A Panel of Interarea Price Indices for All Areas in the United States 1982-2012

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The perfect is the enemy of the good – Voltaire

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Abstract

This paper describes the production of a panel of price indices for housing services, other produced goods and services, and all produced goods and services for each metropolitan area in the United States and the non-metropolitan part of each state for each year from 1982 through 2012. Our general approach is to first produce interarea price indices for a single year 2000 and then use BLS time-series price indices to create the panel. Our geographic housing price index for 2000 is based on a large data set with detailed information about the characteristics of rented dwelling units and their neighborhoods throughout the United States that enables us to overcome many shortcomings of existing interarea housing price indices. For most areas, our price index for all goods other than housing is calculated from the price indices for categories of nonhousing goods produced each quarter by the Council for Community and Economic Research, formerly the American Chambers of Commerce Researchers Association. In order to produce a nonhousing price index for areas of the United States not covered by their index, we estimate a theoretically-based regression model explaining differences in the composite price index for nonhousing goods for areas where it is available and use it to predict a price index for these goods for the uncovered areas. The overall consumer price index for all areas is based on the preceding estimates of the price of housing and other goods. Electronic versions of the price indices are available online. The paper and its online appendices report many sensitivity analyses, and the paper compares the new housing price index with the most widely used indices of differences in the rents of identical units across areas.

Keywords: Interarea price indices, interarea housing price indices, geographic cost-of-living differences, geographic price differences

JEL Codes: C8, R1, R2, R3

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1. Introduction

Empirical estimates of behavioral relationships explaining how individuals will respond to changes in their circumstances are often based on data for households living in different geographic areas. In economic theory, prices play a central role in explaining individual behavior. Despite the obvious large differences in prices that prevail in different areas, surprisingly few empirical studies based on data for households living in different areas include price indices for consumer goods as explanatory variables. Most studies take no account of geographic price differences or attempt to control for them by adding to the regression location fixed effects or location specific characteristics that are arguably correlated with interarea price differences. These approaches severely limit the policy simulations that can be conducted with the estimated equations.

Recent studies have shown that the failure to account for price differences can have large effects on the conclusions of empirical research. Moretti (2013) finds that half of the apparent increase in the return to college between 1980 and 2000 disappears when account is taken of geographic price differences. Slesnick (2005) shows that the failure to account for geographic price differences leads to severely biased estimates of the parameters of systems of demand equations. Effects on descriptive statistics are equally large. For example, Jouliffe (2006, Table 1) finds that when poverty thresholds are not adjusted for geographic price differences, the poverty rate in non-metropolitan areas is 28 percent higher than in metropolitan areas, but when it is adjusted for them, the poverty rate is 12 percent lower in non-metropolitan areas. Dalaker (2005, Table 4) finds that the poverty rate for Hispanics is about 11 percent higher when geographic price differences are accounted for.

An important reason for the failure to account for price differences in studies based on U.S. data has been the absence of official interarea price indices. The U.S. government has not produced them since 1981 when the Bureau of Labor Statistics (BLS) discontinued its series [Johnson, Rogers, and Tan, 2001]. For the previous 15 years, the BLS had used the price data that underlies its time-series consumer price indices (hereafter CPI data) together with data from the Consumer Expenditure Survey (CEX) to produce interarea price indices for 39 metropolitan areas and the non-metropolitan urban areas in four regions.

Since 1981, a small number of studies have been devoted exclusively to the production of interarea price indices. Analysts within the federal government (for example, Kokoski, Cardiff, and Moulton, 1994; Moulton, 1995; Aten, Figueroa, and Martin, 2011) have produced exploratory interarea price indices for various categories of goods for particular years based on the CPI and CEX data, sometimes supplemented with data from the American Community Survey (ACS) or the Decennial Census.[1] Despite these exploratory studies, the publication of official interarea price indices is not imminent. Economists outside the government (for example, Blackley and Follain, 1986; Follain and Ozanne, 1979; Thibodeau, 1989, 1995) have used data from the metropolitan American Housing Survey (AHS) to produce interarea housing price indices for up to 20 metro areas each year from 1974 through 1992. Because the AHS contains much more detailed housing and neighborhood information than the ACS, CPI data, or Decennial Census, price indices based on it more accurately describe the difference in the rental price of identical housing for the specific areas identified in the AHS.

Given the absence of official interarea price indices and the limited geographical and temporal coverage of the exploratory indices, some whose research would benefit from them have used privately produced price indices or constructed their own from non-CPI data.[2] Both panels and single cross-sections have been produced to study particular questions.

Since the demise of the BLS interarea price indices, the American Chambers of Commerce Researchers Association (ACCRA) indices have been the most widely used for nonhousing goods and services. ACCRA, now the Council for Community and Economic Research, has produced interarea price indices since 1968. These are a series of cross-sections rather than a panel. In 1990, they acquired semi-official status with their inclusion in the Statistical Abstract of the United States. ACCRA produces an overall consumer price index and price indices for six composite commodities each quarter for urban areas that account for about 70 percent of the U.S. urban population. Because data collection depends on the voluntary participation of local chambers of commerce, the cities covered vary somewhat from quarter to quarter. In recent years, price indices have been produced for more than 300 urban areas (as

[1] Online appendix A provides more details about these and other efforts to create interarea price indices. All online appendices are available at http://eoolsen.weebly.com/price-indices.html.
[2] The CPI data is not readily available to people outside the government. Indeed, it is not routinely available to government employees outside the BLS. Furthermore, it has an important disadvantage for constructing interarea price indices for all areas of the country, namely, data is collected in only about a fourth of all metropolitan areas, a small fraction of all non-metro urban areas, and not at all in rural areas. About half of the U.S. population lives in areas where data is not collected.

opposed to 87 for the CPI data). Some studies that have relied at least in part on the ACCRA price indices such as Winters (2009) have used a cross-section for the places reported in a single year.[3] Others such as Albouy (2012) have expanded the geographical coverage in a single year by predicting price indices for places not covered by ACCRA. A few such as Baum-Snow and Pavan (2012) have created a panel of price indices for housing services and other goods by applying BLS time-series price indices to a single cross-section.

Due to concerns about the accuracy of the ACCRA housing price index (namely, its failure to account sufficiently for differences in the characteristics of dwelling units and their neighborhoods and inaccuracies in predicting the market rent of owner-occupied units) and the availability of alternative data sets for producing such indices, many studies that have used the ACCRA price indices for nonhousing goods have created alternative housing price indices based on the ACS or Decennial Census to conduct sensitivity analyses. Applications that account only for differences in housing prices (for example, Albouy, 2009; Chen and Rosenthal, 2008; Gabriel and Rosenthal, 2004; Malpezzi, Chun, and Green, 1998; and Moretti, 2012) rarely use the ACCRA housing price index. Instead, they use data from the AHS, ACS or Decennial Census to create their own index.

The primary purpose of this paper is to document the production of a panel of price indices for housing services, other goods and services, and all goods and services (hereafter goods) for all areas of the United States from 1982 through 2012.[4] Our general approach is to first produce interarea price indices for a single year 2000 and then use BLS time-series price indices to create the panel. We use well established methods, a data set that is especially well suited to producing housing price indices throughout the country, and the best existing publicly available nonhousing price indices to produce price indices whose use in empirical research would be better than current practices in accounting for geographic price differences. It will save those who would have produced their own price indices considerable time and enable others to produce more credible results. These price indices will be useful for estimating behavioral relationships, studying the workings of markets, and assessing differences in the economic circumstances of people living in different areas.

[3] Dumond, Hirsch, and Macpherson (1999) average the ACCRA consumer price index over eleven years for each locality to create a single cross-section.
[4] If usage justifies it, the panel will be extended each year beyond 2012. It has already been updated twice since the initial panel was posted.

Our geographic housing price index for 2000 is based on data on the gross rent and numerous housing, neighborhood, and location characteristics of about 173,000 units throughout the United States. Information on the census tract of each dwelling unit makes it possible to append detailed information on its immediate neighborhood from the Decennial Census to each observation. For most areas, our price index for all goods other than housing is calculated from the ACCRA price indices for categories of nonhousing goods. In order to produce a nonhousing price index for areas of the United States not covered by their index in 2000, we estimate a theoretically-based regression model explaining differences in the composite price index for nonhousing goods for areas where it is available and use it to predict a price of other goods for the uncovered areas. The overall consumer price index for all areas is based on the preceding estimates of the price of housing services and other goods.

Given the geographic information in our data set, many alternative levels of geographic aggregation are possible. This paper documents the production of a panel of price indices for each metropolitan area in the United States and the non-metropolitan part of each state. These price indices together with annual county population estimates have been used to produce prices indices from 1982 through 2010 for counties, states, and census divisions and regions. All of the price indices are available online at http://eoolsen.weebly.com/price-indices.html .

The next section documents the data and methods used to produce the new interarea housing price index for 2000. Section 3 reports selected results. Section 4 compares this housing price index with housing price indices resulting from alternative methods applied to the same data, price indices based on alternative widely used data sets, and existing indices that are often used to approximate the rental price of identical housing in different locations. Section 5 describes the methodology used to construct the interarea price indices for other goods and all produced goods for 2000 and reports selected estimates. Section 6 describes how the BLS's CPI time-series price indices for particular areas together with these cross-sectional price indices are used to produce a panel of price indices for all years between 1982 and 2012, and it discusses selected results. Section 7 uses our price indices to estimate a housing demand function and compares its income and price elasticities with those estimated with an alternative housing price index. The final section summarizes the paper.

2. **Data and Methodology for Constructing Housing Price Index**

The primary source of the housing data is HUD's 2000 Section 8 Customer Satisfaction Survey (CSS). All units in the data set were occupied by renters with HUD's Section 8 housing vouchers or certificates (hereafter vouchers). Voucher recipients are free to occupy any unit that meets the program's standards and they can afford with the help of the voucher subsidy. Previous research has indicated that the rents paid to landlords of tenant-based voucher units are almost identical to the rents of unsubsidized units with the same characteristics [Mayo et al., 1980; Wallace et al., 1981; Leger and Kennedy, 1990; ORC/Macro, 2001, Chapter V].

The CSS provides detailed information on the characteristics of the dwelling unit and tenant perceptions of its neighborhood.[5] The CSS was mailed to 280,000 families in HUD's voucher program. Families were instructed to fill out the survey and return it to HUD. The response rate was roughly 62 percent [Gray et al., 2002]. The questionnaire asks 60 questions about the unit, building, and neighborhood that provide a level of detail about these matters similar to the American Housing Survey. The pilot study indicated a very high agreement between residents and trained inspectors in answering the questions [Building Research Council, 1998]. HUD added information on the gross rent of the unit (that is, the sum of the tenant's and government's payment to the landlord plus an allowance for tenant-paid utilities), the number of persons in the unit, and its exact location. Because the data set identifies the census tract of each dwelling unit, we are able to append information about its immediate neighborhood from the 2000 Decennial Census such as population density and mean travel time to work.

Since the data are not a random sample of unsubsidized units in each area, it is important to consider their appropriateness for constructing an interarea index of market rental prices. We consider how voucher units differ from other units and the significance of this difference for our purposes.

The joint distribution of housing and neighborhood characteristics is different for units occupied by voucher recipients and all households. Due to the program's minimum housing standards, voucher recipients do not live in the worst housing units, and the generosity of the voucher subsidy is not sufficient to induce them to live in the best housing. The average unit occupied by a voucher recipient is similar to the average unsubsidized rental unit in terms of its overall desirability. On average, voucher units rent for amounts about equal to the program's

[5] Building Research Council (1998) describes the pilot studies that led up to the CSS survey.

applicable Fair Market Rent (FMR) [Leger and Kennedy, 1990, p. 28], the average two-bedroom FMR in April 2000 was $625 a month, and the median gross rent of all two-bedroom rental units in this year was $620 a month.[6] Mast (2009, Exhibit 7) reports that the mean values of the answers to two broad questions about the desirability of the housing and its neighborhood are virtually identical for voucher recipients and other renters in the 2001 National AHS. Because the average desirability of owner-occupied units is greater than renter-occupied units, voucher units tend to be below the average of all units with respect to their overall desirability. The mean values of Mast's two measures for rental units are 25 and 35 percent of one standard deviation below the means of these measures for all units (U.S. Census Bureau, 2002, Table 2-7, 2-8). Voucher recipients are also widely dispersed. More than 80 percent of all census tracts in the 50 largest metropolitan areas have at least one voucher recipient [Devine and others, 2003, p. 10]. Voucher recipients account for more than 10 percent of all households in only 3 percent of these census tracts and more than 25 percent in almost none [Devine and others, 2003, p. ix].

Although the joint distribution of housing and neighborhood characteristics is different for units occupied by voucher recipients and all households, the difference is of little consequence for our purposes, namely, to produce a single housing price index to characterize differences in housing prices across areas. Obviously, units with different combinations of characteristics have at least somewhat different relative rents across areas. A separate price index for units with each different combination of characteristics would more accurately characterize differences in housing prices across areas. Producing accurate price indices for units with each combination of characteristics would require a much larger sample. The best available evidence suggests modest differences in relative rents for units at very different points in the quality spectrum (online appendix B). In light of this evidence, the restriction of the sample to units occupied by voucher recipients has an advantage for our purposes. It almost surely reduces the variation in unobserved characteristics of the housing unit and its neighborhood across observations. Our housing price index is intended for users who seek a single price index to characterize differences in housing prices across areas. To the extent that it is viewed as applying to a particular sector of the housing market, it is arguably most applicable to rental housing of average quality and owner-occupied housing of somewhat below average

[6] The FMR is a parameter of the voucher program. Within a locality, it varies with the number of bedrooms in the unit. It also varies across localities for units with a given number of bedrooms.

quality.

To construct an interarea rental housing price index, we estimate a hedonic regression explaining the natural logarithm of gross rent in terms of observed characteristics of the rental unit and its neighborhood, other determinants of its market rent that reflect unobserved characteristics and other factors, and dummy variables representing different geographic areas (metro areas and the non-metro part of each state). Previous studies have found that this functional form fits the data particularly well, and it is the most widely used specification. It is also consistent with our intention to produce a single housing price index to characterize differences in housing prices across areas because it assumes that percentage differences are the same for all types of housing. In total, we create 121 regressors to represent 68 underlying variables that describe the unit, its neighborhood, and contract conditions and dummy variables for 354 geographic areas. Online table 1 describes these regressors and provides descriptive statistics.[7] Estimates of the coefficients of the geographic dummy variables are used in the usual manner to produce estimates of the interarea price index for housing services.

Since our purpose is the (asymptotically) unbiased prediction of the price indices for different locations, we include in the regression all variables at our disposal that are expected to affect the market rent of a dwelling unit. Failure to include these variables risks biasing the estimators of coefficients of the area dummy variables due to correlation between them and the omitted variables. Among units that are the same with respect to the variables included, the mean values of the omitted variables may be different in different locations. Because we have access to many variables that are likely to have small effects on market rent, it is not surprising that some coefficients have unexpected signs and others with the expected sign are statistically insignificant at the standard levels. Good econometric practice argues for the inclusion of all relevant variables.

In our judgment, twenty-four metropolitan areas had insufficient sample size to estimate with much precision a separate rental housing price index. If an area had fewer than 50 observations, those observations were combined with another area. This procedure is based on the assumption that the price of housing differs little between the areas combined. The smallest metropolitan areas were combined with observations on the nonmetropolitan part of the same state. The observations for other metropolitan areas with less than 50 observations were

[7] Due to their length, most tables are posted online at http://eoolsen.weebly.com/price-indices.html .

combined with another nearby metropolitan area of similar size. The estimate of the rent of a unit for the combined areas is then used as an approximation of the price for those metropolitan areas. Delaware and Connecticut had insufficient numbers of observations for their nonmetropolitan areas to allow precise estimates for those areas. Instead, nonmetropolitan observations for Delaware were combined with those for Maryland and nonmetropolitan observations for Connecticut were combined with those for Massachusetts. The price indices derived from the combined samples are used as an approximation of the price of rental housing in those areas. The nonmetropolitan areas of Alaska had only 36 observations. Since no area is in close proximity to the nonmetropolitan areas of Alaska, the price of rental housing was estimated for Alaska using the small number of observations.

As with other surveys, some questions in the CSS either are not answered or do not contain a valid response. Although few variables had missing information for more than 5 percent of the observations, roughly 50 percent of observations had missing data for at least one variable. In all analyses reported, we omit from the estimation of the hedonic regressions observations with missing data for more than 20 of the underlying variables. This removed 2,733 observations, less than 2 percent of the total. In addition, observations with unrealistic rents (less than $200 a month) were excluded in estimating the hedonic regressions. This resulted in 194 observations being dropped.[8] A common method for handling missing data is to restrict the analysis to observations with complete data, normally referred to as complete case analysis (CCA). However, since CCA required the omission of about half of the sample, the housing price index that is posted is based on the estimation of a hedonic regression with omitted variable indicators in which we excluded only the 2,927 [=2,733+194] observations mentioned above. This is the housing price index against which all others are compared. To implement it, a new variable was constructed for each underlying variable with missing values that is coded 0 if the data exists, and 1 otherwise, and the variable itself is assigned a value of 0 if its value is not reported and the reported value otherwise.

To check the robustness of the results, five alternative methods were employed to produce housing price indices based on the CSS data. Two involve alternative methods for dealing with missing data. Online appendix C describes these methods, and it compares the alternative price indices with the basic index. The results indicate that these reasonable

[8] Including these observations had little effect on the housing price index.

alternative methods for producing housing price indices with the CSS data yield indices that are very similar to our basic price index. They are not only highly correlated with the basic price index (correlation coefficients between .971 and .999) but also almost proportional to it.[9]

It has been suggested that we include as explanatory variables amenities and disamenities such as climate, pollution levels, and the existence of a symphony orchestra or professional football team that are common to a broad area. Rosen (1979) and Roback (1982) have shown how these factors result in differences in land prices and wage rates across areas. These differences in input prices affect the production or distribution cost of all goods consumed in the area and hence their prices. Our housing price index is based on a narrower definition of housing services. In our approach, an area that has a higher market rent for otherwise identical units on account of amenities that are common to a broad area is said to have a higher price per unit of housing service rather than to provide a higher quantity of housing services for each unit. This approach seems better suited to explaining differences in consumption patterns across areas such as differences in the size of housing units.

Differences in common amenities and disamenities should be taken into account in assessing differences in standards of living across areas, and many recent empirical studies do that [Albouy, 2012; Chen and Rosenthal, 2008; Dumond, Hirsch, and Macpherson, 1999, Gabriel and Rosenthal, 2004;Winters, 2009]. Nominal income divided by a standard price index is inadequate for this purpose because it does not account for differences in common amenities and disamenities.

3. **Basic Housing Price Index**

Our basic cross-sectional housing price index that will be compared with many alternatives and used to construct the overall consumer price index is based on the estimated hedonic regression model reported in the first column of online table A-2. The coefficient estimates for the missing value indicators and geographic dummy variables are omitted.[10] The fit of the hedonic equation was excellent ($R^2 > .8$), and the coefficients used to create the price indices were estimated with considerable precision. Given its large number of regressors, we limit our discussion of the

[9] If one price index is perfectly correlated with another but not proportional to it, they indicate different relative prices across locations.

[10] The first column of online table A-3 provides housing price indices for all metropolitan areas and the nonmetropolitan parts of each state based on this hedonic regression, scaled so that the price is 1 in Washington, D.C.

results to a few variables. Among units that are the same in other respects, one-bedroom apartments rent for about 19 percent more than efficiencies, two-bedroom apartments for 35 percent more than efficiencies, three-bedroom apartments for 53 percent more, and each additional bedroom adds about 10 percent to rent. Living in a census tract where the mean travel time to work is 30 minutes longer reduces rent by about 10 percent. Households with an additional person per bedroom plus one pay about 14 percent more for an identical unit.

We use the results of the hedonic regression to produce housing price indices for the 331 metropolitan areas in existence in 2000 and the non-metro parts of 49 states.[11] The first column of table 1 gives the values of the rental housing price index for the ten areas with the highest, lowest, and middle housing prices, scaled to have a mean of 1 across all locations.[12] The estimated price indexes were consistent with popular views about differences in housing prices. Among the most expensive places to rent an apartment were the large metropolitan areas on the east and west coasts. The least expensive places to rent tended to be nonmetropolitan parts of states and small metropolitan areas in the South. The most expensive place to rent (San Francisco) was somewhat more than three times as expensive as the least expensive (nonmetropolitan Missouri).

4. Comparisons with Housing Price Indices Based on Different Data

This section compares our basic housing price index with price indices based on different data (the AHS and Decennial Census) and with existing indices that have often been used to compare the rental price of identical housing in different locations (HUD's Fair Market Rent, median gross rent, and the ACCRA housing price index). This is useful for assessing the results of existing studies based on the alternative housing price indices and choosing a housing price index in future studies.

For each alternative housing price index, table 2 reports the results of OLS estimation of a linear regression of the alternative price index on the basic index, after scaling each so that its mean is 1. It also reports the mean and maximum absolute percentage difference between alternative price indices across all areas. If the price indices were identical, the slope coefficient

[11] New Jersey had no non-metro areas in this year. Because 24 small metro areas were constrained to have the same housing price index as a similar nearby metro area and the non-metro parts of two states were constrained to have the same housing price index as the non-metro part a neighboring state for reasons explained earlier, the hedonic regression has 353 rather than 379 geographic dummy variables.
[12] Section 5 describes the construction of the two other price indices reported in table 1.

and coefficient of determination would be 1. The null hypothesis for testing the proportionality of the price indices on average is that the slope coefficient is 1.[13]

The most accurate existing housing price indices are based on the AHS because it contains by far the best information on housing characteristics among public-use data sets available on a regular basis. To insure sufficient sample sizes for the estimation of separate hedonic equations in each area, these price indices have been limited to large metropolitan areas in the AHS metropolitan samples.

We explore the accuracy of a housing price index for all areas that can be produced with the national AHS. To create an AHS-based price index for all areas in 2000, we estimate a single hedonic regression with data from the 1999 and 2001 National AHS, combining data for the two years in order to create a sufficiently large sample for a reasonable number of metropolitan areas (64 of the 133 identified in the data set), and including in the hedonic equation dummy variables for these areas and the two years. To account for the locations of households that did not live in metropolitan areas with a sufficiently large sample size in the national AHS, we included in the hedonic regression dummy variables for all combinations of region and metropolitan status. This yields housing price indices that are the same for the non-metropolitan parts of all states in the same region and all metropolitan areas in a region that are not separately represented by a dummy variable in the hedonic equation. Otherwise, our hedonic specification follows closely the work of Thibodeau (1989, 1995). Unlike Thibodeau, we use monthly housing cost, which includes the cost of utilities, instead of contract rent because our concept of housing services includes utilities. The hedonic regression based on the AHS data contained 45 regressors (in addition to the location and time dummy variables) compared with the 121 in the hedonic based on our combination of CSS and decennial census data. The coefficient of determination in the AHS regression was .57 compared with .81 in the CSS regression.

The first row of table 2 compares the price index based on the AHS data with the basic price index based on the CSS data. The AHS housing price index differs greatly from our basic housing price index. First, the results indicate significant deviation from proportionality.

[13] Because the price indices are scaled so that their means are one, the estimated constant term is one minus the estimated slope, and the test of the hypothesis that the slope is equal to one yields the same conclusion as the test of the hypothesis that the intercept is zero. For this reason, we report only the estimated slope coefficient and its standard error.

Specifically, the AHS index tends to be much lower than the CSS index for metropolitan areas with the highest CSS index. Second, deviations between the indices tend to be large. The mean absolute percentage difference between the price indices across all areas is about 10 percent, and the largest absolute percentage difference is more than 40 percent. The most plausible explanation for these large deviations is the necessity of treating all metropolitan areas in a region that are not separately identified in the AHS as a single area and similarly for the non-metropolitan part of all states in the same region. In some cases, the areas combined surely have very different rental prices for identical housing. The mean absolute percentage deviation between the price indices for the 64 metropolitan areas separately identified in the hedonic equation was less than 5 percent compared with more than 10 percent for all areas.

The second row in table 2 compares housing price indices for the 64 metropolitan areas based on hedonic equations estimated with AHS and CSS data for these metropolitan areas alone. Because the AHS contains information for a random sample of dwelling units and considerable information about housing and neighborhood characteristics, it has been suggested that this comparison would shed light on bias in our price indices due to the non-representative nature of the CSS sample. Since our data set contains housing characteristics similar to the AHS and better information about the neighborhood of each unit, a difference between these price indices would not necessarily indicate a bias in our price indices on this account. However, this comparison perhaps gives some additional reason to believe that the non-representative nature of the CSS sample has not caused any significant bias in our price indices. The results indicate that these two price indices are much more highly correlated and closer to proportional than the previous comparison.

Another important interarea housing price index has been produced using the 1990 Decennial Census PUMS [Malpezzi, Chun, and Green, 1998]. Unlike the AHS, the Decennial Census PUMS provides a sufficiently large sample to estimate a hedonic equation for each area. The American Community Survey now provides the same information about housing on an annual basis for almost 300,000 occupied rental units each year. The primary shortcoming of these data sets for constructing a housing price index is their very limited information about the dwelling unit and its neighborhood. Dwelling units that are the same with respect to the characteristics available can differ enormously in their condition, amenities, neighborhoods, and convenience to jobs, shopping, and recreation facilities. Following closely Malpezzi, Chun, and

Green's hedonic specification but estimating a single hedonic equation for the entire country with dummy variables for different areas, we construct a housing price index using data from the 2000 Decennial Census PUMS and compare it with our basic housing price index. Due to the limited information about the dwelling unit and its neighborhood in the Decennial Census, the R^2 for this regression is .33 compared with .81 for the regression underlying our basic price index. The results reported in table 2 indicate that on average these price indices are very close to proportional to each other, albeit with nonnegligible mean and maximum absolute percentage differences between the price indices.

Because HUD describes the Fair Market Rent in the Section 8 Housing Voucher Program as the cost of renting decent and safe housing in the private market and FMRs are available in all locations in each year, FMR is often used as a housing price index in empirical research. However, it is clear that the procedures used to produce them are not attempting to estimate the rent of identical units in different locations. At the time of our data with some exceptions, FMRs in each locality were set at the fortieth percentile of the rents of unsubsidized rental housing units of standard quality that were not built within the last two years and were newly occupied within this period.[14] The standards used to calculate FMR refer to only a few housing characteristics. Dwelling units of standard quality differ greatly in many respects. About three decades ago, Follain (1979) compared the FMR with an AHS-based housing price index for 39 large cities. We compare it with our housing price index across 331 metropolitan areas in 2000. Although the two price indices are highly correlated, the results in table 2 indicate significant deviation from proportionality. Specifically, the FMR index tends to be higher than the CSS index for metropolitan areas with the highest CSS index. The mean absolute percentage deviation from our basic price index is similar to the deviation for the index based on the 2000 Decennial Census PUMS, but the largest absolute percentage deviation is much larger.

Median rent is the most widely used measure of differences in rental housing prices, especially in the popular press. This measure takes no account of differences in the average values of housing and neighborhood characteristics across areas. Table 2 indicates that the deviations of this measure from our basic housing price index are similar to the deviations for the

[14] Since FY 1996, HUD has established higher FMR in many nonmetropolitan counties than would result from the application of this rule [HUD, 2007, p. 10]. These places are not included in our comparison of FMR and our basic price index. More recently, HUD has implemented a policy of using rents at the fiftieth percentile for areas that meet specified criteria [HUD 2000]. These affect 39 metropolitan areas that account for about 27 percent of all program participants.

housing price index based on the 2000 Decennial Census PUMS that accounts for a few rudimentary housing characteristics, except that there is a much greater deviation from proportionality. As might be expected, median rent understates housing prices in places where housing prices are greatest.

Finally, we compare our basic housing price index with the ACCRA index for the 226 metropolitan areas where it was available in 2000. As mentioned earlier, the primary deficiencies of the ACCRA index are accounting for differences in housing and neighborhood characteristics and predicting the rental value of owner-occupied units. The sixth row of table 2 suggests that the ACCRA index is nearly proportional with our basic housing price index on average, but the correlation between the two indices is much lower than in any of the previous comparisons. The mean absolute percentage deviation from our basic price index is also much larger (except compared with the AHS for all areas), and the largest absolute percentage deviation is almost five times as large as in any of these comparisons. The maximum absolute percentage deviation is for the New York metropolitan area. According to the ACCRA index, housing prices are almost five times higher in this metropolitan area than the mean of the 226 metropolitan areas covered. According to our basic price index, the New York PMSA is 71 percent more expensive than the mean of these areas. Closer inspection reveals the likely source of the difference. The people who collect the ACCRA data sometimes limit their pricing to units in certain parts of the urban area. In 2000, ACCRA data for the New York metropolitan area was limited to Manhattan. Deleting the New York PMSA from the sample yields a price index that is far from proportional to our basic index and not highly correlated with it. This suggests that the previous finding that the ACCRA index is roughly proportional to our basic index is an artifact of an extremely implausible value of the ACCRA index for one locality.

In short, all widely used housing price indices differ from ours to some extent. For many, the differences are substantial. The Decennial Census produces results closest to ours for the entire country.

5. **Construction of Price Indices for Other Goods and All Produced Goods**

Most research questions require price indices for other produced goods or all produced goods, in addition to or instead of a housing price index. For example, the demand for housing services depends not only on its price but also on the prices of other goods. Labor supply depends on the wage rate divided by an index of the prices of produced goods rather than the nominal wage rate.

This section describes briefly how we create an interarea price index for all nonhousing goods and an overall consumer price index for all areas in 2000 and explores the sensitivity of the overall consumer price index to alternative methods for calculating it. Online appendix E provides the details.

Each quarter, ACCRA provides an overall interarea consumer price index for many areas and price indices for most privately produced goods grouped into six categories.[15] However, its indices are not available for many other areas, and our housing price index is based on a much larger sample of dwelling units and is much better than the ACCRA index in accounting for differences in housing and neighborhood characteristics and avoiding errors in predicting the rental value of owner-occupied units. We use ACCRA nonhousing price indices, our housing price index, and other data to construct a price index for all nonhousing goods and an overall consumer price index for all locations in 2000.

The first step is to calculate an index of the price of all goods except housing and utilities for the places where the ACCRA index exists. Our price index for nonhousing goods for the areas covered by ACCRA is the weighted mean of the ACCRA price indices for grocery items, transportation, health care, and miscellaneous goods using the CEX expenditure shares for all consumers as weights.[16]

The second step is to predict the price index for nonhousing goods for areas not covered by the ACCRA index. Our estimates are based on a simple theoretical model that recognizes that each good consumed in a locality involves some local labor and land and some imported inputs, often semi-finished or finished products. We assume that the production functions for housing services and other goods are Cobb-Douglas with constant returns to scale, where output depends on the quantities of local labor, local land, imported inputs, and inputs whose prices are the same at all locations. In the absence of government action, the long-run equilibrium prices of the two goods would be equal to their minimum long-run average production costs. The model allows for the possibility that climate variables (*coolingdays, heatingdays, precip*) affect the output that can be produced with a given input bundle. It also accounts for the possibility that

[15] Council for Community and Economic Research (2006) documents their data collection procedures and price index construction. It also sells a data file with the prices of the individual items used to create these price indices.
[16] In constructing its overall consumer price index, ACCRA uses weights that reflect the consumption patterns of upper income households.

local government policies not only affect input prices but also create gaps between long-run equilibrium prices and minimum long-run average production cost. This gap is assumed to depend on an index of land use regulation (*regindex*). Since an interarea price index for imported inputs is not readily available, we assume that the price of imported inputs is a function of the distance (*dist*) to the nearest metropolitan area with a population in excess of 1.5 million on the argument that areas that are farther from large metropolitan areas would have higher prices of imported inputs. Together these assumptions imply regression equations explaining the prices of housing services and other goods. Since an interarea index of the price of land is not available, we solve the housing price equation for the price of land and substitute it into the equation explaining the price of nonhousing goods. This yields:

$$\begin{aligned} lnP_X = \beta_0 + \beta_1 regindex + \beta_2\, ln(1 + coolingdays) + \beta_3\, ln(1 + heatingdays) \qquad (1) \\ +\beta_4 precip + \beta_5 precip^2 + \beta_6 lnP_L + \beta_7 lnP_H + \beta_8 dist + \varepsilon \end{aligned}$$

where X denotes nonhousing goods, H housing services, and L labor. Online appendix E derives this regression equation and online appendix F provides the definitions of its explanatory variables and the sources of this information.

Table 3 reports the OLS estimates of the parameters of this model.[17] Under plausible assumptions about the underlying error terms, the error term in (1) would be correlated with $\ln P_H$ and hence OLS estimators of the β would be biased. However, since the purpose of this estimated equation is to predict the index of nonhousing prices where it is not reported based on data available, this is not a problem with OLS estimation.[18]

Analysis of the residuals suggests no significant misspecification of functional form, heteroskedasticity, or outliers. If the functional form is correct, we expect the mean of the residuals to be about zero at all predicted values of $\ln P_X$. Across the quintiles of the distribution of these predicted values, the mean of the residuals ranged from -.0141 to .0086. If the error term in the regression model is homoskedastic, the residuals should have about the same

[17] Because the ACCRA prices for New York City refer to Manhattan, an unusually expensive part of the NYC PMSA, we treat these prices as not reported in estimating the model and predict the nonhousing price index for this metro area.

[18] For reasons explained in online appendix E, the insignificance of the regulation index in this regression model does not indicate that these regulations have no effect on nonhousing prices. The appendix reports estimates of the effects of regulations on housing as well as nonhousing prices based on our model and data.

standard deviation at all predicted values of $\ln P_X$. Across the quintiles of these predicted values, the standard deviations of the residuals ranged from .0328 to .0406. The largest deviation between predicted and observed value of the price index for other goods is 10 percent and less than a quarter exceed 5 percent.

Table 1 reports the price indices for other goods and all goods in 2000 for the areas with the ten highest, lowest, and middle values of the housing price index. Each price index is scaled to have a mean of 1 across all locations. The price index for nonhousing goods is the rescaled ACCRA index for the areas where it was available and the predicted index for other areas. The overall price index is the weighted average of the price indices for housing and other goods where the weights are the CEX expenditure shares for all consumers. Online table A-4 reports these price indices for all locations. Table 1 suggests what is generally true. On average, nonhousing prices are higher in areas where housing prices are higher, and the ratio of housing prices to the prices of nonhousing goods are higher in areas with the highest overall CPI. The highest housing price index is three times as large as the smallest. The highest price index for other goods is only 39 percent greater than the smallest.

Since some researchers will want to use the overall consumer price index to study subsets of the population, it is worthwhile to determine its sensitivity to the weights used to construct it. The ACCRA price indices are based on expenditure weights that reflect the consumption patterns of a very special subset of the population. One reason that economists have been reluctant to use the ACCRA index is that they are studying different populations with different expenditure patterns and they believe that price indices would be sensitive to these differences. Koo, Phillips, and Sigalla (2000, pp. 130-131) have found that replacing ACCRA's expenditure weights with weights reflecting average expenditure shares has very little effect on the overall price index, albeit in a study limited to 23 metropolitan areas. The results of our study based on 380 areas supports their conclusion. When we compare an overall price index using the ACCRA expenditure shares in online table A-6 with our price index based on the very different expenditure shares of all consumers from the CEX, the resulting indices are virtually identical. The correlation coefficient between the two price indices exceeds .99, the largest percentage difference between the two is less than 7 percent, and the mean absolute percentage difference is less than 2 percent.

The simple formula used to calculate our overall price index is not ideal from the viewpoint of measuring differences or changes in well-being. That is, nominal income divided by it is an imperfect indicator of the individual's level of well-being. To get some sense of whether moving towards an ideal price index would yield very different results, we develop an ideal overall price index based on a simple assumption about preferences and compare it with our price index. The ideal price index accounts for how individuals respond to changes in relative prices. It is based on the assumption that all people have a Cobb-Douglas utility function involving two goods, housing and nonhousing, with exponents equal to the expenditure shares that underlie the previous overall price index. The formula for this price index is:

$$CPI = (PH/.252)^{.252}(PX/.748)^{.748} \tag{2}$$

After rescaling this ideal price index to have the same mean as the simple expenditure weighted average of the housing price index *PH* and the price index of other goods *PX* in online table A-4, the price indices are almost identical. The correlation coefficient exceeds .999, the mean absolute percentage difference is less than three-tenths of a percent, and the maximum absolute percentage difference is 2.3 across the 380 locations.

6. **Construction of Price Indices for Other Years**

To this point, we have described how we developed interarea price indices for a single year. Most applications require cross-sectional price indices for some other year or a panel of price indices. This section describes how we use the best available time-series price indices for different areas to generate a panel of price indices for 1982 through 2012 from our cross-sectional price indices. A major advantage of this approach is that the panel can be easily expanded forward and backward in time. The entire panel of prices is available as an Excel and a Stata file at http://eoolsen.weebly.com/price-indices.html .[19]

Like Baum-Snow and Pavan (2012), Gabriel, Mattey, and Wascher (2003), and Slesnick (2002, 2005), we use BLS time-series price indices to create a panel of price indices from our cross-sectional prices. For quite some time, the BLS has produced time-series price indices for groups of goods and all goods combined for specific metropolitan areas and groups of urban

[19] Our suggested citation is CEOPricesPanel04.

areas based on region and population.[20] Almost all of our metropolitan areas fit unambiguously into one of these categories. Seventy nine of our MSAs or PMSAs are within the 27 BLS metropolitan areas. For our remaining metropolitan areas, we use the BLS price indices for the relevant population size category in its region. Finally, we use the BLS price indices for the smallest population size category in a region for the nonmetropolitan part of each state in that region, except for Alaska and Hawaii. For non-metropolitan Alaska, we use the BLS indices for Anchorage. For non-metropolitan Hawaii, we use their indices for Honolulu. The BLS does not provide time-series price indices for Phoenix from 1982 through 2001, Tampa from 1982 through 1986, Washington-Baltimore from 1982 through 1996, for the urban areas in each region with populations between 50,000 and 1,500,000 that are not specifically identified prior to 1998, or for rural areas. Online table A-7 describes how we handled these cases.

The BLS does not produce time-series price indices for our categories of goods, namely, shelter and utilities combined and all other goods as a group. With a minor exception, we apply their methods and weights to produce these indices [U.S. Bureau of Labor Statistics, 2010, Chapter 17].[21] With a trivial exception, our time-series price indices are exactly the same as theirs would be if they had produced indices for these composites. First, we use BLS methods and time-series price indices for shelter and utilities to create a time-series price index for housing in each area. The BLS reports a composite housing price index that includes household furnishing and operations as well as shelter, fuel and utilities. Our housing index does not include household furnishing and operations. Second, we use our time-series housing price index and the BLS price index for all goods to create a time series price index for goods other than housing. Finally, we use these two time-series price indices and the overall CPI to inflate and deflate our three cross-sectional price indices.

Online table A-8 provides illustrative results, namely, price indices for housing and all goods in 1982 and 2012 for the areas with the ten highest, lowest and middle overall CPI in 2012 based on the metropolitan areas in existence in 2000. The percentage increase in the CPI between 1982 and 2012 tended to be higher in the places with the highest cost of living than in places where it is average or extremely low. The mean increase was 149 percent in the highest

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[20] Details about the geographic sample of the CPI can be found in U.S. Bureau of Labor Statistics (2010) and Williams (1996).

[21] The BLS does not collect prices every month in all areas. To obtain an annual price index for these areas, they interpolate to obtain price indices for those months where prices are not collected before averaging over the year. We take a simple average of the reported price indices.

group and about 128 percent in each of the other two groups. The mean increase in housing prices was about the same in the middle and lowest group (130 and 125 percent respectively) and about identical to the increase in their CPI. For the ten areas with the highest CPI in 2012, the mean percentage increase in housing prices (178 percent) was much greater than the mean increase in their CPI (149 percent).

The price indices reported in this paper are for the metropolitan areas in existence in June 30, 1999 and in effect until June 6, 2003.[22] They are based on the standards for defining metropolitan areas adopted by the U.S. Office of Management and Budget (OMB) in 1990 and the Census Bureau's analysis of data from the 1990 Decennial Census and other sources. The basic concept of a metro area has stayed the same since its inception, namely, a densely populated core area and adjacent areas that have a high degree of economic and social integration with it. However, the boundaries of the metropolitan areas can change over time due to changes in the locations of households and the official definition of a metropolitan area. Around the time of each decennial census, OMB adopts a new definition of a metropolitan area. About three years later, the Census Bureau creates specific metro area boundaries based on the general definition and an analysis of data from the decennial census. In the ten years between these major modifications, some additions, deletions, and modifications occur based on other data. Each time a new set of metropolitan areas is announced at least some new metropolitan codes are added and others are abolished. Prior to June 6, 2003, the codes were four digits. (0040 is considered a four-digit code.) Since this time, the codes have been five digits, all between 10,000 and 50,000. Therefore, potential users of our price indices may encounter a set of metropolitan codes somewhat or entirely different from the 331 codes that existed on June 30, 1999.

To assist users of our panel of prices, we have produced price indices for all metropolitan areas that have existed between 1982 and 2008.[23] To each metro area that existed prior to or after June 30, 1999, we assign the prices of the 1999 area that has the greatest population overlap with it based on the 2000 populations of the counties (or cities and towns in New England prior to June 6, 2003) in the non-1999 metro area. Specifically, it is assigned the prices of the 1999

[22] The list is at http://www.census.gov/population/metro/data/pastmetro.html .
[23] These are in the files entitled CEOPricesPanel04 at http://eoolsen.weebly.com/price-indices.html

area that accounts for the largest fraction of the 2000 population of its counties in the year closest to 2000.

Few public-use data sets contain information on the location of observations at our detailed level of geography. That is, few contain the exact metropolitan area of each observation in a metro area and the state of each observation in a non-metro area. Some report specific metro codes only for the largest metropolitan areas. Others report whether an observation is in a metro area but not the specific metro area. Some report only region rather than specific state. The Excel and Stata files CEOPricesPanel04 contain the information needed to produce good price indices at the lowest level of geography possible with the geographic information that is available in a wide range of public-use data sets, and its user's guide suggests how to do it.

In addition to our basic panel of price indices CEOPricesPanel04, we have posted a variety of alternative panels covering the period 1982 through 2010 that will be more convenient for many users. To produce them, we first used our cross-sectional price indices for 2000 for the 380 areas to create price indices for all counties outside New England and all cities and towns in New England, then used the latter to create price indices for New England's counties, and finally used BLS time-series price indices to produce a panel of price indices at these low levels of geography. These indices were used to produce panels of price indices for (1) states, (2) census divisions, (3) census regions, and (4) combinations of metro status and state, census division, and census region, and (5) metropolitan areas and the non-metro part of states based on the 1973, 1983, 1993, and 2003 census metro geography.[24] A comparison of the alternative price indices with our panel of price indices CEOPricesPanel04 for the 1983, 1993, and 2003 census metro geography reveals minuscule differences. Therefore, users need not be concerned about differences between the basic and alternative price indices resulting from the slightly different methods used to produce them.

7. Application

To illustrate the use of our price indices, we estimate housing demand functions based on data from the 2007 National AHS. We test the sensitivity of the results to the housing price index used by reestimating these demand functions with a housing price index based on the 2007 ACS. The ACS contains the same housing information as the Decennial Census PUMS that yielded the

[24] These panels reside in the folder CEOAlternativePricePanels at http://eoolsen.weebly.com/price-indices.html.

housing price index closest to ours in 2000, and it has been used to produce price indices in a number of recent studies.

Because the primary purpose of this paper is to document the production of the panel of price indices and compare it with alternative price indices, this application ignores many complexities involved in estimation of housing demand functions such as selection bias due to location and tenure choice and accounting for taxes, saving and dissaving, and moving costs [Olsen, 1987; Goodman, 2003]. No previous study accounts for the majority of these complexities.

The analysis is restricted to the 6,142 renters in the AHS sample living in houses, apartments, or flats in an area without rent control, with positive reported income and rent, without housing assistance from the government, relatives, or employers, and with cash incomes greater than 130 percent of the relevant poverty threshold. We delete observations on the poorest households because they greatly underreport their cash income [Edin and Lein, 1997, pp. ix-xiii, Table 2-6] and they receive large amounts of in-kind assistance that almost surely has a large effect their housing demand and cannot be well accounted for with AHS data.

The 2007 AHS reports the exact metropolitan area for 3,316 units in the sample based on the MSA boundaries implemented in 1983. We assign our 2007 price indices for housing services and other goods for these areas to these observations. For other observations, the AHS identifies their region and metro status. We create price indices for the unidentified metro areas and non-metro areas in each region as population-weighted means of our price indices for their components based on their 2000 populations and assign them to these observations.

To produce the alternative housing price index with the 2007 ACS data, we estimate a hedonic equation explaining the log of gross rent as a function of its limited housing characteristics and dummy variables for the specific metro areas identified in the AHS and the combinations of region and metro status for other areas. The ACS does not identify metro areas. Instead, it identifies each observation's PUMA, an area within a state containing at least 100,000 residents. Creating geographic dummy variables needed to produce price indices for the AHS geography requires a crosswalk between the PUMAs that existed in 2007 and the Census metro geography in 1983. We first created a crosswalk between PUMAs and the metro areas and nonmetro parts of each state that existed in 2000.[25] The few PUMAs that were not entirely

[25] This information is at http://www2.census.gov/census_2000/datasets/PUMS/FivePercent/.

within a 2000 metro area or the nonmetro part of a state were assigned to the area that accounted for the largest part of its population. We then used the crosswalk between this level of geography and the 1983 geography in CEOPricesPanel04 to assign each ACS observation to a 1983 metro area or the nonmetro part of a state.

Table 4 reports the results of OLS estimation of six log linear housing demand functions where the index of the quantity of housing services is the occupant's gross rent divided by the housing price index. The first two columns report results based on our housing price index; the latter two on the ACS housing price index. Our price index for other goods is used in all regressions that include this variable. The explanatory variables in the two regressions reported in the first set of rows are the logarithm of the AHS measure of total cash income INC and the price indices for housing services PH and other goods PX. The second set of rows report results of regressions that impose the restriction that the demand function is homogeneous of degree zero in income and prices. The third set of rows report results of regressions that delete the nonhousing price index. This is of interest because many studies that account for differences in housing prices assume that the prices of other goods are the same everywhere.

The differences in estimated elasticities across these regressions are quite small. The estimated income elasticity ranges from .268 to .271 and the estimated housing price elasticity from -.487 to -.441. These results are broadly consistent with the best existing studies that find income and housing price elasticities well below one in absolute value.[26] These elasticities are estimated with great precision. In the regression that includes the nonhousing price index and does not impose homogeneity, the estimated cross price elasticity is much larger in the regression based on the ACS price indices (.311 versus .066). However, when homogeneity is imposed, the implied cross price elasticity is .21 in both regressions. Excluding nonhousing prices has virtually no effect on estimated income and own-price elasticities. That said, the exclusion of nonhousing prices severely limits the possible uses of the estimated relationships. For example, they cannot be used to predict the effect of any program that results in a nonlinear budget frontier.

The results in table 4 shed light on one potentially important concern about using our price indices for years far from 2000. One source of inaccuracy in our panel of price indices

[26] Mayo (1981) provides the most recent major survey of the empirical evidence. In a refined recent analysis that accounts for some of the complexities ignored in our analysis, Goodman (2003) finds full income elasticities between .30 and .35.

stems from the manner in which the panel is generated from the 2000 cross-section. Except for the large metro areas where the BLS provides time-series price indices, our price indices for years other than 2000 are derived by inflating or deflating the 2000 index for each area by the average percentage change for all metro areas in the same region and same very broad population category. The actual change surely varied to some extent across areas, introducing inaccuracies into our price index. For example, the percentage increase in housing prices in New Orleans between 2000 and 2007 surely exceeded the percentage increase for all metro areas in the South due to Hurricane Katrina. Although the ACS has extremely limited data on housing characteristics, it does not suffer from this defect. Therefore, it might be argued that the ACS price index would form a better basis for judging differences in the rents of identical units in years far from 2000. Table 4 indicates that there is no advantage in basing a housing price index on the ACS. The two price indices yield almost identical results. Separate tabulations indicate that across all of the observations in the AHS sample the two price indices are highly correlated (R=.94) and reasonably proportional on average. Furthermore, the ACS is not available before 2005 and the similar data from the Decennial Census is only available every tenth year.

8. Conclusion

Data on differences in prices in different locations are important for economic research and private and public decision making. Recent studies have shown that the failure to account for price differences can have large effects on the conclusions of empirical studies. Despite the importance of this information, the United States government does not produce official interarea price indices. A few BLS and BEA analysts have produced such price indices on a few occasions at least for the largest metro areas and other urban areas divided into categories by region and population. The data underlying these price indices are exclusively or primarily from 88 urban areas. Since 1968, the Council for Community and Economic Research has produced the ACCRA price indices for six broad categories of goods and an overall consumer price index for many more urban areas. Due to concerns about their reliability or ignorance of their existence, the ACCRA price indices have not been heavily used in economic research.

As a result of the absence of a reliable panel of price indices covering all areas of the country for many years, almost all studies that would benefit from them make no attempt to account for geographic price differences or try to control for such differences by adding to their empirical models a few variables believed to be correlated with prices. Only a few researchers have mustered the energy to construct a cross-section or panel of price indices for particular times and places for the purposes of their studies, and understandably their price indices are not as carefully constructed and documented as they would have been if they had been intended to be used by many others. The primary purpose of this paper is to relieve future researchers of this onerous task and thereby encourage the use of prices in empirical research.

This paper documents the construction of an interarea housing price index for each metropolitan area and the nonmetropolitan part of each state in 2000 based on a large data set with detailed information about the characteristics of dwelling units and their neighborhoods that overcomes many shortcomings of existing housing price indices. The fit of the hedonic equation used to produce this price index was excellent, and the estimated price indexes were consistent with popular views about differences in housing prices. Alternative housing price indices based on the same data but alternative methods are virtually identical. All housing price indices based on inferior data and methods differ from the preceding housing price indices in some important respects. In some cases, the differences are substantial.

For most areas, our price index for all goods other than housing in 2000 is calculated from the ACCRA price indices for categories of nonhousing goods. In order to produce a nonhousing price index for areas of the United States not covered by their index, we estimate a theoretically-based regression model explaining differences in the composite price index for nonhousing goods for areas where it is available and use it to predict a price of other goods for the uncovered areas. The paper then combines the price indices for housing services and other goods with data from the Consumer Expenditure Survey to produce an overall consumer price index for all areas of the United States. It is shown that the resulting overall consumer price index is not sensitive to the expenditure weights used and it differs little from a simple ideal consumer price index that accounts for how individuals alter their consumption in response to price changes.

Finally, BLS time-series price indices are used to produce a panel of price indices for housing services, other goods, and all goods from 1982 through 2012 from the cross-sectional price indices for 2000. The panel can be easily expanded forward and backward in time. Indeed, it has already been updated twice.

We hope that the availability of a new 31-year panel of price indices for each metropolitan area and the non-metropolitan part of each state and other levels of geography will facilitate research based on data across areas of the United States. The panel is well documented, downloadable, and freely available. Its use seems preferable to ignoring geographical price differences in economic research or accounting for them in alternative ways such as including dummy variables for different types of areas as explanatory variables in behavioral relationships. Finally, its availability means that researchers working with data across U.S. areas will no longer need to construct their own interarea price measures.

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Table 1. Price Indices for Housing, Other Goods, and All Produced Goods across Areas (2000)

Geographical Area	Housing	Other Goods	All Goods
Areas with Ten Highest Housing Price Levels			
San Francisco, CA PMSA	2.043	1.155	1.379
Stamford-Norwalk, CT PMSA	1.969	1.124	1.337
San Jose, CA PMSA	1.963	1.124	1.336
Nassau-Suffolk, NY PMSA	1.814	1.233	1.379
Santa Cruz-Watsonville, CA PMSA	1.789	1.134	1.299
Boston, MA-NH PMSA	1.658	1.141	1.271
Middlesex-Somerset-Hunterdon, NJ PMSA	1.634	1.087	1.224
New York, NY PMSA	1.626	1.087	1.223
Bergen-Passaic, NJ PMSA	1.587	1.092	1.216
Monmouth-Ocean, NJ PMSA	1.569	1.089	1.210
Areas with Ten Middle Housing Price Levels			
Springfield, IL MSA	0.949	0.927	0.932
Corpus Christi, TX MSA	0.948	0.969	0.964
Jacksonville, FL MSA	0.947	0.972	0.966
Gainesville, FL MSA	0.945	0.974	0.967
Tallahassee, FL MSA	0.945	1.058	1.029
Toledo, OH MSA	0.943	0.996	0.983
Racine, WI PMSA	0.943	1.002	0.987
Sheboygan, WI MSA	0.943	0.959	0.955
Grand Junction, CO MSA	0.943	0.988	0.976
Corvallis, OR MSA	0.943	1.069	1.037
Areas with Ten Lowest Housing Price Levels			
Nonmetro ND	0.704	0.940	0.880
Dothan, AL MSA	0.702	0.957	0.892
Nonmetro TN	0.702	0.945	0.883
Gadsden, AL MSA	0.682	0.945	0.879
Hattiesburg, MS MSA	0.681	0.951	0.883
Nonmetro MS	0.681	0.951	0.883
Nonmetro LA	0.674	0.942	0.875
Nonmetro AL	0.672	0.916	0.855
Nonmetro AR	0.664	0.955	0.882
Nonmetro MO	0.660	0.937	0.867

Notes: Housing price index is based on specification using missing value indicators. Other goods price index is based on ACCRA indices for goods other than housing and utilities when available and fitted values otherwise weighted by expenditure shares from CES. Overall consumer price index applies average expenditure shares from CES to the price indices for housing and other goods. Each index is scaled so that the mean across all 380 areas is 1.

Table 2. Comparisons with Housing Price Indices Based on Different Data

Alternative Price Index	Regression Results			Sample	Absolute Percent Difference	
	Slope	Std. Error	R2	Size	Mean	Maximum
American Housing Survey (all areas)	0.637	0.029	0.567	380	10.577	42.342
American Housing Survey (64 large metropolitan areas)	1.111	0.038	0.934	64	4.929	27.051
Decennial Census PUMS	1.016	0.025	0.832	343	7.870	26.836
HUD Fair Market Rents	1.217	0.024	0.891	331	7.063	37.748
Median Gross Rent	0.880	0.022	0.832	331	6.977	28.978
ACCRA (with NYC)	0.968	0.090	0.343	226	11.382	181.957
ACCRA (without NYC)	0.676	0.048	0.472	225	10.610	58.407

Table 3. Regression Explaining Differences in Non-Housing Prices

Regressors	Coefficient	Standard Error	t-score	P>t
regindex	0.00314	0.00525	0.60	0.550
ln(coolingdays+1)	-0.01561	0.00522	-2.99	0.003
ln(heatingdays+1)	-0.00094	0.00662	-0.14	0.887
precip	-0.00157	0.00086	-1.82	0.070
precipsq	0.00002	0.00001	1.94	0.053
lnPL	0.08589	0.04108	2.09	0.038
lnPH	0.12777	0.02758	4.63	0.000
dist (in hundreds of miles)	0.00371	0.00253	1.47	0.144
constant	4.75178	0.08540	55.64	0.000

Notes. Dependent variable is natural logarithm of the price index for non-housing goods with sample mean 4.60. Number of observations is 225, $F(8,216)$ is 26.95, and $R2$ is .50.

Table 4. Estimated Housing Demand Functions

	CEO Housing Price Index		ACS Housing Price Index	
Regressors	Coefficient	Standard Error	Coefficient	Standard Error
Constant	6.187	0.100	6.181	0.099
ln(INC)	0.271	0.009	0.268	0.009
ln(PH)	-0.460	0.036	-0.487	0.031
ln(PX)	0.066	0.175	0.311	0.152
Constant	6.167	0.097	6.196	0.097
ln(INC/PX)	0.271	0.009	0.268	0.009
ln(PH/PX)	-0.482	0.026	-0.473	0.025
Constant	6.195	0.098	6.022	0.098
ln(INC)	0.271	0.009	0.269	0.009
ln(PH)	-0.450	0.022	-0.441	0.021

Notes. Dependent variable is natural logarithm of gross rent divided by the housing price index. First two columns based on CEO housing price index; second two on ACS index. All regressions use CEO index of non-housing prices. Sample size is 6,142. R2 is .15 in all regressions.