Should I stay or should I go: The interaction of amenities, earnings, and city price levels

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Abstract

This paper uses three different methodologies to investigate whether, given a fixed level of amenities, workers are fully compensated, in terms of higher wages, for higher price levels across cities. In the first, I use the overall city price level and aftertax earnings as endogenous variables in a two-stage least squares (2SLS) system and find that owners and renters are not fully compensated for higher city price levels. In the second, I split city price levels into housing prices and non-housing goods prices and use housing prices and aftertax earnings as endogenous variables in a 2SLS system. Using this method, I find that highly-educated homeowners and renters are fully compensated for higher housing prices while less-educated homeowners and renters are not fully compensated for higher housing prices. I also find that all homeowners and renters of all education levels are fully compensated for higher non-housing good prices. Finally, I assume that homeowners and renters are fully compensated for higher nonhousing goods prices and use housing prices and aftertax earnings as endogenous variables in a 2SLS system. Using this method, I again find that highly-educated homeowners and renters are fully compensated for higher housing prices while less-educated homeowners and renters are not fully compensated for higher housing prices. In addition, I determine implicit prices for 13 different amenities for both owners and renters with different education levels. While I am not the first to calculate these implicit prices, I am the first to differentiate these implicit prices among education levels and ownership status.

Keywords. house prices; wages; amenities; spatial equilibrium

1 Introduction

The main motivation for this paper comes from a simple but important decision that people often make in their lives: is a person better off receiving higher wages and enjoying better attributes that a city has to offer, such as climate, lack of pollution, and arts and culture, which are called amenities, but paying higher prices for goods and for land in a bigger, more expensive city? In other words, are workers fully compensated, in terms of higher wages and better amenities, for higher price levels in a city?

I use three different methodologies to investigate whether people are fully compensated for higher city price levels. First, using the overall city price level and aftertax earnings as endogenous variables in a two-stage least squares (2SLS) system, I find that owners and renters are not fully compensated for higher city price levels. Next, I split city price levels into housing prices and non-housing goods prices and use housing prices and aftertax earnings as endogenous variables in a 2SLS system. Using this method, I find that homeowners with a graduate degree are fully compensated for higher housing prices while homeowners without a graduate degree are not fully compensated for higher housing prices. I also find that all homeowners are fully compensated for higher non-housing good prices. For renters, workers with at least a bachelor's degree are fully compensated for higher housing prices while workers without a bachelor's degree are not fully compensated for higher housing prices. Similar to homeowners, all renters are fully compensated for higher non-housing goods prices.

Finally, I assume that homeowners and renters are fully compensated for higher nonhousing goods prices and use housing prices and aftertax earnings as endogenous variables in a 2SLS system. I use this method to calculate implicit prices of amenities as well since the previous two methods were used primarily as comparisons to previous work. Using this method, I find that homeowners with a graduate degree are fully compensated for higher housing prices, while less-educated homeowners are not fully compensated for higher housing prices and renters with at least a bachelor's degree are fully compensated for higher housing prices, while renters without a bachelor's degree are not fully compensated for higher housing prices.

In addition, using the conclusion from the theoretical model that workers accept lower wages and pay higher housing prices to enjoy better amenitites, I determine implicit prices for 13 different amenities for both owners and renters

with different education levels. While I am not the first to calculate these implicit prices, I am the first to differentiate these implicit prices among education levels and ownership status. These prices are valuable pieces of information for city officals when they decide how to make their cities more attractive to certain types of people and for business owners when they decide where to locate their business.

Scholars used to claim that cost of living differences among cities was the cause of differences in wages and land prices across cities. This begged the question: what led to these differences in the cost of living among cities? Roback (1982) reframed the inter-city differences in wages and land prices as adjustments to equalize utilities of workers given a set of amenities. This paper laid the theoretical groundwork for nearly all the empirical work done in this area. The basic premise of the paper was that wages and rents were determined by the relative value of local amenities to both firms and workers. In other words, workers might be willing to pay, in terms of lower wages and higher rents, to enjoy the qualities of a particular locale.

Roback (1982) also used a fairly restrictive assumption: that individuals are identical. In a follow-up paper, Roback (1988) relaxed the assumption of worker homogeneity by allowing for two different types of labor, which she referred to as skilled and unskilled labor, while Beeson (1991) allowed for N different types of workers who differ in terms of their endowments of education. I adopt the framework of the theoretical model from Roback (1982 and 1988) as well as two basic assumptions that she used. The first is that the firms produce a composite good using a constant returns to scale production function. The second is that the migration of workers from city to city is costless. However, Roback (1982 and 1988) did not solve for the explicit conditions under which land prices increase with amenities and wages decrease with amenities, did not differentiate types of workers by home ownership status or allow for more than two types of workers, and did not allow wages and rents to be simultaneously determined, each of which I do in this paper. I adopt Beeson's use of cities with N different types of workers, but I include rent in my empirical model which is run using two-stage least squares (2SLS) rather than OLS.

The empirical strategy I employ is partially adapted from two papers. Hoehn, Berge, and Blomquist (1987) looked at the separate effects of 16 amenities on housing prices and on wages. However, there was no joint determination of housing and wages, and housing was measured using apartment rents. Voith

(1991) expanded on Hoehn et al. (1987) by using a simultaneous equations framework in which wages and rents were jointly determined. Voith is closest in concept and in style to this paper. However, Voith used the 1975 PSID which includes only 2,258 total observations for 33 cities. Furthermore, the PSID overrepresents the minorities and the poor. I take a wider view by using 268 cities and over 2 million total observations from the American Community Survey which is more representative of the American population. I also adopt the use of separate regressions based on ownership versus rental status used by Ozanne and Thibodeau (1983) and Potepan (1996).

Winters (2009) uses wages and housing prices to determine whether workers are fully compensated, in terms of higher incomes, for cost of living differences between cities. I adopt Winters methodology, but I use a residential land use regulation index and an age of structure variable to instrument for housing prices while Winters uses lagged housing values and city prices as instruments. I also allow for separate determinations by level of education.

Section 2 of this paper presents the theoretical model and the conditions under which the conclusions that workers accept lower wages and pay higher land prices to enjoy higher amenity levels holds. Section 3 presents the empirical model, a description of the variables used in the estimation, and the results from the estimation. Section 4 concludes the paper.

2 Theoretical Model

2.1 Description of the model

Since workers and firms never explicitly pay for the amenities they consume in a particular city, the value of these amenities is capitalized into land prices and wages. The model I use in this paper extends this idea of the capitalization of amenities into wages and land prices first presented in Roback (1982), for one type of worker, and Roback (1988), for two types of workers, to allow for N types of workers. There are four basic parts to the model: the environment, the worker's problem, the firm's problem, and the equilibrium concept.

Environment. There are J cities in the model, each assigned its own unique bundle of amenities, a, and land, L, and indexed by j. Land is made up of land used for production, L^c and land used for residential purposes, L^r.

Amenities are characteristics of a location, such as climate, crime rate,

leisure activities, or education spending. Certain amenities are clearly exogenous, such as the number of sunny days. It is possible that other amenities, such as the availability of cultural or leisure activities, could be set by the community. However, this is a model of individual decision making, while changing a particular amenity is a group decision. Therefore, I treat the decision to have higher or lower levels of amenities as exogenous to the individual decision making process. Furthermore, it is sometimes argued that such variables as air and water quality are affected by local economic conditions. Again, these variables are determined by the city as a whole and not by an individual location decision.

Each city is made up of workers and firms. Workers have an initial endowment of education, i, one unit of time, an equal share of all land in the economy, and preferences over a variety of city amenities, a. Therefore, the model allows for different preferences across educational groups but not within the groups. The purpose of the equal share of land endowment is to ensure a closed model. Land generates rent and that rent has to go to someone. I assume that these rents go to workers. Furthermore, workers are freely mobile across all cities and migration is assumed to be costless. However, intercity commuting costs are assumed to be prohibitive, so a worker lives and works in the same city.

Firms produce a composite good, X, according to a constant returns to scale production function, $X = \mathrm{f}(\mathbf{n}, L^c; a)$ using land and each type of labor, $\mathbf{n}$, where $\mathbf{n} = (n_1, n_2, ..., n_N)$. Therefore, wages of workers of different types, i, are allowed to differ within a city. The composite good, X, is a freely and costlessly tradeable final consumption good, which is the same across all cities and is produced in all cities in a perfectly competitive environment. The price of the composite good, X, is taken as the numeraire.

The worker's problem. The worker of type i lives in city j, earns wage w_{ij} and receives rents generated by the land share the worker owns, $\theta\pi$ [1], selects a consumption basket of land, L^r, and a tradeable composite consumption commodity, X, to maximize his utility in location j. Thus, the worker's budget constraint is $w_{ij}h_{ij} + \theta\pi = P_j^r L_j^r + X_{ij}$ where h_{ij} is the hours worked by a worker of type i in city j and P_j^r is the price of residential land in city j. The worker has an indirect utility function $V^i(w_{ij},\ P_j^r;\ a_j)$. The total number of workers in the economy is normalized to one.

[1] Workers earn an equal percentage of rent from the total land from all cities in the economy. $\pi = \sum_j P_j \times L_j$ and $\theta = \frac{1}{\sum_i n_i}$

The firm's problem. The representative firm minimizes costs subject to its production function. Therefore, it chooses a city in which to operate, j, as well as an appropriate mix of land, L_j^c, and workers, n_i for all i, based on the price of commercial land, P_j^c, and the price of workers, w_i for all i. The firm, therefore, is a price taker of both land and workers which means that the wage of each type of worker is equal to that type of worker's marginal product, $w_i = F_{L_i^c}$.

Equilibrium. The market equilibrium condition for land is

$$P_j^c = P_j^r = P_j \tag{1}$$

where P_j^c is the price of commercial land, P_j^r is the price of residential land, and P_j is the price of overall land in city j. The land market clearing condition is $L = L^r + L^c$. If $P_j^c > P_j^r$, then landowners covert residential land to commercial land in city j. This increased supply of commercial land leads to a decrease in P_j^c and the decreased supply of residential land leads to an increase in P_j^r until the prices are equal. If instead $P_j^c < P_j^r$, then landowners convert commercial land to residential land in city j. This decreased supply of commercial land leads to a increase in P_j^c and the increased supply of residential land leads to an decrease in P_j^r until the prices are equal. Therefore, P_j is used as the relevant price of land for both workers and firms.

The market equilibrium condition for workers is given by

$$V^i(w_{ij}, P_j; a_j) = k_i. \tag{2}$$

where k_i is the utility level common to all workers of type i across all cities. Therefore, wages and the price of land must adjust, given the level of amenities, to equalize utilities for each type of worker in all cities. Otherwise, some workers would have an incentive to move.

The equilibrium condition for firms is that unit cost must equal the product price, which is assumed to be unity:

$$C(\mathbf{w_j}, P_j; a_j) = 1. \tag{3}$$

where $\mathbf{w_j} = (w_{1j}, w_{2_j}, ..., w_{Nj})$. Otherwise, firms would have an incentive to enter the industry.

Given an equilibrium distribution of firms and workers across locations, wages and price of land differences can be characterized as functions of the

amenities.

In order to draw some conclusions, I simplify the model by reducing to two types of labor, high-skilled, HS, and low-skilled, LS. All conclusions based on this simplification can be easily generalized to a situation in which there are N types of labor. The literature uses the assumption that workers are imperfect substitutes for one another. I use this assumption to solve the model and then I relax this assumption and allow workers to be complements.

Assuming workers are imperfect substitutes for one another, if a high-skilled worker sees his wages, w_{HS}, increase, then, holding all else constant, the wages of low-skilled workers, w_{LS}, will decrease. Firms will substitute away from the more expensive high-skilled workers, towards low-skilled workers, which means that the marginal product of low-skilled workers decreases. Since workers are paid their marginal product in perfectly competitive markets, w_{LS} will decrease. The more substitutable that each low-skilled worker is for high-skilled workers, the more that the wages of low-skilled workers will decrease. A decrease in the wages of high-skilled workers would have the opposite effect on the wages of low-skilled workers for the same reasons mentioned above, so the wages of low-skilled workers would increase.

Now I relax the assumption that workers are imperfect substitutes and allow workers to be imperfect complements in order to determine if my conclusions are still valid. If a high-skilled worker sees his wages, w_{HS}, increase, then, holding all else constant, the wages of low-skilled workers, w_{LS} will again decrease. Firms will hire fewer high-skilled workers because high-skilled workers are now more expensive than they were. Since there are fewer high-skilled workers employed in the firms and high-skilled workers and low-skilled workers are complements, having fewer high-skilled workers reduces the productivity of low-skilled workers. Therefore, the marginal product of low skilled workers decreases. Since workers are paid their marginal product in perfectly competitive markets, w_{LS} will decrease. Furthermore, the effect of a decrease in the wages of high-skilled workers would have the opposite effect on the wages of low-skilled workers for the same reasons mentioned above, so the wages of low-skilled workers would increase.

A similar argument can be made for the other input in the production process, land. If land and workers are imperfect substitutes, then the more expensive land is in a city, the more firms reduce their use of land and increase

their use of labor in production of the composite good and the more land in a city is used for residential rather than production purposes. Using more highly labor-intensive production processes results in lower wages for all types of workers due to diminishing marginal producitvity.

If land and workers are imperfect complements, then the more expensive land is in a city, the more firms will reduce their use of land in the production of the composite good and the more land in a city will be used for residential rather than production purposes. Since land and workers are imperfect complements in production, using less land makes workers less productive. Therefore, workers of all types will be paid lower wages due a decrease in their marginal products.

I draw the same conclusions whether workers are imperfect substitutes or imperfect complements for one another. Therefore, I assume that workers are imperfect complements for one another in my analysis because it is more realistic. All the comparative statics that I do in the next section hold if I were to assume that workers are imperfect substitutes for one another.

2.2 Comparative Statics

The key idea of this model is that, since workers and firms do not explicitly pay for the amenities they consume, the value of these amenities is capitalized into the price of land and wages. To determine how amenities affect wages and land prices, equation 2 and equation 3 can be differentiated with respect to amenities and then be solved for $\frac{\partial w_i}{\partial a}$ and $\frac{\partial P}{\partial a}$. First, I completely differentiate equation 2 with respect to a:

$$V^i_{w_i}\frac{\partial w_i}{\partial a} + V^i_P\frac{\partial P}{\partial a} + V^i_a = 0$$

Next, I solve the equation for $\frac{\partial w_i}{\partial a}$:

$$\frac{\partial w_i}{\partial a} = \frac{-V^i_P\frac{\partial P}{\partial a} - V^i_a}{V^i_{w_i}} \tag{4}$$

I then completely differentiate equation 3 with respect to a:

$$\sum_k C_{w_k}\frac{\partial w_k}{\partial a} + C_P\frac{\partial P}{\partial a} + C_a = 0 \tag{5}$$

Rather than solve completely for $\frac{\partial P}{\partial a}$ at this point, I plug equation 4 into

equation 5 in order to eliminate $\frac{\partial w_i}{\partial a}$ from the solution, group like terms, and solve for $\frac{\partial P}{\partial a}$:

$$\frac{\partial P}{\partial a} = \frac{\sum_k V_a^k \frac{C_{w_k}}{V_{w_k}^k} - C_a}{-\sum_k V_P^k \frac{C_{w_k}}{V_{w_k}^k} + C_P} \tag{6}$$

The last step is to plug equation 6 into equation 4 and add the fractions together in order to solve for $\frac{\partial w_i}{\partial a}$:

$$\frac{\partial w_i}{\partial a} = \frac{C_a V_P^i - V_P^i \sum_k V_a^k \frac{C_{w_k}}{V_{w_k}^k} + V_a^i \sum_k V_P^k \times \frac{C_{w_k}}{V_{w_k}^k} - V_a^i C_P}{V_{w_i}^i (-\sum_k V_P^k * \frac{C_{w_k}}{V_{w_k}^k} + C_P)}$$

Then, I cancel out identical terms of the summations that are subtracted from each other:

$$\frac{\partial w_i}{\partial a} = \frac{C_a V_P^i - V_P^i \sum_{k \neq i} V_a^k \frac{C_{w_k}}{V_{w_k}^k} + V_a^i \sum_{k \neq i} V_P^k * \frac{C_{w_k}}{V_{w_k}^k} - V_a^i C_P}{V_{w_i}^i (-\sum_k V_P^k \frac{C_{w_k}}{V_{w_k}^k} + C_P)} \tag{7}$$

To see the effects of amenities on the price of land and on wages, I fully explore the signs of equations 6 and 7. I first examine the signs of the individual components of these equations. V_P shows how utility changes when the price of land changes. All else equal, there are two effects on utility when the price of land changes. First, an increase in the price of land makes workers worse off because they have to pay more for land. Secondly, an increase in the price of land makes workers better off because the rent generated by land goes to workers. I conclude that workers will be worse off if the price of land increases because the city a particular worker lives in is small compared to the overall economy which means the worker will receive little added benefit from the additional rents while having to pay the additional costs of more expensive land. Therefore, $V_P < 0$.

V_{w_i} shows how utility changes when the wage for people with education i changes. All else equal, people with education i will be better off if their wage increases. Therefore, $V_{w_i} > 0$. C_{w_i} shows how a firm's costs changes when the wage for people with education i changes. All else equal, a firm's costs will increase if the wages of a group of its workers increases. Therefore, $C_{w_i} > 0$. C_P shows how a firm's costs changes when the price of land changes. All else equal, a firm's costs increase as the price of land increases because land is an input to the firm's production process. Therefore, $C_P > 0$.

The remaining variables, V_a and C_a, are less easily signed for two reasons. First, each type of worker has a different indirect utility function. This means that not all types of workers value amenities to the same degree. Some types of workers may consider a city attribute to be an amenity while other types of workers may consider it a disamenity. The second reason is that amenities can be productive or unproductive. The presence of an amenity could raise or lower costs to a firm. These two factors prevent the determination of the signs of V_a and C_a. Therefore, the signs of equations 6 and 7 will depend on whether the amenity is productive or unproductive to firms and whether workers consider it an amenity or disamenity.

Complications arise when more than one of these three groups, type i workers, workers of type $j \neq i$, and firms, consider the city attribute an amenity, so more than one of the cases are non-zero. This can easily be seen with an example. Assume that all types of workers consider the attribute an amenity, and the amenity is productive to firms. Since all types of workers and firms desire to locate in an area with high levels of this amenity, land prices rise. However, the effect on type i workers' wages is ambiguous. The reason is that, though worker i accepts lower wages due to the desirability of the amenity, other types of workers also accept lower wages and firms are more productive. The relative strengths of the effects determines how amenity levels affect wages, but this cannot be determined a priori. This is analagous to the uncertain price and quantity outcome due to a substitution and income effect. Sections 2.2.1 and 2.2.2 lay out the conditions under which the effects on land prices and wages are unambiguous.

2.2.1 Worker i views the city attribute as an amenity (i.e., $V_a^i > 0$)

If the amenity is inherently costless to firms (i.e., $C_a = 0$) and valued only by workers of type i (i.e., $V_a^k = 0$ for all $k \neq i$) then $\frac{\partial P}{\partial a} > 0$ and $\frac{\partial w_i}{\partial a} < 0$. In other words, if firms neither benefit nor lose from the presence of the amenity and only type i workers enjoy the amenity, then land prices increase and the wages of type i workers decrease as amenity levels increase. Type i workers want to live in areas with better amenity levels, which leads to higher land prices, and type i workers are willing to give up some wages in order to live in a higher amenity area.

Now I assume that the other types of workers and firms also place a value on the amenity. Then, land prices increase with the level of the amenity (i.e.,

$\frac{\partial P}{\partial a} > 0$) if the other types of workers, on net, consider the attribute to be an amenity (i.e., $\sum_{k \neq i} V_a^k \frac{C_{w_k}}{V_{w_k}^k} > 0$) and the amenity is productive to firms (i.e., $C_a < 0$). If this is the case, then all types of workers and firms want to locate in a city which has high values of this amenity, and they bid up the price of land. If these conditions are not met, it is still possible for land prices to increase with amenities as long as type i workers value the amenity more than all the other types of workers and firms, on net, dislike the amenity (i.e., $C_a - \sum_{k \neq i} V_a^k \frac{C_{w_k}}{V_{w_k}^k} < V_a^i \frac{C_{w_i}}{V_{w_i}^i}$).

While still assuming that type i workers consider the city attribute an amenity, wages of type i workers decrease with the level of the amenity (i.e., $\frac{\partial w_i}{\partial a} < 0$) if the other types of workers, on net, consider the attribute to be a disamenity (i.e., $\sum_{k \neq i} V_a^k \frac{C_{w_k}}{V_{w_k}^k} < 0$) and the amenity is unproductive to firms (i.e., $C_a > 0$). When everyone else is indifferent to the amenity, type i workers' wages decrease with amenities. If the other types of workers dislike the amenity, then those workers will require a compensating variation (i.e. a higher wage) to live and work in areas with high values of the amenity. This leads firms to hire fewer type k workers. Since fewer type k workers are employed, the productivity of type i workers decreases since these workers are imperfect complements. Therefore, the marginal productivity of type i workers is lower which leads firms to pay type i workers lower wages. Since the amenity is also unproductive to firms, productivity is lower which leads firms to pay all workers lower wages, including type i workers.

If the conditions stated above do not hold, then it is still possible for the wages of type i workers to decrease with the level of the amenity as long as the relative value of the amenity to type i workers is greater than the relative value of the amenity, on net, to firms and all the other types of workers (i.e., $\frac{V_a^i}{V_P^i} < \frac{\sum_{k \neq i} V_a^k \frac{C_{w_k}}{V_{w_k}^k} - C_a}{\sum_{k \neq i} V_P^k \frac{C_{w_k}}{V_{w_k}^k} - C_P}$). The effect of other workers and firms valuing the amenity pushes the wages of type i workers up since firms are more productive and firms hire more of the other types of workers since these workers are willing to take lower wages for higher amenity values. This, in turn, increases the productivity of type i workers while the effect of type i workers valuing the amenity is a decrease in the wages of type i workers. If type i workers value the amenity more than firms and all other types of workers, on net, then the second effect dominates and type i workers wages decrease with the level of the amenity.

Combining these two conclusions, $\frac{\partial P}{\partial a} > 0$ and $\frac{\partial w_i}{\partial a} < 0$ if all types of workers

value the amenity, the amenity is productive to firms, and type i workers value the amenity more than all other types of workers and the firms, on net, do.

2.2.2 Worker i views the city attribute as a disamenity (i.e., $V_a^i < 0$)

If the amenity is inherently costless to firms (i.e., $C_a = 0$) and disliked only by workers of type i (i.e., $V_a^k = 0$ for all $k \neq i$) then $\frac{\partial P}{\partial a} < 0$ and $\frac{\partial w_i}{\partial a} > 0$. In other words, if firms neither benefit nor lose from the presence of the amenity and only type i workers dislike the amenity, then land prices decrease and the wages of type i workers increase as amenity levels increase. Type i workers do not want to live in areas with higher amenity levels, which leads to lower land prices, and type i workers require higher wages to live in a higher amenity area.

Again, assuming that the other types of workers and firms also have a valuation of the amenity, land prices decrease with the level of amenity (i.e., $\frac{\partial P}{\partial a} < 0$) if the other types of workers, on net, consider the attribute to be a disamenity (i.e., $\sum_{k \neq i} V_a^k \frac{C_{w_k}}{V_{w_k}^k} < 0$) and the amenity is unproductive to firms (i.e. $C_a > 0$). All workers and firms find this amenity undesirable, which means they each would pay less for land in areas with high values of the amenity.

If these conditions are not met, it is still possible for land prices to increase with the level of the amenity as long as type i workers dislike the amenity more than all the other types of workers and firms, on net, like the amenity (i.e., $C_a - \sum_{k \neq i} V_a^k \frac{C_{w_k}}{V_{w_k}^k} > V_a^i \frac{C_{w_i}}{V_{w_i}^i}$). If all other types of workers and firms value the amenity, then land prices are bid up. Land prices are bid down if type i workers dislike the amenity. If type i workers' amenity valuation dominates then land prices decrease with amenities.

Retaining the assumption that worker i considers the city attribute a disamenity, wages of type i workers will increase with the level of the amenity (i.e., $\frac{\partial w_i}{\partial a} > 0$) if the other types of workers, on average, consider the attribute to be an amenity (i.e. $\sum_{k \neq i} V_a^k \times \frac{C_{w_k}}{V_{w_k}^k} > 0$) and the amenity is productive to firms (i.e. $C_a < 0$). If the other types of workers value the amenity then they are willing to take lower wages in areas with high values of the amenity. Firms hire more of these other types of workers, which increases the productivity of type i workers. This increases the marginal productivity of type i workers and thus increases the wages that firms pay type i workers. Also, an amenity that is productive to firms raises all workers' productivity which increase wages for all workers. Each of these effects leads to wages of type i workers increasing

with the level of the amenity.

If these conditions are not met, then it is still possible that wages of type i workers increase with the level of the amenity as long as the relative value of the amenity to type i workers is greater than the relative value of the amenity, on net, to all the other types of workers and firms (i.e., $\frac{V_a^i}{V_P^i} > \frac{\sum_{k \neq i} V_a^k \frac{C_{w_k}}{V_{w_k}^k} - C_a}{\sum_{k \neq i} V_P^k \frac{C_{w_k}}{V_{w_k}^k} - C_P}$). If the valuation of type i workers is dominant, then wages will increase with the level of the amenity.

Combining these two conclusions together, $\frac{\partial P}{\partial a} < 0$ and $\frac{\partial w_i}{\partial a} > 0$ if all types of workers dislike the amenity, if the amenity is unproductive to firms, and if type i workers dislike the amenity more than all other types of workers and the firms, on net, dislike the amenity.

2.3 Implicit Price of Amenities

Equations 6 and 7 show how land prices and wages change when the level of amenities change. In equation 7, I factor out $-V_P^i$ from the first two terms in the numerator, factor out $-V_a^i$ from the second two terms of the numerator, and use Roy's identity to substitute p_a^i for $\frac{V_a^i}{V_{w_i}^i}$:

$$\frac{\partial w_i}{\partial a} = \frac{-V_P^i(\sum_k V_a^k \frac{C_{w_k}}{V_{w_k}^k} - C_a)}{V_{w_i}^i(-\sum_k V_P^k \frac{C_{w_k}}{V_{w_k}^k} + C_P)} - p_a^i \tag{8}$$

Using equation 6, I can simplify equation 8, solve for p_a^i, and once again use Roy's identity to substitute for $L = \frac{-V_P^i}{V_{w_i}^i}$:

$$p_a^i = L\frac{\partial P}{\partial a} - \frac{\partial w_i}{\partial a} \tag{9}$$

Equation 9 says that the implicit price of the amenity, a, can be measured by the extra cost of housing a worker must pay minus the wages that a worker must give up in order to enjoy the amenity. Unlike products sold on the market, these characteristics of a city have no real market value. Equation 9 creates market valuations for these amenities which can inform city officials and business owners about where they should apply their energy to attract workers.

3 Empirical Model

3.1 Specification of the Model

In order to test the implications of the theoretical model, I need a framework that allows wages and the price of land to adjust, given a fixed level of amenities. The two main difficulties with this are that wages and the price of land are simultaneously determined and I do not have a measure of the price of land in a city. This means that people are accepting a job and finding a place to live at the same time and each decision influences the other. Furthermore, much of the previous literature uses either the price of a house, the price of land, or the rental price of an apartment to measure the price of land, and the choice of one of these measures over another has led to different results. I assume that apartment prices and house prices are proxies for land prices, and I use each value to separately test the conclusions from the theoretical model.

Furthermore, I use metropolitan statistical areas (MSAs) as proxies for cities. MSAs are a geographical region with a high population density at its core and close economic ties throughout the area as defined by the Office of Management and Budget and used by the U.S. Census Bureau and other government agencies for statistical purposes. I use MSAs because they generally contain the surrounding areas of a city, which makes the assumption that people live and work in the same area significantly more realistic.[2] I also use aftertax annual earnings in place of hourly wages for two main reasons. First, I am using an annual housing value so it makes sense to use an annual earnings value. Since I will be using average hours worked per week as an explanatory variable, annual earnings will be capturing the decision to work in a city rather than a labor supply decision. Second, aftertax earnings are important because higher wages in one city may be less attractive if they move a household into a higher tax bracket. Using aftertax earnings accounts for this.

Since earnings and housing prices are jointly determined, using OLS would give biased results. If I ran an OLS regression with housing prices as my dependent variable, then I would have to include earnings as an independent variable since higher earners can afford and tend to live in more expensive housing. However, the earnings variable is correlated with the error term. The same will be true for an equation with earnings as my dependent variable. This means

[2]Due to the unique nature of New York City, I ran regressions with NYC as a dummy variable and with all people who live in NYC dropped out of the dataset. There were no significant differences in my results in either case.

that any shock to either housing or earnings would affect both housing prices and earnings.

My solution to this problem is to use a simultaneous equations framework in which house prices and earnings are allowed to affect one another and rents and earnings are allowed to affect one another. I use a two-equation 2SLS estimation procedure for homeowners and renters.

The two-equation system for homeowners is:

$$w_{ij} = \alpha_{0i}+\alpha_{1i}h_{ij}+\alpha_{\mathbf{2i}}\mathbf{ind_{ij}}+\alpha_{\mathbf{3i}}\mathbf{work_{ij}}+\alpha_{\mathbf{4i}}\mathbf{a_j}+\alpha_{\mathbf{5i}}\mathbf{m_j}+\alpha_{\mathbf{6i}}\mathbf{H_{ij}}+\alpha_{7i}yr+\alpha_{8i}hours_{ij}+\mu_1 \tag{10}$$

$$h_{ij} = \gamma_{0i}+\gamma_{1i}w_{ij}+\gamma_{\mathbf{2i}}\mathbf{ind_{ij}}+\gamma_{\mathbf{3i}}\mathbf{work_{ij}}+\gamma_{\mathbf{4i}}\mathbf{a_j}+\gamma_{\mathbf{5i}}\mathbf{m_j}+\gamma_{\mathbf{6i}}\mathbf{H_{ij}}+\gamma_{7i}yr+\gamma_{8i}regulation_j+\gamma_{9i}aos_j+\mu_2 \tag{11}$$

The two-equation system for renters is similar:

$$w_{ij} = \phi_{0i}+\phi_{1i}r_{ij}+\phi_{\mathbf{2i}}\mathbf{ind_{ij}}+\phi_{\mathbf{3i}}\mathbf{work_{ij}}+\phi_{\mathbf{4i}}\mathbf{a_j}+\phi_{\mathbf{5i}}\mathbf{m_j}+\phi_{\mathbf{6i}}\mathbf{A_{ij}}+\phi_{7i}yr+\phi_{8i}hours_{ij}+\mu_3 \tag{12}$$

$$r_{ij} = \beta_{0i}+\beta_{1i}w_{ij}+\beta_{\mathbf{2i}}\mathbf{ind_{ij}}+\beta_{\mathbf{3i}}\mathbf{work_{ij}}+\beta_{\mathbf{4i}}\mathbf{a_j}+\beta_{\mathbf{5i}}\mathbf{m_j}+\beta_{\mathbf{6i}}\mathbf{A_{ij}}+\beta_{7i}yr+\beta_{8i}regulation_{ij}+\beta_{9i}aos_{ij}+\mu_4 \tag{13}$$

where α, γ, ϕ, and β are coefficients to be estimated and
i indexes education and j indexes the metropolitan statistical area (MSA);
w_{ij} is the earnings received by people with education i in MSA j;
$\mathbf{ind_{ij}}$ is a vector of individual characteristics for education i in MSA j;
$\mathbf{work_{ij}}$ is a vector of job characteristics for education i in MSA j;
r_{ij} is apartment rent paid by workers with education i in MSA j;
h_{ij} is the price paid for a house by workers with education i in MSA j;
$\mathbf{a_j}$ is a vector of amenities in MSA j;
$\mathbf{m_j}$ is a vector of MSA specific characterisitics in MSA j;
$\mathbf{H_{ij}}$ is a vector of house characteristics for education i for MSA j;
$\mathbf{A_{ij}}$ is a vector of apartment characteristics for education i for MSA j;
yr is a dummy variable for the year of the sample;
$hours_{ij}$ is average hours worked per week for education i in MSA j;
$regulation_j$ is an index for residential land use regulations for MSA j;
aos_{ij} is the age of housing owned or rented by education i in MSA j;
μ_1 is random variation in wages from equation 2.20;
μ_3 is random variation in wages from equation 2.22;
μ_2 and μ_4 are random variation in house prices and rents, respectively;

The vector of coefficients $\alpha_{\mathbf{4i}}$ in the owners' set of equations and the vec-

tor of coefficients $\phi_{\mathbf{4i}}$ in the renters' set of equations show how wages change when each individual amenity changes. These coefficients are the counterparts to $\frac{\partial w_i}{\partial a}$ in the theoretical model. Similarly, the vector of coefficients $\gamma_{\mathbf{4i}}$ in the owners' set of equations and the vector of coefficients $\beta_{\mathbf{4i}}$ in the renters' set of equations show how the price of housing changes when each individual amenity changes. These coefficients are the counterparts to $\frac{\partial P}{\partial a}$ in the theoretical model.

About half of the variables I use vary with the individual but the rest, amenities and MSA specific characteristics, vary only by MSA. Therefore, observations within an MSA are likely correlated but observations across MSAs are not correlated. If I ignore this fact, I have unbiased estimates but standard errors are wrong leading to incorrect inference. Therefore, I use clustered standard errors to account for this.

3.2 Data

Individual level data comes from two samples from the Integrated Public Use Microdata Series (IPUMS) [3]. These samples are the American Community Survey's 2005-2007 3-year sample and the 2000 5% sample. From these samples I use male heads of households, aged 25 to 54, who rent or own an apartment or a house. The Amenity and MSA-specific characteristic data comes from the 2002 and 2007 Cities Ranked and Rated Almanac. The 2002 Cities Ranked and Rated Almanac contains data on MSAs from 2000-2002, while the 2007 Cities Ranked and Rated Almanac contains data on MSAs for 2004-2007. The edited samples contain 268 MSAs with 1,219,796 workers for 2000 and 655,012 workers for 2005-2007. All monetary variables are measured in constant 2000 dollars. The datasets from the two time periods are combined because the more important dichotomy is between owners and renters. There are 1,368,200 owners and 506,608 renters in the dataset.

The first category of variables is endogenous variables. This category includes house prices, rents, and earnings variables for each level of education. I use the log value of each of these variables for the estimation, but Table 1 provides descriptive statistics of the level forms since these are more informative. The earnings provided are the aftertax earnings for households. To determine aftertax earnings, first taxable earnings are calculated using a standard de-

[3] Steven Ruggles, J. Trent Alexander, Katie Genadek, Ronald Goeken, Matthew B. Schroeder, and Matthew Sobek. Integrated Public Use Microdata Series: Version 5.0 [Machine-readable database]. Minneapolis: University of Minnesota, 2010.

duction of $5,350 for 2005-2007 sample and $4,400 for the 2000 sample. Each household is given one deducton each for a spouse and each child under 18 years of age. Using income tax brackets from 2000 and from 2007, the amount of federal taxes households had to pay is subtracted from overall earnings. Secondly, a state and local tax variable is provided by the Cities Ranked and Rated Almanac. This variable is an average of state and local tax rates for each MSA. This rate is used to subtract state and local taxes from overall earnings. After federal taxes and state and local taxes are subtracted from overall earnings, I am left with aftertax earnings.

In order to make apples-to-apples comparisons, annual rent and annual cost of housing are used for rent and house prices. Monthly rent is multiplied by 12 to get annual rent and the annual cost of housing is calculated using a formula created in a working paper for the Federal Reserve Bank of Philadelphia by Crone, Nakamura, and Voith in 2004. The authors claim that the annual cost of housing is equal to the purchase price of the house multiplied by a capitalization rate. To estimate the capitalization rate, the following regression is run:

$$ln(h_{ij} + r_{kj}) = \alpha D_0 + \beta H_{ij} + \mu \tag{14}$$

where D_0 is a dummy variable equal to one if the unit is owned and zero if it is rented and H is a vector of housing characteristics. The capitalization rate is calculated using $e^{-\alpha}$. The results of this method give the followng capitalization rate: $C = .0735$

The final step is to multiply C by h_{ij} and then add this value to the yearly cost of utilities and annual property taxes in order to get a measure of annual housing costs. This value will be used for house price in the upcoming regression results.

Table 1: **Endogenous Variables**

	Owners			Renters		
Education Level	Observations	Earnings	House Price	Observations	Earnings	Rent
High School Grad or less	29.48%	$37,991.34	$15,134.71	41.92%	$23,161.59	$8,089.153
Some College	30.46%	$47,424.94	$18,146.98	28.24%	$29,853.30	$9,252.52
Bachelor's Degree only	25.14%	$64,162.35	$24,333.64	19.28%	$38,458.59	$10,974.48
Graduate Degree	14.92%	$80,090.63	$29,920.48	10.55%	$46,574.44	$12,223.55
Total	1,368,200	$53,724.73	$20,570.65	506,608	$30,472.60	$9,410.51

The second category is the instrumental variables, which are discussed in-depth in the next section. The regulation index is a compilation of 11 sub-indexes, all dealing with how much regulation on residential land use is in place in a city, put together by the Wharton School at the University of Pennsylvania. The larger the number, the more regulations are in place.

Table 2: **Instruments**

Owners				
	Mean	Std. Dev.	Min	Max
average hours	43.22	13.24	0	99
Regulation	.1616	.669	-1.677	4.304
Age of structure	29.37	20.09	2	68
Renters				
	Mean	Std. Dev.	Min	Max
average hours	37.92	16.9	0	99
Regulation	.2562	.6435	-1.677	4.304
Age of structure	34.92	19.01	2	68

The exogenous variables are divided into four categories. Individual characteristics are characteristics of the the worker which include age, marital status, number of children, race, english speaking ability, occupation categories, and a dummy variable for the states hit hardest by the housing bubble. Housing variables include the number of bedrooms in a house or apartment, a dummy variable for whether the house is a single family home, and a dummy variable for whether or not the household has moved in the recent past. The MSA controls include measures of population, density, unemployment, libraries, an index measuring the price of non-housing goods and services[4], and a variable measuring the percent of children in the MSA who attend public school.

The fourth category of exogenous variables are amenity variables whose descriptive statistics are presented in Tables 3 and 4. These variables are broken into two categories based on whether the amenity variables are outside the control of city officials, Table 3, or within the control of city officials, Table 4. In Table 4, *Environment* is a combined index of air quality and water quality which are both measured on a scale from 0 to 100, with better quality represented by a larger number. *Entertainment* is an index consisting of leisure and arts. Leisure is an index ranging from 9 to 90 covering 9 areas that are

[4]This index includes the cost of food, transportation, healthcare, and miscellaneous goods such as clothing, restaurants, repairs, and entertainment

Table 3: **Fixed Amenity Variables**

	Mean	St. Dev.	Min	Max
Mean January Temperature	29.49°	11.92°	−3.6°	65.3°
Mean July Temperature	86.48°	6.09°	65.6°	104.8°
Inches of snowfall	19.82	21.94	0	109
Inches precipitation	35.38	13.92	4	70
Days mostly sunny	216.34	34	131	300
Miles inland water	5.54	2.92	1	11
Coastal City	.4484	.4973	0	1

rated on a 1 to 10 scale. These areas include restaurants, sports, zoos and acquariums, amusement parks, gardens, golf courses, ski areas, and national parks. Similarly, Arts is an index ranging from 9 to 90 covering 9 areas that are rated on a 1 to 10 scale. These areas include arts radio, classical music, ballet, theater, university arts programs, and museums. *Spending per pupil* is the amount of money each MSA spends on education per student measured in hundreds of dollars. Finally, the variable *crime* is the number, in hundreds, of violent crimes and property crimes per 100,000 people in the MSA.

Table 4: **Control Amenity Variables**

	Mean	St. Dev.	Min	Max
Sales Tax	7.05%	1.51%	0%	10%
Spending per pupil	$56.99	$12.83	$30.98	$98.02
Environment	78.08	37.20	6	195
Entertainment	112.22	40.53	19	178
Crime	43.93	11.51	9.07	77.23
Commute Time	26.23	24.67	0	200

3.3 Identification strategy

In order to estimate this system of equations, each individual equation must be identified. For this to occur, valid instruments are needed for both housing prices and earnings and the order and rank conditions for identification must be met. I consider each of these in turn.

First, a valid instrument appears on the right hand side of one structural

equation in the 2SLS system of equations and not in the other structural equation. For equations 11 and 13, the instruments for housing prices are the age of the structure the worker owns or rents and a regulation variable which is an index of how much residential land use regulations are in place in a particular MSA. To be valid instruments, these two variables must be partially correlated with housing prices but not be correlated with earnings other than through their correlation with housing prices. Table 5 below presents the first-stage results of the 2SLS regression. For both owners and renters, the regulation index has a positive and significant effect on housing prices while the age of structure variable has a negative and significant effect on housing prices. Furthermore, F statistics for the excluded instruments are significantly greater than 10 for each category. Therefore, both instruments are strongly correlated with housing prices.

Table 5: **First-stage results: Dependent Variable - Housing prices**

Owners					
Education Level	regulation index	Std. error	age of structure	Std. error	F statistic
HS or less	.1309	.017	-.1239	.0047	395.12
Some college	.1233	.0167	-.1189	.004	487.00
Bachelors	.0975	.0182	-.0831	.0048	174.93
Graduate	.0792	.0201	-.0589	.0056	64.67
Renters					
Education Level	regulation index	Std. error	age of structure	Std. error	F statistic
HS or less	.0446	.0126	-.0692	.0041	153.99
Some college	.0463	.0115	-.0965	.003	552.31
Bachelors	.0402	.0132	-.1027	.0034	513.33
Graduate	.0404	.0153	-.1017	.003	664.34

My contention is that the age of a structure and the regulation index are not correlated with the earnings of workers. While more regulation can be expected to lead to higher house prices, there is little reason to believe that more regulation on land use in a city should affect earnings. It is possible that cities with more regulation on land use may have more regulations and restrictions in other areas which may affect earnings, but I expect this effect to be weak or non-existent. I include the regulation index in a first-stage regression of the earnings equation and find that regulation does not have a significant effect on earnings for owners or renters of any education level.

Similarly, the age of a house or an apartment that a household owns or rents can be expected to affect housing prices, but it should not affect earnings. It is possible that households in higher income brackets may prefer newer houses. In a simple regression of age of structure on earnings, I find that, while earnings has a significant and negative impact on age of structure, the earnings variable explains far less than 1% of the variation in age of structure for owners and renters of all levels of education. While a correlation does exist, it is very weak. Furthermore, I include the age of structure variable in a first-stage regression of the earnings equation and find that while age of structure does have a significant and negative effect on earnings, age of structure explained at most .03% of the variation in earnings.

One final check on the validity of the instruments is an overidentification test which can be used since there are two instruments and one endogenous variable in the equation of interest. The results of a Sargan test and Basmann test of overidentifying restrictions are reported in Table 6 below. I am unable to reject the null hypothesis that the instruments are uncorrelated with the error terms for owners and renters of all levels of education. Based on the results of these tests and the arguments made in the preceding paragraphs, I conclude that age of structure and the regulation index are valid instruments for housing prices in the 2SLS regression.

Table 6: **Overidentification tests**

Owners				
Education Level	Sargan	p-value	Basmann	p-value
HS or less	2.58225	.1081	2.58204	.1081
Some college	.823677	.3641	.823609	.3641
Bachelors	.212485	.6448	.212463	.6448
Graduate	.321925	.5705	.321871	.5705
Renters				
Education Level	Sargan test	p-value	Basmann test	p-value
HS or less	1.33376	.2481	1.33358	.2482
Some college	.165064	.6845	.165029	.6846
Bachelors	.924881	.3362	.924605	.3363
Graduate	.464486	.4955	.464229	.4957

For equations 10 and 12, the instrument for household aftertax earnings is the average hours per week by the head of household. To be a valid instrument, average hours must be partially correlated with household earnings but not

correlated with housing prices other than through its correlation with earnings.

Table 7: **First stage results: Dependent Variable - Household wages**

Owners			
Education Level	average hours	Std. error	F statistic
HS or less	.0885	.0009	10,718
Some college	.0629	.0007	7,060
Bachelors	.0483	.0009	2,925
Graduate	.0382	.0008	2,154
Renters			
Education Level	average hours	Std. error	F statistic
HS or less	.1445	.0009	24,099
Some college	.1204	.0011	11,351
Bachelors	.1041	.0011	8,874
Graduate	.0902	.0017	2,767

Table 7 presents the first stage results for the earnings equation. For both owners and renters, average hours have a postive and significant effect on household earnings, as expected. The F statistics in the table show that average hours is strongly correlated with household earnings. My contention here is that average hours are not correlated with housing prices. People who work long hours may want to live closer to the central business district of a city in order to maximize the time they spend at home. Since property values are higher closer to the city center due to the rent gradient, working longer hours may lead to higher house prices.

To determine if this possibility is a problem, I include average hours worked per week as an independent variable in a first stage regression of housing prices. I find that while average hours has a significant and negative effect on housing prices for owners with up to some college education and a significant and positive effect on housing prices for owners with at least a bachelors degree and for renters of all education levels, average hours explains at most 1.3% of the variation in home prices and at most 2.2% of the variation in apartment rents. When earnings is included as an explanatory variable, average hours remains significant but the explanatory power of average hours drops to .28% of the variation in home prices and 1.26% of apartment rents. Though there is a slight effect of average hours on house prices, the average hours worked per week is still an acceptable instrument as no instrument is perfect and the

problems here are minimal [5].

In addition, people who buy a more expensive house may feel the need to work longer hours in order to pay for the house. In other words, the direction of causality may be going the other way. To determine if this is a problem, I run a regression of average hours on house prices and earnings and find that while house prices have a positive and significant effect on average hours, house prices explain at most only .24% of the variation in average hours worked by owners and .52% of the variation in hours worked by renters. Although it is possible that some correlation exists between house prices and average hours, the correlation is small enough for me to conclude that average hours is a valid instrument for household earnings.

Second, the order condition for identification requires that, for each equation, the number of excluded exogenous variables from the equation be at least as large as the number of right-hand side included endogenous variables. In equations 10 and 11, the earnings equation has one endogenous right-hand side variable, house prices, and regulation and age of structure are excluded from this equation. The house price equation also has one endogenous variable, earnings, and average hours worked per week is excluded. Therefore, equation 10 is overidentified and equation 11 is exactly identified.

In equations 12 and 13 the earnings equation has one endogenous right-hand side variable, rents, and regulation and age of structure are excluded from this equation. The rent equation also has one endogenous variable, earnings, and average hours worked per week is excluded. Therefore, equation 12 is overidentified and equation 13 is exactly identified.

Third, though the order condition is satisfied, to satisfy the rank condition the exogenous variables excluded from the first equation must have a statistically significant effect on the left-hand side variable of the second equation and vice versa. OLS regressions of house price and rent on regulaton and age of structure return significant coefficients. The same is true for OLS regression of earnings on the average hours worked per week. Therefore, the rank condition is satisfied which means that I am able to identify both sets of equations.

[5] I tried a city minimum wage variable and a percent of the city population that is obese variable as instruments and neither variable had significant second stage results

3.4 Results

As discussed in section 3.1, the empirical strategy in this paper is to use 2SLS with annual aftertax earnings and a measure of housing cost as the endogenous variables of interest. The questions I am trying to answer are the following:
1) To what level are workers compensated for higher price levels among cities?
2) What are amenities worth to workers?

3.4.1 1st methodology

I use three slightly different methodologies to answer these questions and to compare my work to that of previous authors. The first method duplicates previous efforts in which I use the overall price level and aftertax annual earnings as my endogenous variables. This first methodology uses the following equations:

$$lnW_{ij} = \beta_1 X_{ij} + \beta_2 lnP_j + \beta_3 a_j + \mu 1_{ij} \tag{15}$$

$$lnP_j = \alpha_1 X_{ij} + \alpha_2 lnW_{ij} + \alpha_3 a_j + \mu 2_{ij}$$

where W is aftertax annual earnings, X is a vector of exogenous variables, P is the price level in the MSA, and a is a vector of amenities.

Table 8: **Elasticity Results: 1st method**

Author (year)	Results (Std. error)
Roback (1988)	$.9724^c$ (.0156)
DuMond et al. (1999)	$.46^a$ (.007)
Winters (2009)	$.760^a$ (.078) for homeowners
	$.416^a$ (.049) for renters
My results	$.8009^b$ (.08896) for homeowners
	$.5614^b$ (.1824) for renters

Notes: ^{a} significantly different from 1 at the 1% level; ^{b} at 5%; ^{c} at 10%

The coefficients listed in table 8 are β_2, which explains how earnings change when the price level changes holding amenities and other exogenous variables constant. For workers to be fully compensated for cost-of-living differences, a 10% increase in the price level would have to be associated with a 10% increase in earnings. Therefore, the city price elasticity of earnings would have to equal one. Each of the previous authors used OLS regressions while I use a 2SLS regression. Each 2SLS regression uses clustered standard errors. Since none of these previous authors have taken into account the simultaneity of earnings

and housing prices, their results will be biased.

In addition to using different econometric techniques, I use 268 MSAs in my data while Roback uses 32 MSAs, Winters uses 167 MSAs, and Dumond uses 185 MSAs. Since the equations for homeowners are slightly different from the equations for renters in my methodology, I can only produce separate estimates for owners and renters and not a combined one like Roback and DuMond provide. Although the estimates of previous researchers appear to differ from my results, statistically they are equivalent.

More specifically, my result for homeowners is statistically equivalent to Roback's result while my result for renter's is not equal to Roback's result. My result for renters is statistically equivalent to DuMond's result while my result for owners is not equal to DuMond's result. Not surprisingly, since Winters (2009) is the paper closest in form and execution to mine, Winters' homeowner result is statistically equivalent to my homeowner result and Winters' renter result is statistically equivalent to my result for renters.

Using this first methodology, it appears that owners are better compensated for higher city price levels than renters. However, the two results are not statistically different. Furthermore, both results are statistically significant and statistically different from 1 at the 5% level. This means that a 10% increase in city price levels is associated with less than a 10% increase in earnings for both owners and renters. Therefore, I can conclude that owners and renters are not fully compensated for changes in city price levels using this methodology.

3.4.2 2nd methodology

The second methodology involves breaking the overall price level apart into housing prices and the price of non-housing goods and services. Full compensation using this methodology requires that a 10% increase in housing prices be associated with a 3.1% increase in earnings for homeowners and a 3.4% increase in earnings for renters, while a 10% increase in non-housing goods prices be associated with a 6.9% increase in earnings for homeowners and a 6.6% increase in earnings for renters. These numbers are calculated from the Consumer Expenditure Survey Expenditure shares for housing, which is .31 for homeowners and .34 for renters. Equations for this method are:

$$lnW_{ij} = \beta_1 X_{ij} + \beta_2 lnHP_{ij} + \beta_3 lnNHP_j + \beta_4 a_j + \mu 1_{ij} \tag{16}$$

$$lnHP_j = \alpha_1 X_{ij} + \alpha_2 lnW_{ij} + \alpha_3 lnNHP_j + \alpha_4 a_j + \mu 2_{ij}$$

where NHP is the non-housing goods price index and HP is housing prices.

Since NHP appears in both equations, there is both a direct and indirect effect of NHP on earnings. Therefore, I calculate a total effect (direct + indirect) of NHP on earnings for owners and renters of each education level. These total effects are reported in the NHP column in Table 9 below.

Table 9: **Elasticity results: 2nd method**

	Owners		Renters	
Education Level	house (s.e.)	NHP (s.e)	rent (s.e)	NHP (s.e.)
High School Grad or less	$.1637^a$ (.0333)	1.085^b (.1907)	$.1202^c$ (.1166)	1.672^a (.359)
Some College	$.2402^a$ (.0214)	.9093 (.1777)	$.1595^c$ (.0906)	1.77^b (.5008)
Bachelor's Degree only	$.2510^a$ (.0191)	.7096 (.1508)	.2561 (.0765)	1.726^b (.5397)
Graduate Degree	.3295 (.0572)	.6400 (.2146)	.3969 (.1024)	2.594^a (.6001)
Overall	$.1993^a$ (.0201)	.9235 (.1769)	$.1645^a$ (.0631)	1.8728^a (.3422)
Winters(2009)	$.143^a$ (.024)	$.165^a$ (.132)	.337 (.038)	$.231^a$ (.106)

Notes: ^{a} significantly different from the budget share (.31 for housing and .69 for nonhousing for owners and .34 for housing and .66 for nonhousing for renters) at the 1% level; ^{b} at 5%; ^{c} at 10%

Winters(2009) is the only paper I found that uses this second method. My overall result and Winters (2009) result for the housing price elasticity of earnings is not statistically different for owners while it is statistically different at the 10% level for renters. For the nonhousing good price elasticity of earnings, my result and Winters' result for owners is statistically different at the 5% level while the result for renters is significantly different at the 1% level. This is not surprising since Winters' used past values of housing prices and nonhousing goods prices to instrument for housing prices and nonhousing goods prices while I used regulation index and the age of the structure as discussed in section 3.3.

My overall results and Winters' results share other similarities. Our results for house price elasticity of earnings for owners are both statistically different from the housing budget share for owners. However, while Winters' results for nonhousing goods elasticity of earnings is statistically different from the nonhousing goods budget share for owners, my result is not statistically different for the nonhousing goods budget share for owners. For renters, on the other hand, Winters' result for rent elasticity of earnings is not statistically different from the rent budget share while my result is statistically different from the rent

budget share. However, both Winters' result and my result for the nonhousing goods price elasticity of earnings are significantly different from the nonhousing goods budget share for renters.

As far as I am aware, this is the first paper to break these results down by levels of education. Each coefficient is statistically significant for both owners and renters of all education levels except for the housing price elasticity of earnings for renters with a high schoold degree or less. For owners, though the housing price elasticity of earnings increases as education increases, the results for owners who do not have a graduate degree are statistically less than the housing budget share while the result for owners with a graduate degree is not statistically different from the housing budget share. Furthermore, though the nonhousing goods price elasticity of earnings decreases with education for owners, the result for owners with a high school degree or less is statistically greater than the nonhousing goods budget share while the results for owners with all higher levels of education are not statistically different than the nonhousing goods budget share.

For renters, the situation is a bit different. The housing price elasticity of earnings increases with education, but the results for renters with up to some college education are statistically less than the housing budget share while the results for renters with at least a bachelor's degree are not statistically different from the housing budget share. Unlike for owners, for renters the nonhousing goods price elasticity of earnings increases with education and each result is statistically greater than the nonhousing goods budget share.

From the results in Table 9, I conclude that, except for owners with a graduate degree, owners are not fully compensated for increases in housing prices and renters with at least a bachelor's degree are fully compensated for increases in higher housing prices while renters who do not have a bachelor's degree are not. I also conclude that owners are fully compensated for increases in higher nonhousing goods prices and state further that owners with a high school degree or less receive larger percentage increases in their wages than the percentage increase in nonhousing goods prices. Renters, on the other hand, are all more than fully compensated for increases in nonhousing goods prices. In order to determine if overcompensation in one area makes up for undercompensation in the other area, I add the housing price and nonhousing price coefficients together in Table 10.

Table 10: **Total Results**

Education Level	Owner's Total (s.e.)	Renter's Total (s.e)
High School Grad or less	1.245 (.1936)	1.793^{b} (.3775)
Some College	1.15 (.179)	1.929^{c} (.509)
Bachelor's Degree only	.9606 (.152)	1.983^{c} (.5451)
Graduate Degree	.9695 (.2221)	2.991^{a} (.6087)
Overall	1.228 (.178)	2.037^{a} (.3479)
Winters(2009)	$.308^{a}$ (.1342)	$.568^{a}$ (.1126)

Notes: ^{a} significantly different from 1 at the 1% level; ^{b} at 5%; ^{c} at 10%

While the results from Table 9 show that some owners are not fully compensated for price changes, Table 10 shows that owners of all education levels are fully compensated for changes in overall city price levels. There is also a substantial difference between my overall result for owners and Winters' result as Winters' result is statistically less than 1 and my overall result is not statistically different from 1. For renters, I find that the coefficient is statistically greater than 1 for all levels of education. Also, though both Winters' result and my overall result are statistically different from 1, Winters' result is less than 1 while my overall result is greater than 1.

3.4.3 3rd methodology

The third methodology I use involves constraining the coefficient on the non-housing goods price index such that earnings adjust fully. In other words, this coefficient is assumed to be equal to households budget share of non-housing goods and services. For homeowners, this value is .69 and for renters this value is .66. Equations for this methodology are the following:

$$lnW_{ij} - (share) \times lnNHPij = \beta_1 X_{ij} + \beta_2 lnHP_{ij} + \beta_3 a_j + \mu 1_{ij} \tag{17}$$

$$lnHP_j = \alpha_1 X_{ij} + \alpha_2 [lnW_{ij} - (share) \times lnNHP_{ij}] + \alpha_3 a_j + \mu 2_{ij}$$

The coefficients listed in table 11 are β_2 which explains how earnings change when the housing price level changes holding amenities and other exogenous variables constant. If this coefficient equals .31 for owners or .34 for renters, then workers are fully compensated for higher price levels.

Using the third methodology, a few patterns emerge among the different lev-

Table 11: **Elasticity results: 3rd method**

	Owners		Renters	
Education Level	house price	Std. error	Rent	Std. error
High School Grad or less	.1644[a]	.0296	.1701[c]	.0897
Some College	.2414[a]	.0194	.1859	.0985
Bachelor's Degree only	.2518[b]	.0246	.2618	.0578
Graduate Degree	.3333	.0441	.4144	.0938
Overall	.2004[a]	.0188	.1323[a]	.0597
Winters(2009)	.297	.042	.091[a]	.021

Notes: [a]Significantly different from the housing budget share (.31 for owners and .34 for renters) at the 1% level; [b] at 5%

els of education. First, the coefficient on house price and rent for the earnings equation for owners and renters, respectively, increases as education increases. Since this coefficient is the percent change in earnings associated with a percent change in housing price, it is the housing price elasticity of earnings by definition. The elasticity is statistically significantly less than .31 for owners with a High School degree or less, with some college, and with a bachelor's degree only. Owners with a graduate degree have an elasticity that is not statistically different from .31. Therefore, I conclude that owners with education up to and including a bachelor's degree are not fully compensated for higher housing price levels in a city and owners with a graduate degree are fully compensated for higher housing price levels in a city when I assume that owners are fully compensated for higher non-housing good prices.

For renters, the elasticity is statistically significantly less than .34 for people with High School degree or less while the results for all more highly educated renters are not statistically different from .34. Therefore, I conclude that renters with a high school degree or less are not fully compensated for higher housing price levels in a city and all renters with at least some college education are fully compensated for higher housing price levels in a city when I assume that renters are fully compensated for higher non-housing good prices.

Furthermore, it is apparent that, at low levels of education, owners are better compensated than renters for higher housing prices, while, at high levels of education, renters are compensated at least as much as owners for higher housing prices. Although these differences in coefficients across groups, both education level and home ownership status, are not all statistically significant,

it is the case that owners and renters with a graduate degree are better compensated for higher housing prices than owners and renters with a high school degree or less, respectively.

A partial explanation for the pattern in Table 11 is that less-educated workers are more likely to operate in a local labor market while more educated workers are more likely to operate in a national labor market. Table 12 lists the percentage of workers in the samples who remained in the same house, moved to a new MSA within the same state, or moved into an out-of-state MSA. Two things are readily apparent. Renters are significiantly more likely to migrate across state lines than homeowners and migration across state lines increases as education increases for both renters and owners.

One reason renters may be better compensated than owners for higher housing prices at high levels of education is that owners are much less likely and less able to move to take advantage of better amenities and/or higher wages. Furthermore, the fact that migration increases with education for both owners and renters can explain why both renters and owners are better compensated for higher housing prices as education increases. In both cases, it is likely that there is some kind of migration cost, whether it be psychological or financial in nature, that is keeping certain groups of people from moving to areas in which they would be better off in terms of earnings, housing prices, and amenities.

Table 12: **Migration Status last 5 years**

Owners			
Education Level	Same House	Moved within State	Moved from out of state
High School Graduate or less	73.3%	23.6%	3.1%
Some College	70.3%	25.1%	4.6%
bachelor's Degree	66.9%	25.5%	7.6%
Graduate Degree	68.6%	21.8%	9.6%
Renters			
High School Graduate or less	46.0%	43.0%	11.1%
Some College	39.4%	45.5%	15.2%
bachelor's Degree	35.2%	40.0%	24.8%
Graduate Degree	33.5%	31.7%	34.9%

Another reason why workers are not fully compensated is that the dependent variable is earnings. Non-earnings income, such as health insurance, pensions,

401k, stock options, and subsidized housing bring workers of each level of education closer to full compensation. Non-earnings income is especially significant for workers with more education, which means that the differences in elasticities between workers with little education and workers with much education is probably greater than it appears in the table.

Lastly, since Winters (2009) did not break down results by education, I compared my overall result to Winters' overall result. Though my coefficient for owners is smaller than Winters' coefficient and my coefficient for renters is larger than Winters' coefficient, these differences in coefficients are not statistically significant.

I further examine how housing prices and earnings change with population and over time. First, the coefficient on population in the earnings equation for owners, how earnings increase when MSA population increases, rises with education, as seen in Table 13. Population has both a direct and indirect effect on earnings and housing prices. Therefore, I calculate a total effect (direct + indirect) of population on earnings and housing prices for owners and renters of each education level.

Table 13: **Population elasticity of earnings**

	Owners	Renters
Education Level	estimate (Std. error)	estimate (Std. error)
High School Grad or less	−.0191 (.0205)	$-.0495^{a}$ (.0172)
Some College	.0178 (.0177)	−0.0129 (.0266)
Bachelor's Degree only	$.0403^{b}$ (.0173)	−.0225 (.0245)
Graduate Degree	$.0426^{b}$ (.0208)	−0.0074 (.0328)
Overall	.017 (.0147)	−.0251 (.0168)

Notes: ^{a} denotes significance at the 1% level; ^{b} at 5%; ^{c} at 10%

More educated owners are better off in bigger MSAs than are less educated owners, since more educated workers see their earnings increase in larger cities while less educated workers see no change in earnings. For renters, workers with a high school degree or less receive lower earnings in larger cities. However, all more educated renters do not see significant changes in their earnings in larger cities.

Table 13 also shows that owners are at least as well off as renters at all levels of education. There is a statistically significant difference in coefficients between

renters and owners for all education levels except for owners and renters with some college education.

Second, Table 14 shows the coefficients on population in the housing equations, how housing prices change as population changes, for renters and owners. Houses are cheaper in bigger MSAs for owners of all education levels and, there is no significant difference in rent between different size cities for renters of all education levels. There is a statistically significant gap between the two sets of coefficients which means that owners are significantly better off in larger MSAs than are renters since owners face larger decreases in the price of housing than renters in bigger MSAs. Based on tables 13 and 14, I conclude that owners are better off than renters in larger MSAs since owners receive bigger increases in earnings and receive bigger decreases in housing costs than renters in larger MSAs.

Table 14: **Population elasticity of housing prices**

	Owners	Renters
Education Level	estimate (Std. error)	estimate (Std. error)
High School Grad or less	$-.1124^a$ (.0279)	$-.025$ (.0165)
Some College	$-.1262^a$ (.027)	$-.0306$ (.019)
Bachelor's Degree only	$-.1132^a$ (.0301)	$-.0284$ (.0258)
Graduate Degree	$-.085^a$ (.0256)	$-.0155$ (.025)
Overall	$-.1117^a$ (.025)	$-.0263$ (.0212)

Notes: ^{a} denotes significance at the 1% level; ^{b} at 5%; ^{c} at 10%

A third area is how workers fare in the two different time periods in the data. Table 15 shows the percentage change in earnings for renters and owners over the two time periods in the sample, the year 2000 and the years 2005-2007. I again look at both the direct and indirect effect of the changing time period in the regression results. Owners with higher levels of education appear to be increasingly better off in the later time period, though the differences in coefficients are not statistically significant. Renters are better off over time and this change in wages increases as education increases, though these differences in coefficients are not statistically significant. Furthermore, less-educated owners became better off over time than less educated renters while owners with a graduate degree became worse off over time than renters with a graduate degree, though none of these differences are statistically significant.

Table 15: **Change in earnings over the two time periods**

	Owners	Renters
Education Level	estimate (Std. error)	estimate (Std. error)
High School Grad or less	$.1542^a$ (.0324)	$.1031^a$ (.0343)
Some College	$.1675^a$ (.0216)	$.1277^a$ (.034)
Bachelor's Degree only	$.1784^a$ (.0237)	$.1613^a$ (.0375)
Graduate Degree	$.1949^a$ (.0325)	$.245^a$ (.0434)
Overall	$.1717^a$ (.0174)	$.1301^a$ (.0252)

Notes: ^{a} denotes significance at the 1% level; ^{b} at 5%; ^{c} at 10%

Finally, Table 16 shows the percentage change in housing costs for renters and owners over the two time periods in the sample. At all levels of education, over the two time periods housing costs went up for both owners and renters. These large increases in housing values over the two time periods are likely a result of the housing bubble. The differences in coefficients for renters of all the education levels are not statistically significant. Though the owners trend appears to be downward, none of the differences in coefficients for owners of the five educational levels is statistically significant. The table also shows that housing costs for owners went up more than housing costs for renters and these differences in coefficients between owners and renters of all levels of education are statistically significant.

Table 16: **Change in housing prices over two time periods**

	Owners	Renters
Education Level	estimate (Std. error)	estimate (Std. error)
High School Grad or less	$.3969^a$ (.0362)	$.17^a$ (.0204)
Some College	$.3934^a$ (.0334)	$.1642^a$ (.0161)
Bachelor's Degree only	$.392^a$ (.0377)	$.1845^a$ (.0245)
Graduate Degree	$.3519^a$ (.0413)	$.1907^a$ (.0253)
Overall	$.3897^a$ (.0347)	$.1754^a$ (.0171)

Notes: ^{a} denotes significance at the 1% level; ^{b} at 5%; ^{c} at 10%

Based on tables 15 and 16, I conclude that renters are better off over the two time periods than owners are, since there are no statistically significant differences in the changes in earnings for owners and renters and housing prices for owners increase by a much higher percentages than housing prices for renters.

3.5 Implicit Prices of Amenities

Based on the results from the theoretical model, for a variable to be an amenity, the coefficient on the variable in the earnings equation must be negative, indicating that workers give up earnings for a higher level of the amenity. Similarly, the coefficient on the variable in the housing equation must be positive, indicating that workers pay more for housing in order to enjoy a higher level of the amenity. For a variable to be a disamenity, the coefficient on the variable in the earnings equation must be positive, indicating that workers give up earnings for a lower level of the disamenity, and the coefficient on the variable in the housing equation must be negative, showing that workers pay more for housing in order to enjoy lower levels of the disamenity. If both coefficients are of the same sign or one or both coefficients are not statistically significant, then the variable is not a true amenity or disamenity.

I use the regression results for owners and renters of each education level to estimate the implicit value of amenities for both owners and renters. Since people do not actually pay for amenities, Equation 9 in Section 2.3 can be used to determine an implicit price of amenities using the amount of earnings the worker is willing to give up to enjoy a particular amenity subtracted from the amount of rent or yearly cost of housing the worker is willing to pay to enjoy the amenity. In terms of the regression results, this is the coefficient on the MSA attribute in the housing equation minus the coefficient on the MSA attribute in the earnings equation.

There are two ways of expressing amenities in the equations. The first is amenities in the level form. Equation 9 is modified in the following way:

$$p_a^i = [\frac{PL}{w_i} \cdot \frac{\partial logP}{\partial a} - \frac{\partial logw_i}{\partial a}]w_i \tag{18}$$

$\frac{PL}{w_i}$ is the share of land in the worker's budget and is calculated by dividing the average annual value of housing for workers of type i divided by the average annual earnings for workers of type i. This gives an implict price in terms of dollars per one unit change in the amenity value.

The second is amenities in the log form. Equation 9 is modified to deal with this as well:

$$p_a^i = [\frac{PL}{w_i} \cdot \frac{\partial logP}{\partial loga} - \frac{\partial logw_i}{\partial loga}]\frac{w_i}{a} \tag{19}$$

This price is equal to dollars per unit change in each of the amenity vari-

ables. I multiply this value from equation 18 and equation 19 by the standard deviation of the variable in order to get the price for a one standard deviation change in the amenity value. Tables 17 and 18 list the implicit prices of amenities for owners and Table 19 and 20 list the implicit prices for renters.

Table 17: **Implicit Prices of Amenities for Owners**

Fixed Amenities (units)	HS Grad or less	Some College	bachelor's Degree	Graduate Degree
Avg temp in January (degrees)				
1 unit change	$192.99*	$179.21*	$135.02*	$157.75*
1 Std. Dev. change	$2,299.39*	$2,186.64*	$1,587.12*	$1,809.88*
Avg temp in July (degrees)				
1 unit change	-$106.00*	-$124.30*	-$164.47*	-$219.85*
1 Std. Dev. change	-$617.93*	-$759.14*	-$967.76*	-$1,261.94*
Inches of snow (inches)				
1 unit change	-$41.71*	-$53.28*	-$89.40*	-$108.32*
1 Std. Dev. change	-$951.48*	-$1,213.99*	-$1,932.86*	-$2,298.40*
Inches of precipitation (inches)				
1 unit change	-$41.90*	-$53.32*	-$57.29*	$0.00*
1 Std. Dev. change	-$565.24*	-$746.05*	-$765.41*	$0.00*
Sunny Days (days)				
1 unit change	$49.89*	$45.28*	$39.90*	$97.58
1 Std. Dev. change	$1,659.94*	$1,578.28*	$1,313.12*	$3,159.78
Inland water (miles)				
1 unit change	$139.12*	$140.65*	$0.00*	$0.00*
1 Std. Dev. change	$399.96*	$407.08*	$0.00*	$0.00*
Coastal City (dummy)				
1 unit change	$0.00*	$0.00*	$0.00*	$0.00*
1 Std. Dev. change	$0.00*	$0.00*	$0.00*	$0.00*

A positive price signifies that workers pay for higher levels of the MSA attribute which means that workers consider the attribute an amenity. A negative price means workers are compensated for higher levels of the MSA attribute, which means that the attribute is a disamenity. A starred (*) amenity valuation means that the variable is not a true amenity or disamenity. In other words, the earnings and housing price coefficient have the same sign or one or both of these are statistically insignificant. I still calculate an implict price for these variables, but I star them in order to note that they are not true amenities or disamenities as I defined them in the theoretical section of the paper.

The implict prices can easily be compared across education levels for a one unit change in each individual amenity. It is difficult to make comparisons across amenities since a one unit change in number of sunny days is completely different from a one unit change in crime. Therefore, I also present the prices of a one standard deviation change in the amenity value.

For the set of amenities not under the control of city officials in Table 17, owners of all education levels pay to live in areas with lower summer temperatures, higher winter temperatures, less snowfall, and more sunny days. Except for winter weather, workers feel more strongly about these amenities, in terms of paying for higher or lower values of the amenity, as education increases. Since less educated workers are more likely to be working outside, they may be willing to pay more for warmer winter weather. Finally, no owners pay money to live in a city with any amount of coastline. This may be due to the fact that sunny days, temperatures, and entertainment activities are held constant.

There is disagreement among workers of different education levels about the valuation of inches of rain and inland water. The explanation for these differences may be that less-educated workers are more likely to work outside or as simple as the existence of different preferences for different groups of workers.

In Table 18, which lists the amenities over which city officials have control, owners with different levels of education agree on whether each of the attributes is an amenity or a disamenity. Owners with different levels of education differ, however, on how much they like or dislike a particular amenity.

For the amenity variables, more spending per pupil, better entertainment, and better environmental quality are valued more highly as education increases. The only exception is that owners with a graduate degree value education spending the least among all educational groups. This may be due to the children of these owners being more likely to attend private school. For the disamenity variables, a shorter commute time, a lower sales tax rate, and less crime are more highly valued as education increases.

Within the levels of education the relative valuations of the amenities are compared using the one standard deviation implicit price. Commute time is valued most highly by homeowners of all education levels. This means that the amount of traffic and how close a person can live to his or her work greatly influences a homeowner's decisionmaking. Owners with a high school degree

Table 18: **Implicit Prices of Amenities for Owners**

Control Amenities (units)	HS Grad or less	Some College	bachelor's Degree	Graduate Degree
Sales Tax (%)				
1 unit change	-$234.02*	-$389.94*	-$560.03*	-$881.21*
1 Std. Dev. change	-$342.43*	-$596.24*	-$842.98*	-$1,329.77*
Spending per pupil (100s of $)				
1 unit change	$220.90	$231.81	$296.64	$154.13*
1 Std. Dev. change	$2,754.62	$2,869.65	$3,813.58	$2,067.84*
Environment (0-200 index)				
1 unit change	$7.70*	$10.77*	$19.01*	$24.39*
1 Std. Dev. change	$285.02*	$396.84*	$700.81*	$898.89*
Crime (in hundreds)				
1 unit change	-$32.05*	-$39.68*	-$125.10	-$164.59
1 Std. Dev. change	-$375.83*	-$452.16*	-$1,415.66	-$1,858.37
Commute time (minutes)				
1 unit change	-$243.37	-$231.38	-$228.39	-$306.05
1 Std. Dev. change	-$6,228.48	-$5,756.76	-$5,685.70	-$7,196.01
Entertainment (18-180 index)				
1 unit change	$0.26*	$58.77*	$107.60	$156.63
1 Std. Dev. change	$10.75*	$2,350.22*	$4,143.24	$5,939.61

or less and owners with some college education value education spending second highest while owners with a bachelor's degree and owners with a graduate degree value entertainment second highest. Therefore, less-educated owners put more value on education and more-educated owners put more value on the restaurants, bars, outdoor activities, shopping, and other entertainment activities available in a city. This may be due to financial constraints. On the one hand, more highly-educated workers are more able to utilize alternatives to public schooling than less-educated workers are. On the other hand, more-educated workers are better able to utilize all the entertainment activities a city has to offer than are less-educated workers.

Table 19 presents the implict price of amenities for renters that are outside the control of city officials. While the valuations of renters are similar to those of owners in many ways, there are important differences.

First, only less-educated renters pay for warmer winter weather while owners of all education levels pay for warmer winter weather. Second, only renters

Table 19: **Implicit Prices of Amenities for Renters**

Fixed Amenities (units)	HS Grad or less	Some College	bachelor's Degree	Graduate Degree
Avg temp in January (degrees)				
1 unit change	$94.60*	$102.85*	$0.00*	$0.00*
1 Std. Dev. change	$1,121.62*	$1,234.60*	$0.00*	$0.00*
Avg temp in July (degrees)				
1 unit change	$0.00*	-$30.65*	$0.00*	-$56.05
1 Std. Dev. change	$0.00*	-$206.06*	$0.00*	-$637.16
Inches of snow (inches)				
1 unit change	-$12.96*	$18.07*	-$26.16*	$28.43*
1 Std. Dev. change	-$272.39*	$381.67*	-$528.31*	$567.81*
Inches of precipitation (inches)				
1 unit change	-$8.74*	$22.95*	$0.00*	$0.00*
1 Std. Dev. change	-$131.50*	$345.82*	$0.00*	$0.00*
Sunny Days (days)				
1 unit change	$33.63	$32.32	$57.16	$95.95
1 Std. Dev. change	$1,170.56	$1,170.44*	$1,934.02	$3,125.21
Inland water (miles)				
1 unit change	$82.96*	$81.56*	$103.71*	$120.26*
1 Std. Dev. change	$243.98*	$240.31*	$307.26*	$353.86*
Coastal City (dummy)				
1 unit change	$0.00*	$0.00*	$0.00*	$3,753.89*
1 Std. Dev. change	$0.00*	$0.00*	$0.00*	$3,753.89*

with some college education and with a graduate degree pay for cooler summer weather while owners of all education levels pay for cooler summer weather. Third, renters of different education levels disagree about whether snow is an amenity or disamenity while owners of all education levels view snowfall as a disamenity. Fourth, only renters with some college education or less view rainfall as a disamenity while owners with a bachelor's degree or less view rainfall as a disamenity. Fifth, renters of all education levels pay for more inland water in a city while only owners with a high school degree or less and owners with some college education pay for more inland water. Lastly, renters with a graduate degree pay to live in a city on the coast while no owners pay more to live in a city on the coast.

Table 20 presents the implict price of amenities for renters that are within the control of city officials. Similar to owners, renters of all levels of education value spending per pupil as a true amenity and commute time as a disamenity,

though their valuations of these city attributes are not the same.

Table 20: **Implicit Prices of Amenities for Renters**

Control Amenities (units)	HS Grad or less	Some College	bachelor's Degree	Graduate Degree
Sales Tax (%)				
1 unit change	$324.48*	$0.00*	$0.00*	$0.00*
1 Std. Dev. change	$485.02*	$0.00*	$0.00*	$0.00*
Spending per pupil (100s of $)				
1 unit change	$178.08	$197.76	$305.15	$361.90
1 Std. Dev. change	$2,340.78	$2,495.55	$4,088.15	$5,048.81
Environment (0-200 index)				
1 unit change	$0.00*	$0.00*	$4.88*	$8.23*
1 Std. Dev. change	$0.00*	$0.00*	$183.61*	$304.30*
Crime (in hundreds)				
1 unit change	$0.00*	$0.00*	-$21.10*	-$40.77*
1 Std. Dev. change	$0.00*	$0.00*	-$240.70*	-$461.95*
Commute time (minutes)				
1 unit change	-$267.49	-$302.74	-$376.00	-$607.60
1 Std. Dev. change	-$6,573.39	-$7,248.47	-$8,477.62	-$13,357.89
Entertainment (18-180 index)				
1 unit change	-$24.57*	$16.87*	$22.81*	$24.29*
1 Std. Dev. change	-$1038.89*	$687.52*	$882.71*	$902.19*

Just as with the fixed amenities, there are also important differences between renters and owners with control amenities. First, only renters with at least a bachelor's degree pay to live in cities with better air and water quality while owners of all education levels pay for better air and water quality. Second, only renters with at least a bachelor's degree pay to live in cities with lower crime rates while owners of all education levels pay to live in cities with lower crime rates. Third, renters with less education view entertainment activities as a disamenity and renters with more education view entertainment activities as an amenity while owners of all education levels view entertainment as an amenity. Fourth, renters of all education levels either view sales tax as an amenity or are indifferent to the sales tax while owners of all education levels view a higher sales tax as a disamenity.

Like owners, renters value the amenity and disamenity variables more highly as education increases. Renters of all education levels value commute time most

highly. After commute time, education spending is the next most valued variable for renters of all education levels. Furthermore, entertainment is not valued nearly as highly for renters as it is for owners. Therefore, entertainment options play a significantly smaller role in the choice of where to rent as opposed to the choice of where to buy.

4 Conclusion

Several important results come out of this paper which address some shortfalls in the literature on the capitalization of amenities into wages and housing prices. First, I lay out the conditions under which a particular attribute of a city is considered an amenity or disamenity. Previous authors have done this with one or two types of workers but not with N types of workers as I have done.

Second, while previous authors have looked at whether people are compensated in terms of higher earnings and better amenities for a higher city price level, these studies have been insufficient in a few ways. One is that these studies look at the overall price level in the city without taking into account the endogeneity of housing prices or the endogeneity of the prices of non-housing goods and services. Not doing this ensures that the results from these papers are biased. Another is that these studies do not separate workers both by education and by whether the worker rents or owns his home. Both of these are addressed in my paper.

Third, while previous authors have looked at the implict price of amenities, to my knowledge no one has looked at the implicit price of amenities by education or by owners and renters. Both of these worker characteristics have a significant effect on a worker's valuation of amenities.

Fourth, even though it is not an explicit result of my paper, a major implication is that choosing only house prices or rents in an amenity capitilazation paper or any other study involving housing prices will have a serious impact on one's results. Any study that does not report both opens itself up to significant and valid criticism.

The results in this paper are important to workers, firms, and local governments. First, the model shows city officials what attributes of a city workers consider amenities and how strongly those workers feel about those amenities.

If city officials would like to attract workers of a certain education level, they can put resources into improving amenities that are within their control and are most highly valued by the education group they are trying to woo to their city. Furthermore, city officials can focus on amenities important to either renters or owners depending on whether the city's goal is to attract homeowners or to expand the city's rental market.

Second, this model can inform firms about the most desirable cities in which to locate. The firms can select locations that have high levels of the amenities most desired by the types of workers they demand. Therefore, the firms can pay these workers lower wages. The firms will have to be careful to ensure that the wage savings they earn are not offset by the increase in land prices caused by higher amenity levels. Third, this model allows workers to determine if they will be fully compensated for a move to a new city based on their level of education and if they plan to rent or own their housing.

In future papers, I would like to determine how the compensation for higher price levels differs for husbands and wives in a household and how their respective amenity valuations differ. I would also like to use the implict price of amneity valuations results to construct a city ranking index for owner and renters of each type of education.

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