Estimating Interregional Price Indexes: Opportunities and Pitfalls

by

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ABSTRACT: Many economists recognize the importance of accounting for retail price variation when comparing standards of living between geographic areas. Such indexes are used to allocate education funds, for calculating income transfers, and in relocation decisions. Currently, public policy shows a trend toward giving states more control over the distribution of federal monies through block grant programs. However, many states do not have a system for measuring price variations and use the U.S. CPI or an index for a major city within their state to estimate cost of living variation throughout their state. These indexes are highly inaccurate as measures of variation within a state. They do not account for the tastes and preferences of population groups of the state nor do they account for local market baskets. Rural areas, in particular, are always excluded from these measures. So that, a major task facing economists, especially those in predominantly rural states, is how to calculate geographic price differences within a state accurately. This paper will address issues economists confront in attempting to put together such indices. It contains a discussion and examination of the opportunities and pitfalls involved with special emphasis on theory, implementation, and reality.
I. Introduction

Measuring a price index for a state that specifically utilizes counties has some distinct issues. Generally, we do not expect much variation for places in close proximity. That is, differences in tastes at the county level are not held to be a problem. For instance, preferences for certain food items may not vary within a state compared to a large geographic separation as northern and southern states. (See Sherwood (1975) for a discussion on foods.) Another issue is the selection of a lifestyle and its attached market basket. For the most part, indexes that are most commonly familiar to us are price indexes or cost of living (COL) indexes, that are technically calculated as price indexes whose market basket has been selected based on a particular lifestyle and/or family structure and is derived from the cost to purchase that market basket. If a price index rather than a COL index per se is used then the selection of a lifestyle or a particular family structure can be avoided altogether.¹

For a state, the tax structure is the same and climate variation is minimal. But, specific geographic, social, and economic issues may be more of a concern at the county level than at the state level. That is, the availability and range of goods and services may vary within a state. Supply might be more limited in rural areas relative to urban areas and that supply may be affected by what can be utilized within the area to lower costs - for example, home produced goods or other natural resources, such as well water versus county water. Transportation costs are higher in more isolated areas and the proximity to main population centers usually means lower transportation costs in urban

¹To confuse this issue further, the standard of living index is considered to be the dual to the cost of living index. (See Chapter 9, Blackorby et. al. (1978)).
areas. Even though maintenance items such as gas, oil, etc. are low, insurance costs may be extremely high in urban cities. As mentioned, counties face the same Federal and state taxes, so that unless there are specific county or city taxes, this item is constant. The supply of housing is more inelastic and the subsequent price variation is smaller at the state level. However, within a state and even within a county, housing costs, also the largest budget item, has the most variation. And, though climate variation is minimal, counties will have variations in clothing costs and utility costs. Clothing costs are affected by the availability of retail outlets as well as the degree of urbanization. For example, because the item selection and number of retail outlets is limited, a rural county may rely more on mail-order companies.\(^2\) Urbanites may use this service for time savings or name brand recognition. Though utility costs may not vary radically within a state, the control of various public utility commissions may be a factor. The need for various public services may be greater in more populated areas. Also, there is a beginning trend to charge for services by fire and emergency care units. Of course, all of the above is affected by tastes and preferences of the consumer.

II. Previous Research

Studies that have tried to ascertain the determinants of cost of living generally evaluate commonly accepted measures of the cost of living. These include the use of BLS Family Budget (FB) Studies, the American Chamber of Commerce Researchers Association Cost of Living Index (ACCRA (1992)), city Consumer Price Indexes (CPI’s) and some state measure of price indexes.\(^3\)

\(^2\)This raises the issue of “borderless” prices. The use of mail/telephone ordering and internet purchasing reduces the concept of markets to a universe with price variations amounting to variations in shipping charges only.

\(^3\) See Blanciforti and Kranner (B-K) (1995) for more information on differences between the ACCRA and CPI and for the results of a survey on state price indexes.
Most of these studies (Haworth and Rasmussen (1973), Cebula (1980, 1983a, and 1983b), Hogan and Rex (1984 and 1985) focus on metropolitan areas. A few studies focus on states (McMahon (1991), McMahon and Melton (1978), and Cebula (1986)) or counties within a state (Kurre (1992a and 1992b)) and Langston et al (1985)). Variables are selected based on the agglomeration/congestion hypothesis, rent theory, and other factors, and typically include population, population density, population growth, income, measures of housing, utilities or some other factor related to climate. Most of these studies use regression analysis. However, McMahon (1991) estimated a reduced-form (hedonic) equation that combined supply and demand factors. Similarly, Kurre’s studies for rural Pennsylvania counties used regression analysis on ACCRA data for communities throughout the U.S. to estimate an equation and out of sample forecasts to estimate COL.

Many of these studies cast aside theoretical foundations and use some combination of supply and demand factors. The issue I’d like to discuss in this paper is what theoretical foundations must be considered and what adjustments to that structure are needed when going to the real world. The focus will be on the unique aspects of estimating price indexes for counties within a state. The goal is to ascertain elements that are general and yet specific to a state so that the method could be utilized by other states while maintaining sound economic techniques.

III. Economic Foundations

Most of the indexes we are familiar with deal with time. However, the type of index we are dealing with here is a spatial one and could be extended to a combination of space and time, one that is not commonly considered. For the most part, two common approaches to developing indexes rest on statistical soundness and on meeting tests of specific properties. As hinted at above, the
comparison of costs between two places within the same state should be relatively easy to ascertain since inhabitants of areas sufficiently close together should have similar consumption choices. At least, one would expect these consumption choices to be more alike than for inhabitants of two cities in two different countries. However, two major issues need to be addressed. 1.) Do we want to measure solely price movement or cost of living movement? And, 2.) how do we implement this theory to obtain accurate and complete coverage in the form of a spatial or interregional price index? Next, I would like to discuss the difference between price and COL indexes and then discuss their implementation issues from a spatial perspective.

III.A. Price versus Cost of Living

Economic theory tells us that measuring COL and price indexes are not the same though people tend to use these two concepts interchangeably. A price index like the Consumer Price Index is a Laspeyres index and measures the change in the cost of purchasing a fixed market basket of goods - food, clothing, housing, etc. - that people buy for day-to-day living at two points. It is an index of price ratios weighted by budget shares. These price indexes can be time or place though we are most familiar with time-type indexes. The key theoretic point is that the market basket remains the same for everyone.

A COL index measures the cost to live (CTL) at two different points. Similar to a price index the COL index uses prices and market baskets as well. But, the COL index defines the market basket based on purchases usually by some defined population subgroup to attain a specific living standard, often referred to as a level of utility. The COL is the ratio of the lowest amount spent to buy the goods that provide that living or satisfaction level at two different sets of prices - the base period and
the new period, a time or a place⁴. The important point here is that the COL measures the effect of price changes on achieving that base period's CTL in the new period while the price index only measures the price change of purchasing the base period's consumption basket in the new period. The COL measures price changes but for goods that define a living level rather than just a quantity or market basket of goods. Therefore, hypothetically, a COL index would vary the basket as long as the same living standard is maintained.⁵

The market basket or the set of goods that define the CTL could change for the two periods but for most practical purposes are usually kept the same. This would be more of an issue for time-type indexes since goods change over time. This is not so much an issue for spatial indexes when comparing adjacent counties or states because we do not expect goods to change very much at nearby places. However, for comparisons of states or, on a broader scale, countries, where more variation occurs, this could be an issue. But, the theoretical point regarding the COL index is that the baskets may differ as long as they provide the same level of satisfaction. The difficulty is that a standard of living has to be defined and estimated in some way and maintained for some base period.

Spatial indexes comparing a number of cities at a particular point in time require the definition of a base city or place. This becomes more difficult the greater the distance between the cities compared, i.e. comparing two cities in the same state is far easier than comparing two cities in two different countries. As mentioned, when places are close in proximity then similar

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⁴Period here is used to refer to base point. It is typically associated with time but the reader can also substitute place.

⁵From a practical perspective, data collection for the CPI allows for some flexibility in the goods priced so that market baskets do vary for both the CPI and COL index. Also, the living standard for calculating the COL index is difficult to define and keep constant.
consumption habits may be assumed whereas distance increases the diversity of consumption. Goods can and should be fixed for within state comparisons.

Also, note that the CTL is conceptually related to an average family whereas price indexes are more individualistic. Converting to cost per capita or cost per adult equivalent might result in a cost difference apart from the real difference one wants to measure.⁶

The utility level is the key ingredient in the COL index. We are dealing with an indifference surface that corresponds to a certain scale of preference of consumption. Note that the same utility can be reached by varying the quantities consumed on that same indifference level. If a common state of want satisfaction or living standard occurs then we obtain the true COL index ala Konüs (1939) by dividing the cost of living at one point by the other. In other words, the true COL index is the ratio of the costs of maintaining the same satisfaction level at the two points.

If we ignore the many theoretical issues that arise as the issue of the true index lying between the Laspeyres and Paasches indexes, we cannot close our eyes to two important issues. One is that the true cost of living depends on the representative level of satisfaction. The other is that price changes affect the CTL differently for distinct individuals or households, even if they have identical tastes, reflected in varying expenditure patterns. But, in actuality, this is unlikely to occur. (See Deaton and Muelbauer (1980).⁷

First, calculation of the cost of living depends on knowledge of the cost function, $C(u^8, p')$.

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⁶ Note that the number of adults and kids per average family differs in two places and conversion factors do not exist for most items. Some exist for foods but not for other items.

⁷ Here, the cost and utility functions are proportional and the price index is independent of utility. Only when all indifference curves are the same shape and, in other words, given homothetic preferences will expenditure patterns be constant.
and of the reference utility level, $u^R$. To obtain this information would require the estimation of a complete system of demand with some compromise as to what system to estimate. Even though from duality theory we know that the cost function can be approximated from total expenditures, we need some level of quantities to be priced. So we have come full-circle to the concept of a fixed market basket and can fully understand why our statistical agencies have proceeded the way they have.

III.B. Space

Another issue, that cannot be ignored, is how do we modify this analysis when we are considering space. When comparing price changes in two places at one point in time, we need a cross-sectional index.\footnote{The Bureau of Labor Statistics does generate a CPI for cities but it is not a cross-sectional index but a temporal index. It measures price change in a specific place over time. Using a city CPI allows one to interpret inflation over time at certain major cities but not how cities compare to each other. For example, from city CPI data you could say that dairy products cost 5% more in Miami than they did a year ago and 1% more in San Diego but not how much more dairy products cost relatively between Miami and San Diego.} Again, if we are treating adjacent places then the market basket for the CPI and COL index should be the same, given we are looking at the purchases of two similar household groups or individuals, and we would only have to worry about price change and a price index would suffice. But, from a spatial perspective, we need to reconsider the question are we asking. Are we asking how much does it cost for the representative household or person in base county $i$ to buy his market basket of goods in another county? Or, we are asking if the consumer from base county $i$ would spend their money in the same way, that is, buy the same kinds and amounts of goods, if relocated to another county? Again, the most obvious point is whether the market basket is fixed or not.

For our purposes, we are looking at the problem of comparing the level of prices in different
counties within the same state. If we can assume that consumers in one county have the same preferences as consumers in another county in the same time period and if we can assume that there are no significant differences in nonmarket variables\(^9\) in the two locations then we can combine some well-known concepts.

Some economists would agree that cost of living comparisons should proceed this way, first, we could assume that all consumers had the same tastes. This assumption would allow counties to be treated as a set of quasi-persons with a common preference map. For our purposes, this assumption should not be a major problem since county tastes are more homogenous than might be supposed.\(^{10}\)

Second we can combine theories presented by Pollak (Pollak (1975)) and by Caves, Christensen, Diewert (C-C-D) (Caves et al (1982)). Pollak's theory of subindexes requires the assumption of a separable utility function and deals with the consumer as a group facing two groups of goods at each location. The C-C-D approach looks at the individual consumer facing prices at different locations at one point in time. Combining subindexes with the C-C-D approach, the consumer's COL index is derived as a cost minimization problem for two consumers at two places for two general categories of goods: \(X_1\), the market goods, and, \(X_2\), the nonmarket locational amenities (NMLA). There will be \(R\) locations and \(H_i\) households in each location \(r\). If we consider household \(h\) in location \(r\), then utility function of a household \(h\) at location \(r\) is \(F^{hr}(X_1, X_2^{hr})\). The consumer minimization problem for \(r = 1, 2, ..., R\) locations and \(h = 1, 2, ..., H\) households becomes

\(^{9}\) These would be amenities or environmental variables or other demographic variables.

\(^{10}\) County tastes, as for other aggregate groupings, are more homogenous than for individuals. A high proportion of county variation in consumption patterns can be explained by real incomes, prices, and demographic patterns such as age or household structure of the county, given a constant climate though, it may be unrealistic but for the time being we will assume market goods and nonmarket goods to be separable.
\[
\min_{X}\{p \cdot x : F^{hr}(X_2^{hr}, X_1) \geq u^{hr}, X_1 \geq 0\} \equiv C^{hr}(u^{hr}, p \cdot, X_2^{hr}) > 0.
\]

If we use the preferences and amenities of household \(h\) in location \(r\) as the reference quantity and compare the cost of living in location \(r\) to another location \(j\) then the Konüs Cost of Living or Price Index, the ratio of the COL at two points, becomes

\[
K^{hr}(p \cdot, p \cdot) = C^{hr}(u^{hr}, p \cdot, X_2^{hr})/C^{hr}(u^{hr}, p \cdot, X_2^{hr}) \quad \text{for } r, j = 1, 2, \ldots, R; \ h = 1, 2, \ldots, H_r
\]

\[
= p \cdot X_1^{hr}/C^{hr}(u^{hr}, p \cdot, X_2^{hr}).
\]

Similarly, if we use the preferences and amenities of household \(k\) in location \(j\) as the reference quantities and compare the cost of living in location \(r\) to location \(j\) then the Konüs Cost of Living Index becomes

\[
K^{kj}(p \cdot, p \cdot) = C^{kj}(u^{kj}, p \cdot, X_2^{kj})/C^{kj}(u^{kj}, p \cdot, X_2^{kj}) \quad \text{for } r, j = 1, 2, \ldots, R; \ k = 1, 2, \ldots, H_j
\]

\[
= C^{kj}(u^{kj}, p \cdot, X_2^{kj})/p \cdot X_1^{kj}.
\]

C-C-D state that without knowledge of the cost function and its coefficients, these indexes \(K^{hr}\) and \(K^{kj}\) cannot be computed. However, under certain mild restrictions on preferences, the geometric mean of these theoretical price indexes can be computed from knowledge of the observable price vectors in the two counties, \(p^r\) and \(p^j\), the consumption vector of household \(h\) in county \(r\), \(X_1^{hr}\), and
the consumption vector of household \( k \) in county \( j \), \( X_{1}^{kj} \).  

Note that we are dealing with the individual preferences of consumers in each county. In order to compare prices in counties we need to average over the households in each county. The weighting scheme usually used is to weight by expenditure, that is, weight in proportion to the household’s share of the county’s consumption. The Konüs county \( r \) COL index becomes a weighted geometric mean of the individual indexes within county \( r \).

\[
K^{r}(p^{r}, p^{j}, \omega^{r}) = \prod_{k=1}^{H_{r}} K^{hr}(p^{r}, p^{j})^{\omega_{k}^{r}}.
\]

Note this index uses preferences from county \( r \) only and uses prices from both counties so that to fairly represent preferences of both counties we would take a geometric mean of the Konüs county \( r \) and Konüs county \( j \) indexes. Thus, the Konüs COL index comparing counties \( r \) and \( j \) becomes \( K(p^{r}, p^{j}, \omega^{r}, \omega^{j})=P^{r}(p^{r}, p^{j}, X_{1}^{r}, X_{1}^{j}) \).

Using the Pollak structure, if we assume that \( P^{j} \) is the subindex over market goods, that \( p_{1}^{r} \) and \( p_{1}^{j} \) are the vectors of observed market prices at locations \( r \) and \( j \), respectively, \( F(X) = F(X_{1}, X_{2}) \)

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11 Theorem 5 (Caves et. al. (1982)) states that if the expenditure function is translog for household \( h \) in county \( r \) and household \( k \) in county \( j \) with identical coefficients on the second order terms in commodity prices, making preferences somewhat similar, then the Törnqvist index is equal to the geometric mean of \( K^{hr} \) and \( K^{kj} \). In this case,

\[
[K^{hr}(p^{r}, p^{j}), K^{kj}(p^{r}, p^{j})]^{1/2} = \prod_{n=1}^{n} (p^{nr}/p^{nj})^{[(1/2)(p^{nr}X_{1}^{nr}X_{1}^{hr}) - (p^{nj}X_{1}^{nj}/p^{nr}X_{1}^{hr})])
\]

\[
= P^{r}(p^{j}, p^{r}, X_{1}^{rk}, X_{1}^{hr})
\]

12 Defining \( \omega^{r} = (\omega_{1}^{r}, \ldots, \omega_{H_{r}}^{r}) \) as the weights for households in county \( r \) and these weights \( \sum_{h=1}^{H_{r}} \omega_{h}^{r} = 1 \), where \( \omega_{h}^{r} = p^{r}X_{1}^{rh}/p^{r}X_{1}^{r} \) for \( r = r \) or \( j \) and \( h = 1, \ldots, H_{r} \), and where \( X_{1}^{r} = \sum_{h=1}^{H_{r}} X_{1}^{rh} \) is county \( r \)’s aggregate consumption of market goods.
is the utility function defined over combinations of market goods \(X_1\) and NMLA \(X_2\). At the two locations, location \(r\) and location \(j\), \(X_1^r\) and \(X_1^j\) are the observed market choices for consumers, \(X_2^r\) is the amenity vector in location \(r\), \(X_2^j\) is the amenity vector in location \(j\). The utility function will represent the choices of market goods and amenities by consumers at each location, i.e., \(X^r = (X_1^r, X_2^r), X^j = (X_1^j, X_2^j), u^r = F(X^r), \) and \(u^j = F(X^j)\). The subindex for market goods at locations \(r\) and \(j\) is

\[
C^1[F(X^r), p_1^r, X_2^r] \cup C^1[F(X^j), p_1^j, X_2^j] = P^1(p_1^r, p_1^j, F(X^r), X_2^r) \quad \text{and} \quad C^1[F(X^j), p_1^j, X_2^j] \cup C^1[F(X^j), p_1^j, X_2^j] = P^1(p_1^r, p_1^j, F(X^j), X_2^j).
\]

And, the equivalent subindex for NMLA at locations \(r\) and \(j\) is

\[
C^2[F(X^r), p_2^r, X_1^r] \cup C^2[F(X^j), p_2^j, X_1^j] = P^2(p_2^r, p_2^j, F(X^r), X_1^r) \quad \text{and} \quad C^2[F(X^j), p_2^j, X_1^j] \cup C^2[F(X^j), p_2^j, X_1^j] = P^2(p_2^r, p_2^j, F(X^j), X_1^j).
\]

In the above \(p_1^r \equiv (p_1^r, p_2^r, \ldots, p_N^r)\) is the price vector of market goods 1 to \(N\) at location \(r\), \(p_1^j \equiv (p_1^j, p_2^j, \ldots, p_N^j)\) is the price vector of market goods 1 to \(N\) at location \(j\), and, similarly, \(p_2^r\) and \(p_2^j\) are equivalent price vectors for the NMLA. However, unlike market goods, the nonmarket locational amenities are not finite.

What has been presented allows the quantity all goods to vary based on satisfaction of the consumer’s budget constraint. However, in reality, nonmarket locational goods are fixed exogenously even though consumer’s may be willing to pay varying prices and only use partial amounts. For the time being, I would like to assume that these goods are fixed and provided to all in that location without a charge for use, that is, similar to collective goods, the consumer cannot
control the amount consumed\textsuperscript{13} nor the amount supplied.\textsuperscript{14}

This next section is an attempt to adjust the above for amenities. It follows similar concepts as expressed by Deaton and Muellbauer (1980). First, let us define amenities, $X_2'$, as the NMLA in location $r$. In the previous analysis we only assumed amenities to be fixed in each location but ignored that their might be a price attached. Assume the amount consumed is a fixed quantity equal to $X_2'$ at location $r$. A price may be charged for $X_2'$, assumed to be $p_2'$, but usually is not obvious in the market price sense. That is, it may be incorporated into other factors that enter the location decision and may be an ‘opportunity price’. Given the consumer has chosen the location $r$ for his employment and living site, he is theoretically purchasing both amenities and goods at that location.\textsuperscript{15} Returning to the cost function, define a conditional cost function as $C^r(u, p, X_2')$ at location $r$, where $u$ and $p$ include both market goods and amenities.

$$C^r(u', p', X_2') = \min_{X'} \{p' \cdot X' : F^r(X_1', X_2') \geq u' | X_2'\}$$

where $p'$ is the vector of nonnegative prices at location $r$ given $X_2'$. Note that NMLA is chosen or bought through the location decision and is treated as fixed. The presence of the NMLA may make the consumer better off but cannot make him worse off so the conditional function is greater than or equal to the unconditional cost function. If the consumer would chose the amount $X_2'$ ordinarily

\textsuperscript{13} For some items, the consumer does control the amount e.g. the use of a recreational amenity. However, for an amenity as air quality the individuals control is minimal.

\textsuperscript{14} The total available amount enters the utility function, not the amount purchased as with market goods.

\textsuperscript{15} This deals with the consumer facing prices, for more on the entire analysis combining the location decision based on labor, housing, and amenities, see Roback (1982).
then the conditional and unconditional cost functions would be the same. With the NMLA consumed in a fixed amount, the conditional cost function becomes

\[ C^r(u^r, p^r, X_2^r) = p_2^r X_2^r + \min_{X_1^r} \{ p_1^r \cdot X_1^r : F(X_1^r, X_2^r) \geq u^r \}. \]

In a sense, this treats the amenity component as a fixed cost and the other market good component as a variable cost.\textsuperscript{16} If \( X_2^r \), the NMLA at location \( r \), would have been bought anyway, the derived demand functions will not depend on the price \( p_2 \) and the conditional demand will equal the unconditional demand (Deaton and Muellbauer, p. 111). And, the Hicksian demand functions would be

\[ h_i^r[u^r, \ p_{i \in Z}, \ h_2^r(u^r, p)] = h_i^r(u, p) \]

where \( i \) refers to individual market goods and \( i \in Z \) refers to all goods excluding the amenities. To examine the cross-price derivatives, differentiate the above with respect to \( p_2 \) so that

\[ \frac{\delta h_i^r}{\delta X_2^r} \cdot \frac{\delta h_i^r / \delta p_2}{\delta h_2^r / \delta p_2} = \frac{s_{i2}}{s_{22}} \]

where \( s_{i2} \) and \( s_{22} \) are the cross-price substitution terms that occur when the amenities are the desired amounts. Generally, the own-price substitution effect is negative so that the above result implies that if the NMLA increases the demand for complements rises and the demand for substitutes falls. Differentiating with respect to the prices of the market goods

\textsuperscript{16}But this also implies that amenities are strongly separable which may not be true.
\[ \frac{\delta h_i(u, p)}{\delta p_i} = \frac{\delta h_i^{'''}(u)}{\delta p_1} + \frac{\delta h_i^{'''}(p_1)}{\delta p_2} \cdot \frac{\delta h_2^e}{\delta p_i}. \]

The conditional substitution effect, \( s_{ii}^{'''} \), is

\[ s_{ii}^{'''} = s_i^{'''} - \frac{s_{i2}}{s_{22}}. \]

And, this is greater than or equal to the unconditional effect as mentioned above.\(^{17}\) Alternatively, the price of the NMLA could be determined using shadow price concepts (also, see Deaton and Muellbauer pp. 112-113). The price of the NMLA, \( p_2 \), is the fixed charge for one more unit of the amenity and \( p_2 \) measures how much more it costs to remain on the indifference curve when the amount of the amenity \( X_2 \) increases. Deaton and Muellbauer have also shown that the compensated decrease in all goods of an increase in \( X_2 \) equals the increase in the shadow price of \( X_2 \) resulting from a compensated increase in all prices.

III.C. Implementation Issues

The main issue is do we want a price or COL index? Stemming from this question comes the issues of how to define the utility level, the cost function, or the demand system. If we want a COL index we can go back to the idea of costs based on a standard of living. The standard could be defined in a general way as was done in the BLS’ FBs (USDOL (1966, 1967, 1980, and 1981)). For example, we could consider purchases made by a household of four consisting of two parents,

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\(^{17}\) Since \( s_{22} \), the own-price effect in the denominator, is always negative and the numerator term is squared, the second term of this equation will be greater than or equal to zero.
one working as a school teacher\textsuperscript{18} and the other non-working,\textsuperscript{19} and two elementary school children, a 12 year old and a six year old, with some median level of household income. This definition could also be more reflective of some state or U.S. demographic averages. The BLS FBs used this same concept. But, the FB Program was discontinued in 1981.\textsuperscript{20}

Second, where do we draw the line on fixed amenities? Can we assume that adjacent counties have the same amenity level and how do we account for counties separated by some distance. Also, how do we adjust for variable amenities or disamenities, as crime and congestion.

Note in practice the various approaches to determining a cost of living or price index is based on various aggregation methods. However, prior to undertaking the construction of an index, decisions must be made in terms of the desired goal (e.g. a cost of living versus price index noting price change, adjusting salaries for a specific population group or the expense of living at one place versus another); how much expense one is willing to incur in terms of time and money; how precise one needs to be (i.e. how much variance one would allow). If we follow the BLS methodology then we rely on a series of samples - a sample defining the population or consumer group, a sample of items purchased by the consumer group, a sample of outlets where these consumers shop, etc.

\textsuperscript{18} The idea for using a school teacher in the standard of living comes from the stated purposes of the indexes. Most states use price indexes to distribute educational funds or to adjust teachers salaries. Also, it should be noted that teaching is a universal occupation.

\textsuperscript{19} This may be a worker too since this is more typical of ‘todays’ social structure or may even be redefined to include one parent with or without a partner.

\textsuperscript{20} The BLS Family Budgets (FBs) compared the costs for maintaining three standards of living - at low, intermediate, and high income levels. In 1980, low income was $14,000, intermediate was $23,000 and high was $34,400 for a family of 4. The family consisted of a 38 year old husband employed full time, a nonworking wife, a boy of 13, and a girl of 8. (See Blanciforti and Kraner (1995)).
Should the sample be a truly random sample or a stratified random sample and on what criterion should the stratification be based. That is, do we want to select a few random counties to represent the whole population or a few counties from a number of geographical groupings or geographic locations or would we want to select counties containing major retail centers and how do we define these centers for rural population groups? So that right from the beginning decisions need to be made as to the population group, the number and kinds of sampling locations, the sample size: how many households should be sampled in an expenditure survey; how many outlets should be sampled in a point of purchase survey; how many expenditure categories are realistic; how many items should be priced in an expenditure category; in how many outlets should each item be priced and in how many different kinds of outlets should items be priced; what specifications should be used to select an item; and, if more than one item satisfies the specifications, how should the item be selected and priced; and, generally, what kind and amount of variation should be built into the survey to assure true randomness. The following mentions some of these surveys and related issues.

III. C.1. A Demographic Survey

First, a thorough demographic survey of the state population is needed to ascertain the desired population group. Generalizing from the larger surveys conducted by the U.S. Census Bureau, use of existing surveys limits one to the existing sample design. However, sample stratification process could be used to select the surveyees. First, a sample of areas, e.g. metropolitan or nonmetropolitan, urban or rural, or some combination in line with the surveys goals, and based on a certain population criterion could be selected. This could be based on city size or population in an area. For example,

\[\text{\footnote{For the most part, the currently existing surveys mentioned here are based on urban or metropolitan population.}}\]
the CPI's primary sampling unit and strata are defined based on a combination of region, population size, SMSA designation, population changes, major industry, degree of urbanization, etc. From the population surveys, a random sample of census tracts can be chosen. Then, a random sample of housing units to be surveyed. The questionable issue that arises from using existing surveys is: is this going to portray a true picture of all households including rural given most of the major surveys are conducted for urban populations?

III.C.2. An Expenditure Survey

Second, an expenditure survey is important in the selection of items and in the definition of the standard of living. From the expenditure survey, one can ascertain the population group, the market basket of goods and its respective item weights, and the income criterion, and thus determine what the population group purchases and what standard of living they have attained. But how extensive can a state be in conducting such a survey? Again, the issue of cost and practicality arises. And, along with that, what criterion or degree of accuracy is acceptable, especially when one does not expect accurate responses to the income question? As an example, the FPLI uses Orlando (sampled by the BLS in the Consumer Expenditure Survey (CEX) for the CPI) so the basket and percent spent on each item is based on what an average wage or clerical worker household (CPI-W) in Orlando in a base year purchases. Would nonurban areas be accurately represented?

III.C.3. The Market Basket

For a fixed market basket or cost of living, item specification should be identical in all places. Therefore, for this to work one needs very detailed item specifications and to be able to locate the same items in each place of pricing. But, sometimes even the most commonly sold items are not

22 For more information on this, see USDOL, BLS (1984).
available in every location or at each specified retail outlet. The CPI item structure has four levels of classification: seven major product groups, (68) expenditure classes, (265) item stratum, and (382) entry level items. Within these classifications, the CPI designates four regional market basket universes from the CEX. Eight independent samples of entry level items are selected for each region and the two population groups, the CPI-W and CPI-U, i.e. 64 sample selections. Each of the very large population areas, i.e. those designated as having one pricing area or officially self-representing or primary sampling units (PSU's), e.g. New York City, is assigned 2 of the 8 item samples and the rest, the non-self-representing areas, are assigned 1 of the 8. This was done to allow for replication and variance estimation.\textsuperscript{23} The entry level item (ELI) sample is selected first for the population group. Then, selection probabilities are defined from the CEX based on the relative proportion of spending on the items for the item stratum by the population group in a region. The CPI-W population item sample is selected first and then CPI-U one and a conditional probability technique is used to maximize the amount of overlap in item selection and, hence, to minimize data collection expense.

III.C.4. The Outlets

A survey of outlets is needed to determine where the population group shops. Note many outlets sell a variety of items but some are specialty stores selling only one kind of item with varied specifications. And, the growth of mail order outlets supplies a great deal more variety for shoppers in rural areas. Though, many urbanites use mail order outlets to save time and for name brand recognition. How would one account for such purchases and what is the effect on prices paid for

\textsuperscript{23} Due to changes made at the BLS through the Office of Price and Index Number Research (Zieschang etc.) variance estimation is done differently today.
goods within state borders? Does this mean a national market exists for such items without any price variation?

For the CPI, a point-of-purchase survey (POPS) is conducted to provide demographic data on households purchasing at an outlet and a sampling frame of outlets based on the amount spent on over 130 relatively broad categories of expenditures, name and location of the purchase place of these same items purchased at intervals of weeks to biannual. Initially, the survey was conducted at all 87 primary sampling unit. Now, one-fifth of the PSU’s are sampled each year on a rotating basis, thus providing new outlets and new item specifications each year. This continuing POPS or CPOPS is very similar to what occurs in the expenditure surveys only the focus is on outlets. For non-point of purchase items sampling designs are obtained from other agencies or constructed by BLS. The frame consists of all outlets providing the commodity or service in each sampling area. A measure of size is determined based on the amount of revenue generated from the specific population in the sample. If revenue is not available then an alternate measure of size as number of employees, number of customers, or quantity of sales could be used. This type of information may be available from a state revenue collecting agency. In any case, a single sample of outlets and size measure is needed for estimating the weights for specific population groups. Here, a conditional probability technique can be used with probability proportional to the measure of size.

III.C.5. The Items

Items must then be selected based on some criterion. For the BLS, a field representative, trained in multistage probability selection techniques selects an item in accord with a checklist that includes descriptive characteristics identifying the item and explaining any item price differences. Additionally, price collectors have lists suggesting stages of grouping of items for quick selection,
worksheets to define the item categories, selection probabilities, and even random number tables to use in identifying the next item to select. Representatives may define sales categories through direct response or through inventory measures. They are also given alternative ways to define sales percentage. Sales proportions are obtained from respondents, by ranking categories by importance and obtaining their proportions, or by using preassigned proportions, by using shelf space, or by using equal probability techniques. The BLS feels this procedure allows greater objectivity and flexibility in pricing. Using a wide variety of specific items reduces the variance within item groups, lowers the correlation of price movement between areas, and lessens the required number of price quotes. Additionally, this procedure increases the probability of finding a priceable item within the item definition and sample of outlets. But, in a practical sense, is the market basket still fixed?

III.C.6. Other Issues

Most surveys depending on their degree of thoroughness are very costly and time consuming. So how does one obtain these representative samples to represent the cost of living or price changes of a given population given limited funds? Other issues are what pricing cycles to use and when to price. Additionally, how does one control for seasonal items, quality changes, introduction of new items and the deletion of old items? To ensure representative price sampling, the BLS divides each month into 3 pricing periods of 6 business days each including an equal variety of outlets and prices the same size sample in each period. This is done to ensure reliability and spread out the flow of information for processing. Again, this would be costly for a state budget.

III.C.7. Housing

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24 Florida pays a private company $250,000 a year to survey its counties on a limited basis once a year.
Housing is the largest and most complicated budget item. One could define the specific components (quality and quantity of items) of a house in a base year and place and price that specified house. Building costs would be determined by materials and labor and some transportation and other essential real estate fees. If equity in labor quality and materials is assumed then most quality differences that might occur in housing should be restricted. Alternatively, a hedonic approach of pricing base characteristics for housing as done by Gillingham (1983), Moulton (1995), Thibodeau (1989), Bellante and Killion (1976) and other authors in the July 1991 issue of the Journal of the American Real Estate and Urban Economic Association.

III.D. Some Other Theoretic Statistical Issues

Returning to country comparisons, there are three theoretic statistical issues mentioned with regard to: time reversal, factor reversal, and circularity. Time reversal means that the percentage change in two years should calculate to the same number irrespective of the selected base year. Factor reversal means that a quantity index multiplied by a price index equals the change in the expenditure index between the two periods. And, circularity means that if we are comparing three things - A, B, and C - then the ratio of A to B (A/B) times the ratio of B to C (x B/C) should equal the ratio of A to C (= A/C).

These theoretic statistical issues would also be important for an interregional or interstate index. Circularity should hold so that comparisons can be made among different places. Time reversal would be important because one would want to create an index that could be carried over

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25 These tests are summarized in Banerjee (1976), Frisch (1930), and Pollak (1971). In addition, the identity, commensurability, determinateness, and a base test are mentioned. Other authors, for example, Kravis (1984) and Marris (1984) also include the properties of transitivity, base-invariance, preference-conservation, and the absence of bias.
throughout the years. In addition, one would want place reversal, that is, time reversal applied to space. The factor reversal test could be somewhat problematic since it requires a quantity index. But, quantities are typically derived from expenditures and result in pseudo-quantity indexes. Thus, indexes of some composite of goods in the factor reversal test should never fail when looking at groups of items.

IV. Summary

An idealistic oversimplification of the problem can be summarized as follows. We are concerned with price movement alone or changes in consumption resulting from that price movement. The true COL index ala Konüs compares the utilities derived from consuming goods. That utility translated into an indifference surface reflects a certain preference scale and is analagous to a level of living, that is, different amounts are consumed to achieve the same level of satisfaction. The true COL index is then the ratio of costs required to maintain the same standard of living at two points, in time or space. However, the true COL index is still an abstract concept that cannot be measured exactly. Generally, this level of living or indifference surface would not necessarily stay the same in two periods but may do so when comparing two places at one point in time. Ideally, defining expenditures or utility or pure price movement would entail coverage of all commodities, impractical from a cost or efficiency point of view. Given we are focusing on space, we must consider that in reality the relevant preference orderings differ between two places, since price, income, tastes and even utility all can and do change. But, some of these changes may not be major! The definition of a reference preference ordering with a reference basket of goods reflecting consumption patterns for a reference place seems to be the most appropriate way to approach the problem. So we return to the initial problem, how do we proceed to answer the question, solve the
problems and minimize the weaknesses that violate the theory from a practical perspective.

V. Suggestion

Two suggestions will be summarized here. The first is to follow an aggregation approach the second an econometric approach.

V.A. Aggregation Approach

In practice, measures of the COL index or CPI are trying to estimate the true index using aggregates and this data collection is a costly and time consuming endeavor. If we fashioned a FB survey as the BLS used just for WV we would need to define a population grouping. Also, market baskets should be made identical for all areas and we would need to assume that consumers would be equally satisfied with any of the market baskets. In a sense some of the problems with the BLS’s FBs can be eliminated when making intercounty (within state) comparisons. Going back to the idea of costs based on a standard of living, the standard could be defined, for purchases made by a household of four as described above. The fixed market basket could assume there would be usage differences of items such as fuel, transportation, clothing and food preferences but there would be homogeneity with regard to taxes and climate that would affect home fuel, electricity, and other utilities as well as clothing purchases. Item groups could be defined using a strategy similar to expenditure categories used by the BLS and pertinent to the region. And, the selection of retail outlets (a random selection within groups stratified by outlet size) and weighting scheme (sales volume and market share for the type of outlet in the region) could also follow the same BLS methodology. Again, this is a costly and time consuming endeavor and requires a number of decisions.

V.B. The Econometric Approach
The second option would be to proceed along the lines of an econometric study this could take two directions: the hedonic approach of the Country Product Dummy Method (CPDM) or the deterministic approach of ascertaining the determinants of an index in general. These will be summarized below. However, the first requires collection of prices and item specifications for each item while the second requires the existence of an index for the left hand side variable.

V.B.1. The Hedonic Approach

Comparisons of national incomes and prices are commonly done at the international level. The idea of comparing goods in one region to another or one country to another are quite similar. However, for interregional comparisons within one nation variations arising from differences in exchange rates can be ignored. The CPDM (Summers (1973)) developed by Robert Summers for the United Nations International Comparison Project (Kravis et al. (1975) and Kravis (1978)) is one usable approach. It is an hedonic regression approach requiring only two sets of dummy variables - one representing occurrence in a geographic location and the other representing the occurrence of an item - and some estimate of price. Blanciforti (1986) applied this methodology to the food and beverage expenditure category of the CPI program for all 12 months of 1984.\textsuperscript{26} The U.S. was defined into 41 regions and indexes were developed for 80 item strata. Her work extended the CPDM to regions where the item is priced, to item specifications from the BLS field representatives checklists, and to other relevant information that was collected. For example, a dummy variable was

\textsuperscript{26} This is a unique data tape only available internally at BLS. It contains information on locations of outlets, prices of goods, specifications of items and numerous other pieces of information. Observations ranged from about 2,000 to 100,000 for various item groups. The result is a massive data base with close to one million observations.
coded for the month that the price was collected, for the country of origin of the product, and for
pricing cycles. This method provides price estimates where unilateral and bilateral comparisons
can be made. Generally, the relative price level estimates are considered to be both base invariant
and circular.

Blanciforti's study only deals with individual food items. She pursued the aggregation issue
to the extent of presenting six index formulas from Ruggles (1967) and evaluating one expenditure
class (flour and cereal products) for two regions. An aggregation of the entire food group was
presented using the Laspeyres index and BLS's weights (Blanciforti (1995)). Kokoski et al. (1994)
have extended the methodology to all CPI items. However, one should note that at the international
level, the aggregation problem is far more complex than at the regional level.

V.B.2. The Deterministic Approach

The deterministic approach is not in itself unique to this research only a variation. Most of

\[ \text{\[footnote{27} For foods, this is usually the U.S. but in some cases imported foods are priced.}\]

\[ \text{\[footnote{28} Prices for foods are collected in every month so this variable was not used but for items priced bi-monthly in categories other than foods this would be a relevant variables}\]

\[ \text{\[footnote{29} Aggregation in this methodology is an issue in itself and was dealt with to a minor extent in the Blanciforti (1986) study. Kokoski (1991), Primont and Kokoski (1990 and 1991), and Kokoski and Cardiff (1992) extended the Country Product Dummy Methodology to medical services and utilities, and also examined aggregation and the calculation of variances. Love, Primont, and Jain (1988) used a price-relative methodology developed by Westat (1980) under contract to the BLS to define an interarea price index for four food items. This study also deals with variation and aggregation.}\]

\[ \text{\[footnote{30} These are the Laspeyres, Paasche, Palgrave, Fisher Ideal, Theil, and the Walsh price indexes. The first four are based on arithmetic formulations; the last two are based on geometric formulations. The Elletto, Koves, and Szulc or EKS, the Van Yzeren, and the Geary-Khamis methods are three other aggregation methods that are also presented. The Geary-Khamis method was most favored by the United Nations International Comparison Project.}\]

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the research along this line uses already estimated ACCRA (1992) or FB data and estimates an equation for an area not included in the original sample (Kurre, McMahon, and Cebula). In a sense this is an aggregative outside of sample forecasting approach. The approach of Blanciforti and Kranner (1995) (B-K) is similar except that it estimates an equation at a disaggregated level - counties within a state - and applies this equation to an out of sample state defined by counties, a disaggregated outside of sample forecasting approach. In all such analyses a variable that measures prices, cost of living, or their changes and the definition of variables that would determine such an index is needed, hence the reliance on ACCRA or FB data. B-K estimated an equation for Florida and have replicated that equation for Minnesota. Both states are very different places in terms of population density, location, climate, types of natural resources, tax structure, types of business that have located there, and average incomes. Generally, the determinants are standard economic variables and include some determinants that provide flexibility when applying the model to different states, i.e. some nonstandard factors. These nonmarket features of a state include the number of parks or recreation sites, if the state features a shore or ski resort, the availability of a natural resource, distance to urban centers, the quality of public schools, or some other amenities.

VI. Directions for Future Research

First and foremost is to decide whether to take a price collection approach or an econometric approach. As mentioned, the price collection approach is costly and time-intensive. However, it may be more accurate than the econometrics approach. When using an econometric approach (for example, Kurre or B-K), one must consider issues related to out of sample forecasting such as the goodness of fit, the scope of the data, and the appropriateness of the equation structure. Are we really capturing price movements within a state or region or specific population group when using
the ACCRA or FB data and estimating equations over the entire U.S. for one year. Also, is the same equation structure used to estimate the aggregate index applicable to all subcategories indexes. Doing so would eliminate determinants that may directly affect the subgroups - e.g. degree of concentration of food stores may be a factor in a food subindex. However, one must also consider that at the county level, food, clothing, health care and utilities may not vary as much as housing - especially when the climate is similar throughout a state. It may be that only a few items, such as, food, clothing, and housing, would suggest most or even all of the price variation and may be the only items one needs to consider in the market basket.

Second, given the misgivings that arise from using the econometrics approach and also to validate what has been done by other researchers, I would like to use the B-K model with regional data collected by ACCRA and with county or other sublevel data.

Third, a further examination of the hedonic approach is warranted. It would be useful to see how well the CPDM approach works at the regional/county level by applying this method to the Florida data.

Finally, the CPI or aggregation-type approach is recommended since it requires the establishment of a single market basket that would be priced in each location and a measure of the relative expenditure weights for that basket of goods (for that household/family in an area) whereas the family budget approach requires the development of a market basket for a designated family type in each location. Items still need to be identical in terms of quantity and quality.\textsuperscript{31,32} Since this

\textsuperscript{31} Remember that the CPI because of its temporal nature substitutes items as long as the price movements of the replacement item are similar and are influenced by similar market forces.

\textsuperscript{32} The estimation of housing is difficult. The CPI uses an estimate of the rental equivalence of owner-occupied housing. For a spatial index a measure of the cost of building a

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would be a spatial index, rather than using fixed base-year weights and an index of price relatives from one period to another as required by a time-type index like the CPI, a base place (e.g. one county - maybe, the county that includes the state capitol) - a group average, or a state average would be selected and an index of price relatives for each place compared to the base are needed. Initially, rather than sampling every county, cost may be reduced by some method of grouping homogeneous counties so that only one county from that homogeneous group might be priced. However, this process of grouping could eliminate or hide price differences, the point of this exercise.

And, outlets could be ascertained through the state department of taxes and revenues. Any state that collects sales tax should have available some system, of identifying the location of outlets, their sales volume, and the amount of tax revenues collected. Alternatively, some states might also have a state Census of Business so that information on the amount purchased of each item at each kind of retail outlet might be available. These together would provide similar information as the point of purchase survey of the CPI, that is, a sample of outlets stratified by type and sales volume in each location.

standard structure with a specific design is required. Cost would vary since differences in the costs of materials, labor, and other construction costs occur. This assumes the same quality of materials and labor skills are used at each location. If the index is used spatially over time then a hedonic regression measuring the effect of different characteristics on the selling price in each location would be consistent with the idea of rental equivalence.

33 It may be that a specific SMSA or city in one’s state may have been surveyed recently by the BLS’s CPI program so that one well-defined market basket and a set of expenditure values would be available to calculate weights. This is what was described above for Florida.
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