The Effect of Amenities on Local Wage Distributions

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November 5, 2010

Abstract

This paper imposes structure on the model presented in Roback (1988) by employing Elickson's (1971) single-crossing condition and predicts that local wage distributions will contract with an improvement in amenities. The range of estimated amenity-wage gradients across the wage distribution reveals the misleading nature of the average amenity-wage gradient, which is generally estimated in the literature. Workers at the lower end of the wage distribution are shown to earn more in locations with better amenities while those in the higher end are shown to earn less. In addition, both the implicit price paid for amenities and the implicit share of income spent on amenities are shown to increase substantially with wage level. The latter provides the first empirical evidence of an assumption that it commonly employed in urban models, namely, that amenities are luxury goods.

JEL classification: D31; J31; R13; Q51. Keywords: Amenities; Amenity Capitalization; Wage Distribution;

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1 Introduction

This paper imposes structure on the model presented in Roback (1988) by employing Elickson's (1971) single-crossing condition on worker utility. The prediction derived from the model is that local wage distributions will contract with better amenities. Using a difference-in-differences approach to identify the effect of amenities on wage quantiles, wage distributions are found to contract with an improvement in amenities as workers at the lower end of the wage distribution earn more while those in the higher end earn less. Since amenity-wage gradients are found to differ in sign and magnitude systematically with wage level, the average wage gradient generally estimated in the literature will be greatly misleading for most workers.

The simultaneous capitalization of amenity value into rents and wages was first modeled in the study of Roback (1982), which shows that rent and wage gradients are determined with amenities, housing is shown to be a necessary good, and amenities are shown to be luxury goods. Thus, the three conditions of the model that are su cient for wage distributions to contract with better amenities are shown to hold in the data.

Estimating wage gradients separately at di erent points in the wage distribution is important for at least three reasons. First, average wage gradients are misleading, especially for the workers whose actual wage gradients are of opposite sign to the average. Second, it allows us to observe amenity valuation separately by wage income, which may be more of interest to policy makers. For example, these estimates may be used to make more precise predictions on changes in the tax base due to a change in amenities, particularly when income taxes are progressive. Lastly, these estimates allow the estimated implicit price paid for amenities to vary across the wage distribution. The implicit price estimates in turn enable us to show that the share of income spent on amenities increases with wage level. This result con rms what has generally been assumed but never empirically shown, namely, that amenities are luxury goods.

The empirical results in Section 3 tie together previous results that separate workers by education (Black et al 2009) or occupation (Lee 2010). Blac of

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wage gradients reported here are due to differences in wage levels, not differences in education

2.1 Workers

There are 2 types of workers indexed by $k \in \{A; B\}$. Workers differ across type with respect to how their labor input enters the production function. The reader may think of these types as being high-skilled and low-skilled respectively although it is not necessary for workers to differ in skill. The important aspect of worker differences is that they enter the production function as separate inputs that are imperfectly substitutable. Thus, their wages are allowed to differ within a location.

Each worker selects a single location in which to reside and work. A worker of type k residing in location j earns wage w_j^k and pays rent r_j. The worker selects a consumption basket of land l and a numeraire consumption good x to maximize his utility in location j and has an indirect utility function $V(r_j; w_j^k; \;_j)$.[2]

Migration is assumed to be costless and thus utility must be equated across location in equilibrium for each type of worker. Otherwise, some workers would have incentive to move. This condition is described by

$$V(r_j; w_j^A; \;_j) = V^A \tag{2.1}$$

for type A workers and symmetrically

$$V(r_j; w_j^B; \;_j) = V^B \tag{2.2}$$

for type B workers. Roback (1988) allows preferences to differ across worker types. Here, I find it useful and plausible to assume that preferences are identical but that a worker's willingness to accept higher rents in locations with better amenities increases with his wage similar to Elickson (1971).[3] That is, I assume workers only differ exogenously in their place in the production function. This may be thought of as assuming that workers have different preferences over occupations or differences in innate ability.

[2] It is assumed that the utility function of the workers is such that a positive amount of land l is always purchased.

[3] A utility function that satisfies this condition is provided in Elickson (1971) as the nested CES function $U(x; l; \;) = f[a_1 \;]$

2.2 Firms

The market for the consumption good is perfectly competitive and the good's price, which is taken as the numeraire, is set by global markets. Firms produce the consumption good according to a CRS production function $x_j = f(n_j^A; n_j^B; l_j; \quad _j 9)$ using land and both types of labor, n_A and n_B, which are assumed to be imperfect substitutes. Both types of labor are necessary for production and amenities may e ect the productivity of all inputs. In equilibrium, the unit cost function is equal to the price of the numeraire in equilibrium

$$C(w_j^A; w_j^B; r_j; \quad _j) = 1: \tag{2.3}$$

Otherwise, rms would have incentive to enter or exit a particular market where unit cost is not equal to unity.

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for the factor whose price is p.[6] Note that if an amenity is productive, it will lower unit costs of the firm (< 0) and if it is unproductive, it will raise costs (> 0).

Simultaneously solving equations 2.4 through 2.6 yields the factor price gradients in percentage changes.

$$\hat{w}^A/\hat{} = {}^{1}[\ s^A(\ _r + \ _{w^B} s_l^B) + s_l^A(s^B\ _{w^B}\ )] \tag{2.7}$$

$$\hat{w}^B/\hat{} = {}^{1}[\ s^B(\ _r + \ _{w^A} s_l^A) + s_l^B(s^A\ _{w^A}\ )] \tag{2.8}$$

$$\hat{r}/\hat{} = {}^{1}(s^A\ _{w^A} + s^B\ _{w^B}\ ) \tag{2.9}$$

where $= \ _r + s_l^A\ _{w^A} + s_l^B\ _{w^B} > 0$ is the percentage of revenue from each unit of x that accrues to land.[7] As this term increases, the magnitude of all gradients decrease. That is, as more of the total revenue generated by production is soaked up by land costs, all prices are less able to respond to changes in amenities.

The first term in the numerator of equation 2.7 is more negative the larger the implicit budget share of amenities (s^A) and the larger is the amount spent on land by other agents ($\ _r + \ _{w^B} s_l^B$). The value of s^A captures the direct effect of type A's demand for amenities while that of $\ _r + \ _{w^B} s_l^B$ captures the fact that as more revenue from x production is directed toward land, less is available for type A's wages. The second term can only be signed if the productivity effect of amenities is known. So long as amenities are not unproductive (0), the second term will be unambiguously positive and increasing with the budget share of land (s_l^A) and the amount of revenue from production that the other workers spend on amenities ($s^B\ _{w^B}$). The intuition here is that the more revenue is spent on land, the less willing workers will be to trade off amenities for wages and the more cost savings the firm enjoys from type

[6] To see this derivation, write $C(w^A; w^B; r;\ ) = C_{w^A}(\ )w^A + C_{w^B}(\ )w^B + C_r(\ )r$ before taking the total derivative in equation 2.3.

[7] This is because the firm pays $\ _r$ of each unit of revenue to land and $\ _w^k$ to worker k, who spends s_l^k of $\ _w^k$ on land.

curve cross only once in $f\ \ ;rg$ space and is depicted in Figure 1 by the steeper slope of type A's indifference curve.

Elickson (1971) first used the single-crossing assumption to explain why jurisdiction

Likewise, from equation 2.8 it can be shown that $(\hat{w}^B = \hat{})$ Q 0 as

$$R\; s^A \;{}_{w^A} \quad (s^B = s^B_l)(\;{}_r + \;{}_{w^A} s^A_l) \quad {}_{w^B}: \tag{2.11}$$

Finally, equation 2.9 implies that $\hat{r} = \hat{}$ Q 0 as

$$R\; s^A \;{}_{w^A} + s^B \;{}_{w^B} \quad {}_r: \tag{2.12}$$

It is relatively straightforward to show that ${}_{w^A} < {}_{w^B} < {}_r$ when preferences exhibit single-crossing.[10] However, additional information on preferences is required in order to determine the di erence in wage gradients,

$\frac{\hat{w}^A}{\hat{}} \quad \frac{\hat{w}^B}{\hat{}} \quad = \quad {}^1(\quad {}_r(s^A \quad s^B$-2 Tf 7.211 1.793 Td 9T0t Td [(B)]TJ/F40 7.9701 Tf 0 -7.892 Td [(

pressure on all prices. As rents fall, $\hat{w}^A = \hat{\ }$ is the rst gradient to turn negative since type A's willingness to pay higher rents for amenities is more responsive to the change in amenity levels, followed by $\hat{w}^B = \hat{\ }$, whose responsiveness is not as great.

If amenities become unproductive enough (su ciently positive), the decrease in demand for land from the rms and workers will cause the rent gradient to become negative. In

richer description of amenities' effect on wages. The estimated coefficients on the amenity index are predicted to decrease with wage quantile. This would yield evidence that the low-wage workers are being penalized less (or compensated) for residing in high-amenity (high-rent) locations than high-wage workers.

A well-known problem with using Census data is that the income variable is top-coded to protect the privacy of individuals.[16] For this reason, coefficients are estimated via the censored quantile regressions first proposed by Powell (1984, 1986a) by using the simple algorithm described in Buckinsky (1994).[17] To determine the effect of the control variables on the q^{th} quantile, the censored quantile regression finds the vector $\beta^{(q)}$ and constant $\gamma^{(q)}$ that solves

$$\min_{\beta^{(q)};\,\gamma^{(q)}} \frac{1}{N} \sum_{ijt} \rho_{(q)}\left(w_{ijt} - \min\{w^0_{jt}, \mathbf{x}'_{ijt}\beta^{(q)} + \gamma^{(q)} A_{jt}\}\right) \tag{3.1}$$

where $\rho_{(q)}(\lambda) \equiv \lambda(q - I(\lambda < 0))$ is the tilted absolute value function or the "check function", w_{ijt} is the natural log of wage income, w^0_{jt} is the censoring value, and $\mathbf{x}_{ijt}$ is a vector of wage controls.[18] Subscripts i, j, and t denote individual, location, and time respectively. Location here is defined as the Metropolitan Statistical Area (MSA). The minimization problem is then iteratively resolved using only observations whose estimated conditional quantile $\hat{w}^{(q)}_{ijt}$ is less than the censoring value w^0_{jt} until convergence is reached.

This procedure is applied to the 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} wage quantiles. The coefficients of a quantile regression are interpreted analogously to those of a least-squares regression. For example, $\hat{\gamma}^{(10)}$ is interpreted as the effect of a one unit increase in the amenity index on the 10^{th} quantile of the wage distribution. If local wage distributions contract with amenities, we would expect to see $\gamma^{(q)} < \gamma^{(q')}$ for all $q > q'$.

Empirical studies that estimate quantile regressions over the distribution of wages generally estimate bootstrapped standard errors from 100 repetitions (Buchinsky 1994; Machado

[16] 1.98% of the workers in the sample used here are top-coded.

[17] An alternative estimator is suggested in Buchinsky and Hahn (1998) but was shown to take more than twice the amount of computing time to estimate. Given the large sample size used here, this estimator was not used.

[18] The censoring values differ across states and years in the Census data. Thus, it is written with a time and location subscript.

and Mata 2005; Poterba and Rueben 1994[19]). Due to the large data set used in this study, it is not practical to do so here. Therefore, I estimate bootstrapped standard errors from 100 repetitions only for the coe cients estimated from regressions where censoring is an issue. For the remaining coe cients, the estimated standard errors are those reported by STATA, which are estimated using the method suggested by Koenker and Bassett (1982) with the density of the residuals at zero estimated by the method described in Rogers (1993). Finally, for comparison with previous literature, the e ect of amenities on average wages is also estimated using a least squares regression.[20]

To alleviate omitted variable bias present in cross-section estimates, I follow Bayer et al (2009) in using a di erence-in-di erences approach. The coe cients on the amenity index are identi ed o its variation across time while controlling for other MSA factors via xed e ects. If the coe cients of interest were estimated using only a cross section of data, the amenity index and the MSA xed e ects would have a one-to-one relationship, prompting us to use only the amenity index. The index would then be correlated with any MSA-speci c factor, which would likely bias the estimates.

However, by using MSA xed e ects and variation of amenity scores across time, we are able to alleviate this potential bias. The estimated relationship for each conditional quantile is

$$w_{ijt}^{(q)} = x_{ijt}^{0} \; {}^{(q)} + \; {}^{(q)} \; {}_{jt} + \, {}'^{(q)}_{j} \mathrm{MSA}_{j} + \; {}^{(q)}_{ijt}; \tag{3.2}$$

where x_{ijt} contains a year indicator and the di erence between the wage of observation 2 in location 1 in year 2 and observation 1 in location 1 in year 1 identi es ${}^{(q)}$,

$$w_{212}^{(q)} \quad w_{111}^{(q)} = (x_{212} \quad x_{111})^{0} \; {}^{(q)} + \; {}^{(q)}(\; {}_{12} \quad \; {}_{11}) + \; {}^{(q)}_{212} \quad {}^{(q)}_{111}. \tag{3.3}$$

The MSA terms drop out here as both observations reside in the same location.

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[19] Poterba and Rueben (1994) estimated both bootstrapped and analytical standard errors and found the di erences between them to be small. The same result is found here where using either standard error would not change the con dence level with which any of the coe cients are estimated.

[20] The symmetrically censored least squares estimate is more appropriate here as a measure of the average e ect of amenities on wages. However, in this particular case, the censoring did not pose an issue and thus the estimation reduces to OLS.

In the wage regressions, each individual's wage and salary income is used as the dependent variable. The control variables are total hours worked in the last year (calculated from average hours worked in a week and total weeks worked), sex, age, potential experience,[25] categorical dummies for education, the ability to speak English, work disabilities, marital status, MSA of residence, and a year dummy. Squared terms for age and potential experience are also included.

In Section 6.1, rental rates and housing values are regressed on housing characteristics and the amenity index to test the model's assumption on the rent gradient. The dependent variable used is reported rental rates for renters and the reported value of the house for owners. Descriptive variables include the housing unit's age, acreage, categorical variables for type of heating used, number of other units physically attached, indicators for trailers and units that are not houses (ex. boats), existence of complete plumbing, number of bedrooms, phone availability, MSA location, and indicators for having a kitchen and ownership of the unit.[26]

The amenity data is obtained from the *Places Rated Almanac*, a semi-regular publication of location specific amenity measures used to construct rankings of metropolitan areas. MSA's in the United States (and Canada) are scored in several categories and then ranked according to their overall score. For the amenity index $_{jt}$, the scores of all categories that did not include data on wages or housing costs were obtained from the *Places Rated Almanac* 1989 and 2000 editions: climate, crime, arts, recreation, healthcare, education, and transportation.

In the 1989 edition, *Places Rated* describes the methodology of scoring each category and lists both the scores and the ranks of MSA's for each category and overall. However,

Descriptive statistics for the change in amenity measures are presented in Table 1 and a geographic distribution of the change in the amenity index across time is displayed in Figure 4. The bins in Figure 4 were constructed so that each contain 20% of the MSA's. Correlations of the change in amenities across time are presented in Table 2. The changes in category percentiles are mostly uncorrelated as the largest of these, the correlation of the change in recreation and the change in health care, takes a value of 0.263.

5 Results

5.1 Amenities' Effect Across the Wage Distribution

The results from the quantile wage regressions are presented in Table 3. In addition to the full sample results, results from quantile regressions run on aggregate industry-occupation groups with more than 75,000 total observations are also displayed. The coefficients are scaled up so that they may be interpreted as the percentage change in wages due to a 100 point increase in the amenity index (this is equivalent to increasing a single amenity category from worst to best). Notice the significantly positive coefficients on all of the lower quantiles. This is evidence that low wage workers are compensated with higher wages in the presence of better amenities. Likewise, negative signs on the coefficients for the higher quantiles is evidence of high-wage workers trading off wages for amenities.

The results confirm that wage distributions contract with amenities. All groups have coefficients that are positive for the lowest quantile and generally monotonically decrease as quantile increases. Only three coefficients, that from the 75^{th} quantile regression for administrators and sales representatives in retail (row 4) and managers in professional services (row 5) and that from the median regression for managers in manufacturing (row 6), do not follow the monotonically decreasing pattern. However, these differences are not likely significant.[27] In all but one group, administrators and sales representatives in retail (row 4), the coefficient eventually becomes negative as quantile increases. The lack of negative

[27] I am unable to statistically test that the coefficients are monotonically decreasing with quantile. To do so requires simultaneous estimation of all censored quantile regressions. Due to the length of computing time necessary for such an estimation, the approach was not taken here.

coe cients for this group indicates that these workers are likely not near the top of their

5.3 Estimated Implicit Prices Across the Wage Distribution

Since workers do not explicitly pay for local amenities, they will pay for them implicitly through rent premiums and forgone wages. The implicit price of an amenity is the additional income spent on land plus the forgone wages due to the presence of the amenity. Implicit prices are often constructed from average wage and rent gradients to value local amenities, environmental goods, and public goods and/or to measure the quality of life. If wage gradients differ across workers, then the implicit price paid for local amenities will likely differ as well. If these differences are great, the standard approach of estimating mean implicit prices may not be useful, particularly when equity is valued or when a particular income group is the subject of concern. The implicit price paid for amenities can be derived From equations 2.1 and 2.2 for each worker as

$$P^k \qquad \frac{V^k}{V^k_w} = l^k \frac{\mathrm{d}r}{\mathrm{d}} \qquad \frac{\mathrm{d}w_k}{\mathrm{d}} \tag{5.1}$$

or in percentage terms as

$$(P^k{=}w^k) = s^k_l \frac{\mathrm{d}\log r}{\mathrm{d}} \qquad \frac{\mathrm{d}\log w^k}{\mathrm{d}}: \tag{5.2}$$

Recall that all workers are assumed to have the same rent gradient in each location but are allowed to have different wage gradients and budget shares for land. Here each worker earning the q^{th} quantile wage is treated as a separate worker type and the budget share for housing is substituted for the budget share for land.

To compare the implicit shares of income spent on amenities, we must hold constant both the amenity index and the price of housing that each quantile worker faces so that only wage differs across the workers. Thus, this analysis must be carried out at the MSA level rather than the national level where housing prices and the amenity index will differ across the workers.

The implicit price is estimated for each quantile for Chicago, the MSA with the largest number of observations.[28] An estimate of the share of income devoted to housing is used as a proxy for the share of income devoted to land. This is estimated for both years and for each quantile by nding the q^{th} quantile wage earner and taking his housing share value as the estimate.[29] The rent and wage gradients are taken from Table 3. The pattern of implicit prices across wage quantile are qualitatively the same across years. To conserve space, only those reports for the year 2000 are displayed here in the rst row of Table 5.

The numbers reported in the rst row of Table 5 are interpreted as the percentage of income a worker is willing to pay for a 100 point increase in the amenity index (equal to an improvement from worst to best in a single category). For example, the worker whose wage is equal to the 90^{th} wage quantile in Chicago is willing to give up approximately 2.3 percent of his income for a 100 point increase in the amenity index. The monotonicity in the implicit prices mimics that observed in the coe cients on the amenity index in the wage regressions; larger quantiles pay more for amenities. Interestingly, some workers have negative estimated implicit ob

A full analysis would entail formally modeling local governments that take into consideration the migratory responses to changes in local amenities and prices.[31]

6 Assumption and Robustness Checks

6.1 Assumption Checks

The three assumptions of the model that lead to the prediction of contracting wage distributions are that rents increase with amenities, land shares are decreasing with wages, and implicit amenity shares are increasing with wages. Each of these assumptions are tested below and found to hold in the data.

To test the requirement that rents are increasing with amenities, a symmetrically censored least squares (SCLS) regression (Powell 1986b) and a censored median regression of the rental rate or housing values on housing characteristics and amenities are estimated.[32] The SCLS estimation equation is

$$P_{ijt} = \min\{(P^{0;own}_{jt});\ \mathbf{h}'_{ijt}\ {}_{h} + \ {}_{h}\ {}_{jt} + \ {}_{ijt}\}; \qquad (6.1)$$

where P_{ijt} is the natural log of monthly rental rate (reported value of unit if owned), $P^{0;own}_{jt}$ is the censoring value conditional on ownership status,[33] $\mathbf{h}_{ijt}$ is a vector of housing unit characteristics, and ${}_{jt}$ is the amenity index. The algorithm for SCLS "recensores" the data from below to restore symmetry in the errors and estimates OLS coefficients on observations with predicted values below the top-code. The analogous conditional median is estimated measure may not be precise enough to accurately measure amenities' effect on the wage distribution. The results for rents are presented in Table 6. Reported standard errors are those estimated from the last iteration of either algorithm clustered by MSA-year.[34]

The signs of both coefficients are positive and significant with 99% confidence. This is evidence that the amenity index constructed here is sufficient for empirically measuring local amenities. Mean and median rental rates and housing values would increase by approximately 3.7% and 4% respectively with a 100 point increase in the amenity index.

The estimated implicit prices can be used to check the assumption that the share of wages spent on amenities is increasing with wage ($\frac{\partial s}{\partial w} > 0$). The assumption that land shares decrease with wage ($\frac{\partial s_l}{\partial w} < 0$) is also verified by the data. Table 5 displays the estimates of housing and amenity shares as well as their ratio for each quantile of the full sample using estimated shares for the year 2000. The same pattern is observed for each industry-occupation group and across years but not presented here for brevity. Housing shares are decreasing with income and amenity shares are increasing with income. Thus, the assumptions presented in Section 2 for the prediction on relative wage gradients to hold are validated by the data. Furthermore, the increasing shares of wages spent on amenities constitute the first empirical evidence that amenities are luxury goods.

6.2 Robustness Checks

One potential issue with the analysis above is that one cannot tell how much variation across time is due to the change in scoring methods and how much is due to actual variation in amenities. Although weather patterns do change over time, the variation in the climate category displayed in Table 1 may seem too high to be strictly a result of actual variation in climate conditions. Some outliers are due to the addition of hazardous conditions in the 2000 edition. As a robustness check, I removed each category one at a time from the amenity index and reran the quantile regressions for the industry/occupation groups. My analytical results were qualitatively the same across all specifications.[35]

[34] Bootstrapped standard errors were not estimated due to practical reasons.
[35] These results are not presented here but available upon request.

To allow amenities to have differential effects on wage quantiles, the amenity index was split into its composite categories and the empirical analysis was repeated. To conserve space, only the estimated coefficients on the individual amenity categories for the largest group, Managers in the Professional services industry, are presented in Table 7. For the most part, the pattern of decreasing coefficients holds. The biggest exception is the crime category, for which the pattern did not hold for any group. This may be due to crime's differential effect across wage level. Those with high wages that live in high-crime cities may reside in neighborhoods with private security and/or removed from the troubled neighborhoods. If this is the case, it violates the assumption that all amenities are viewed the same by all workers and we would not expect the results to hold for this category.

Finally, to test if refinements of the measurements used in The Places Rated Almanac across time could be driving my statistical results, a Monte Carlo experiment was conducted using simulated data with an amenity measure that improved in precision over time. A total of 10,000 simulations were run using a model where amenities were constructed to effect all wage quantiles the same.[36] If the increase in precision of amenity measure is for0sCsini6enitdp1r(y) conducted

Table 1: Descriptive Statistics of the Change in Amenity Scores

Category	Mean	Standard Deviation	Min	Max
Climate	-0.27	31.43	-58.41	86.81
Healthcare	-0.01	18.92	-61.72	52.34
Crime	0.59	14.64	-50.20	54.33
Transportation	0.23	24.82	-82.08	65.49
Education	0.50	21.77	-65.47	66.17
Art	0.24	18.17	-69.90	56.68
Recreation	0.05	23.92	-81.71	76.65

Table 2: Correlation of Amenity Changes Across Time

Variables	health	crime	transport	edu	art	rec	climate
health	1.000						
crime	-0.092	1.000					
transport	0.162	-0.123	1.000				
edu	0.059	-0.127	0.068	1.000			
art	0.059	0.046	-0.014	0.254	1.000		
rec	0.263	-0.055	0.151	0.014	0.021	1.000	
climate	0.041	-0.057	0.158	-0.150	-0.009	-0.111	1.000

Table 3: Coe cients on the Amenity Index

Dependent Variable: ln(wage)	quantile					
Group	90	75	50	25	10	N
IND: Manufacturing OCC: Labor	-0.233	0.335	1.128***	2.141***	2.714***	88,994
	(0.67)	(0.483)	(0.539)	(0.64)	(0.898)	
IND: Manufactruing OCC: Production	-2.016***	-0.809***	-0.33	0.285	1.551	82,208
	(0.71)	(0.482)	(0.493)	(0.687)	(1.026)	
IND:Construction OCC: Production	-1.294	0.216	1.607***	2.644***	3.585***	75,600
	(0.795)	(0.648)	(0.643)	(0.815)	(1.186)	
IND: Retail OCC: Admin	0.157	2.168***	0.897***	2.404***	4.01***	77,909
	$(1.380)_a$	(0.883)	(0.742)	(0.836)	(1.205)	
IND: Professional OCC: Management	-4.214***	-1.215	-1.297***	0.197	1.425	156,145
	$(1.466)^a$	$(0.924)^a$	(0.579)	(0.638)	(1.022)	
IND: Manufacturing OCC: Management	-2.097***	0.0128	0.617	0.401	2.633***	115,822
	$(1.202)^a$	$(0.593)^a$	(0.428)	(0.524)	(0.912)	
Full Sample	-1.711***	-0.440**	0.097	1.173***	2.780***	1,437,957
	$(0.284)^b$	$(0.183)^b$	(0.164)	(0.199)	(0.294)	

standard errors are in parentheses

a bootstrapped standard errors

b analytical standard errors from last iteration of censored quantile regression

Table 4: OLS and Median Wage Regressions

Regression	Amenity Index Coe cient	N
OLS	0.472 (0.560)	1,454,299
Median	0.097 (0.164)[a]	1,454,299

standard errors are in parentheses

a analytical standard errors reported by STATA in the last iteration

Table 5: Housing Shares, Amenity Shares, and Implicit Prices in Chicago (1999)

	quantile				
	90	75	50	25	10
Implicit Price of Amenity Index ($P^{(q)}=w^{(q)}$)	2.326	1.058	0.652	-0.281	-1.590
Amenity Share (s^q)	0.983	0.465	0.296	-0.131	-0.765
Housing Share (s_l^q)	0.124	0.125	0.151	0.180	0.240
Ratio ($s^q=s_l^q$)	7.911	3.723	1.957	-0.729	-3.183

Implicit Price is percent of wage income implicitly paid for a 100 unit increase in $_j$

Table 6: SCLS and Censored Median Housing Regressions

Regression	Amenity Index Coefficient	N
SCLS	3.738*** (1.252)	1,454,299
Median Regression	4.046*** (0.000)	1,454,299

standard errors are in parentheses.

Table 7: Amenity Coe cients for IND: Professional OCC: Management

	quantile				
Amenity	90	75	50	25	10
Climate	-7.344**	-2.055	-2.177*	1.055	3.531*
	(3.125)[a]	(1.494)[a]	(1.192)	(1.295)	(1.999)
Health Care	-3.137	2.88	-0.448	0.959	0.317
	(5.006)[a]	(2.411)[a]	(1.929)	(2.096)	(3.244)
Education	-11.525 **	-6.84 **	-2.811	0.594	5.353
	(5.851)[a]	(2.835)[a]	(2.261)	(2.453)	(3.806)

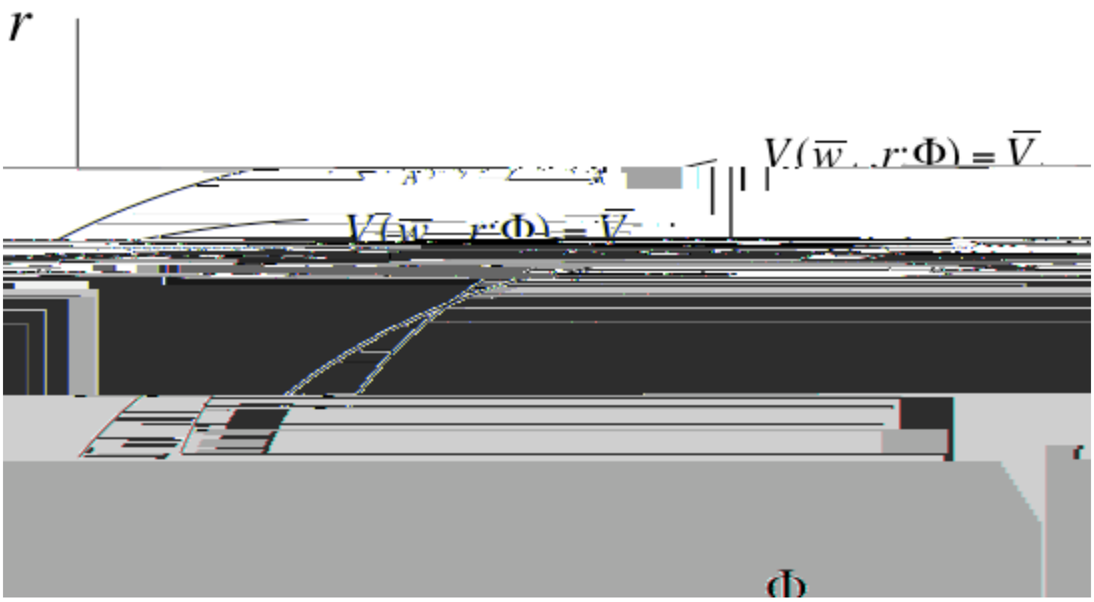

Figure 1: Single-Crossing Condition

Figure 2: Price Gradients as Functions of a Hick's Neutral Change in

Figure 3: Summary of Gradient Signs and Relative Magnitudes

Figure 4: Change in Amenity Index (1999-1989)

A Appendix

Proof that $_{w^A} < \; _{w^B} < \; _r$

$$_{w^A} < \; _{w^B}$$

when

$$0 < (\; _r + \; _{w^A} s_l^A + \; _{w^B} s_l^B)[(s^A = s_l^A) \quad (s^B = s_l^B)]:$$

The single-crossing assumption guarantees that the right hand side is positive. Likewise,

$$_{w^B} < \; _r$$

when

$$0 < (s^B = s_l^B)(s_l^B$$

A.1 Monte Carlo Experiment

To test whether the additional information used in the 1999 categories of the amenity index has a bias that makes it more likely to nd conditional quantile coe cients that decrease with quantile, a monte carlo experiment was carried out. First, 100 draws of x were taken where $x \sim U(0;1)$. The dependent variable y was constructed such that

$$y = a + bx + e \tag{A.1}$$

for half the observations and

$$y = a + b($$

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