions are valid.

Tables 4A and 4B offer another view of the effect of house prices on female labor market behavior. Here the dependent variable is earnings rather than LFP, including women with no earnings; Table 4A presents linear estimates while Table 4B shows Tobit estimates. Earnings capture two additional behaviors that might be affected by house prices. Most obviously, earnings incorporate the effect of variation in hours, but in addition may capture individual investments in earning capacity not picked up by years of education. The hypothesis would be that higher house prices induce women to earn more both by working more and by earning more per hour, which is borne out by the positive estimates in columns (2) and (4) of both Tables 4A and 4B. However, instrumenting for house prices in columns (3) and (5) reveals insignificantly positive effects of house prices on female earnings in the linear estimates in Table 4A and insignificantly negative effects in the Tobit estimates of Table 4B. At 95% confidence, the upper bounds of the estimates in Table 4A imply that a standard deviation in house prices raises female earnings by about \$1000, while the Tobit estimates imply a much smaller effect of about \$300. So while it is very unlikely that house prices have an appreciable positive effect on labor force participation, the effect on female earnings may well be positive.¹²

From these IV estimates, one can conclude that house prices have at most a very small positive effect on female labor force participation with a possibly somewhat greater effect on female earnings. To check the robustness of the results in Tables 3 and 4 to alternative instruments, I reestimated the models in Tables 3 and 4 using the geographical and regulatory instruments used by Saiz (2010). The results were not dramatically different.

4.4. Does labor supply affect house prices?: Instrumenting for labor supply

The theoretical model predicts both that variation in land availability (θ) will increase labor supply, and that for variation in preferences for work (ψ_2) will raise house prices. I now turn to a test of the second of these causal statements. Here the search for valid

¹² The Rosen–Roback model predicts a positive correlation between earnings and land prices if productivity varies across metro areas. Both female earnings and land rents will be higher in more productive metro areas. The empirical results in Tables 3 and 4 are presumably not the result of this mechanism since house price variation is induced by the geographic instruments which should be independent of productivity. Also, the results are unaffected when I control for population size as a proxy for agglomeration-based productivity differences.

Table 6

First stage estimates for IV estimates in Table 5.

	(1) Female labor force participation rate	(2) Median female earnings
Mobilization rate	–20.18*** (4.37)	–9.36*** (1.19)
Median male earnings	.455** (.065)	.46*** (.024)
Fraction of buildable land	8.81*** (1.81)	.974 (.54)
Slopes above 20%	–2.44 (3.59)	2.98** (1.17)
Number of observations	231	257
F-statistic	20.37	158.39

* 10% Significance.

** 5% Significance.

*** 1% Significance.

instruments is more difficult. Metro area differences in the determinants of labor supply at the individual level are valid instruments only if one supposes that they do not affect house prices directly, except for their influence on female LFP or earnings. For example, other family income and number of children under five affect spousal labor supply but also likely exert a direct effect on housing demand. For an instrument, I follow Acemoglu et al. (2004) and use the fraction of males in the metro area who were in the military during World War II. As Acemoglu et al. (2004) and Goldin and Olivetti (2013) show, this disruption to civilian labor markets had long-lasting effects on the labor supply of women.

Table 5 shows the IV estimates explaining house prices across metro areas instrumenting for female LFP and earnings with male mobilization rates during World War II.¹³ The F-statistic on the mobilization rate is 11.8 in the first stage regressions (shown in Table 6) explaining labor force participation and 14.1 in those explaining female earnings so the instrument is not a weak one by the Stock–Yogo criteria. The estimates in Table 5 show no statistically significant effect of female labor force participation or earnings on house prices. However, looking at the 95% confidence bounds we

¹³ Data from U.S. Selective Service System (1948). Data is provided only at the state level. For metro areas entirely within one state, I assume that state's mobilization rate applies to the metro area. For metro areas crossing state boundaries, I construct a weighted average of the relevant states' mobilization rates, the weights being the shares of the metro areas population in each state.

cannot rule out a positive effect size as large as 0.17 (for labor force participation) or .36 (for female earnings). These would imply substantial effects on house prices; a 6 percentage point increase in LFP or \$2800 more in earnings would raise house prices by a standard deviation. So we cannot rule out the possibility of substantial positive effects of female labor market activity on house prices from the cross section data. However, the data do not allow us to detect even the direction of an effect with any confidence.

Can we detect an effect of labor force participation on changes in house prices using changes over time within metro areas instead of cross-metro area data? To pursue this, I regress the percent change in house prices over a decade on the female LFP rate at the beginning of the decade, using metro area data and a fixed effects estimator. The two decades of data are the 1980s and the 1990s, since quality-adjusted house price data by metro area is not available before the 1970s. The result is:

$$\% \Delta \text{Houseprice}_{i,t} = 2.04 \text{ FemaleLFP}_{i,t-1} - .408 \text{ Decade90s} - .471$$

The standard error on lagged female LFP is 2.83 so we cannot reject the hypothesis of no relationship, but the mean effect is positive and not trivial in size.

5. Conclusion

We began with the observations that female LFP and house prices are positively related across US metro areas and that both have risen in the past three decades. The paper seeks to discover whether any causal direction can be teased out of the data. A model of the joint determination of labor supply and housing demand within a metro area generates the prediction that land values will be sensitive to labor supply determinants such as preferences for purchased goods relative to non-market time. The model can also generate labor supply affected by determinants of land values such as the availability of buildable land in the metro area.

Instrumenting house prices with geographic variables which are proxies for land availability, it appears to be quite unlikely that house prices raise female labor force participation, though there may be effects on earnings. Instrumenting for female LFP with World War II male mobilization rates, the effect size or direction cannot be pinned down with any precision so we cannot rule out a positive effect of female labor supply and earnings on house prices.

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