RESEARCH REVIEW
INDEX NUMBERS AND CHANGES IN FOOD PRICES

By R McFall Lamm, Jr *

INTRODUCTION

During periods of rapid inflation it is frequently asserted that fixed weight price indices overstate the magnitude of changes in the cost-of living as consumption patterns change over time This is an erroneous proposition, however, because most price indices are designed to measure changes in prices and not to serve as indicators of cost-of living change Even so, many fixed weight indices such as the Consumer Price Index (CPI) are often improperly utilized as cost-of-living measures

A more relevant topic in the measurement of price change involves the appropriate type of weighting scheme to use in index number construction Fixed base-period quantity weights (Laspeyres) are used most often because of ease of construction [1] Variable current period quantity weights (Paasche) are used infrequently since time series data on both quantities and prices are necessary for construc tion

This note compares changes in food prices implied by alternative index number specifications Laspeyres, Paasche, and Fisher's Ideal Index are calculated for a market basket of 42 basic foods over 1964-77 The results imply that the use of variable weight price indices does not lead to a significant restatement of food price change For this reason, most U S Department of Agriculture (USDA) statistics based on Laspeyres indices (such as the market basket) would not be altered substantially if computed with variable weights

ALTERNATIVE PRICE INDICES

Virtually all price indices that USDA currently uses are Laspeyres indices Prices Received by Farmers, Prices Paid by Farmers, Market Basket Statistics, most food consumption and production indices, and Farm to Retail Price Spreads—all of which utilize fixed base-period weights The Consumer and Producer Price Indices, constructed by the U S Department of Labor's Bureau of Labor Statistics (BLS) (*2*),[2] are also Laspeyres The Implicit Price Deflator, constructed by the U S Department of Commerce's Bureau of Economic Analysis, is perhaps the most important Paasche index currently used on a large scale[3] The major reason for the dominant use of Laspeyres indices is that they are the simplest to construct and maintain, only additional price data are required following a survey in the base year to determine quantity weights

Laspeyres indices measure price change under the assumption that the same market basket of goods consumed in the base year is consumed in subsequent years The Laspeyres index is calculated as follows

$$L = \frac{\Sigma q_0 p_1}{\Sigma q_0 p_0}$$

where L is the value of the index, the q's are quantities of goods consumed, the p's are the corresponding prices, and the subscripts denote time period with 0 representing the base year

The Paasche index allows quantity weights to change each year It represents price changes under the assumption that the same market basket of goods consumed this year was consumed in the base year The Paasche index is computed as follows

$$P = \frac{\Sigma q_1 p_1}{\Sigma q_1 p_0}$$

Since household consumption patterns change from year to year, but only to a limited extent, actual changes in prices may lie somewhere between these two extremes One index used to approximate partial adjustment in quantity weights is Fisher's Ideal Index, which is calculated on the basis of the Laspeyres and Paasche indices as follows

$$F = (L \cdot P)^{1/2}$$

This index satisfies a weak set of the five conditions required of index numbers as proposed by Fisher (see Eichhorn (*3*) for a discussion)

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[1] A true cost of-living index requires that utility be constant over time The Laspeyres index is the cost-of-living index corresponding to a fixed-coefficients utility function which allows no substitution among commodities—an unlikely representation of consumer behavior

[2] Italicized numbers in parentheses refer to items in References at the end of this note

[3] See (*1*) for a discussion of how the Implicit Price Deflator is constructed

METHODOLOGY

So that the effects of using variable-quantity indices as measures of changes in food prices could be determined, Laspeyres, Paasche, and Fisher's Ideal indices were computed for a market basket of 42 foods sold at retail over the 1964-77 period Quantity data were obtained from *Food Consumption, Prices, and Expenditures* and other USDA sources Prices were obtained from series provided by BLS All quantity statistics used were expressed on a per capita consumption basis in pounds, and prices were expressed as dollars per pound The base period for prices was 1967, the same base as for the CPI The base period for quantities was 1972, the first year of the most recent BLS expenditure survey used to obtain quantity weights for the CPI

Table 1 lists the 42 foods included in the index number calculations These foods represent most of the basic foods consumed domestically and more than 50 percent of consumer food expenditures (for food consumed at home) in each year of the study period Some important foods are omitted, however, be cause of data limitations

RESULTS

Table 2 presents computed index numbers for the 42-food market basket, as well as corresponding values of the CPI for food Strikingly apparent is the close association be tween the Laspeyres and Paasche indices for the 42-food basket The indices are highly colinear, with a correlation coefficient of 0 999 The same is true for the relationship between Fisher's Ideal Index, and the Laspeyres and Paasche indices Further, the CPI for food increases more rapidly than do the 42-food market basket indices This most likely occurs because the composition of the indices differ and because all food consumed away from home is reflected in the CPI for food

The strong relationship between the three constructed indices emerges even more clearly if percentage changes are compared over time (table 3) Indications are that the indices are highly correlated with changes of similar magnitude in years of declining and increasing food prices A substantial discrepancy does occur in 1977, however, the Laspeyres index increases 3 9 percent, while the Paasche index rises only 2 8 percent

Although the Laspeyres and the Paasche indices are closely related for the 42-food market basket, it is not clear that this would be true for the major components of these indices Thus, Laspeyres and Paasche indices were computed for meats, based on the beef and pork data from the 42-food market basket The results of this exercise indicate that, as with the aggregate basket, both the Laspeyres and Paasche indices are highly colinear The largest discrepancy is a 0 7-percent difference occurring in 1975 when meat prices rose 12 5 percent based on the Laspeyres index and 11 8 percent based on the Paasche index

Table 1 — Market basket foods

Meats
- Beef
- Pork
- Chicken
- Turkey

Vegetables
- Frozen french fries
- Tomatoes
- Asparagus
- Cabbage
- Carrots
- Celery
- Lettuce
- Spinach
- Canned peas
- Canned tomatoes
- Dry beans
- Frozen broccoli
- Potatoes

Fruits
- Bananas
- Grapes
- Strawberries
- Canned pears
- Frozen orange juice
- Canned fruit cocktail
- Watermelon
- Oranges
- Grapefruit
- Apples

Fats and oils
- Cooking oil
- Margarine

Dairy products
- Eggs
- Butter
- Cheese
- Evaporated milk
- Fluid milk
- Fluid lowfat milk
- Ice cream

Other
- Rice
- Sugar
- Wheat flour
- Roasted coffee
- Instant coffee
- Tea

Table 2 — Food price indices, 1964 77

Year	Laspeyres	Paasche	Fisher s Ideal	CPI for food
		(1967=100)		
1964	94 1	94 0	94 0	92 4
1965	97 2	97 3	97 2	94 4
1966	102 1	102 0	102 1	99 1
1967	100 0	100 0	100 0	100 0
1968	103 6	103 5	103 6	103 6
1969	110 3	110 1	110 2	108 9
1970	114 3	114 2	114 2	114 9
1971	116 1	115 8	115 9	118 4
1972	123 1	123 1	123 1	123 5
1973	148 3	147 8	148 1	141 4
1974	168 0	167 9	168 0	161 7
1975	180 9	180 0	180 5	175 4
1976	178 0	177 6	177 8	180 8
1977	184 9	182 6	183 7	192 2

Table 3 — Changes in alternative food price indices, 1965 77

Year	Laspeyres	Paasche	Fisher's ideal	CPI for food
		Percent		
1965	3 3	3 5	3 4	2 2
1966	5 1	4 9	5 0	5 0
1967	−2 1	−2 0	−2 0	0 9
1968	3 6	3 5	3 6	3 6
1969	6 4	6 4	6 4	5 1
1970	3 6	3 7	3 6	5 5
1971	1 6	1 4	1 5	3 0
1972	6 0	6 3	6 2	4 3
1973	20 5	20 1	20 3	14 5
1974	13 3	13 6	13 4	14 4
1975	7 7	7 2	7 4	8 5
1976	−1 6	−1 3	−1 5	3 1
1977	3 9	2 8	3 3	6 3

CONCLUSION

Using Paasche variable quantity indices does not, based on these results, lead to a substantial restatement of food price change This is true both for a broad basket of foods, as well as for a subgroup of related foods such as meats For this reason, the large costs involved in collecting additional data to construct Paasche or other variable quantity indices may not be justified These findings are similar to those of other studies indicating that computing the CPI for all items using the Paasche index would not lead to results significantly different from those obtained with the Laspeyres index

In addition, stability over time characterizes domestic food consumption patterns If this were not the case, changes in the Paasche and Laspeyres food price indices would be less highly correlated

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INTRADAY COMMODITY PRICE MOVEMENTS

By Jitendar S Mann*

INTRODUCTION

Sharp changes in commodity prices in the past few years have focused attention on the need to understand shortrun price movements better The behavior of daily price changes has been widely studied [1] This note analyzes the movements of intraday prices

Research on intraday prices began in 1937 when Irwin tried to identify different kinds of trading on the floor of a commodity exchange Irwin was interested in the impacts of speculation, manipulation, and movement trading on price changes (*5*) According to Irwin, there is a

> tendency for the speculative operations to center approximately upon the price justified by the conditions existing at the time, whereas movement trading has no such a check This difference accounts for the tendency of true speculation to stabilize prices and for the tendency of movement trading to widen price swings

Working studying the actual behavior of traders, tried to establish a relationship between price movements and the behavior of scalpers and day traders (*13 15*) He concluded that the following major difference existed between scalping and day trading "In scalping, the interval between purchase and sale, or between a sale and a subsequent purchase, is ordinarily not more than a few minutes In day trading, the interval may be an hour or more " Working characterized the scalper as one who stands ready to buy at 1/8 cent below the last price or to sell at 1/8 cent above it [2] For successful scalping, any small price change should be followed by a price change in the opposite direction Working called this tendency for price reversals "price jiggling " Recently, interest in intraday price movements has revived because of the problem of dual trading, that is, the floor brokers and future commission merchants trade for their own accounts as well as for those of customers

Olson analyzed the participation of floor trades in intraday price movements of potatoes on the New York Mercantile Exchange (*11*) [3] There are several categories of trades in the commodity pit Intraday price analysis may help to explain the activities of floor traders and scalpers For example, too many reversals (in contrast to continuations) provide scalpers an opportunity to buy and sell on small price changes

The data used in this analysis are from a computer system maintained by the Chicago Mercantile Exchange Prices are collected by exchange pit clerks, who on hearing the price of a trade, a higher bid, or a lower offer than the prevailing market price, record the information on cards which in turn are time-stamped and given to keyboard operators to enter into the computer If the market is not active and the price does not change, the last price is repeated after a specific time interval However, if trading is extremely active, not all price changes are recorded Thus, the prices are not strictly one price for each transaction The prices analyzed here are for the July 1975 contracts of frozen pork bellies for all trading days during July 1975 Each observation during July 1975 has been included in the analysis [4]

THE RANDOM WALK HYPOTHESIS

This study tests the hypothesis that intraday commodity prices behave like a random walk In a random walk, a price series follows the stochastic process

$$P_t = P_{t-1} + E_t$$

where E_t is an independent random variable with zero mean Working's theory of anticipatory prices outlines the basic process for random walk in futures prices (*14*) In an efficient competitive market, price is determined by the actions of many traders, each acting based on expectations Traders' expectations, in turn, are based on information from diverse sources As prices reflect expectations, new information affects prices only to the extent that it differs from what was previously anticipated The price-making mechanism starts with a specific opening price and adds to it in each interval

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[1] Italicized numbers in parentheses refer to items in References at the end of this note

[2] Working was referring to wheat

[3] See also Niederhoffer and Osborne (*10*) for a study of intraday prices in stock markets

[4] Analysis of the February 1976 contract for pork bellies, traded during the latter half of July 1975, gave results similar to those reported in this note

a random factor, E_t, which encompasses the influence of all the new information available to generate the next price All currently available information is incorporated into each successive price change The best expected price for the next period is the current price, past price history is irrelevant

Muth states that in the very short run "if the production and consumption flows are negligible compared with the speculative inventory level, the process approaches a random walk" (*9*)

In the very short run, when the demand and supply of contracts depend only on price movements, the price will follow a random walk Let

$$D_t = b \Delta P_t + G_t$$

$$S_t = g \Delta P_t + N_t$$

where D, S, and ΔP are respectively demand, supply and price change, b and g are constants, and G and r are random errors Equating demand and supply, one obtains

$$\Delta P_t = \frac{N_t - G_t}{b - g}$$

which is a random walk, a linear combination of independently distributed random variables

The empirical interpretation of the random walk hypothesis is that the price differences are temporally independent The price change following a given transaction is not influenced by the sequence of past price changes

A more precise statement of the requirements for a "fair" market is provided by the Martingale hypothesis, which requires only that the conditional expectation of ΔP_t be zero

$$E(\Delta P_t \mid \Delta P_{t-1},$$

$$\Delta P_{t-2} \quad) = E(\Delta P_t) = 0$$

Successive ΔP_t may be drawn from different distributions as long as their means are zero A "fair" market is defined as a market where no trader can profit from predicting price movements based on past observations [5]

STATISTICAL ANALYSIS

To test the random walk hypothesis, I constructed a joint frequency distribution of consecutive price changes [6] The results showed only 285 cases of a price change—142 declines and 143 rises—equal to the minimum of 2 5 cents per cwt The price changes involving half-cents were generally less frequent Price changes clustered around multiples of 5 cents Price changes of 10 cents were more frequent than those of 5 cents

To guarantee that there was no zero entry (table 1), I collapsed the frequency table of successive price changes and calculated a matrix of transition probabilities (table 2) This stochastic matrix gives the probabilities of each of the current price changes (items in boxheads of table 2), given a certain last price change (stub entries in table 2) The tendency for large changes to be followed by small changes is apparent when one examines the largest probability for each row Table 2 shows, for example, that in all cases of a price decline between 12 5 and 10 0 cents, the ratio of another similar decline was 0 114 (=29/255)

This change pattern is highlighted by table 3, which has been abridged to give only the direction of change [7] Although it appears that the number of positive and negative changes were equal, the tendency for changes of the same sign to follow each other is more frequent A Chi-square test for a 2 X 2 table rejected the hypothesis that price changes were independent The number of cases where a change was followed by a change in the same direction (continuity) was 1,933; whereas the number of reversals was 1,360 In the series as a whole, 41 percent of cases were reversals [8]

Under the random walk hypothesis, the probabilities of a price change are not influenced by the past price changes, that is

$$\text{Prob}\,(\Delta P_t = X \mid \Delta P_{t-1},$$

$$\Delta P_{t-2} \quad) = \text{Prob}\,(\Delta P_t = X)$$

[5] See Samuelson (*12*)

[6] The pork belly prices are quoted in cents per pound A contract equals 38,000 pounds The minimum price change was 2 5 cents per cwt (*3*) This note uses cents per cwt

[7] Cases with zero changes have been excluded from table 3

[8] Working reported a tendency to reversals in intraday price movements for Chicago wheat (*13*, *15*) He studied 143 series of 100 successive price changes during 1927 40 and found that 140 of the series had 65 percent or more reversals

Table 1 — Frequency of successive price changes, frozen pork bellies, July 1975 contract*

Last price change (P(t−1)) (cents/cwt)	This price change (P(t)) (cents per cwt)							
	−15 and less	−12 5 and −10 0	−7 5 and −5 0	−2 5 to 2 5	5 0 and 7 5	10 5 and 12 5	15 0 and more	Total
	Number							
−15 and less	1	6	13	2	29	16	4	71
−12 5 and −10 0	6	29	75	15	111	13	6	255
−7 5 and −5 0	15	68	595	180	269	129	18	1,274
−2 5 to 2 5	5	32	149	283	187	24	4	684
5 0 and 7 5	23	93	295	177	633	95	13	1,329
10 5 and 12 5	19	21	122	27	87	35	6	317
15 0 and more	2	6	25	1	12	6	3	55
Total	71	255	1 274	685	1,328	318	54	3,985

*During July 1975

Table 2 — Matrix of transition probability of successive price changes, frozen pork bellies, July 1975 contract*

Last price change (P(t−1)) (cents/cwt)	This price change (P(t)) (cents per cwt)								
	−15 0 and less	−12 5 and −10 0	−7 5 and −5 0	−2 5 to 2 5	5 0 and 7 5	10 5 and 12 5	15 0 and more	Marginals	Chi square
−15 0 and less	0 014	0 084	0 183	0 028	0 408	0 225	0 056	0 018	42 00
−12 5 and −10 0	024	114	294	059	435	051	024	064	42 23
−7 5 and −5 0	012	053	467	141	211	101	014	320	162 84
−2 5 to 2 5	007	047	218	414	273	035	006	172	345 75
5 0 and 7 5	017	070	222	133	476	072	010	334	135 28
10 5 and 12 5	060	066	385	085	274	110	019	080	56 77
15 0 and more	036	109	454	018	218	109	054	014	22 48

*For July 1975

This means that the probabilities in each set of entries for each stub item (each row) should be independent of each other This hypothesis is tested by a Chi-square test recommended by Anderson and Goodman (*1*) The null hypothesis is that the probabilities in each row are equal to the marginal probabilities The estimated value of Chi-square appears below the last boxhead items (column in) table 2 The null hypothesis (of independent rows) is rejected for each of the seven rows A hypothesis that both rows and columns are independent was also rejected (results are not shown here)

Another null hypothesis tested was that conditional probabilities of a price change, given a past price change, are constant (and equal), which means that each probability in a row equals 1/7 This hypothesis was also rejected for each row

Table 3 — Direction of change of successive changes, frozen pork bellies, July 1975 contract*

Last price change	This price change		
	Negative	Positive	Total
Negative	922	678	1 600
Positive	682	1 011	1 693
Total	1 604	1 689	3,293

*During July 1975

CONCLUSION

Although the random walk hypothesis for price movements has been well accepted in academic circles,[9] the empirical work is based on analysis of daily price changes An analysis of intraday price movements leads to a rejection of the random walk hypothesis Niederhoffer and Osborne reach a similar conclusion from a study of intraday stock prices (*10*) Martell and Helms indicate that their analysis of intraday prices leads to conclusions different from those based on daily closing prices (*8*)

A possible explanation for lack of randomness in intraday price movements is that not all price changes result from discounting of information The floor traders, who trade on their own account, make trades based on past and expected price movements This behavior adds a nonrandom element to price changes

[9]See (*4*)

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CAQUEZA: LIVING RURAL DEVELOPMENT

Hubert Zandstra, Kenneth Swanberg, Carlos Zulberti, and Barry Nestel
International Development Research Centre, Ottawa, 1979, 321 pages
$15 00

*Reviewed by David W Culver**

It is interesting and unsual to find a book that treats a range of development issues while telling the story of a small rural development project in Colombia And the story is generally convincing

The book and, to a significant extent, the project itself are products of the International Development Research Centre (IDRC) of Canada In addition to publishing the book, IDRC provided the outside funding (U S $908,000) for the 5 years covered in the book as well as the expatriate advisors—initially two and later three Of the four authors, three served as IDRC advisors on the project, while the other was an associate director of IDRC's Agriculture, Food, and Nutrition Sciences Division from 1970 to 1976, during which time he negotiated and managed IDRC's involvement in the Caqueza project

The book is divided into five parts Part 1 covers the experience and ideas on rural development drawn from various countries, the status of agricultural research and extension in Colombia, and characteristics of the Caqueza project area Chapter 1 reviews four specific rural development projects which made "some significant progress (on) the question of how to transform existing institutions so as to enable society to capture the economic gains implicit in new technological alternatives " The four projects are Borgo Mozzano in Italy, the Comilla Project in East Pakistan (now Bangladesh), the Intensive Agricultural District Program in India and the Puebla Project in Mexico Chapters 2 and 3 are helpful as background for the Colombia story but are not otherwise of general interest

Part 2 describes the 5 years of experience in the Caqueza project Each chapter is organized identically, the sections on organization and programming, research, dissemination, and evaluation are probably the most important The closing section of each chapter, a brief "resume of the year," is helpful The mixture of frustration and hope, of personal and organizational conflict, the apparent resourcefulness and flexibility of project staff combine so as to keep the reader eagerly pressing to discover what lies ahead

The two chapters in part 3 interpret the research activities of the project The first discusses the evolving methodologies used and describes the work on understanding existing production systems The second summarizes those experiments testing the value of recommended practices An interesting point is the gradual recognition by members of the project staff of the importance of economic factors in the farmers' production decisions, including their adoption of new technology Most staff members were trained in one of the biological sciences, especially agronomy While that may seem logical for research and extension focused mainly on crops, the economist reader will probably be amused by the gradual process through which the staff learn about the role of prices and price variability

Part 4 examines factors which relate to technology-adopting rates—risk, credit, marketing, training, and buffer institutions The chapters on risk and credit are good However, the chapter on marketing is weak—the low point of the book for this reader For example, one of the discussions relates to a comparison between atomistic (competitive) markets—as with crops in Caqueza—and oligopolistic markets (pp 236-237) One of its arguments is that "the atomistic market system is a dumping ground for the unemployed," with the clear implication that an oligopolistic system would be preferable The authors do not discuss the impact of such a change on overall efficiency They imply that since the system has many marketing agents, there is also overcapacity in transport equipment And they offer the "corollary" that "returns to the marketing agents were below the opportunity cost for the value of the services that they rendered " They do not indicate the available alternatives nor calculate opportunity costs for these unwanted marketing agents Nor do they recognize the apparent conflict with their earlier description of the marketing system as "a dumping ground for the unemployed " Perhaps there is good reason why the marketing plan developed by project staff failed

Part 5 deals with measuring achievements Although one must be cautious about how people evaluate their own work, as in this case, this section offers a reasonable view Even with some bias allowed for, it is likely that the project was relatively successful

Most of the book is pleasant to read There are only a modest number of typographical or other mechanical irritants, although the use of abbreviations and acronyms is excessive There is a rather lengthy bibliography but no index

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For forty years Wesley C Mitchell was a pathfinder in business cycle research—the analysis of the proc esses of expansion, recession, contraction, and revival ' There is considerable dissatisfaction on the part of some with the progress in Mitchell's approach of painstaking examination series by series, as well as the inadequacies of the historical approach toward the development of the comprehensive theory of business cycles The viewpoint of the econo metricians (is) that a system of structural equations can be developed which will describe the operations of the economy and the theory of business fluctuations (One test) found that (an econometric) model fared no better than a "naive" model which simply extrapolated the value of each variable

Nathan M Koffsky
Vol IV, No 4, pp 142, 143
October 1952

In Earlier Issues

Many extremes have occurred in our economic situation and activity There have been eras of great prosperity, severe depression, recovery, war, and postwar readjustment Economic forecasting is difficult because of the large number of factors and the complexity of relationships that influence the economic system Federal Government economic forecasts that relate to agriculture over a 30 year period received an accuracy evaluation score of 76 on a scale which ranged from 100 for perfect forecasts to 0 for totally wrong forecasts, with 50 for the expectation from pure guessing

John D Baker, Jr and Don Paarlberg
Vol IV, No 4, pp 105, 107, 114
October 1952

It is obviously a waste of time and money to address envelopes and to mail questionnaires to people who do not return them The statistical aspects of the problem are even more serious Individuals who receive mail questionnaires are more likely to fill them out and return them when they have had some previous personal contacts with the agency

Cecil C Smith
Vol IV, No 4 p 126, October 1952

Progress toward the solution of the world food problem is a stern and urgent challenge to Western Civilization The best immediate prospects are in areas of high present economic activity and well developed education in technology But the long time view is a different matter involving the much more difficult tropical lands

Charles E Kelley
Vol IV, No 4, pp 135, 136
October 1952

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