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Working Paper

Heterogeneous Individual Valuations of a Mild Climate

CESifo Working Paper, No. 12402

Provided in Cooperation with:

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Brueckner, Jan K. (2026) : Heterogeneous Individual Valuations of a Mild Climate, CESifo Working Paper, No. 12402, Munich Society for the Promotion of Economic Research - CESifo GmbH, Munich

This Version is available at:

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Working Papers

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Imprint:

CESifo Working Papers

ISSN 2364-1428 (digital)

Publisher and distributor: Munich Society for the Promotion
of Economic Research - CESifo GmbH

Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740

Email office@cesifo.de
<https://www.cesifo.org>

Editor: Clemens Fuest

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Heterogeneous Individual Valuations of a Mild Climate

by

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August 2025, Revised October 2025, January 2026

Abstract

This paper has explored heterogeneous individual valuations of an important amenity, climate mildness, using a traditional Rosen-Roback empirical framework. It does so by including interaction terms between the amenity and worker characteristics in an hedonic wage regression that also include a housing-price measure. The results suggest that non-young workers (those in the mid-age and old groups) value a mild climate more than do young workers, matching the usual view that the tolerance for cold weather declines with age. The findings also suggest that, like their highly educated counterparts, workers with low education levels also highly value a mild climate, with workers in the middle range of education having a lower valuation. These findings, which contradict the view that only better-off individuals care about amenities, could reflect the lower burden in mild weather of the manual work done by the less educated. In addition to presenting these empirical findings, the paper further contributes by presenting new analytics for the Rosen-Roback model in a setting with individual heterogeneity.

Heterogeneous Individual Valuations of a Mild Climate

by

Jan K. Brueckner[†]

1. Introduction

The pioneering work of Rosen (1979) and Roback (1982) provided a theoretical framework for predicting the effect of amenities on wages and real-estate prices, and their approach has influenced all subsequent work in this area. In their framework, a city's amenities enter both the worker's indirect utility function and the firm's cost function, both of which also depend on the local wage (a cost to the firm) and the price of real estate, which is an input for the firm as well as a consumption good for the worker. For the equilibrium requirements of spatially uniform utilities and production costs to be satisfied, wages and real-estate prices must vary with city amenity levels in a particular fashion. The required variation is ambiguous in general, but if the effect of amenities on firm costs is small in absolute value, then higher amenities in a city lead to lower wages and higher real-estate prices than elsewhere.¹

Traditional empirical work based on the Rosen-Roback model is mostly focused on estimating consumer valuations of various amenities, including climate amenities, crime, and sometimes fiscal amenities. The approach relies on hedonic wage and house-price regressions to uncover the willingness-to-pay for better amenities. Notable papers include Henderson (1982), Blomquist, Berger and Hoehn (1988), Gyourko and Tracy (1989), Gabriel and Rosenthal (2004), and Albouy, Graf, Kellogg and Wolff (2016), with Gyourko, Kahn and Tracy (1999) providing an extensive survey. Like the Rosen-Roback framework itself, all of this hedonic-based empirical research assumes that, aside from income dependence, *individuals' amenity valuations do not depend on their own observable characteristics*, being based on common indirect utility function. The purpose of the present paper is to relax this assumption by

[†] I thank David Albouy, Sofia Franco, Albert Solé-Ollé, Joe Tracy and several referees for comments. The usual disclaimer applies.

¹ Brueckner (2011), Ch. 11, for a diagrammatic proof

allowing individual characteristics to affect amenity valuations, with a focus on age and education. This exercise, which relies on an hedonic wage regression using US data, extends the traditional Rosen-Roback approach, and it shows notable heterogeneity in amenity valuations.²

Although amenity valuations that depend on individual characteristics are absent from the traditional literature, more-recent structural models allow such dependence. In Bayer, Ferreira and McMillan (2007), for example, the valuation of school-quality amenities depends on race and education, while Diamond (2016) allows the valuation of a generalized amenity measure to depend on race. In addition, Fan, Fisher-Vandem and Klaiber (2018) estimate amenity valuations that depend on individual characteristics using a sorting model. The current paper provides a link between this new literature and the traditional approach by showing that heterogenous amenity valuations can be captured in a simple hedonic wage regression.

The paper first extends the Rosen-Roback theory to a setting with two individual (hereafter, worker) types, whose indirect utility functions differ. The empirical investigation then estimates hedonic wage functions, which depart from the standard Rosen-Roback approach by allowing the amenity's wage impact to depend on worker characteristics. The focal characteristics are age and education, which would appear in level form in the standard Rosen-Roback wage regression, capturing the wage effects of productivity and seniority. The amenity also enters in level form in the standard regression, yielding a common shift in the wage for all types of workers. However, the present regressions differ by replacing the amenity level with *interactions* between the amenity and the worker's age and education. This specification allows worker amenity valuations to be heterogeneous via dependence on individual characteristics.

The empirical analysis focuses on a single amenity: climate mildness, which is arguably the most important climate factor affecting individual well being. Use of only a single amenity has a precedent in the recent important paper of Albouy et al. (2016), who also focus on a climate mildness measure. Exclusion of other climate variables is also beneficial on grounds of simplicity, since use of additional variables would generate an unmanageable multitude of

² Hoch and Drake (1974), in a study written before the Rosen-Roback approach became standard, ask how the relation between wages and climate variables varies across occupations, using regressions stratified by occupation. A similar approach of stratifying by age and education, instead of occupation, would be possible in the present context, as discussed further below.

amenity/worker-characteristics interactions.

In addition to using a mildness measure, Albouy et al. (2016) also recognize the heterogeneity of preferences, although in different fashion than in the present paper. They effectively assume that preference heterogeneity is idiosyncratic, not depending on observable characteristics, but they generate separate valuation estimates for workers living in different PUMAs within their data set, thus allowing amenity valuations to vary according to the PUMA’s climate.³ They find that workers living in PUMAs with the mildest climate have the highest valuations of mildness, concluding that workers sort across PUMAs according to their idiosyncratic amenity preferences. By contrast, the present paper relates the valuation of climate mildness directly to worker characteristics, also recognizing that preferences may be partly idiosyncratic in way not tied to observables.

To see the connection between the hedonic wage regression used in the present paper and previous approaches, note first that the canonical early study of Blomquist et al. (1988) made use of two regressions, an hedonic wage regression and a hedonic housing-price regression, with climate amenities appearing as explanatory variables in both. The results of these regressions were then “blended” to generate amenity valuations, in a manner described in the theory section below. Albouy et al. (2016) used an equivalent approach where the blending occurs at the outset, with a weighted average of the wage and housing price used as the dependent variable in a regression with amenities on the right-hand side. Henderson (1982), in a study that predates these other papers, used a simpler approach where the housing price appeared along with amenities as an explanatory variable in an hedonic wage regression. Under this approach, which appears to have been overlooked in the subsequent literature, the regression’s climate coefficients directly yield amenity valuations, without the need for the blending step used in the other approaches. The present paper uses this same simpler approach while adding amenity interactions. The interconnections between the various approaches are formally laid out in the theory section.

The paper relies on a smaller version of the dataset of Brueckner and Neumark (2014), which draws wage and worker characteristics data from the Current Population Survey. Their

³ PUMA stands for Public Use Microdata Area, each contains about 300,000 people.

sample covered the 1995-2004 period, whereas the current sample is for the period 1998-2002, as explained below. Use of 20-year-old data should not be an issue since amenity valuations are likely to be fairly stable over a relatively short time interval. Admittedly, the US climate has changed slightly over this period, but this alteration is likely not large enough to compromise the relevance of the empirical estimates.

The next section of the paper develops the analytics of the Rosen-Roback model extended to a setting with two worker types, and section 3 discusses the data. Section 4 presents the empirical results, which contain some surprises, and section 5 offers conclusions.

2. Theory

This section extends the analysis of Rosen (1979) and Roback (1982) to a setting with two types of workers, who have different preferences. However, as will be seen below, the empirical investigation divides workers into more than two types, using three age and three education categories. Nevertheless, the lessons learned from a theoretical model with just two worker types can apply in this more-complex empirical setting.

The Rosen-Roback approach typically uses a total-income variable, but for consistency with the empirical exercise, the hourly wage y is used in place of total income, with the two measures being proportional when labor supply is inelastic. Letting r the unit price of “real estate” and a the amenity level (which could be a vector), the indirect utility functions for the worker types are given by $v(y_i, r, a; \theta_i)$, $i = 1, 2$. The parameter θ_i represents characteristics other than the wage that may affect utility and differ across individuals. In the empirical work, these characteristics are age and education. For convenience, let the function $v^i(y_i, r, a)$ be a shorthand for the full indirect utility function, with the influence of θ_i captured in the i superscript. Utility is increasing in the wage and amenities and decreasing in the real-estate price, with v^i ’s partial derivative satisfying $v_y^i, v_a^i > 0$ and $v_r^i < 0$. In equilibrium, utilities must be the same in all cities for a given type, so that

$$v^i(y_i, r, a) = u_i, \quad i = 1, 2, \tag{1}$$

where the u_i , $i = 1, 2$, are the types’ fixed utility levels.

Production exhibits constant returns to scale and uses both types of labor as well as real estate as inputs. The zero-profit condition requires that the unit cost equals the output price, which is the same in all cities and normalized to one. Letting $C(\cdot)$ denote the unit cost function, which depends on amenities as well as on the input prices, this condition is

$$C(y_1, y_2, r, a) = 1. \quad (2)$$

The derivatives C_1 , C_2 , and C_r of cost with respect to the input prices are positive, while the amenity derivative C_a can take either sign, indicating that a higher amenity could raise or lower production costs, with a negative or zero effect being most plausible.

Condition (1) determines a worker's wage as a function of the real-estate price, the amenity, and the fixed utility level. Totally differentiating (1) with respect to y_i , r , and a yields

$$v_y^i dy_i + v_r^i dr + v_a^i da = 0. \quad (3)$$

A first question of interest is how the wage responds to the amenity level, conditional on r . In other words, how does the wage respond to a holding the real-estate price fixed along with the utility level? This question can be answered by setting dr in (3) equal to zero, with rearrangement then yielding

$$\frac{\partial y_i}{\partial a} |_{conditional} = -\frac{v_a^i}{v_y^i} \equiv -\phi_i, \quad (4)$$

where ϕ_i is the marginal rate of substitution between the amenity and the wage, which equals the MRS between a and the numeraire nonhousing good. Eq. (4) thus gives the dollar value of an increase in the amenity level for a type- i worker. In a regression of worker wages on the amenity, with controls present for the local real-estate price and worker characteristics, the amenity coefficient thus directly reveals valuation of the amenity, equal to the willingness-to-pay in forgone income for a higher level. The empirical analysis in section 4 starts by running a conditional hedonic-wage regression of this form, with differences in amenity valuations

captured by interactions between the amenity and worker characteristics (age and education). In his study of amenity valuations, Henderson (1982) also relied on conditional regressions, but without the interactions used here. The relationship between the conditional-regression approach and others used in the literature is discussed below.

A different question, addressed by Rosen and Roback, concerns how wages vary with amenities in an unconditional sense, not controlling for variation real-estate prices. In other words, are wages increasing or decreasing in amenities across cities? The same question applies to real-estate prices. Although both effects are generally ambiguous in a model with one worker type, as noted above, a clean answer emerges if the effect of amenities on production costs is small in absolute value, as seems realistic. Then wages are lower and real-estate prices are higher in high-amenity cities than in low-amenity cities. This predicted unconditional wage effect then has the same negative sign as the conditional effect in (3), although the two magnitudes differ.

In the model with two worker types, the unconditional effects of amenities on wages, along with the real-estate price effect, are determined jointly by the two conditions in (1) along with (2), which together determine y_1 , y_2 and r as functions of amenities a . Totally differentiating (1) again gives (3), but with r changing in response to a , rearrangement now yields

$$\frac{\partial y_i}{\partial a} \big|_{unconditional} = \frac{v_r^i}{v_y^i} \frac{\partial r}{\partial a} - \phi_i = q_i \frac{\partial r}{\partial a} - \phi_i, \quad (5)$$

where q_i is real-estate consumption and where $v_r^i = -q_i v_y^i$ is used in the second equality of (5). Note that if $\partial r / \partial a > 0$, then the unconditional $\partial y_i / \partial a$ in (5) is larger than in the conditional $\partial y_i / \partial a$ value from (4). Thus, if the unconditional effect remains negative, it is less negative than the conditional effect. This outcome is natural, since a higher real-estate price lessens the gain from the amenity increase, making the required compensating decline in the wage smaller than when r is held fixed.

The a -derivatives of y_i and r in (5) can be expressed in terms of fundamentals of the model, but before doing so, the prior uses of this equation deserve note. Rearranging (5) yields $\phi_i = q_i \partial r / \partial a - \partial y_i / \partial a$, so that ϕ_i can be identified by first estimating $\partial r / \partial a$ and $\partial y_i / \partial a$ from

hedonic regressions of r and y_i on the amenity, and then applying the formula using a value for q_i . Blomquist et al. (1988), for example, used this approach, and Albouy et al. (2016) applied a variant of it by regressing $q_i r - y_i$ on the amenity and using its coefficient to estimate ϕ_i . The conditional regression from (4), where y is regressed on the amenity controlling for r , is equivalent.

To express a -derivatives of y_i and r in terms of fundamentals, (2) is also totally differentiated, yielding

$$C_1 \frac{\partial y_1}{\partial a} + C_2 \frac{\partial y_2}{\partial a} + C_r \frac{\partial r}{\partial a} + C_a = 0, \quad (6)$$

Substituting the two wage derivatives from (5) into (6), a solution for $\partial r / \partial a$ can be derived, and it equals

$$\frac{\partial r}{\partial a} = \frac{C_1 \phi_1 + C_2 \phi_2 - C_a}{C_1 q_1 + C_2 q_2 + C_r}. \quad (7)$$

With all the other terms positive, the sign of (7) depends on the sign of C_a . The ambiguities of the Rosen-Roback model with one worker type vanish when C_a is small in absolute value, yielding the familiar prediction of lower wages and higher real-estate prices in high-amenity locations. Therefore, this assumption is imposed in the current setting. The first two terms in the numerator of (6), which are positive, then dominate in determining the numerator's sign, making it and thus (6) positive given positivity of the denominator. Therefore, the real-estate price rises with amenities, the familiar Rosen-Roback prediction.

Finally, substituting (7) into (5) yields solutions for the two wage derivatives:

$$\frac{\partial y_1}{\partial a} = \frac{-C_2 q_2 \phi_2 (\phi_1 / \phi_2 - q_1 / q_2) - (C_a q_1 + \phi_1 C_r)}{C_1 q_1 + C_2 q_2 + C_r} \quad (8)$$

$$\frac{\partial y_2}{\partial a} = \frac{C_1 q_2 \phi_2 (\phi_1 / \phi_2 - q_1 / q_2) - (C_a q_2 + \phi_2 C_r)}{C_1 q_1 + C_2 q_2 + C_r}. \quad (9)$$

In the standard Rosen-Roback model with only type-1 workers, the first term in the numerator expression of (8) disappears, so that the expression becomes $-(C_a q_1 + C_r \phi_1)$. When C_a is small in absolute value, the positive $C_r \phi_1$ term dominates, making this expression negative and implying that a higher amenity level reduces y_1 .

In the two-type case, the presence of the additional first term in the numerators of (8) and (9) introduces ambiguity, so that both unconditional wage effects could be negative or positive. However, the type-1 effect can be signed under certain assumptions. Suppose that type-1 workers have the stronger valuation of amenities, so that $\phi_1 > \phi_2$ holds, implying $\phi_1/\phi_2 > 1$. Next, suppose $\phi_1/\phi_2 > q_1/q_2$, so that housing consumption varies less between the types than does their amenity valuation. This outcome would emerge, for example, if the types differ only in wages (having the same θ values) and if both housing and amenities are normal goods (so that $q_1/q_2, \phi_1/\phi_2 > 1$) but with the wage effect stronger for amenities, as in Brueckner, Thisse and Zenou (1999).

Alternatively, type-1 workers could be high valuers of amenities ($\phi_1/\phi_2 > 1$) but lower demanders of housing, so that $q_1/q_2 < 1$. In both situations, $\phi_1/\phi_2 > q_1/q_2$ holds, making the $\phi_1/\phi_2 - q_1/q_2$ term in (8) positive and the entire first numerator expression negative. This sign reinforces the negativity of the last term and makes the entire numerator negative. The upshot in these cases is that the wage of the type-1 group falls with the level of amenities ($\partial y_1/\partial a < 0$), as in the single-type case.

For the type-2 workers, the effect of amenities on the wage under these assumptions is ambiguous. The reason is that the first expression in the numerator of (9) is positive in either of the above cases, countering the negativity of the last term. As a result, the type-2 wage could either rise or fall as amenities increase. Intuitively, with a low amenity valuation, the type-2 worker's gain from the higher amenity could be fully offset by the resulting increase in r from (7), so that the type-2 wage need not fall to keep utility constant as a rises, unlike the wage for the higher-valuation type-1 workers.

This point can be made more precise by computing the difference in the magnitudes of the wage derivatives. Using (7) and (8), this difference is

$$\frac{\partial y_1}{\partial a} - \frac{\partial y_2}{\partial a} = - \frac{(C_1 + C_2)q_2\phi_2(\phi_1/\phi_2 - q_1/q_2) + (q_1 - q_2)C_a + (\phi_1 - \phi_2)C_r}{C_1q_1 + C_2q_2 + C_r}. \quad (10)$$

Under the Brueckner-Thisse-Zenou assumptions from above, all the terms in the numerator of

(10) are positive, yielding

$$\frac{\partial y_1}{\partial a} < \frac{\partial y_2}{\partial a}. \quad (11)$$

The same conclusion emerges in the alternative case of high type-1 amenity valuation and low housing demand if $q_1 - q_2$ is not too far below zero, maintaining positivity of (10)'s numerator. Since $\partial y_1/\partial a$ is negative in either of these cases while $\partial y_2/\partial a$ is algebraically larger by (11), $\partial y_2/\partial a$ could be either positive or negative.

The second hedonic-wage regression estimated in the empirical work follows the second part of this analysis by being unconditional in nature, with the real-estate price r dropped as a covariate. As in the conditional regression, education, age, and the amenity variable appear in level form along with amenity $\times$ age and amenity $\times$ education interactions. These regressions show how wages vary across cities with different amenities for workers with different characteristics. With the r control absent, they should show smaller amenity effects than the conditional regressions, as argued in the discussion following (5).

3. Data

The US dataset for the regressions is a subset of the data used by Brueckner and Neumark (2014), which were drawn from Current Population Survey (CPS) and other sources. While their sample covered the period 1995-2004, the time period is narrowed to 1998-2002 for reasons explained below, removing about 632,000 of their 1.04 million observations. These labor-market data come from the Outgoing Rotation Group (ORG) files of the CPS, covering workers aged 18-64 who earn wages or salaries (the self-employed and those working without pay are excluded). Following Brueckner and Neumark (2014), the dependent variable is the log of the nominal hourly wage, either reported by hourly workers or computed for non-hourly workers.

Public-sector workers, who are often unionized, were a focus of Brueckner and Neumark's analysis. Their results showed that rent-seeking by such workers through high local taxes appears to raise their wages in high-amenity areas, whose attractions limit punitive outward migration of taxpayers in response to those high tax burdens. Given this finding, public-sector workers are dropped from the current sample, as are unionized private-sector workers, whose market power may similarly violate the underpinnings of the Rosen-Roback model. These

exclusions remove about 99,000 observations. In addition, the sample is limited to workers with residence in an MSA, with non-metropolitan workers excluded, removing about 81,000 observations. Finally, wages below the federal 2000 minimum wage of \$5.15 are dropped, removing 8,300 observations. While the wage exclusions are asymmetric, using the 95th-99th midpoint instead of the 95th percentile as an upper cutoff allows inclusion of more high-wage observations. The resulting sample contains 257,478 observations across 219 MSAs.

Worker characteristics are captured by three age dummies: *young* (age < 35 years), *mid_age* ($35 \leq \text{age} < 55$), and *old* (age ≥ 55), as well as dummies for *male*, *black*, and *hispanic* workers.⁴ Other controls are six marital-status dummy variables from the CPS as well as year dummies. The coefficients of these variables are not reported.

Education is a focal worker characteristic in the analysis, and it is captured in the CPS by 16 dummy variables, which are converted into a more-abbreviated set of dummies: *low_ed*, which indicates that the worker has a high-school diploma or a lower level of education; *mid_ed*, which indicates that the worker has some college or an associate (junior college) degree; *high_ed*, which indicates that the worker has a bachelor's or master's degree, or a professional or doctoral degree.

While Brueckner and Neumark used two climate and two non-climate amenity variables, the current analysis uses only their *mildness* climate variable, which is likely to be most salient climate measure.⁵ The *mildness* variable is computed at the county level using data from Mendelsohn et al. (1994), and it equals the negative of the sum of the absolute values of the differences between monthly county-average temperature and 20 degrees Celsius, summed over January, April, July, and October, thus being an increasing function of climate mildness. County *mildness* values are then used to generate MSA values. Summary statistics in Brueckner and Neumark (2014) show that North Dakota is the least mild state and Florida the mildest. Note that *mildness* effectively blends the more-familiar heating- and cooling-degree-day measures, which separately capture downward and upward deviations from a moderate

⁴ Since workers in their later 30s are not considered middle-aged, use of *mid_age* is more appropriate than the alternative designation of *middle_age*.

⁵ Their other climate variable is a dryness measure, and the two non-climate variables capture nearness to water and population density, which is viewed as a positive amenity.

reference temperature.⁶

The real-estate price appears in the conditional regressions, and it is initially captured by a CMSA-level variant of Brueckner and Neumark’s *houscost* index, which they measured instead at the state level. Using the replication package from Albouy (2016), the housing-cost index is the CMSA-specific intercept in a highly detailed hedonic housing-price regression that includes both owner-occupied and rental dwellings, based on data for the 2000 Census. For comparison purposes, results using the state level housing-cost measure from Brueckner and Neumark (2014), which is generated using the same methodology, are also presented.

To capture factors other than climate mildness that affect wages, MSA-level employment shares in the 23 principal 2-digit SIC categories are included as controls, capturing the structure of local employment. Since the SIC codes were redefined in 1997 and the MSA codes were redefined in 2003, the years 1995-1997 and 2003-2004 in the Brueckner-Neumark sample are dropped, as noted above, leaving 1998-2002 as the sample period. Since the SIC employment shares change slowly over time, the shares for the midpoint year of the sample (2000) are used as controls, being applied to all sample years. The coefficients of the SIC-share variables are not reported.

Table 1 shows summary statistics for the sample, with the *mildness* variable being de-meaned, yielding a zero mean. As can be seen, the mean hourly wage is \$15.63, with the minimum equal to the federal minimum wage of \$5.15 and a maximum of \$293.27. Slightly more than half the workers are male, 8.9% are black, 13.7% are hispanic, and the shares of the education groups decline slightly as education rises. The young and mid-age groups are similar in size, but only 8.5% of workers are in the old group. Being omitted from the regression tables, the year and marital-status variables’ statistics are not shown in Table 1, but the observations are very evenly split across the five sample years, and the most common marital statuses are married with civilian husband (54.0%), never married (29.0%), and divorced (10.7%).

⁶ The *mildness* measure is also based on average monthly rather than daily temperature deviations. The mildness measure could be called “degree-months”.

4. Empirical Results

The estimated hedonic wage regressions are shown in Tables 2–3. Table 2 shows a Rosen-Roback wage regression with a standard treatment of amenities, where the *mildness* variable appears only in level form. Table 3 adds interactions between *mildness* and education and between *mildness* and age. The various columns in the tables show a conditional regression (which directly gives amenity valuations) along with the corresponding unconditional regression (where *houscost* is dropped), with the theory used to motivate comparisons between the two regressions. All of the regressions are weighted by the CPS wage-representativeness variable, *ernwgt*, ensuring that the observations reflect the overall population. Standard errors are clustered at the MSA level. Since no complications are present in the estimation, the regressions use ordinary-least-squares.

4.1. Standard regressions

Column 1 of Table 2 shows the conditional version of a standard hedonic wage regression, with *houscost* appearing on the right-hand side. This variable’s coefficient is significantly positive, indicating that wages are higher in high housing-cost areas. Recall that the coefficient of *mildness*, which appears only in level form, directly reveals (in absolute value) the average valuation of the amenity across all workers, given the presence of *houscost* (see (4)). The coefficient is negative and statistically significant, as expected, indicating that workers will accept a lower wage to live and work in a milder climate.

Column 2 of Table 2 drops the *houscost* variable, yielding an unconditional wage regression. While the *mildness* coefficient is still negative and significant, it increases in absolute value relative to column 1, rather than decreasing, as predicted by the theory.⁷ This pattern persists through the results below that use *mildness* interactions instead of the variable’s level, along with the CMSA-level *houscost*. A possible explanation is that this *houscost* variable is correlated with some unobserved MSA-level determinants of wages (e.g., high worker productivity in high-cost San Francisco), which prevent the expected drop of the *mildness* coefficient when *houscost* is removed from the regression. As will be seen below, the expected pattern emerges using the state-level version of *houscost*, which may be less correlated with these

⁷ Since the coefficients come from different regressions, a formal test for equality is not possible.

unobservables.

Turning to the dummy control variables, *low_educ* and *young* are dropped, so that the default worker is a young, female married to a civilian husband (the default marital status) with low education and a non-Black, non-Hispanic race. The wage effects of the dummy variables are as expected. More education or a non-young age raises the wage, with the point estimate of the age effect slightly smaller for old workers. Male wages are higher than those of females, and Black and Hispanic workers earn less than workers outside these groups. All these coefficients are strongly statistically significant.

4.2. Regressions with amenity interactions

Table 3 introduces amenity interactions with the three education dummies and the age dummies. Only education interactions are present in columns 1 and 2, with columns 3 and 4 containing only age interactions. Columns 5 and 6 contain both types of interactions. The first column within each pair shows the conditional regression, and the second column shows the unconditional regression. In all the regressions, the *mildness* variable only appears in interacted form, not as a level variable.

In the conditional regression in column 1, which includes *houscost*, coefficients for two of the *mildness* interaction variables, $mildness \times low_ed$ and $mildness \times high_ed$, are negative and significant. However, the $mildness \times mid_ed$ coefficient, while negative, is insignificant and its absolute magnitude is smaller than those of the other two coefficients while being separately statistically unequal to each of them. The hypothesis that all three interaction coefficients are equal is also rejected. The results thus suggest that workers in both the high- and low-education groups value a mild climate, while workers in the middle range of education (high school with some college or an associate degree) have a lower and perhaps zero valuation of climate mildness.

While well-educated, and thus well-off, households are often thought to value amenities highly (see for example, Brueckner et al. (1999)), the presence of a similar valuation among the least-educated workers is noteworthy. A possible explanation is that workers with no more than a high-school education are frequently employed in jobs that require manual labor, which often occurs outside rather than indoors. As a result, climate mildness may make the jobs

of such workers easier, accounting for their valuation of mildness. While the best-educated workers may have ample leisure time to enjoy outdoor activities, which could contribute to their valuation of climate mildness, the apparent lower valuation for workers in the middle range of education is somewhat puzzling. Conceivably, compared to the least-educated, fewer of these workers may hold manual jobs, while their lower earning power relative to the most-educated may mean longer work hours and less time for outdoor activities, thereby reducing the middle-range group's valuation of climate mildness.

Climate-mildness valuation by the least educated workers but not by the *mid_ed* group also raises another issue related to the premises of the Rosen-Roback model. That model is based on the assumption that all workers are mobile across regions, and one may wonder whether this assumption is accurate for low-education workers, for whom moving costs may be unaffordable. While this observation may cast doubt on the applicability of the model to this group, it could be argued that everyone is mobile in a sufficiently long-run context, even workers with low resources.

Turning to the unconditional regression in column 2 of Table 3, the coefficients of the *mildness* interactions with *low_ed* and *high_ed* remain negative and significant. The coefficients are larger in absolute value than those in column 1, following the unexpected pattern in Table 2.

As for the remaining coefficients in columns 1 and 2, they follow the pattern of Table 2. Note that, while the education effect on wages now involves the interaction terms, the wage effects of the education dummies evaluated at mean *mildness* value (equal to zero given demeaning) are simply given by the positive uninteracted coefficients.

Column 3 of Table 3 shows the conditional regression containing *mildness* interactions with the age variables but no education interactions. The coefficients of all three interaction variables are negative and significant, suggesting that workers in all three age groups value a mild climate. However, the *mid_age* and *old* interaction coefficients are larger in absolute value than the *young* interaction coefficient, implying that non-young workers value a mild climate more than young workers. This pattern is consistent with a lessening tolerance for cold weather as people grow older. However, while the difference between the *mid_age* and

young interaction coefficients is statistically significant, the difference between the *old* and *young* interaction coefficients is not (the hypothesis that all three coefficients are equal is rejected). Column 4 shows the same sign and significance pattern as in column 3 for the interaction coefficients, which are again larger in absolute value than the column-3 coefficients, contrary to expectations.

The regressions in columns 5 and 6 of Table 3 contain *mildness* interactions with both the education and age variables. Note that to avoid multicollinearity, the *mild* $\times$ *young* interaction variable is deleted in both columns. While all of the interaction coefficients remain negative, only the *mildness* $\times$ *high_ed* and *mildness* $\times$ *mid_age* coefficients retain statistical significance. Note, however, that the *mid_ed* interaction coefficient is still smaller in absolute value than the *low_ed* and *high_ed* interaction coefficients, preserving the pattern of columns 1 and 2. The insignificant *mildness* $\times$ *old* coefficients are now much smaller than the *mid_age* interaction coefficient, in contrast to their closer magnitudes in columns 3 and 4.

That columns 5 and 6 have a less clear message than Table 3's other columns is perhaps not surprising since they attempt to simultaneously capture amenity-valuation differences associated with two worker characteristic (education and age) rather than a single one. As a result, more credence could be given to the patterns seen in columns 1-4.

4.3. Regressions with amenity interactions using the state-level housing cost

In order to generate the expected relative magnitudes for conditional and unconditional amenity coefficients, Tables 4 and 5 present versions of Tables 2 and 3 using the state-level *houscost* measure instead of the CMSA-level measure. The unconditional regressions in both tables (where *houscost* is dropped) are, of course, the same as those in Tables 2 and 3 but are included for easy comparison.

In column 1 of Table 4, the *mildness* coefficient increases in absolute value, being now larger than the coefficient in column 2, which is unchanged. This is the pattern predicted by the theory, with the required compensating decline in the wage as *mildness* increases being smaller when *houscost* exerts its own separate utility-equalizing force (rising with *mildness*) rather being held fixed. The other estimates in Table 4 are similar to those in Table 3.

As in Table 3, column 1 of Table 5 again suggests that workers with low and high education

levels value climate mildness more than do workers with education in the middle range. While again larger in absolute value, the $mildness \times low_ed$ and $mildness \times high_ed$ coefficients are also again both statistically different from the mid_ed interaction coefficient. The latter coefficient, however, is now also statistically significant. Note that the column-1 interaction coefficients are now larger in absolute value than the unconditional column-2 coefficients, as predicted by the theory.

As in Table 3, all the age interaction coefficients in column 3 of Table 5 are negative and significant, with the mid_age and old interaction coefficients larger in absolute value than the $young$ interaction coefficient. As before, the difference is statistically significant only for the mid_age interaction coefficient. As predicted by the theory, the column 3 interaction coefficients are now larger in absolute value than the unconditional coefficients in column 4.

Turning to columns 5-6 of Table 5, the $mildness \times high_ed$ coefficient in column 5 now retains the statistical significance seen in column 1, with the $mildness \times mid_ed$ coefficient losing it. That coefficient is again statistically different from the other two, implying that workers in the middle education range have a lower mildness valuation than the other education groups. Column 5's age interaction coefficients show the same pattern as in Table 3. Note that, while column 5's education interaction coefficients are now larger than those in column 6, as predicted, that relationship does not hold for the age interaction coefficients.

While mostly matching the theoretical prediction regarding conditional vs. unconditional coefficient magnitudes, the results in Table 5 also reaffirm the conclusions from Table 3. They suggest that workers with high and low education levels value climate mildness by more than workers with moderate education levels, and that young workers value climate mildness less than non-young workers.

4.4. Further connections to the theory

While Tables 4 and 5 show the predicted theoretical relationship between the coefficient magnitudes in the conditional and unconditional regressions, the analysis in section 2 offers some further guidance in appraising the results. In particular, recall that the theory shows how differences in housing demands and amenity valuations between the two posited worker types can affect the magnitudes of the unconditional amenity wage effects for the types. Consider

the unconditional regression in column 2 of Table 3, which pertains to the three education groups. While the regression has three groups rather than the two worker types in the model, pairwise comparisons can be made between the interaction coefficients using the theory, carrying out a *low_ed/mid_ed* comparison and a separate *high_ed/mid_ed* comparison, relying on the effectively zero value for the *mid_ed* interaction coefficient.⁸

Consider first the *low_ed/mid_ed* comparison. Relative to the *mid_ed* group (type 2 in the theory), the *low_ed* group (type 1) has a higher mildness valuation given the results of column 1 in Table 3, with $\phi_1/\phi_2 > 1$. But given its lower income, housing demand should also be lower for the *low_ed* group, implying $q_1/q_2 < 1$. From above, these two inequalities together yield a negative unconditional type-1 (*low_ed*) wage effect in equation (8) along with an ambiguous (possibly zero) sign for the type-2 (*mid_ed*) effect in (9), matching the results in column 2 of Table 3.

For the *high_ed/mid_ed* comparison, the higher income of the *high_ed* group (now type 1) should make $q_1/q_2 > 1$ (type 2 is again the *mid_ed* group). The greater *high_ed* mildness valuation from the unconditional regression means $\phi_1/\phi_2 > 1$, but if the valuation of amenities rises faster than housing demand as income increases (the Brueckner-Thisse-Zenou assumption), then $\phi_1/\phi_2 > q_1/q_2 > 1$. The conditional type-1 (*high_ed*) wage effect in (8) is then again negative while the type-2 (*mid_ed*) effect is ambiguous and possibly zero, as in column 2 of Table 3.

4.5. Robustness check: Stratified regressions

As a robustness check, this section replaces the regressions using *mildness* interaction variables with separate regressions stratified by individual characteristics. In other words, the single regression with *mildness*-education interactions in column 1 of Table 3 is replaced by three separate regressions, one for each education category, with *mildness* appearing in level form in each regression. A comparison of the *mildness* coefficients across the three regressions

⁸ This exercise is justifiable because deleting the *low_ed* and alternatively *high_ed* observations from the regression, leaving only two groups, yields the same coefficient pattern as seen in column 2: negative (zero) *low_ed* (*mid_ed*) interaction coefficients in the regression containing only *low_ed* and *mid_ed* observations; negative (zero) *high_ed* (*mid_ed*) interaction coefficients in the regression containing only *low_ex* and *mid_ex* observations.

provides a different way gauging how valuation of the amenity changes across individuals in the different education categories. Similarly, the single regression with *mildness*-age interactions in column 3 of Table 3 is replaced by three separate regressions, one for each age category, with *mildness* again appearing in level form. This approach follows Hoch and Drake (1974), who used the stratified approach to investigate how the effect of climate amenities on wages varies across occupations.

In contrast to the interaction approach, which implicitly constrains the coefficients of the control variables to be the same across education or age groups, the use of separate regressions under the stratified approach allows these coefficients to differ across groups. If the conclusions generated by the interaction approach also emerge under the less-restrictive stratified approach, then robustness is demonstrated.

The results of the stratified approach are shown in Table 6, with columns 1-3 showing regressions stratified by education and columns 4-6 showing regressions stratified by age.⁹ The table uses the CMSA-level housing cost variable. As can be seen, all of the *mildness* coefficients are significantly negative, suggesting that all the education and age groups value climate mildness. However, the patterns seen in the interaction regressions are only partly evident in Table 6.

If the education-interaction coefficient pattern were repeated in Table 6, then the *mildness* coefficients in columns 1 and 3 would both be larger in absolute value than the mildness coefficient in column 2. Instead, the *mildness* coefficients in the *mid_ed* and *high_ed* regressions of column 2 and 3 are almost exactly the same size, with absolute values less than half that of the *mildness* coefficient in the *low_ed* regression of column 1. The implication is workers with low education levels value a mild climate more than workers in the two other groups. This conclusion at least preserves the previous finding that low-education workers highly value climate mildness, but it does not show highly educated workers joining in this high valuation.

Columns 4-6 of Table 6 show similar valuations of climate mildness in the *young* and

⁹ Note that to conveniently evaluate education and age effects under the stratified approach, age is omitted from the stratified education regressions and education is omitted from the stratified age regressions. The alternative would be to run nine different regressions, one for each education-age combination, and to make comparisons across them.

mid_age groups, but a lower valuation for older workers. Therefore the previous conclusion that non-young workers value climate mildness more than the young is not replicated.

These differences in results come from not constraining the control-variable coefficients to be the same across groups, the consequences of which can be seen in the variation in these coefficients across the regressions in Table 6. For example, the wage effect from being male is considerably larger for mid-age workers than for low-education workers (compare columns 5 and 1 of Table 6). One could argue that, if the goal is to compare amenity valuations across groups, then giving gender and race effects the same freedom to vary across groups prevents drawing the sharp conclusions that are sought. On the other hand, allowing flexibility in the control coefficients may end up giving a truer picture of amenity valuations. For the current exercise, however, the conclusions drawn from the amenity-interaction approach match intuition better than those implied by Table 6, making them appear more credible.

4.6. Discussion

The results Tables 3 and 5 suggest that high- and low-education workers value climate mildness more than workers with educations in the middle range, and that young workers value climate mildness less than non-young workers. While the age-related valuation differences are expected, the evidence of strong valuation of climate mildness by low-education workers is unexpected and novel.

Interestingly, the paper’s results can be used to predict how the wage distributions across groups within a city should differ between cities with low and high climate mildness. Focusing first on the education groups, and recalling that the results show wages rising with education, the larger mildness wage effect for the *low_ed* group relative to that for the *mid_ed* group implies that the wage gap between those two groups becomes larger when climate mildness increases (with *low_ed* wage falling by more). Similarly, the larger mildness wage effect for the *high_ed* group relative to that for the *mid_ed* group implies that the wage gap between the groups becomes smaller when climate mildness increases (with the *high_ed* wage falling by more). Therefore, a milder climate *compresses* the education-related wage gap at the top of the education range while *widening* it at the bottom. Carrying out the same exercise for age, the larger mildness wage effects for workers in the *mid_age* and *old* groups relative to that

for the *young* implies that the wage gap between non-young and young workers shrinks with climate mildness, being smaller in a city with a mild climate than in less-mild city.

The different interpretations of the conditional and unconditional wage regressions also bear further review. The conditional regression, which controls for *houscost*, shows how wages respond to variation in the amenity *across cities with the same housing prices*. This regression also directly reveals the valuation of the amenity. The unconditional regression, by contrast, shows how wages respond to amenity variation across cities without conditioning on housing costs, thus showing how wages vary between high- and low-amenity cities without constraining housing prices to be the same. Housing prices rise with climate mildness, as noted above, which should dampen any unconditional tendency of wages to fall in compensating fashion as *mildness* increases, a prediction that is affirmed in Tables 4 and 5.

Finally, worker sorting across cities with different climate mildness, as in Albouy et al. (2016), requires discussion. While some sorting of older workers according to mildness (retirees in Florida, for example) is apparent, low-education workers are needed for manual jobs in cities of all climates, limiting the possibility of locational sorting based on their higher valuation of climate mildness. Wage differences across cities for these workers offset the benefits of mild locations, undercutting the incentive to sort.

4.7. Quantitative impacts

To judge quantitative impacts, consider a worker belonging to both the *high_ed* and *mid_age* groups, and let *mildness* increase by one standard deviation, a change of approximately 12 units from Table 1. Using the conditional estimates from columns 1 and 3 of Table 3, and recalling that the wage is in logs, the wage of this worker would then fall by a percentage value equal to $12 \times (0.00181 + 0.00263) = 5.3$. Therefore, the willingness-to-pay of a mid-age, high-education worker for this increase in climate mildness is more than 5% of the wage. With the *low_ed* coefficient larger than the *high_ed* interaction coefficient, use of that 0.00322 value in place of 0.00188 in this calculation yields a larger wage decline, equal to 7.0% for a mid-age, low-education worker. If the worker belongs instead to the *mid_age* group but is still highly educated, then the 0.00181 in the above formula becomes zero, and willingness-to-pay drops to 3.2% of the wage. Quantitative effects using the estimates from Table 5 are similar.

5. Conclusion

This paper has explored heterogeneous individual valuations of an important amenity, climate mildness, using a traditional Rosen-Roback empirical framework. It does so by including interaction terms between the amenity and worker characteristics in an hedonic wage regression that also include a housing-price measure. The results suggest that non-young workers (those in the *mid_age* and *old* groups) value a mild climate more than do young workers, matching the usual view that the tolerance for cold weather declines with age. The findings also suggest that, like their highly educated counterparts, workers with low education levels also highly value a mild climate, with workers in the middle range of education having a lower valuation. These findings, which contradict the view that only better-off individuals care about amenities, could reflect the lower burden in mild weather of the manual work done by the less educated. The paper’s results complement the findings of more recent structural papers that allow amenity valuations to depend on individual characteristics, doing so in a traditional framework. In addition to presenting these empirical findings, the paper further contributes by presenting new analytics for the Rosen-Roback model in a setting with individual heterogeneity.

The results of the paper could be used to predict the dynamic effects of climate change on wage patterns in the US. As rising temperatures make some currently mild locations with temperate climates hotter and thus less mild, the wages of low- and high-education workers as well as non-young workers would be expected to rise in these locations. Conversely, as some locations with colder winters become warmer and thus more mild in response to climate change, the wages of these worker groups would be expected to fall. The key implication is that the wage effects of climate change would be heterogeneous in step with the heterogeneous valuations of climate mildness.

The paper’s results are, of course, dependent on choices made in framing the empirical exercise. The most important among them is the focus on a single climate amenity measure, climate mildness, a choice that the paper shares with Albouy et al. (2016). Although introducing additional climate variables would complicate the empirical exercise by expanding the number of interaction terms that must be handled, some steps in this direction might be manageable and could be a direction for future research. It would be worth knowing whether the

results of the paper are robust to such a generalization.

Table 1: Summary statistics

<i>Variable</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
wage (\$/hr)	15.63	10.93	5.15	293.27
houscost (CMSA index)	.052	.251	-.544	.783
mildness	0	12.03	-28.76	21.38
low_ed	.409	.492	0	1
mid_ed	.307	.461	0	1
high_ed	.284	.451	0	1
young	.440	.496	0	1
mid_age	.476	.499	0	1
old	.085	.279	0	1
male	.509	.500	0	1
black	.089	.279	0	1
hispanic	.137	.344	0	1

Observations = 257,478 across 219 MSAs.

Variable Definitions

houscost is a CMSA-specific index equal to the intercept from a detailed hedonic housing price regression.

mildness measures annual month-level deviations from a temperature of 20 degrees Celsius at the MSA level.

low_ed is a dummy variable indicating that the worker has a high-school degree or less.

mid_ed is a dummy indicating that the worker has some college or a junior-college degree.

mid_ed is a dummy indicating that the worker has a college degree or a post-graduate degree.

young is a dummy indicating that the worker's age is less than 35 years.

mid_age is a dummy indicating that the worker's age is at least 35 but less than 55 years.

old is a dummy indicating that the worker's age is at least 55 years.

Table 2: Standard Rosen-Roback hedonic wage regressions

VARIABLES	(1) lwage	(2) lwage
mildness	-0.00202** (0.000326)	-0.00227** (0.000454)
houscost	0.225** (0.0229)	—
mid_edx	0.215** (0.0106)	0.218** (0.0104)
high_edx	0.607** (0.0136)	0.611** (0.0134)
mid_age	0.165** (0.00412)	0.166** (0.00428)
old	0.125** (0.00771)	0.126** (0.00769)
male	0.187** (0.0108)	0.187** (0.0107)
black	-0.127** (0.00766)	-0.130** (0.00754)
hispanic	-0.241** (0.0163)	-0.240** (0.0165)
Constant	-0.385 (1.035)	1.694 (1.550)
Observations	257,478	257,478
R^2	0.431	0.426

Standard errors clustered at the metro level in parentheses.

** p<0.01, * p<0.05

Marital-status, SIC employment-share, and year coefficients not reported.

Table 3: Hedonic wage regressions with amenity interactions

VARIABLES	(1) lwage	(2) lwage	(3) lwage	(4) lwage	(5) lwage	(6) lwage
houscost	0.223** (0.0227)	—	0.224** (0.0229)	—	0.222** (0.0227)	—
mid_ed	0.203** (0.00618)	0.204** (0.00611)	0.215** (0.0105)	0.218** (0.0103)	0.203** (0.00620)	0.204** (0.00612)
high_ed	0.601** (0.0125)	0.604** (0.0123)	0.607** (0.0136)	0.612** (0.0134)	0.600** (0.0125)	0.604** (0.0123)
mid_age	0.165** (0.00412)	0.166** (0.00427)	0.172** (0.00395)	0.173** (0.00403)	0.172** (0.00396)	0.173** (0.00404)
old	0.124** (0.00756)	0.125** (0.00755)	0.128** (0.00754)	0.130** (0.00752)	0.127** (0.00717)	0.128** (0.00716)
mildness $\times$ low_ed	-0.00322** (0.000648)	-0.00358** (0.000684)	—	—	-0.00258** (0.000594)	-0.00292** (0.000613)
mildness $\times$ mid_ed	-0.000728 (0.000426)	-0.000902 (0.000515)	—	—	-9.10e-05 (0.000505)	-0.000245 (0.000545)
mildness $\times$ high_ed	-0.00181** (0.000607)	-0.00200** (0.000680)	—	—	-0.00106 (0.000699)	-0.00123 (0.000728)
mildness $\times$ young	—	—	-0.00134** (0.000364)	-0.00158** (0.000440)	—	—
mildness $\times$ mid_age	—	—	-0.00263** (0.000380)	-0.00290** (0.000519)	-0.00130** (0.000379)	-0.00134** (0.000378)
mildness $\times$ old	—	—	-0.00198** (0.000592)	-0.00225** (0.000722)	-0.000509 (0.000585)	-0.000539 (0.000599)
male	0.188** (0.0107)	0.187** (0.0105)	0.187** (0.0108)	0.187** (0.0106)	0.188** (0.0106)	0.187** (0.0105)
black	-0.127** (0.00747)	-0.130** (0.00730)	-0.127** (0.00771)	-0.130** (0.00759)	-0.127** (0.00752)	-0.130** (0.00734)
hispanic	-0.236** (0.0137)	-0.235** (0.0140)	-0.242** (0.0165)	-0.241** (0.0166)	-0.237** (0.0138)	-0.235** (0.0140)
Constant	-0.374 (1.031)	1.686 (1.546)	-0.372 (1.040)	1.704 (1.553)	-0.359 (1.036)	1.699 (1.549)
Observations	257,478	257,478	257,478	257,478	257,478	257,478
R^2	0.431	0.427	0.431	0.426	0.431	0.427

Standard errors clustered at metro level in parentheses.

** p<0.01, * p<0.05

Marital-status, SIC employment-share, and year coefficients not reported.

Table 4: Standard Rosen-Roback hedonic wage regressions with state-level housing cost

VARIABLES	(1) lwage	(2) lwage
mildness	-0.00252** (0.000436)	-0.00227** (0.000454)
houscost	0.0135** (0.00318)	—
mid_ed	0.216** (0.0105)	0.218** (0.0104)
high_ed	0.611** (0.0134)	0.611** (0.0134)
mid_age	0.166** (0.00418)	0.166** (0.00428)
old	0.125** (0.00774)	0.126** (0.00769)
male	0.187** (0.0107)	0.187** (0.0107)
black	-0.126** (0.00748)	-0.130** (0.00754)
hispanic	-0.241** (0.0162)	-0.240** (0.0165)
Constant	-1.253 (1.731)	1.694 (1.550)
Observations	257,478	257,478
R^2	0.428	0.426

Standard errors clustered at the metro level in parentheses.

** p<0.01, * p<0.05

Marital-status, SIC employment-share, and year coefficients not reported.

Table 5: Hedonic wage regressions with amenity interactions and state-level housing cost

VARIABLES	(1) lwage	(2) lwage	(3) lwage	(4) lwage	(5) lwage	(6) lwage
houscost	0.0133** (0.00316)	—	0.0135** (0.00318)	—	0.0133** (0.00316)	—
mid_ed	0.203** (0.00618)	0.204** (0.00611)	0.216** (0.0105)	0.218** (0.0103)	0.203** (0.00619)	0.204** (0.00612)
high_ed	0.604** (0.0123)	0.604** (0.0123)	0.611** (0.0134)	0.612** (0.0134)	0.603** (0.0123)	0.604** (0.0123)
mid_age	0.166** (0.00418)	0.166** (0.00427)	0.173** (0.00401)	0.173** (0.00403)	0.172** (0.00402)	0.173** (0.00404)
old	0.125** (0.00759)	0.125** (0.00755)	0.129** (0.00761)	0.130** (0.00752)	0.128** (0.00725)	0.128** (0.00716)
mildness $\times$ low_ed	-0.00378** (0.000706)	-0.00358** (0.000684)	—	—	-0.00312** (0.000649)	-0.00292** (0.000613)
mildness $\times$ mid_ed	-0.00118* (0.000489)	-0.000902 (0.000515)	—	—	-0.000532 (0.000545)	-0.000245 (0.000545)
mildness $\times$ high_ed	-0.00228** (0.000662)	-0.00200** (0.000680)	—	—	-0.00152* (0.000732)	-0.00123 (0.000728)
mildness $\times$ young	—	—	-0.00184** (0.000448)	-0.00158** (0.000440)	—	—
mildness $\times$ mid_age	—	—	-0.00314** (0.000493)	-0.00290** (0.000519)	-0.00132** (0.000378)	-0.00134** (0.000378)
mildness $\times$ old	—	—	-0.00248** (0.000656)	-0.00225** (0.000722)	-0.000510 (0.000586)	-0.000539 (0.000599)
male	0.187** (0.0106)	0.187** (0.0105)	0.187** (0.0107)	0.187** (0.0106)	0.187** (0.0106)	0.187** (0.0105)
black	-0.126** (0.00727)	-0.130** (0.00730)	-0.126** (0.00753)	-0.130** (0.00759)	-0.126** (0.00732)	-0.130** (0.00734)
hispanic	-0.236** (0.0136)	-0.235** (0.0140)	-0.242** (0.0163)	-0.241** (0.0166)	-0.237** (0.0137)	-0.235** (0.0140)
Constant	-1.216 (1.727)	1.686 (1.546)	-1.237 (1.735)	1.704 (1.553)	-1.197 (1.731)	1.699 (1.549)
Observations	257,478	257,478	257,478	257,478	257,478	257,478
R^2	0.428	0.427	0.428	0.426	0.428	0.427

Standard errors clustered at metro level in parentheses.

** p<0.01, * p<0.05

Marital-status, SIC employment-share, and year coefficients not reported.

Table 6: Stratified wage regressions

VARIABLES	(1) lwage low_ed = 1	(2) lwage mid_ed = 1	(3) lwage high_ed = 1	(4) lwage young = 1	(5) lwage mid_age = 1	(6) lwage old = 1
houscost	0.230** (0.00758)	0.276** (0.00986)	0.275** (0.0125)	0.294** (0.00852)	0.326** (0.00948)	0.302** (0.0235)
mildness	-0.00259** (0.000120)	-0.00104** (0.000154)	-0.000994** (0.000194)	-0.00232** (0.000134)	-0.00259** (0.000149)	-0.00165** (0.000373)
male	0.188** (0.00234)	0.175** (0.00310)	0.244** (0.00384)	0.129** (0.00264)	0.272** (0.00294)	0.334** (0.00747)
black	-0.120** (0.00388)	-0.118** (0.00520)	-0.133** (0.00853)	-0.148** (0.00450)	-0.265** (0.00537)	-0.250** (0.0145)
hispanic	-0.253** (0.00311)	-0.173** (0.00552)	-0.265** (0.00918)	-0.325** (0.00374)	-0.470** (0.00491)	-0.436** (0.0144)
Constant	-1.182* (0.500)	-3.114** (0.747)	-6.871** (1.362)	-2.062** (0.627)	-3.203** (0.746)	-3.679* (1.868)
Observations	105,180	79,128	73,170	113,165	122,466	21,847
R^2	0.224	0.220	0.159	0.223	0.215	0.201

Standard errors clustered at metro level in parentheses.

** p<0.01, * p<0.05

Marital-status, SIC employment-share, and year coefficients not reported.

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