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Wage Differentials Across Labor Markets and Workers: Does Cost of Living Matter?

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Abstract

Wage differentials studies rarely account for interarea differences in cost of living, owing both to data limitations and theoretical ambiguity. This study develops a price index for 185 metropolitan areas comprising about 70% of the U.S. labor force. Current Population Survey data for 1985-95 and data on site-specific amenities are used to estimate earnings differentials based on nominal wages, wages fully adjusted for measured cost of living, and a simple approximation of "real" wages with partial adjustment for price-level differences. Dispersion in approximate real wages across 185 labor markets and differentials by region and city size are substantially lower than dispersion in nominal or full adjustment wages. Estimates of racial and ethnic differentials display moderate sensitivity to choice of a wage measure, whereas other standard differentials do not. Both nominal wages and wages fully adjusted for cost of living may provide misleading estimates of real wage differentials. Absent data on interarea prices and amenities, researchers should include detailed controls for region and city size in nominal wage equations. (*JEL* J31, R23)

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I. Introduction

An implication from economic theory is that utility gained from labor services should tend toward equality across competitive labor markets among similar workers. Many studies have examined the dispersion in wage rates across areas in order to shed light on the competitive hypothesis (for a review, see Dickie and Gerking [1989]). Such studies provide little support for the hypothesis of wage equalization, although analysis is often constrained by limited information on area prices, amenities, and individuals across a large number of labor markets. Even following control for measurable worker and area characteristics, there exists considerable dispersion in wages across markets. Moreover, interarea differentials are *not* reduced following full adjustment for measured cost of living (Johnson [1983]).

Independent of this line of inquiry, the empirical literature in labor economics abounds with regression estimates of wage differentials by, among other things, region, city size, race, gender, public-private status, part-time status, union status, schooling, marital status, and industry. Because of a lack of information about cost of living, standard wage differential estimates are based on nominal (i.e., not price adjusted) rather than price-adjusted wages. The relationship between cost of living and wage differentials based on individual or labor market characteristics, therefore, is not widely known.

Even were interarea worker, price, and amenity data readily available, it is far from clear how such data should be used. Studies that control for cost of living generally assume (implicitly or explicitly) that measured differences in prices reflect true differences in acquiring utility across markets. Yet differences in cost of living in part reflect the valuation placed on land and other goods and services owing to site-specific amenities valued by consumers or businesses (see, among others, Roback [1982, 1988] and Beeson and Eberts [1989]). Differences in area wages that are fully adjusted for measured cost of living might accurately reflect utility differences if *none* of the price variation reflected household valuation of area amenities (i.e., if all price differences reflected cost differences in acquiring utility). Nominal wage differentials might accurately measure utility differences if *all* variation in prices reflected workers' valuation of area amenities. Neither assumption is likely to be correct. Moreover, heterogeneity in tastes makes real wage comparisons problematic, since workers and businesses tend to sort into markets with relative prices and amenities most in line with their preferences or cost structure.

Our paper explores two principal lines of inquiry. First, we examine differences in estimated wage differentials among regions, by city size, and across labor markets, measured alternatively by nominal wages, wages fully adjusted for measured cost of living, and by a partial adjustment method that may better approximate a real wage. Evidence here allows us to address the competitive hypothesis of wage equalization, as well as to assess alternative methods for dealing with interarea price differences. To conduct this analysis, we assemble cost of living information for 185 metropolitan areas (comprising 70% of our Current Population Survey (CPS) sample across the entire U.S.) based on 1985-95 survey data from the cost of living index gathered by the American Chamber of Commerce Researchers Association (ACCRA). The ACCRA price data are in turn matched to data on individual workers from the Current Population Survey Outgoing Rotation Group (CPS-ORG) monthly earnings files for October 1985 through May 1995, and to data on area amenities.

The second line of inquiry focuses on estimation of wage differentials by race, gender, union status, part-time status, private/public status, and industry. Here we examine the sensitivity of nominal, full adjustment, and partial adjustment wage differential estimates to the presence of controls for detailed city size. Our conclusions provide guidance as to appropriate standard practice when estimating wage equations with and without the presence of cost of living information.

II. Wages and Cost of Living: Theoretical Issues

Absent barriers to mobility, real wages in long-run equilibrium should be equivalent for workers with identical skills and preferences residing in labor markets with similar amenities. The term "real" refers here to deflation by a "true" (but not directly measurable) price index accounting for interarea differences in the available mix of goods and amenities, and changes in the consumption mix in response to differences in relative prices. To say that real wages are equivalent across markets implies that workers have equal utility generated from their labor services across markets or, alternatively, there is no incentive for workers to move.

Wage rates, of course, will differ across labor markets in the long run since worker skills vary across markets and because preferences regarding area amenities differ. Empirical analysis can control for measurable worker skills; unmeasured skills may pose a problem if not randomly distributed across labor markets. Also problematic from a measurement standpoint are differences in preferences. Since workers tend to migrate toward cities whose mix of amenities and relative prices correspond most closely with their tastes, price indices based on a fixed bundle of goods across areas need not accurately measure cost differences in obtaining utility for the *average* worker.[1] Utility should tend toward equality for marginal city residents, whereas inframarginal residents receive locational rents. But individuals with identical preferences and skills should obtain identical real wages.

Wages will differ not only because of skill and taste differences, but also because area amenities, fiscal conditions, and the price of goods and services vary across cities. In particular, prices may vary significantly for housing and other non-traded geographically-tied goods (e.g., climate, a mountain view, agglomeration economies). As emphasized by Roback [1982, 1988], among others, area amenities act either to lower equilibrium wages or increase the price of land and non-mobile resources. Whether amenities raise land costs or lower wages depends on how amenities directly affect firms' costs of production. In Roback's model, a "productive" amenity (i.e., one that lowers a firms' costs) leads to higher land prices, but has an ambiguous effect on wages. Conversely, if amenities are unproductive, wages fall, but the amenity effect on rents is ambiguous. A combination of productive and unproductive amenities could both lower wages and increase the price of land.

Beeson and Eberts [1989] and Beeson [1991] provide particularly clear models of wage and rent determination in which site-specific characteristics affect both labor supply (an amenity effect) and labor demand (a productivity effect). Even if capital and labor are fully mobile, the equilibrium wage structure (e.g., returns to skill) will differ across labor markets. They conclude that productivity effects have at least as important an impact on wages as do amenity effects. Relatedly, Rauch [1993] emphasizes the positive

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[1] A co-editor provides an instructive (and amusing) example. Aspiring actors and actresses may find it optimal to accept low wages in high-priced Los Angeles, but would require a high wage to live in, say, College Station, Texas. Conversely, "dem guys" who care about good barbecue will readily accept low wages in low-priced College Station, but would not do so in L.A.

productivity effects of human capital spillovers (a type of agglomeration economy), whereby given workers are more productive in markets with high human capital levels. In his model human capital productivity effects must increase not only wages, but also prices, so that real wages equalize across markets.[2]

Even were worker skills and area amenities fully measurable and worker preferences homogeneous, conventional price indices would not measure worker utility precisely owing to substitution in consumption. Most cost of living measures (including the one employed here) are based on a Laspeyres index that compares relative prices for the same bundle of goods. Because the bundle is fixed, it does not accurately measure the compensating differential necessary to provide equivalent utilities across any two regimes.[3] Measured price indices undercompensate for price differences as one moves from low cost areas (where the priced bundle of goods is suboptimal and not purchased) toward average cost of living areas where the measured bundle provides the preferred (i.e., utility maximizing) mix of goods and services. But as one moves from average cost areas toward higher cost cities, measured price indices overcompensate for price differences. In both cases, the difference between a standard fixed bundle index and a utility constant price index stems from the ability of workers to change their consumption mix from that measured in the fixed bundle. An implication of the above is that the relationship between wages and prices should be nonlinear.[4] As one moves from less costly to more costly cities, nominal wages should increase at a decreasing rate in order to keep utility constant. In a log wage equation, inclusion of linear and quadratic log price terms on the right hand side should produce a positive coefficient on the linear term and a negative coefficient on the squared term. In what follows, we emphasize results with only log price on the right side, but subsequently examine the linearity of the wage-price relationship.

Discussion above assumes that we observe a long run equilibrium outcome. At any point in time there may exist disequilibrium in wages across markets owing to demand and supply shocks from which adjustment is incomplete (for evidence that shock effects can last a number of years, see Blanchard and Katz

[2] Blomquist, Berger, and Hoehn [1988] and Gyourko and Tracy [1991] also focus on the valuation of area amenities. The latter study emphasizes the importance of area-specific fiscal conditions (primarily tax rates), which are capitalized into housing prices and wage rates.

[3] The now discontinued measure of family budgets from the Bureau of Labor Statistics (BLS) utilized different bundles across cities. Differences in consumption mix, however, can reflect differences in income, preferences, valuation (e.g., greater value placed on heat in Maine than in Florida), and substitution in response to relative price differences.

[4] An earlier working paper version of our paper, available on request, develops this point in detail.

[1992] and Eberts and Stone [1992]). In empirical work, however, it is appropriate to assume that one is observing an approximation of long-run equilibrium in a cross section. While there exist real wage differences for identical persons across labor markets, these differences are presumed to be small or uncorrelated with measured wage determinants.[5]

III. Wages and Cost of Living: Measurement

Estimation of real wage differentials among workers and across labor markets has been limited for at least four reasons: 1) microdata sets often identify a small number of local areas or have small sample sizes within each market; 2) cost of living data across labor markets are not readily available; 3) area amenities are difficult to measure and incomplete at best; 4) and, as discussed in the previous section, interarea price indices do not accurately reflect "true" cost of living since they fail to account for substitution or differences in preferences, and reflect in part the valuation of site-specific amenities and productive characteristics by workers and firms.

In this paper, we address in a satisfactory fashion limitations 1 and 2 through the use of cost of living data for 185 metropolitan areas matched to a large CPS data set on individual earners. Limitation 3 is partially addressed -- we control for a variety of site-specific area amenities, although important site characteristics valued by workers and firms remain unmeasured. We address limitation 4 in an indirect fashion. We cannot measure true cost of living indices across areas and test directly the competitive hypothesis that real wages or utilities equalize across labor markets. We address this question indirectly, however, and in the process provide useful evidence on the relationship between interarea wages and prices. Our evidence suggests that real wages are far more similar across areas than are either nominal wages or wages fully adjusted for measured price differences.

As discussed in the previous section, interarea wages are expected to increase less than proportionately with respect to cost of living. This presents a dilemma for the measurement of wage differentials. Let's suppose that half the difference in measured price levels between two cities reflects

[5] Greenwood, Hunt, Rickman, and Treyz [1991] conclude that errors generated in the estimation of compensating differentials by erroneously assuming regional equilibrium appear to be relatively minor, both quantitatively and qualitatively.

higher prices necessary to achieve a given level of utility, while the other half reflects the greater valuation placed on (unmeasured) amenities or the ability of consumers to substitute in response to differences in relative prices. On the one hand, comparison of wages fully adjusted by a cost of living index would exaggerate the true cost of living and understate real wages in the higher-priced city. On the other hand, comparison of nominal wages across the two cities would fail to account for true cost of living differences and overstate relative wages in the higher-priced city.

Ideally, one would like to provide a partial adjustment to wages based on cost of living differences necessary to achieve equivalent utility levels (i.e., half the measured price difference in the above example). Prior literature typically uses one of two extremes -- nominal wage differentials without cost of living adjustment or a measure of "real" wages based on full adjustment for cost of living. The former explicitly or implicitly assumes that differences in cost of living fully reflect differences in valuation of area amenities, whereas the latter assumes that none of the difference in measured prices reflect differences in valuation.[6]

In this study, we argue for a partial regression-based cost of living adjustment to wages that lies between the no adjustment (nominal) and full adjustment approaches. We present estimates of wage differentials based on all three approaches. Our method for adjustment is quite simple. Let log wage equations (1), (2), and (3) below represent the cases where there is no adjustment for cost of living (i.e., a standard nominal wage equation), full adjustment, and partial regression adjustment, respectively.

(1) $lnW_{ikt} = X_{ikt}\beta + \varepsilon_{ikt}$

(2) $ln(W/P)_{ikt} = (lnW\text{-}lnP)_{ikt} = X_{ikt}\beta_i + \varepsilon_{ikt}$

(3) $lnW_{ikt} = X_{ikt}\beta_{ikt} + \theta lnP_k + \varepsilon_{ikt}$

[6] Eberts and Stone [1992] rely on the former assumption, while Bellante [1979], Sahling and Smith [1983], Montgomery [1992] and most other studies adjusting for cost of living assume the latter. An exception is Roback's [1988] analysis, based on CPS data from large Standard Metropolitan Statistical Areas (SMSAs). As we will do in this paper, Roback includes the log of price on the right side of a nominal log wage equation, therefore allowing for partial rather than full adjustment for measured cost of living. A rarely noted advantage of using panel data and wage change equations is that this controls not only for worker-specific preferences and skills, but also interarea differences in cost of living if households have not moved (this is true by construction in CPS panel data sets), whereas wage level equation estimates compare earners across areas with different costs of living. Krueger [1988] makes this point in the context of private-public sector wage differential estimates.

Here lnW_{ikt} is the natural log of hourly earnings for individual i in labor market k in year t, X is a vector of personal and labor market characteristics (including amenities) and β is the corresponding coefficient vector, lnP is the log of the cost of living index in area k, and ε is an error term with zero mean and (by assumption) constant variance. If cost of living (lnP) were identical across markets then equations (1) and (2) -- the nominal and full adjustment wage equations -- would be equivalent, differing only by a constant. Equations (2) and (3) are equivalent if $\theta=1$, implying that nominal wages rise in equal proportion to measured interarea price indices. β and ε will not in general be equivalent in equations 2 and 3 if θ is not equal to unity.

The maintained assumption of this paper is that real wage differentials are better approximated by a regression-based partial adjustment method (equation 3) than by either nominal wages or wages with full price adjustment (equations 1 and 2, respectively). As estimated subsequently, the wage adjustment parameter θ is significantly greater than zero and significantly less than unity (our point estimate of θ is about .4). We contend that a reasonable approximation to real (i.e., utility constant) wages is to provide a partial adjustment to measured cost of living differences based on regression estimates of θ. That is, $\theta=.4$ would indicate that it is reasonable to assume that 40% of measured price differences represent a true price differential, while 60% reflects a valuation of goods and services across markets owing to area amenities, the ability to substitute as relative prices change, and any overstatement of true cost of living differences by the measured price index.[7]

Our approach to measuring the real wage is, at best, an approximation. First, specification (3) above assumes a simple linear relationship between lnW and lnP, whereas substitutability in consumption in response to changes in prices (in particular, housing services) implies that wages should increase at a

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[7] The superiority of specification (3) over (1) does not automatically follow. Suppose that the true θ equals unity and that lnP measures the true cost of living on average, but with random measurement error. In this case, estimates of θ are biased toward zero (bias increases with the ratio of measurement error to the variance in true cost of living). Under these circumstances, estimating equation (1), which implicitly restricts θ to unity, is preferable. For reasons discussed in the paper, lnP is expected to systematically overstate the true cost of living, leading to estimates of θ less than unity. Based on evidence presented in the paper, we argue that in practice, estimates from (3) are preferable to those from either (1) or (2). In addition, we show that interarea wage dispersion is minimized using a value of θ very close to that estimated in (3), suggesting that classical measurement error is not an important explanation for the finding $\theta<1$.

decreasing rate with respect to prices.[8] Second, the partial adjustment method assumes that the relative proportion of price differences that reflects true difference in the cost of obtaining utility are equivalent across markets. Even if θ is correct on average, θ will not be identical across markets. Hence, the finding that there exist interarea wage differentials following use of the partial adjustment method does not allow us to reject the competitive hypothesis. But a finding of *substantially* lower dispersion in interarea wages partially adjusted for cost of living, as opposed to full or no adjustment, certainly provides stronger support for the competitive hypothesis of real wage equalization than has been evident in prior studies.

Regression estimates of θ are more likely to approximate a correct price adjustment if *unmeasured* worker quality does not vary with area cost of living and, by extension, city size. We offer no direct evidence on unmeasured skills and city size. Some authors contend that part of the city size wage premium is a compensating differential for higher worker quality[9] But it is not clear whether or to what extent unmeasured quality varies with cost of living and city size. Indeed, papers by Glaeser and Maré [1994] and Ciccone and Hall [1996] suggest that there exists a positive relationship between productivity and size not so much because of unmeasured worker quality, but because of the nature of jobs or agglomeration economies in larger cities or in dense markets.[10] If unmeasured worker quality is higher in more costly labor markets, estimates of θ will be biased upward.

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[8] Equation (3) holds that $lnW\text{-}\theta lnP$ approximates the real wage. A less restrictive approach, which we adopt in a subsequent section, is to include lnP and higher orders of lnP (i.e., quadratic, cubic, and quartic) on the right hand side. If P is centered close to 1.0 rather than 100, the scaling of $lnW\text{-}\theta lnP$ has greater intuitive appeal.

[9] For example, Fuchs [1967, 34] speculates: "One of the most promising hypotheses to explain the city-size differential is that it reflects differences in labor quality not captured by standardization for color, age, sex, and education. This might take the form of better- quality schooling, more on-the-job training, selective in-migration to the big cities of more ambitious and hard working persons, or other forms."

[10] Glaeser and Maré utilize both the NLSY and PSID in order to examine wage changes among those moving into and out of SMSAs. Movers in *both* directions receive wage gains, suggesting that more is at work than cost of living differences or unobserved worker skills. They conclude that a principal source of the city size wage premium is that workers in cities acquire more intense training; hence, over time workers accumulate greater skills and realize higher wages. They argue that it is the nature of jobs in dense markets, rather than gains associated with superior matching of workers and jobs, that is primarily responsible for greater skill accumulation (also see Rauch [1993], discussed previously). Ciccone and Hall proffer a model (and provide interstate evidence) in which there are aggregate increasing returns with respect to spatial density owing either to local externalities or the diversity of local intermediate services, while at the same time disamenities associated with density (e.g., commuting time) require compensating wage differentials for workers. An equilibrium with multiple labor markets (rather than a single market) arises in which compensating (nominal) wage differentials just offset productivity increases at the margin.

IV. Data and Estimates of Nominal, Full, and Partial Adjustment Wage Equations

Individual earnings data used in our analysis are from the 116 monthly Current Population Survey Outgoing Rotation Group (CPS-ORG) earnings files between October 1985 and May 1995. This is the period in which the CPS designated households' residence in one of 202 CMSAs or MSAs with populations over 100,000 in July 1983. The ORG files include the quarter samples of households from each monthly CPS (i.e., the outgoing rotation groups) who are asked questions in the earnings supplement (e.g., earnings, hours worked, and union status). Our sample includes all employed wage and salary workers ages 16 and over with positive earnings and weekly hours worked. We exclude employees whose principal activity during the survey week is school. The total usable sample size among the 185 CMSA/MSAs for which we have cost of living data is 1,133,580.[11]

All wage differentials presented in the paper are expressed as logarithmic differentials, based on coefficient estimates from standard log wage equations.[12] Wages are measured by usual weekly earnings divided by usual hours worked per week, in May 1995 dollars (we deflate worker earnings using the monthly CPI-U). Weekly earnings in the CPS are top-coded by the Census at $999 through 1988 and at $1,923 beginning in January 1989. For the relatively few workers who are top-coded, earnings are assigned based on the assumption that the upper tail of the earnings distribution follows a Pareto distribution, with the parameters of the distribution estimated separately by year and gender.[13] To reduce measurement error, workers whose implicit hourly earnings are below $2.00 or above $99.99 are excluded from the sample.

Previous studies accounting for interarea differences in cost of living typically use the BLS publication *Urban Family Budgets and Comparative Indexes for Selected Urban Areas*, discontinued after 1981, which provides cost of living comparison for large Standard Metropolitan Statistical Areas (SMSAs). This index forms the basis for studies by, among others, Johnson [1983], Sahling and Smith [1983], Roback

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[11] Prior to October 1985, the CPS designated 44 SMSAs. After May 1995 designated areas changed to 1993 Census definitions. CPS-ORG files are not Census public use data, but are prepared for use by the Bureau of Labor Statistics. Public access versions and record layouts are provided by the BLS Data Services Group.

[12] Percentage differentials are approximated by $[\exp(\beta)-1]100$, where β is the log differential.

[13] The mean earnings assigned to workers at the cap, as well as a discussion of the Pareto distribution, are provided in Hirsch and Macpherson [1998, 6]. The means at the caps are roughly $1,500 prior to 1989 and $3,000 beginning in 1989. The estimated means rise slightly over time and are higher for men than for women.

[1982, 1988], Hirsch and Neufeld [1987], and Montgomery [1992]. Other researchers have developed state or regional price indices, with the BLS information as their primary source (e.g., Bellante [1979] and Fournier and Rasmussen [1986]). Such indices mask variation in cost of living within states and regions. An additional impediment to adjusting for cost of living in wage studies is that detailed area identifiers may not be available or city sample sizes are small.[14]

The principal source of information currently available on interarea cost of living is the ACCRA Cost of Living Index, available in quarterly publications from the Chamber of Commerce. The index measures six components of cost of living: housing, groceries, transportation, health care, utilities, and miscellaneous goods and services. Data are provided on an overall area index and its component parts.[15] This index has received limited use in wage studies (but for a recent study using the index, see Glaeser [1998]) owing in large part to a number of practical difficulties. The index is not collected for every MSA in every quarter (indeed, many MSAs rarely report information), cost of living is reported for some but not all areas of a CMSA or MSA, and (less frequently) cost of living is reported for different areas within a metropolitan area over time. Moreover, reliability of the index is likely to be lower than with an index produced by the BLS.[16]

Using the ACCRA data, we construct a cost of living index for 185 CMSA/MSAs (out of the 202 in the CPS) for the period 1985:4 through 1995:2. In order to fill in information for all quarters, linear interpolation is used for all missing quarters between two non-missing quarters. When the index is not reported for endpoints of the period, the value of the index for the first reported period is extended back to 1985:4, and the index for the last reported period is extended forward to 1995:2. This makes the reasonable assumption that *relative* interarea prices changed little during the period over which the data are extended. In CMSAs where price information was available only for component PMSAs, and in MSAs where

[14] Of the 44 SMSAs designated in the CPS public release files prior to October 1985, cost of living data were available for 29. This constituted 29 of the 30 largest SMSAs, with Miami being the exception.. The NLSY provides only information on whether a person resides in an SMSA on their public use files, but on request will normally make more detailed information available to researchers. The PSID provides information on state and county of residence.

[15] Note that wage and price indices are not (nor should they be) independent. Although there is no explicit wage component in a cost of living index, high wages relative to productivity will be associated with higher prices (and vice-versa), particularly for non-traded services with a large labor cost component.

[16] For a summary of recent government efforts to develop interarea wage and price indices, see the U.S. Department of Labor [1997].

information was available only for component cities, a weighted index was formed for the larger units based on population counts of the smaller units from the 1990 *Census of Population*.[17] Once values are assigned to all quarters for all CMSA/MSAs, we took the arithmetic average within each metropolitan area to arrive at a single index for each area for the entire 1985:4-1995:2 period. Although averaging over the 1985:4-1995:2 period masks real changes over time in *relative* cost of living across areas, it reduces what we believe is more substantial error owing to measurement error in an area's index at any single point in time. Values of the ACCRA Index for our 185 CMSA/MSAs are provided in Appendix 1.[18]

We also utilize data on area amenities, compiled from the *Places Rated Almanac* (Boyer and Savageau [1989]). Measured amenities primarily affect worker utility rather than business costs or productivity, and are treated as time-invariant over the 1985-95 period. Measures included are the property crime rate (measured over the previous five years), average annual relative humidity, annual snowfall, annual rainfall, and aggregate indices intended to measure the quality of health care, arts and culture, and education. Weather measures are provided for 132 of our 185 metropolitan areas; the remaining 53 are matched to nearby cities with available data. Other amenity measures are available for all 185 areas.

Prior to presenting estimates of nominal and real wage differentials, we examine briefly the question of how much of the variation in interarea cost of living can be accounted for by region and city size. Table 1 presents regression results with *lnP* as the dependent variable (n=185), with combinations of broad region, detailed region, a large metropolitan dummy, and detailed city size dummies as right hand side variables. City size categorical dummies are defined based on population counts in 1990. The conclusion from Table 1 is that detailed region and city size dummies provide a fairly good proxy for cost of living differences, whereas more aggregated measures do not. For example, controlling for broad region and a large metropolitan area dummy (column 2) accounts for just over one-third of the variation in measured cost of

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[17] In some CMSAs, price information was available for some but not all of the component PMSAs, and in some MSAs information was available for some but not all of the component cities. In these cases, the component PMSAs or cities for which data were available were reweighted so that their sum equalled unity (weights were set to zero for PMSAs or cities with missing data).

[18] The simple correlation of the index over time is high, indicating little change in relative cost of living across areas over the period. As a practical matter, the results in the paper are affected little when we use each quarter's index, rather than their average over the period.

living, whereas control for the nine detailed Census regions and seven city size categories (column 5) accounts for almost two-thirds of the variation.

Empirical analysis in the next two sections focuses on two general issues. First, we compare the dispersion in nominal, full adjustment, and partial adjustment (approximate real) wages across geographic areas following control for measured worker, job, and market characteristics. Second, we examine the sensitivity of racial, gender, union, and other commonly estimated wage differentials to the treatment of cost of living.

V. Interarea Wage Differentials: Do Real Wages Equalize?

Economic theory suggests that real wages (utility) for equivalent workers should tend toward equality across labor markets. Because area amenities valued by workers and firms differ across labor markets, however, neither nominal wages nor wages fully adjusted for measured cost of living accurately measure real wages across markets. A strict test of the competitive hypothesis would almost certainly be rejected, given the absence of a true interarea price index, because labor markets need not be in long-run equilibrium at any point in time, and because many aspects of worker quality and site-specific productive and nonproductive amenities remain unmeasured. A weaker test of the competitive hypothesis is whether interarea differences in "approximate real" wages are "small", and if the interarea dispersion in approximate real wages is less than the dispersion in either nominal wages or wages fully adjusted for measured cost of living differences. Although we cannot measure real wages explicitly, we have argued that our partial adjustment for measured price differences provides an approximation to real wages that is preferred to either nominal or full adjustment wages.[19]

[19] An alternative test of the competitive hypothesis is to examine whether the returns to skills are equivalent across markets. If workers are heterogeneous and the heterogeneity is not fully measured, however, then measured returns will not be equivalent. Earnings function parameters estimated within cities represent only within-labor market returns and not total returns, since the latter includes interarea mobility and sorting. For example, an increase in schooling not only enhance one's opportunities within markets, but also increases the probability of working in labor markets where jobs require greater skills and provide higher pay. Within-city rates of return capture the former but not the latter. Studies examining interarea wages typically conclude that intercity differences result more from coefficient differences across markets than from differences in worker means of measured characteristics across cities (Hanushek [1973], Beeson and Groshen [1991], and Beeson [1991]).

There exists relatively few studies, however, comparing real versus nominal wages across metropolitan areas, following control for worker characteristics (for a review, see Dickie and Gerking, 1989; for an interesting recent study based on data from 114 U.S. cities for 1879-1919, see Rosenbloom [1996]). One of the better studies is by Johnson [1983], who provides such an analysis for 33 SMSAs in 1973-76 (some SMSAs are assigned cost of living based on the index in a nearby area). He finds that wage dispersion across the SMSAs *increases* following full adjustment for cost of living. Johnson outlines the conditions under which such a result will be obtained while Roback [1988], as discussed above, outlines a theoretical rationale for such a finding.

In what follows, "nominal" refers to wages not indexed for interarea cost of living differences, "full adjustment" refers to wages fully indexed by interarea cost of living differences, and "partial adjustment" to wages regression adjusted for cost of living by the inclusion of *lnP* on the right hand side of the log wage equation. Our approach below is to provide estimates of differentials based on estimates from nominal, full adjustment, and partial adjustment log wage equations, as shown in (1), (2), and (3) above. In order to conserve space, neither standard errors nor t-ratios attaching to wage differentials are presented. With such large sample sizes, even small log differentials are statistically significant by standard criteria.

We first examine South/non-South wage differences, then turn to a broader examination of regional differences, and then to the wage gradient with respect to city size. We then turn to the key issue of differentials across labor markets, comparing the dispersion in nominal and real wages across 185 metropolitan areas.

Regional and City Size Wage Differentials.

Table 2 presents estimated nominal, full adjustment, and partial adjustment wage differentials for the South relative to the non-South, among the 9 Census regions, and between metropolitan areas of different population size. Results are presented with standard control variables, with and without detailed city size dummies, and with and without area amenities included. The South/non-South differential has been the focus of previous research (e.g., Bellante [1979] and Sahling and Smith [1983]). As found in studies for earlier periods, relative earnings in the South are found to be substantially higher following control for cost of living. In a standard specification absent city size controls, the South nominal log wage disadvantage is -.075. Following full adjustment for cost of living, however, the South displays a .085 wage advantage. That is, adjusting fully for measured cost of living increases relative urban Southern wages by .16 log points. Control for city size greatly moderates both extremes -- the nominal Southern wage disadvantage is estimated to be -.043 and the full adjustment wage advantage .039.

We have argued that full adjustment for cost of living overstates real wages in low cost of living areas. Based on our preferred partial adjustment method, we find that South/non-South differences in approximate real wages are in fact quite small. Based on specification with city size controls, we find a Southern earnings disadvantage of -.02. In the specification including area amenities, our partial adjustment estimate of the South/non-South differential (shown in the last column) turns positive but is effectively zero (.012), the change reflecting a somewhat higher level of amenities in the South for cities with similar measured cost of living (see Greenwood et al. [1991] for evidence on area differences in amenities). We believe these results lend credence to the partial regression adjustment method for approximating real wage differentials.

Also informative is an examination of wage differentials among the nine Census regions. Table 2 presents these results with New England being the omitted reference group. To summarize results, we calculate the standard deviation of the regional log wage differentials, weighting by employment in each region (the omitted region is assigned a differential value of zero). Our principal result is that in comparison to regional dispersion in nominal wages, dispersion in wages fully adjusted for cost of living is substantially higher, while dispersion in approximate real wages across regions is substantially lower. For example, in the specification without city size or amenity controls, the weighted standard deviations of the region coefficients are .058, .088, and .035 from the nominal, full adjustment, and partial adjustment wage equations, respectively. As expected, inclusion of detailed city size dummies lessens estimated dispersion, producing values of .036, .071, and .032 for the three respective methods. Results with amenities included are similar. In short, our preferred estimates suggest very modest differences in wages across the nine Census regions, with the dispersion in approximate real wages less than half that of wages fully adjusted for measured cost of living.

The sensitivity of regional wage estimates to cost of living adjustment can also be seen by examining specific region coefficients. For example, focusing on the specification that includes city size dummies but excludes amenities, the nominal wage equation suggests that the New England and Pacific regions have the highest (and similar) wages, with the lowest wages being in the East South Central region, with wages .12 lower than in the highest wage regions. Following full adjustment for cost of living, New England is estimated to have the *lowest* wages (all other coefficients are positive, with the largest deviation being .20). Both sets of estimates suggest large wage differences between New England and the rest of the country, but in opposite directions! By contrast, our approximation of the real wage suggests very small differences between New England and the rest of the country, with the exception of a .07 differential with the Pacific region. Again, results with amenities included are similar. Our contention is that the partial regression adjustment method provides better measures of regional real wage differentials than the use of either nominal wages or wages fully adjusted by measured cost of living.

Also rather startling are the substantial differences between alternative estimates of city size wage differentials. Presented in Table 2 are coefficient estimates for six city size categories, with small MSAs (populations less than 200,000) the omitted reference group. Focusing first on the nominal log wage equation (without amenities), the wage advantage of workers in the largest (population greater than 5 million) relative to the smallest metropolitan areas is .20 (22.1%), while the wage advantage in the largest relative to the next largest size (2 to 5 million) is .05. In sharp contrast, full adjustment for cost of living produces estimates of a -.078 wage *disadvantage* in the largest relative to the smallest urban areas, and a -.098 wage deficit compared to workers in cities with populations 2 to 5 million.

Neither the nominal nor full adjustment results provide plausible city size wage differentials. By contrast, differential estimates are highly plausible using the partial regression adjustment method. One obtains a positive real wage-city size gradient roughly half as large as the nominal wage-size gradient. As compared to the smallest urban areas, workers in metro areas with populations 200-500 thousand display an approximate 5% wage advantage, those in areas sized 1/2 to 2 million a 7% advantage, and those in areas 2 million and over an approximate 10% advantage. In short, there appears to be a real wage difference between those in very small urban areas and larger areas, with a relatively flat wage-size gradient for workers in urban areas with populations greater than 200 thousand. Calculation of the weighted standard deviation of city size coefficients using the nominal, full adjustment, and partial adjustment wage methods without control for amenities produces figures of .060, .052, and .026, respectively.

Following control for area amenities, nominal and full adjustment wage differences across size categories are substantially reduced, to levels similar to that obtained using our partial adjustment approach. Clearly, both city size and cost of living reflect to a substantial degree site-specific amenities and disamenities. With or without control for amenities, however, we find a modest but positive size-wage gradient using our partial adjustment method. We suspect that omitted productivity and disamenity differences not reflected in measured cost of living account for much of the remaining wage-size gradient. Weighted standard deviations of the size coefficients are .029, .027, and .028 using the three methods. These results reinforce our conclusion that real wage dispersion with respect to city size is modest, and further support the plausibility of approximating unobserved real wages through the use of a regression-based partial adjustment for interarea differences in measured cost of living.

Wage Differentials Across Labor Markets.

In this section, we provide an analysis of intercity differences in wages. Our initial approach is similar to Johnson [1983]. In contrast to his study, we examine more recent evidence, have wage and cost of living data for 185 metropolitan areas, and provide estimates using a regression based adjustment for cost of living in addition to nominal and full adjustment differentials. Specifically, we estimate area-specific wage differentials for the 185 CMSA/MSAs. We do this by first calculating the means of the residuals by city from the nominal, full adjustment, and partial adjustment wage regressions (equations 1-3), with inclusion of detailed region and city size dummies. Interarea wage dispersion is measured by the employment weighted standard deviation of the city differentials and by the weighted mean absolute error across labor markets. In the top part of Table 3, we provide estimates based on wage equations 1-3 with amenities excluded. Using the partial adjustment approach, we obtain an estimate of *2* of .370. The bottom part of the table is based on specifications with amenities included. Consistent with expectations, *2* rises with the inclusion of amenities, to .457, but is still far below unity.

As in Johnson [1983], we find an *increase* in intercity wage dispersion as we move from nominal wages to wages fully adjusted for measured price differences. Looking at the weighted standard deviation of the metropolitan area differentials, we obtain a value of .084 from the nominal wage equation, compared to .114 with *ln(W/P)* the dependent variable. However, we reject the apparent inference that interarea dispersion in real wages exceeds dispersion in nominal wages. When we estimate the wage equation with *lnP* on the right side (i.e., $lnW - \theta lnP$ as the implicit dependent variable), our preferred approximation of the real wage, the standard deviation of the metropolitan area coefficients drops sharply to .052, less than half the dispersion exhibited when full adjustment is used. These results are far more consistent with the competitive hypothesis of real wage equalization than results based on standard analysis, and suggest that mobility is sufficiently strong in the U.S. so as to limit the magnitude of real wage differences.

At the bottom of Table 3, results are presented based on specifications with amenities included. We prefer to emphasize results *without* amenities in order to better reflect how the treatment of cost of living affects estimated wage dispersion in standard analysis. Although we find the same pattern of results following control for amenities, differences in residual wage dispersion is lower -- .049, .062, and .038 -- using the three methods. In short, controlling explicitly for a small number of readily-measured site amenities accounts for some of the residual wage dispersion evident using nominal or full adjustment wage regressions. Even with measures of amenities, however, the partial regression approach reduces residual wage variation across labor markets.[20]

A similar pattern of results are obtained using the mean absolute deviation as a dispersion measure (see the far right column). In all cases, we conclude that dispersion in partial adjustment wages across markets is lower than the dispersion in nominal wages or wages adjusted fully for measured cost of living. Although this is not a direct test of the competitive hypothesis, the finding of small interarea wage

[20] *Unweighted* standard deviations across labor markets are .077, .066, and .056 based on nominal, full adjustment, and partial adjustment methods without amenities. Corresponding figures with amenities are .060, .059, and .046. Note that decrease in dispersion following adjustment by θlnP is to be expected by construction as well as theory since the parameter θ measures the extent to which wages adjust to *lnP*, on average, as one moves from cities with lower to higher measured cost of living. As seen below, a nonlinear specification including a quadratic price term decreases dispersion across cities even further.

dispersion provides support for the expectation that in the long run real wages for equivalent workers tend to equality across labor markets.[21]

Specification.

In results shown to this point, we have imposed the restriction that the relationship between log wages and log price is linear. Emphasis on the linear model has been for convenience. In this section, we assess the appropriateness of the linearity assumption. As discussed in Section II, theory predicts a nonlinear relationship, with log wages increasing at a decreasing rate with respect to log prices. Moreover, we expect that inclusion of higher order terms of lnP, allowing a closer fit of wages to prices, might be associated with an even lower level of dispersion in "approximate" real wages across labor markets.

In Table 3, coefficients on the price terms from nonlinear specifications are presented. As predicted, the relationship is nonlinear, with log wages increasing less than proportionately with respect to log prices. Introducing higher order price terms reduces the dispersion in the log wage regression residuals across our 185 labor markets. As previously shown, the weighted standard deviation of mean residuals across metropolitan areas is .084 from the nominal wage equation (without amenities), .114 from a regression with the full adjustment wage (lnW-lnP) as dependent variable, and .052 from a regression with lnW-.370lnP as the (implicit) dependent variable. Using the quadratic adjustment (.793lnP-.737lnP^2) dispersion declines substantially, from .052 to .042. Including cubic and quartic adjustments has virtually no effect on interarea dispersion, however, with values of .042 and .043, respectively. A similar pattern is found when amenities are included although, again, overall dispersion is lower than without amenities -- .033 versus .042 using the quadratic specification. Despite the gain from use of a quadratic, we use a simple linear model elsewhere in the paper for ease of presentation. If anything, this has caused us to understate the strength of our results.

An additional probe of the linear adjustment model is to estimate the dispersion in real wages across labor markets using alternative values of θ. The value of θ that minimizes dispersion is found by using a grid search down to four decimal places. In the specification without amenities, we obtain a minimum

[21] We tested for the null that mean residuals across labor markets are equivalent, obtaining F ratios of 258.03, 489.67, and 93.78 for the nominal, full adjustment, and partial adjustment equations (without amenities). Although F ratios are far lower for the partial adjustment approach, in all cases the null is rejected using either standard critical values or a more stringent criterion suggested by Leamer [1978, 114] that adjusts critical F values upward to reflect large sample sizes.

dispersion of wages (measured by the weighted standard deviation) of .0516, which is produced by a value of θ of .3943. This is very close to the dispersion value .0518 we obtain based on the linear regression value of θ of .370, but much larger than the value of .042 obtained using a quadratic *lnP* adjustment. A similar pattern is found when amenities are included in the wage regressions. One can improve upon the linear specification and our simple approximation to the real wage. But the important point to be made is the distinction between interarea wage dispersion following the use of a partial regression adjustment, as opposed to dispersion in nominal wages or wages fully adjusted for measured cost of living.

Comparison with an Alternative Cost of Living Index.

As a check on the reliability of our ACCRA index, we compare it to cost of living figures constructed from the BLS *Urban Family Budget and Comparative Indexes for Selected Urban Areas*, updated from its 1981 value to 1989 using the city-specific CPI-U. The ACCRA index, BLS index, and city CPI data are available for 22 large metropolitan areas. Among these 22 cities, the BLS index has weighted and unweighted correlations with our ACCRA index of .87 and .94, respectively. Relative dispersion and the range of the ACCRA index are higher, however, than the BLS index. For the 22 cities, the coefficients of variation for the ACCRA and BLS indices are 16.6 and 9.4, respectively, while ranges are 76.6 and 53.6. The lower range of the BLS index is not surprising in that it allows substitution across areas (i.e., different consumption weights), whereas the ACCRA index prices a fixed bundle of goods and services.

We estimate log wage equations for the 22 cities with *lnP* on the right side. The equation includes the standard controls (but not amenities) and, owing to the limited number of cities, includes broad region but not city size dummies. We obtain values of θ of .366 using the ACCRA index, very close to what is obtained with our full sample. Using the BLS index, however, we obtain an estimate of θ of .526. If it is the case that the BLS index is the better measure of cost of living while the ACCRA index overstates differences between low and high cost areas, then regression estimates of θ should not only be less than unity, but also lower using ACCRA than alternative indices. Such a result argues further against reliance on wages fully adjusted to price differences as measured by the ACCRA index.

Differences in the Wage-Price Relationship by Education Group.

Beeson [1991] has examined how the valuation of site amenities can differ by education level. Likewise, estimates of θ, reflecting the extent to which wages rise with measured cost of living, may well differ between groups of workers if amenity valuation differs. We briefly explore this issue by estimating separate wage equations and θ values for four education groups -- high school dropouts, high school graduates, those with some college, and those with a college degree or beyond. Education provides a useful pre-market characteristic by which to segment skill groups since it is correlated with earnings but not a direct market outcome (wage equations that truncate observations on the basis of the dependent variable generally bias coefficients toward zero).

In our partial adjustment model (equation 3) without amenities, estimates of θ are .32, .34, .37, and .39 for the low to high education groups, respectively. Following addition of amenities, estimates of θ rise, as expected, to .49, .45, .48, and .39. Although estimates of θ are broadly similar among those with high school and some college, there is a clear tendency for θ to rise with respect to schooling in wage equations without amenities, and fall with respect to schooling following control for amenities. It appears that amenity valuation among college graduates differs from that of less educated workers. A lower θ for college graduates than for non-graduates (in specifications with amenities) also may reflect a greater ability and willingness to alter consumption bundles (in particular, housing services) in response to area price differences. Hence equilibrium wages need rise less quickly with respect to measured prices. A careful examination of amenity valuation and differences in θ across worker groups warrants study, but is beyond the scope of this paper.

VI. Wage Differentials Based on Nominal, Full Adjustment, and Partial Adjustment Methods

In this section, we examine the sensitivity of wage differential estimates to both the treatment of cost of living and the richness of controls for region and city size. Among the differentials examined are those for race, Hispanic status, returns to schooling, the gender gap, union wage premiums, the part-time penalty, and industry and occupational wage differentials. All results are shown *without* control for amenities in order to facilitate comparison with existing literature. The results not only provide new evidence on group wage differentials, but also provide guidance to researchers estimating wage equations.

Race and Ethnic Differentials.

In this section we examine gender-specific black-white, Hispanic, and Asian-white wage differentials. For ease of calculation and presentation, we have estimated log wage regressions pooled across worker groups (and years), with dummies included to measure wage differentials for the appropriate groups. Separate equations are estimated to obtain nominal, full adjustment, and partial adjustment wage differentials, with and without detailed controls for city size. As it turns out, the inclusion of city size dummies substantially lessens differences between nominal and partial adjustment wage differentials. A clear-cut implication is that researchers lacking appropriate data on true cost of living should control in some detail for city size differences.

Our results with respect to race are interesting (Table 4). Although African-Americans are heavily represented in the South, where cost of living is lower, they also are over-represented in relatively high cost of living cities within regions. On net, price adjusted black-white wage gaps are moderately *larger* than are nominal gaps (we do not show differentials relative to nonwhite non-blacks). Focusing first on the male racial gap, absent controls for city size, we find that the nominal racial gap increases in magnitude from -.134 using nominal wages, to -.182 with full adjustment for measured cost of living. The partial adjustment male racial gap is -.156, or 2 percentage points higher than the estimated nominal gap. Inclusion of city size dummies narrows this differential, producing a nominal estimate of -.151 and an approximate real estimate of -.159 (the full adjustment gap is -.172). The racial gap among women shows a similar pattern -- absent city size controls we obtain nominal, full adjustment, and partial adjustment estimates of -.033, -.080, and -.054, respectively. Following controls for city size, the respective gaps are -.051, -.069, and -.058. As before, the inference is that absent measures of cost of living, inclusion of detailed controls for city size in nominal wage equations is crucial. And if cost of living data are available, full adjustment produces unreliable estimates of real wage differences.

We next examine wage differentials between Hispanics and non-Hispanics.[22] As seen in Table 4, failure to account for cost of living differences causes an understatement of the Hispanic wage gap. This results in part because Hispanics are disproportionately represented in relatively high cost of living cities such as New York, Miami, and cities in California. For example, using standard controls and detailed region (but not city size) the Hispanic male nominal wage deficit of -.110 increases to -.181 following full adjustment for measured price differences. The regression adjusted gap estimate is -.143. Our estimate of an approximate real male Hispanic gap following control for city size is -.147, close to the nominal differential obtained with city size controls. An identical pattern of coefficients in estimates of the Hispanic female gap, where our preferred partial adjustment gap is -.082. As was the case for race, we conclude that real Hispanic wage gaps are larger than nominal gaps, and that it is important to control for detailed city size when estimating gaps with nominal wages.

Finally, we focus on the wage differential between Asians and whites.[23] Once again, the relatively high concentration of Asians on the high-cost West Coast causes the relative wages of Asians to be overstated. Whereas the nominal wage gap using standard controls plus city size is -.103 for males, the full adjustment wage gap is -.187. Our preferred gap estimate based on partial price adjustment is -.141. We observe an equivalent pattern for Asian women, obtaining estimates of -.045, -.131, and -.083 Asian-white log wage gaps in the case of nominal, full adjustment, and partial adjustment differentials, respectively. Asian-white estimates with and without control for city size are highly similar. As was our conclusion regarding the racial gap, nominal wage differentials understate the gap in real wages between Asian and white workers.

Other Wage Differentials: Nominal Versus Real.

This section provides a relatively brief analysis of other wage differentials. Table 5 presents results

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[22] Hispanics may be white or black; all equations include separate race dummies in addition to a Hispanic dummy. In results not shown, we find the Hispanic nominal wage disadvantage to be larger in our urban sample than in the full national sample. This may reflect a tendency for urban Hispanics to be less likely than nonurban Hispanics to have achieved English proficiency or be fully assimilated into Anglo culture. On the importance of language proficiency, see, among others, McManus, Gould, and Welch [1983] and Bloom and Grenier [1993].

[23] Prior to 1989, Asians were not separately identified in the CPS but, rather, included in a race category labeled "other." A separate category labeled "Asians and Pacific Islanders" was identified beginning in 1989. The Asian results shown in Table 4 are based on data for the period 1989-1995.

for alternative differential estimates with respect to union status, schooling, public sector status, part-time status, gender, marital status, and industry. Nominal, full adjustment, and partial adjustment log wage differentials are shown for specifications with and without controls for city size.

Consistent with previous work by Hirsch and Neufeld [1987] based on a smaller CPS sample in 29 large SMSAs, we conclude that adjustment for cost of living has little effect on estimates of union-nonunion wage differentials. The union premium is estimated to be about .14 regardless of specification or price adjustment method. In work not shown, we find (as in Hirsch and Neufeld) somewhat higher union premiums based on the full U.S. sample, as compared to our sample from 185 urban areas.

If highly educated workers are more likely to live in higher cost areas, one might expect real rates of return to schooling to be lower than nominal rates. Such an effect could be offset, however, by a positive correlation between unmeasured ability, schooling level, and cost of living (city size). Moreover, if there exist spillover effects from employment where a workforce is highly educated (Rauch, 1983), then productivity (and nominal wages) should be higher, but prices should rise to equalize real wages. As evident in Table 5, however, we find small differences in schooling coefficients based on alternative adjustment methods and specifications, suggesting that the above factors either are not important or are offsetting.[24]

Most estimates of public sector wage differentials show relatively little sensitivity to cost of living differences.[25] The exception is for non-postal federal employees in the specification controlling for city size, where we find differentials with respect to private sector workers of .102 using nominal wages, .066 with full adjustment for cost of living, and .084 with partial price adjustment. Wage differential estimates for postal, state, and local workers, who are broadly distributed geographically, are not sensitive either to control for city size or the method of price adjustment.

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[24] Schooling coefficients are estimated in specifications without occupation dummies, since returns to schooling derive from both intra- and inter-occupational mobility.

[25] In regressions estimating public sector differentials, we omit control variables for union status and industry, since pay comparability laws typically require comparison of public sector workers (jobs) to those for the entire private sector (for a discussion of the issues involved, see Linneman and Wachter [1990]).

Estimates of gender, part-time, and marital status wage differentials are highly similar both across specifications and between equations using nominal, full adjustment and real wage measures. Because differences are so small, we do not explore or discuss these further.

A final comparison is between nominal and real industry wage differentials. We examine whether some of the dispersion in industry wages (e.g., Dickens and Katz [1987]), as well as its inter-temporal constancy, results because workers in more highly paid industries are more likely to reside in cities with high living costs. To test this thesis, we examine the weighted standard deviation of the differentials from the 14 industry categories, based on the nominal, full adjustment, and partial adjustment log wage equations. The dispersion in industry wage coefficients is highly similar, regardless of the measure. An identical conclusion is reached when we calculate unweighted standard deviations. We soundly reject the thesis that a portion of industry wage differentials can be accounted for by cost of living differences.[26]

VII. Interpretation and Conclusions

This paper has examined the role of cost of living in the estimation of wage differentials and provides estimates of nominal, full price adjustment, and partial price adjustment wage differentials across labor markets. Differences in cost of living reflects not only true cost differences in achieving given levels of utility, but also the valuation of productive and nonproductive site-specific amenities. Substitution in consumption and locational sorting with respect to relative prices add further complexity to the wage-price relationship. But in general we expect nominal wages to increase less than proportionately with respect to measured cost of living and at a decreasing rate. Such a relationship is borne out in our data.

We have argued that neither nominal wage rates nor wages fully adjusted for measured cost of living provide a good measure of interarea differences in real wages. We have proposed that real wages, by which we mean the utility generated from equivalent labor services, be approximated by $lnW - \theta lnP$, where θ represents the regression coefficient on the log of the price level in a standard log wage equation. This very

[26] We performed a similar exercise for occupations and found no difference in occupational wage dispersion based on coefficient estimates from nominal, full adjustment, and partial adjustment equations. An alternative that we did not explore, given the clarity of our results, is to include dummies for the roughly 230 detailed industries or 500 occupations identified in the CPS, and then calculate the dispersion in those coefficients.

simple partial adjustment method provides an admittedly crude approximation of real wages, yet one that is superior to either full adjustment for price differences or no adjustment. Even more accurate is a regression adjustment for cost of living based on a quadratic price adjustment.[27]

Adjusting for price differences has a large effect on estimates of interarea wage differentials. For example, following full adjustment for cost of living, estimates indicate that workers in the South realize a substantial wage advantage rather than a large wage penalty. By contrast, our regression adjusted approximation to the real wage suggests rough equality between wages in the South and elsewhere. Likewise, estimation of nominal city size wage differentials indicates that wages are more than 20% higher in the largest metropolitan areas than in small urban areas, whereas after full adjustment for price differences one finds over a 7% large city disadvantage. Our real wage measure suggests a positive but modest wage-size gradient, roughly half as large as that suggested by the use of nominal wages.

The dispersion in wage rates across 185 labor markets (following control for worker and location characteristics) is examined using alternative wage measures. We find interarea wage dispersion to increase slightly following full adjustment of nominal wages for measured price differences. By contrast, the dispersion in approximate real wages (i.e., partially price adjusted) is substantially lower than the dispersion in nominal wages. Our evidence is supportive of the expectation that labor mobility tends to equalize utility from wages at the margin for similarly skilled workers across markets.

In wage regressions without detailed controls for city size, we find significant differences between nominal, full adjustment, and partial adjustment wage differentials between blacks and whites, Hispanics and non-Hispanics, and Asian and whites. Relatively minor differences are found to be associated with public sector employment, schooling, union status, gender, marital status, part-time status, and industry.

The findings from this study provide guidance to researchers. Cost of living and amenity information are not readily available for many areas of the U.S. Moreover, price differences generally overstate true cost differences in obtaining utility. Measures of region and city size, however, provide a surprisingly good proxy for what we believe to be true cost of living differences. In a regression of the log

[27] A far more difficult alternative, not explored in this paper, is to estimate true price indices. This involves specifying and estimating utility functions based on data on consumption and prices. For an example of such an effort with national data, see Baye and Black [1986].

of the price level on detailed region and city size dummies, roughly two-thirds of the variation in the measured price level is accounted for. More important, estimates of wage differentials from *nominal* wage equations including detailed region and city size dummies typically provide estimates fairly close to those obtained by equations using our real wage approximation. In all cases, estimation of nominal wage equations with detailed region and size controls is superior either to nominal wage equations without controls, or to wage equations that fully adjust wages for measured interarea cost of living differences. The clear implication is that researchers should routinely provide detailed controls for city size and region in nominal wage equations.

Our results also have implications for public and private pay determination. Efforts by private firms, the federal government, or states to fully differentiate pay in accordance with ACCRA (or other) price indices will tend to overcompensate workers in high cost areas, whereas the absence of any price adjustment will undercompensate such workers. We do not know how widespread are attempts to fully adjust area wages for price differences, although the presence of numerous Internet sites with city "cost of living calculators" suggests that price differences play a substantive role in private location and wage decisions. Our results provide support for recent efforts by the federal government both to collect better data on area-specific occupational wages and to adjust non-postal federal wages on the basis of area wage differences. Public policies that pursue public-private wage comparability for similar workers and jobs within labor markets may also lead to more equal real wages among public workers across labor markets.

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Table 1
Metropolitan Area Price-Level Regressions

	(1)	(2)	(3)	(4)	(5)
Size 2: 200 thousand-300 thousand	–	–	–	0.0323	0.0221
				(1.71)	(1.65)
Size 3: 300 thousand-500 thousand	–	–	–	0.0156	0.0190
				(0.83)	(1.43)
Size 4: 500 thousand-1 million	–	–	–	0.0523	0.0376
				(2.80)	(2.81)
Size 5: 1 million-2 million	–	–	–	0.0395	0.0384
				(1.63)	(2.25)
Size 6: 2 million-5 million	–	–	–	0.1135	0.1057
				(4.69)	(6.20)
Size 7: 5 million and over	–	–	–	0.3191	0.2717
				(8.19)	(9.71)
Large MSA/CMSA, 1 million and over	–	0.0798	0.0794	–	–
		(5.55)	(6.31)		
Broad Region (3)	Yes	Yes	No	No	No
Detailed Region (8)	No	No	Yes	No	Yes
n	185	185	185	185	185
R^2	0.280	0.382	0.533	0.298	0.658

Notes: The unit of observation is the MSA/CMSA and the dependent variable is ln*P*, the log of the metropolitan area cost of living index. Broad regions are the Northeast, North Central, South, and West. The omitted city size category is MSAs with populations between 100 and 200 thousand (our smallest size category). Detailed regions are New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain, and Pacific. Population size based on 1990 Census of Population counts. *T*-ratios are in parentheses.

Table II
Nominal, Full-Price Adjustment, and Partial Price Adjustment Log Wage Differentials, by Region and City Size

	Without City Size or Amenities			With City Size Dummies			With City Size and Amenities		
	Nominal	Full Adjustment	Partial Adjustment	Nominal	Full Adjustment	Partial Adjustment	Nominal	Full Adjustment	Partial Adjustment
South/non-South:	-.075	.085	-.013	-.043	.039	-.020	-.029	.063	.012
Region:									
New England	–	–	–	–	–	–	–	–	–
Middle Atlantic	-.009	-.052	-.012	-.058	.015	-.031	-.071	.073	-.005
East North Central	-.059	.148	.009	-.070	.170	.019	-.049	.132	.034
West North Central	-.116	.203	.039	-.086	.202	.020	-.062	.205	.060
South Atlantic	-.081	.150	.028	-.075	.148	.007	-.042	.157	.049
East South Central	-.173	.153	-.015	-.122	.138	-.026	-.078	.148	.025
West South Central	-.121	.207	.010	-.104	.195	.007	-.066	.181	.047
Mountain	-.091	.193	.015	-.060	.180	.029	-.086	.209	.049
Pacific	.034	.137	.066	-.000	.188	.069	.044	.141	.088
Weighted SD	.058	.088	.035	.036	.071	.032	.042	.051	.031
City Size:									
MSAs 100 thousand-200 thousand				–	–	–	–	–	–
Size 2: 200 thousand-300 thousand				.073	.024	.055	.058	.028	.044
Size 3: 300 thousand-500 thousand				.041	.027	.036	.039	.031	.036
Size 4: 500 thousand-1 million				.079	.057	.070	.063	.070	.066
Size 5: 1 million-2 million				.082	.046	.069	.054	.075	.063
Size 6: 2 million-5 million				.150	.020	.102	.099	.087	.094
Size 7: 5 million and over				.200	-.078	.097	.107	.103	.105
Weighted SD				.060	.052	.026	.029	.027	.028

Note: CPS ORG monthly earnings files, October 1985 through May 1995. Sample size is 1,133,580. Nominal wage regressions have ln$W$ as the dependent variable; Full Adjustment regressions have ln(W/P) as dependent variable; and Partial Adjustment wage regressions have ln$W$ as the dependent variable and ln$P$ included on the right hand side, where W is hourly earnings and P is the cost of living index. Wage regressions in first three columns also include years of schooling, potential experience and experience squared, and dummies for gender by race and Hispanic status (7), marital status (2), union status, public sector employment (3), part-time status, industry (13), and occupation (12). The results in the next three columns add city size dummies and include detailed region dummies. In the last three columns, the following amenity variables are added: property crime rate (measured over the previous five years), average annual relative humidity, annual snowfall, annual rainfall, and aggregate indices measuring the quality of health care, arts and culture, and education. Weighted standard deviations of region and city size coefficients use CPS wage and salary employment weights.

Appendix 1:
ACCRA Cost of Living Index by Metropolitan Area, 1985:4-1995:2

Albany-Schenectady-Troy, NY MSA	110.4
Albuquerque, NM MSA	102.3
Allentown-Bethlehem, PA-NJ MSA	109.1
Altoona, PA MSA	97.2
Anchorage, AK MSA	130.4
Anderson, IN MSA	95.6
Anderson, SC MSA	95.3
Appleton-Oshkosh-Neenah, WI MSA	97.3
Asheville, NC MSA	99.6
Atlanta, GA MSA	103.9
Augusta, GA-SC MSA	99.0
Austin, TX MSA	100.2
Bakersfield, CA MSA	110.6
Baltimore, MD MSA	109.1
Baton Rouge, LA MSA	97.5
Beaumont-Port Arthur, TX MSA	96.3
Bellingham, WA MSA	105.3
Benton Harbor, MI MSA	106.1
Biloxi-Gulfport, MS MSA	92.6
Binghamton, NY MSA	101.3
Birmingham, AL MSA	99.6
Bloomington-Normal, IL MSA	100.1
Boise City, ID MSA	100.2
Boston-Lawrence-Salem, MA-NH CMSA	150.2
Bradenton, FL MSA	102.0
Brownsville-Harlingen, TX MSA	91.1
Buffalo-Niagara Falls, NY CMSA	107.2
Burlington, VT MSA	113.1
Canton, OH MSA	92.9
Cedar Rapids, IA MSA	99.9
Champaign-Urbana-Rantoul, IL MSA	103.3
Charleston, SC MSA	100.8
Charleston, WV MSA	98.7
Charlotte-Gastonia-Rock Hill, NC-SC MSA	99.8
Chattanooga, TN-GA MSA	92.5
Chicago-Gary-Lake County, IL-IN-WI CMSA	122.7
Chico, CA MSA	110.2
Cincinnati-Hamilton, OH-KY-IN CMSA	102.9
Cleveland-Akron-Lorain, OH CMSA	102.8
Colorado Springs, CO MSA	94.5
Columbia, MO MSA	92.0
Columbia, SC MSA	97.7
Columbus, GA-AL MSA	94.8
Columbus, OH MSA	104.4
Corpus Christi, TX MSA	96.3
Dallas-Fort Worth, TX CMSA	102.1
Davenport-Rock Island-Moline, IA-IL MSA	96.8
Dayton-Springfield, OH MSA	101.7
Denver-Boulder, CO CMSA	104.2
Des Moines, IA MSA	101.8

Detroit-Ann Arbor, MI CMSA	114.4
El Paso, TX MSA	97.8
Erie, PA MSA	104.0
Eugene-Springfield, OR MSA	103.0
Evansville, IN-KY MSA	94.3
Fayetteville, NC MSA	98.7
Fayetteville-Springdale, AK MSA	90.5
Florence, AL MSA	91.9
Florence, SC MSA	95.0
Fort Collins-Loveland, CO MSA	96.3
Fort Myers, FL MSA	101.6
Fort Smith, AR-OK MSA	90.9
Fort Walton Beach, FL MSA	96.3
Fort Wayne, IN MSA	94.1
Fresno, CA MSA	110.6
Gainesville, FL MSA	101.1
Grand Rapids, MI MSA	107.6
Greensboro-Winston-Salem-High Point, NC MSA	97.8
Greenville-Spartanburg, SC MSA	96.2
Harrisburg-Lebanon-Carlisle, PA MSA	104.0
Hartford-New Britian-Middletown, CT CMSA	125.0
Hickory, NC MSA	96.7
Honolulu, HI MSA	136.5
Houston-Galveston-Brazoria, TX CMSA	99.1
Huntington-Ashland, WV-KY-OH MSA	95.2
Huntsville, AL MSA	98.7
Indianapolis, IN MSA	97.3
Jackson, MI MSA	103.3
Jackson, MS MSA	99.3
Jacksonville, FL MSA	97.4
Johnson City-Kingsport-Bristol, TN-VA MSA	95.5
Joplin, MO MSA	89.7
Kalamazoo, MI MSA	107.7
Kansas City, MO-KS MSA	97.3
Killeen-Temple, TX MSA	95.5
Knoxville, TN MSA	94.9
Lafayette, LA MSA	98.4
Lake Charles, LA MSA	96.7
Lakeland-Winter Haven, FL MSA	100.4
Lancaster, PA MSA	107.1
Las Vegas, NV MSA	105.4
Lawton, OK MSA	96.0
Lexington-Fayette, KY MSA	100.4
Lima, OH MSA	97.0
Lincoln, NE MSA	92.3
Little Rock-North Little Rock, AK MSA	95.9
Los Angeles-Anaheim-Riverside, CA CMSA	124.6
Louisville, KY-IN MSA	94.1
Lubbock, TX MSA	92.7
Macon-Warner Robins, GA MSA	97.9
Madison, WI MSA	113.8
Manchester, NH MSA	120.6
Mansfield, OH MSA	98.2
McAllen-Edinburg-Mission, TX MSA	96.5

Medford, OR MSA	101.5
Melbourne-Titusville-Palm Bay, FL MSA	104.3
Memphis, TN-AR-MS MSA	96.2
Miami-Fort Lauderdale, FL CMSA	112.1
Milwaukee-Racine, WI CMSA	104.9
Minneapolis-St. Paul, MN-WI MSA	103.4
Mobile, AL MSA	95.1
Monroe, LA MSA	98.1
Montgomery, AL MSA	97.8
Muskegon, MI MSA	101.8
Nashville, TN MSA	97.0
New Haven-Meriden, CT MSA	122.6
New London-Norwich, CT-RI MSA	133.2
New Orleans, LA MSA	95.9
New York-N. New Jer.-Long Is., NY-NJ-CT CMSA	173.9
Norfolk-Virginia Beach-Newport News, VA MSA	101.0
Ocala, FL MSA	95.0
Oklahoma City, OK MSA	93.9
Olympia, WA MSA	99.9
Omaha, NE-IA MSA	93.5
Orlando, FL MSA	101.1
Pensacola, FL MSA	94.2
Peoria, IL MSA	104.0
Philadelphia-Wilm.-Trenton, PA-NJ-DE-MD CMSA	123.9
Phoenix, AZ MSA	103.3
Pittsburgh-Beaver Valley, PA CMSA	106.1
Portland, ME MSA	109.8
Portland-Vancouver, OR-WA CMSA	106.9
Poughkeepsie, NY MSA	115.8
Providence-Pawtucket-Fall River, RI-MA CMSA	108.9
Provo-Orem, UT MSA	91.9
Pueblo, CO MSA	87.6
Raleigh-Durham, NC MSA	100.9
Reading, PA MSA	108.8
Reno, NV MSA	107.9
Richmond-Petersburg, VA MSA	106.3
Roanoke, VA MSA	96.5
Rochester, NY MSA	113.1
Rockford, IL MSA	105.0
Sacramento, CA MSA	108.5
Saginaw-Bay City-Midland, MI MSA	100.0
Salem, OR MSA	99.6
Salt Lake City-Ogden, UT MSA	97.2
San Antonio, TX MSA	96.1
San Diego, CA MSA	129.5
San Francisco-Oakland-San Jose, CA CMSA	137.3
Sarasota, FL MSA	100.1
Savannah, GA MSA	98.0
Scranton-Wilkes Barre, PA MSA	99.2
Seattle-Tacoma, WA CMSA	110.5
Sharon, PA MSA	96.3
Shreveport, LA MSA	98.3
Sioux City, IA-NE MSA	99.5
Sioux Falls, SD MSA	94.2

South Bend-Mishawaka, IN MSA	93.5
Spokane, WA MSA	98.5
Springfeild, MO MSA	91.0
Springfield, IL MSA	97.4
Springfield, MA MSA	119.5
St. Louis, MO-IL CMSA	97.7
Syracuse, NY MSA	99.0
Tallahassee, FL MSA	102.7
Tampa-St. Petersburg-Clearwater, FL MSA	97.6
Terre Haute, IN MSA	101.8
Toledo, OH MSA	104.0
Tucson, AZ MSA	102.0
Tulsa, OK MSA	93.9
Tuscaloosa, AL MSA	97.7
Utica-Rome, NY MSA	106.2
Visalia-Tulare-Porterville, CA MSA	108.0
Waco, TX MSA	95.2
Washington, DC-MD-VA CMSA	132.8
Waterbury, CT MSA	127.0
Waterloo-Cedar Falls, IA MSA	98.1
West Palm Beach-Boca Raton-Delray B., FL MSA	113.4
Wheeling, WV-OH MSA	94.5
Wichita, KA MSA	96.1
Williamsport, PA MSA	104.7
Worcester, MA MSA	121.5
York, PA MSA	100.4
Youngstown-Warren, OH MSA	93.7

Source: American Chamber of Commerce Researchers Association (ACCRA) and calculations by authors, as described in text.