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Laspeyres and his Index

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Abstract

Price indexes comprise an important set of instruments for measuring relative price movements and inflation, key microeconomic and macroeconomic variables. Their creators and the context of the debates surrounding their creation have been less-studied. The Laspeyres method, for example, has several famous drawbacks. Laspeyres indexes overstate the rise in prices, because they do not take account of substitution away from goods as they become more expensive relative to other goods. The direction of this substitution bias is known ex ante, but the magnitude is not. Related to this issue is the cost of collection. Because data on amounts bought are more expensive to collect than price data, there are fewer and less frequent observations. More fundamentally, the price indexes give no weight to future consumption, only to current consumption. Laspeyres himself was balancing some of these issues as he developed and calculated his indexes. Current controversies echo the past over calculation methods and the importance of various biases. The 1800s saw a controversy over the correct method for calculating price indexes: arithmetic versus geometric averages, whether or not to weight the index and by which quantities.

Laspeyres argued for an arithmetic average weighted by quantities in the first period, the well-known Laspeyres price index, but his practice was otherwise. The Laspeyres price index method was not used by Laspeyres in his famous "Hamburger Waarenpreise 1850-1863 . . ." *(Jarbücher für Nationaloekonomie und Statistik*, Jena 1864, Band III, pp.81-118) nor in his last major papers in 1901. This paper examines Laspeyres' articles to evaluate what he understood and why his decades of price statistics research estimated price changes without weights.

Price indexes are important to economists, governments, and to the general public. They comprise the set of instruments for measuring relative price movements and inflation, key microeconomic and macroeconomic variables. The frequent definition of inflation as "a continuing rise in the general price level" is dependent on calculating a price level, which is usually done with the Laspeyres method. Measurable inflation and effective policy prescriptions to lower measured inflation are influenced by the method used to calculate inflation. This affects the cost-of-living adjustments. But inflation indexes have even more wide-ranging effects. The CPI is used to calculate price indexes for some components of the national income accounts. Overestimating inflation, for example, means real growth in these components is understated.[1]

Current controversies echo the past over calculation methods and the importance of various biases. Persky (1998) presents an overview of the history of price indexes, back to Aristotle. The 1800s saw a controversy over the correct method for calculating price indexes: arithmetic versus geometric averages, whether or not to weight by quantities. These controversies extend to the present. Controversial because differences in their calculation can have wide-

[1] For a discussion of this issue, a summary of the Boskin Commission results, and some remedies proposed to adjust for the estimated 1.1 percentage points overestimate of inflation by the CPI, see Boskin et al. (1998) and Abraham et al. (1998).

ranging effects, price index theories and calculations have been studied for centuries.

But some of the information out there is wrong. The reports have not been error-free on either the men nor on the theories and techniques. Some currently-taught and recently-published information is wrong. For example, a major macroeconomics text (Mankiw (2000)), states (p.31) that "a price index with a fixed basket of goods is a *Laspeyres index* and a price index with a changing basket a *Paasche index*." (italics his) This is incorrect, since both are fixed-weight indexes, but from different perspectives, with the Laspeyres index using the first-period quantities for weights and a Paasche index using the last period as weights. (Multiperiod indexes in the GDP previously were implicit price indexes, neither Laspeyres nor Paasche indexes, with changing weights, though the Commerce Department has now move toward true chain indexes.)

Other errors are reported about the men and their research. For example, Rinne (1981) claimed that Laspeyres was not particularly interested in his index formula, since he did not publish price indexes after his 1871 paper defending his famous formula. But Laspeyres did discuss the price index issues in 1883, compared his index, Paasche's formula, discussed weighting in general, and defended arithmetic against geometric averaging for price indexes. And price indexes are by no means absent from his papers. His last enormous work, published in 1901, included a price index of agricultural products (unweighted by

quantities). These misconceptions about price indexes and their developers indicate that it would be useful to set the record straight.

Finally, the German economists in the latter half of the nineteenth century have been overshadowed (at least in English-speaking countries) by British giants such as Marshall and Jevons. But the empirical researchers like Laspeyres had a very modern perspective on economics, both the theory and ways data could test theories, increase knowledge, and improve economic conditions. Laspeyres is one whose approach to research and economics has much in common with economists 100 years later.

Price indexes: Many measures of changing prices. Laspeyres was not the first, nor his generation of economists the first, to index prices. The Frenchman Charles de Ferrare Dutot is credited with the first modern price index in 1738.

Jevons, Laspeyres and Paasche were all writing at approximately the same time, with Jevons' 1865 article on London prices, defending geometric averaging, roughly contemporary with Laspeyres' 1864 article on commodity prices in Hamburg, in which Laspeyres averages prices arithmetically, but without weights (essentially Carli's formula). Paasche's price index followed a few years after Laspeyres's 1871 defense of arithmetic averaging using first-period weights

Table 1: Price Index Formulas[2]

Economist	Date	Formula	Function
Dutot	1738	$P^2/P^1 = (\Sigma P^2/N)/(\Sigma P^1/N)$, summed from n=1 to N	Ratio of Average Prices
Carli	1764	$P^2/P^1 = \Sigma(p^2/p^1)/N$, summed from over prices n=1 to N	Arithmetic Average of Price Ratios
Scrope	1833	$P^2/P^1 = \Sigma(p^2x/p^1x)$, summed over prices n=1 to n, where the x's are a quantity vector from 1 to n	Arithmetic Average, Weighted Index, Vaguely-Specified Weights
Jevons	1865	$P^2/P^1 = \Pi (p^2/p^1)^{1/N}$	Geometric Average
Laspeyres	1871	$P^2/P^1 = \Sigma(p^2x^1/p^1x^1)$, summed over prices n=1 to N, where the x's are the period 1 quantity vector for goods 1 through N	Arithmetic Average, Weighted Index, First-Period Weights
Paasche	1874	$P^2/P^1 = \Sigma(p^2x^2/p^1x^2)$, summed over prices n=1 to N, where the x's are the period 2 quantity vector for goods 1 through N	Arithmetic Average, Weighted Index, Last-Period Weights
Walsh	1901	$P^2/P^1 = [(\Sigma p^2(x^1x^2)/N)^{1/2}]/[(\Sigma p^1(x^1x^2)/N)^{1/2}]$, prices summed from n=1 to N	Ratio of Average Prices, Weights Geometric Means of 2 Quantity Vectors
Pigou/Fisher (Fisher Ideal Price Index)	1920/ 1922	$P^2/P^1 = [P_L P_P]^{1/2}$, where P_L is the Laspeyres Index and P_P is the Paasche Index	Geometric Mean of Paasche and Laspeyres Indexes
Törnqvist	1936	$P^2/P^1 = = \Pi (p^2/p^1)^s$, where $s = (1/2)(p^1x^1/P^1X^1) + (1/2)(p^2x^2/P^2X^2)$	Weighted Geometric Mean of Price Ratios, Weights are Average Expenditure Shares on Each Good

[2] The formulas and sources for the formulas are in Diewert (1987a).

(apparently end-period weights were not available), with Paasche choosing arithmetic over geometric weighting, but using end-period weights (early-period weights being unavailable). The Fisher Ideal Price Index recognized that the Laspeyres formula overstates price increases (because buyers substitute away from more-expensive goods) and the Paasche formula understates price increases for the same reason, with the geometric mean of the two indexes having desirable properties (see Diewert 1987).

Divergence of Theory and Practice. Laspeyres (1871) argued for an arithmetic average weighted by quantities in the first period, the well-known Laspeyres price index, but his practice in general was otherwise. The Laspeyres price-index method was not used by Laspeyres in his famous 1864 article on commodity prices in Hamburg. His 20th century (1901) article on plant and animal farm product prices used an unweighted average for the price index. So an obvious question is, why is the fixed basket of goods, weighted by the first-period's quantities, universally called the Laspeyres method, even though he hardly used it? We examined Laspeyres' articles to evaluate what Laspeyres understood about prices and price indexes, why he argued for his formula, and why in his applications he averaged price changes without weights.

I. Life of Étienne Laspeyres

Price index theory has been well-studied, but Laspeyres' contribution is known by name but not much else. Information about Laspeyres is limited from contemporaries like Marshall who read his articles (and called "Die Kathedersocialisten und die statistischen Congresse" a "short but masterly essay"[3], or English-speaking writers like Correa Mylan Walsh whose 1901 book summarized the index numbers debate.[4] Opinions on Laspeyres as an economist were not uniformly favorable. Schumpeter called him "a man who cannot without qualification be called an economist at all"[5] to contrast him with the economists like Jevons, Edgeworth and Fisher who were also interested in index numbers.

Ernst Louis Étienne Laspeyres was born November 28, 1834 in Halle/Saale, son of a law professor. The Laspeyres family were Hugenots who had emigrated to Berlin in 1696. From 1853-1859, Etienne Laspeyres studied law and public finance in Tübingen, Berlin, Göttingen, and Halle/Saale, then earned his Ph.D. in political science and public finance from Heidelberg. He held positions at universities and colleges (Hochschule) in Heidelberg, Basel, Riga (at the Polytechnical School, a German-language college), Dorpat (a German-language university in Tartu, the second-largest city in Estonia), and Karlsruhe,

[3] *Memorials of Alfred Marshall*, edited by A.C. Pigou, August Kelley Publishers, NY, 1966, p. 168
[4] *The Measurement of General Exchange Value*, Correa Mylan Walsh, The MacMillan Company, NY 1901
[5] *History of Economic Analysis*, Joseph A. Schumpeter, Oxford University Press, New York, 1954, p. 1093.

until finally, in 1874 he settled in Giessen, where he occuppied a chair in Political Science until he retired in 1900.

During his time in Giessen, Laspeyres founded the Seminar in Political Science Statistics and was an active member of the International Statistics Institute (ISI). He regularly attended their conferences (including one in 1893 in Chicago for which he received and extra 3000 Marks traveling expenses). He died August 4, 1913 and is buried at the Alten Friedhof in Giessen along with many other professors, including Röntgen.[6]

Laspeyres's works are not well-known to American economists since they are available only in German. His index number formula $(\Sigma p_1 q_0)/(\Sigma p_0 q_0)$ is ubiquitous, and used in most widely cited price indexes like the U.S. Consumer Price Index. A search on the web for the name "Laspeyres" produced 955 entries, mostly referencing his price index (though there were a few biology references – there is an insect named after a Laspeyres). There were only 14 entries from a search on "Etienne Laspeyres", with those mostly on his index (plus a statistics prize named after him in Karlsruhe). But Laspeyres in his time was also known for his work on public finance and economic history. His early book *Geschichte der volkswirtschäftlichen Anschauungen der Niederländer und ihrer Litteratur zur Zeit der Republik* (Literary History of the Economic

[6] See the summary in *Encyclopaedia of the Social Sciences*, Edwin R.A. Seligman Editor-in-Chief, The Macmillan Company, New York 1933, Vol. 9 pp. 183-184. Rudolph Meerwart, the author of Laspeyres' biographical information, calls Laspeyres a "German statistician and

Perspectives of the Netherlands in the Time of the Republic), published in 1863, was still being cited in 1949[7]. From his early career (following Engel) he investigated the well-being of workers. Overall, Laspeyres's research attention was on economic applications, rather than statistical theory. His books were reviewed by the economic journal *Jahesbücher* reviewers. Despite Schumpeter, by the criteria of where Laspeyres published and his research interests, Laspeyres was an economist who developed statistical and price index tools.

II. Concerns about Price Indexes in Laspeyres's Time

Laspeyres wrote repeatedly about price movements, descriptions of the distribution of prices and how that distribution changed. He argued for his famous formula in his 1871 article, "Die Berechnung einer mittleren Waarenpreissteigerung" (Calculation of an average commodity-price increase) p.306. Even introducing and arguing for his formula, he had reservations about the general application. For instance, he said, the purchases of Hamburg (a single city) may not match the consumption of a whole country. [*Ob die in Hamburg eingefuhrten Waarenquantitäten gegeneinender in demselben Mengenverhältniss stehen, wie die in Deutschland verbrauchten Waarenquantitäten, möchten wir sehr bezweifeln…*]His 1871 reasons for not using weights in his empirical work were practical. Laspeyres wrote that his

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economist". For more details, see Rinne (1981). Rinne called Laspeyres an "econometrician" because he wanted to integrate economics and statistics.

[7] In, for example, Haney, Lewis H., *History of Economic Thought,* 4th Edition, 1949, the MacMillan company, New York, p. 972.

arithmetic averages may not be as right as the weighted averages using his formula, but that the weights are so difficult to find for even the major purchases, let alone for all consumer goods, that the errors from omitting weights are smaller than the problems or mismeasurements from omitting commodities. In fact, he wrote "*Eine vollständig richtige Berechnung der durchschnittlichen Waarenvertheuerung oder Geldentwerthung ist beim heutigen Stande de Consumtions- und Preisstatistik noch unmöglich. Darum brauchen wir aber eine annähernd rightige nicht zu verstossen."* (A perfectly right calculation of the average price inflation (or gold depreciation) is still impossible with the current state of consumer and price statistics. Therefore, we need to not toss away a nearly-right method.)[8]

Laspeyres did use some expenditure data to calculate weighted indexes in his 1871 paper and again in 1883. But the quantity weights were available for only a small subset of the commodities for which he had prices (82 versus 313 in the 1871 paper). The weights were for imports into Hamburg, not necessarily a reasonable approximation of consumption. But they allowed Laspeyres to demonstrate his formula. In Laspeyres's calculations, his simple averages gave results very similar to his weighted averages. Using weights and prices for 82 commodities in Hamburg. Laspeyres calculated an index of average price increases, contrasting the average prices of first half of the 1850s decade to the average prices of the second half. His formula yielded an 8.8% increase for the weighted index versus 9.65% increase for unweighted. But for most

[8] 1871, p.309.

commodities, expenditure data were not available. Without weights, Laspeyres could use as many as 313 prices in his averages, so he judged that the extra information from including more goods was worth more than the losses from errors caused by using a slightly wrong formula.

Laspeyres further explained his reasoning in his 1883 entry in *Meyers Konversation-Lexikon*. His formula (which he underscored as recognized by others (Paasche and Conrad) as the correct way to calculate cost-of-living increases over time and international comparisons of prices) was still beyond reach for comparisons with the past, for which prices but not quantities were available. Moreover, his present-time series on quantities were a small fraction of the available price data. Laspeyres argued again that the bias from using a small sample of prices was larger than the bias from omitting weights, at least for cost-of-living questions over relatively long periods. In the subsets for which he had quantity data, the differences in the weighted and unweighted averages mostly disappeared when multiple years are averaged together. But Laspeyres went further. He argued that for some questions, "*Aber selbst wenn auch bei Berücksichtigung vieler Hunderte von Waren die gezwungene Außerachlassung der Mengen für die Verteuerung des Lebens im Durchschnitt nicht stimmen würde mit dem Ergebnis aus Mengenberücksichtigung, so wäre doch für andre Fragen das arithmetische Mittel aus allen Einzelbegungen viel brauchbarer als die Beobachtung von einigen zwanzig Waren mit Mengenberücksichtigung."* *(E*ven if there are big differences in the indexes with and without quantites, a

larger sample of goods with a simple arithmetic average is more useful than an index weighted with quantities but including only 20 goods.)[9]

Laspeyres further argued that since the value of purchases was more stable than prices for these data, if the pure price change was wanted, the value numbers would understate the rise or fall in prices. He noted that value was more stable than prices in these data because along with the price increase, there was a corresponding quality decrease in imports (the source of the quantity data). Laspeyres discovered the quality changes by comparing imported goods prices with corresponding prices of domestic goods in Hamburg.[10]

Laspeyres (1871 pp.300-302) checked the differences between list and market prices. He was also concerned with problems of aggregating prices of heterogenous goods, quality differences (changes over time and differences across regions), and over-weighting high priced goods.[11]

Laspeyres mitigated aggregation and units problems by expressing prices in current currency units per hundredweight, and then indexing them to the same year. So his price series for each good are 100 in the base period (1841-1850). The percentage price changes are then easily read for each good, and the average price level for a period is the average of these indexed prices. The

[9] 1883, p. 796-797.
[10] 1883, p. 797.
[11] 1864, p. 210, 1883 p. 795.

average inflation is the percent change in the average level. This is his unweighted, arithmetic-averaged index.

III. Laspeyres's Writings on Price Indexes

The first price index is attributed to Dutot (1738), who averaged prices in two periods, then formed a ratio (arithmetic average of period 1 prices divided by arithmetic average of period 2 prices). Carli (1764) suggested an arithmetic average of the relative prices instead. But mathematically, geometric means are the appropriate technique for averaging ratios. Jevons (1865) was a proponent of geometric averaging, because he considered price ratios (relative prices) to be the important issue, not currency prices and values.[12]

Laspeyres (1864) argued forcefully for arithmetic means, rather than geometric means. This controversy is summarized in Walsh (1901). In the 1860s, neither Jevons nor Laspeyres mentioned the method of weighting they favored in their averages. The issue discussed there is the definition of exchange value, if prices move in different directions. What happens to the exchange value if one price rises and the other falls? If a constant weight of goods (5 pounds of mixed groceries, but with a changing mix) is purchased, does this count as constant exchange value? (Laspeyres (1864) p. 96-97). While for small price movements unweighted geometric means and unweighted arithmetic

[12] Walsh (1901) pp. 220-222 and Chapter VIII.

means produce similar results (within a couple of percentage points), for big swings in prices (or regional differences) the averaging methods can differ by 50% or more.

Laspeyres's Example Defending Arithmetic Means. (1864, pp. 96-97) From 1845 to 1850, the price of cocoa nearly doubled. So if the 1845 price were indexed at 100, the 1850 price would be 200. At the same time the price of cloves fell to half its 1845 value, or indexed from1845=100, the price of cloves fell to 50 in 1850. The average price level is the average of the indexed 1850 prices, or 125, yielding an average price change of 25%. Jevons (Laspeyres wrote) argued that, in truth, the average price was unchanged, since the geometric mean, (square root of the product of the indexed prices) is 100, or no change in average prices. The geometric mean assures expenditure shares are constant.

Laspeyres argued that buying power is what matters. Assume that to start in 1845, equal sums (100 thaler each) of money are spent on cocoa and cloves, a hundredweight of each, for a total of 200 thaler for 2 hundredweights. (That's a lot of cloves.) In 1850 the 200 thaler would not buy the same hundredweight of each goods. Is the correct formulation that the total sum of money spent the two goods is held constant? Then the buyer could get 3/4 of a hundredweight of cocoa for 150 thaler and his hundredweight of cloves for 50 thaler, (total 200 thaler). Or the buyer could get a hundredweight of cocoa and no cloves for his 200 thaler. These are smaller quantities, and Laspeyres concluded that, since it

would require 250 thaler, rather than 200 thaler, to purchase a hundredweight each of cloves and cocoa, that extra 50 thaler measures the increase in goods prices. This increase is 25% higher than the original expenditure of 200 thaler, and was the same conclusion as from the arithmetic average for the prices. Note that the index is measuring purchasing power for equal quantities (weights) of goods indexed so the base period equals 100, then prices are averaged. This is similar to real-world sales-weighting if high-priced goods are purchased in smaller quantities, low-priced goods in higher quantities, and the purchases are spread over a large number of kinds of goods. In general, this equal-weights averaging would not match real purchasing decisions.[13] But the principle of whether the early basket (here, made up of equal weights of all goods) is achievable in a later period was already established by Laspeyres as the key measure of buying power.

The argument against arithmetic averaging (and for geometric averaging) is that buyers will substitute toward the good whose relative price has fallen, in this case, cloves. If the buyer bought all cloves, he could even get 4 hundredweights, a higher quantity. This is unlikely behavior. One argument for the geometric mean is that it adjusts for such changes in purchasing. The geometric mean measures price increases after substitution (holding expenditure shares constant, rather than quantities).[14]

[13] I'm told that at the most disaggregated levels of the CPI calculations, prices are averaged without weights in a similar manner. I'm trying to check up on this information.

Should the quantities in the basket of goods be fixed by consumers' original choices? This was Laspeyres' formula in his 1871 article. Then if a higher sum of money is required to purchase equal quantities of both goods, the cost of living has risen, while the well-being of consumers and the exchange-value of money have fallen. Laspeyres noted that the appreciation of the value of goods (or depreciation of currency value) was in general larger for his arithmetic means than for Jevons's geometric means and recalculated Jevons's results in his 1964 paper. Laspeyres measured inflation in London from the base 1845-50 period to the 1860-62 period to be 13.1%, contrasting with Jevons's geometric measurement of 10.25%, for a group of 118 commodities.

Laspeyres's demonstration of his formula (1871, pp. 306-308) The data on imports into Hamburg include quantities and list prices for the base period of 1851-1855 for 82 of his commodities. To this data, Laspeyres added market prices in Germany for the second period of 1856-1860 (quantities for that period were not available). But quality may have changed over this period, or may have been different in Hamburg from the rest of Germany. Laspeyres repeated his warning (also in his 1864 article) that price appreciation may be caused partly by higher quality. He also acknowledged it is a mistake to mix city only and whole country data, not to mention list and market prices, but these were the only price/quantity data available.

[14] Walsh (1901) Chapter XIV, especially pp. 472-474.

Table 2. Laspeyres Demonstrated his Formula in 1871

Commodities, in each case using the quantities from 1851-1855	Total value with 1851-1855 prices	Total value with 1856-1860 prices	Index of second-period value, setting first period's value=100
The first 20	35,524,750	41,090,000	112.9
The second 20	61,500,852	71,103,000	115.6
The third 20	15,570,644	18,366,000	117.9
The fourth 22	114,245,005	116,262,000	101.8
All 82 commodities, using 1851-55 quantities	226,245,005	246,821,000	108.8

Table from Laspeyres (1871) p. 307

Laspeyres may have demonstrated a Laspeyres index for 82 commodities, but he reiterated his decision not to give up on his simple arithmetic average. The simple (no quantities) average of indexed prices for these 82 commodities grew 9.65%, not far from the 8.8% price growth of his weighted index. "*Wir glauben aber praktisch um so mehr bei unserm arithmetischen Mittel stehen bleibe zu können, als jede noch so richtige, aber mit der Richtigkeit immer schwieriger werdende Berechnung, doch so lange falsch bleibt, als wir den Consum aller oder auch nur der wichtigsten Gegenstände in einem Lande nicht kennen."* [We believe it is more practical to remain with our arithmetic mean,

even though it is not so correct, because the correct way becomes ever harder to calculate, and moreover remains wrong, since we know neither the country's total consumption nor even just the most important goods.] (Laspeyres (1871) p. 308)

Laspeyres defended his formula in 1883. His overall positions remained the same. The goal for price-level statistics should be to measure and compare cost of living over different countries or in the same country over time. His comparison of indexes with and without quantity weights yielded approximately the same results for average price changes. Using import data on 22 commodities, Laspeyres estimated a price index with and without quantity weights for the period 1868-1880, using an average for 1847-1867 as his base period. Differences between the quantity-weighted and unweighted indexes averaged out over time.

Table 3. Laspeyres's 1883 Import-Price Index, 1868-1880

Years	With Quantity Weights	Without Quantity Weights
1847-1867	100	100
1868	118.5	104
1869	107.7	106
1870	98.0	103
1871	108.0	109
1872	116.6	121
1873	120.1	124
1874	114.1	113
1875	103.2	106
1876	102.9	106
1877	104.1	105
1878	92.1	96
1879	90.4	98
1880	96.9	87
1868-1880	105.85	106

Laspeyres (1883) p. 796

Laspeyres considered Paasche an ally in the battle against geometric mean price indexes. He quoted Paasche approvingly, "*Die jetzt verbrauchte Menge verschiedener Güter würde nach früheren Preisverhältnissen so und soviel gekostet haben, nach jetzigen so und soviel, die Differenz kann allein durch den Preisunterschied bedingt sein; also muß die Verhältniszahl, welche den Unterschied ausdrückt, der sich für die Summe vieler Waren in diesen beiden Geldmengen zeigt, die durchschnittliche Preisveränderung jener Produkte ergeben."* [The quantity of currently-used various goods would have cost such-and-such under earlier prices, and currently costs such-and-such, so the difference between the two amounts can come only from the price differences. Therefore, the proportional number which expresses the difference measured by the sum of many commodities in the two quantities of money shows the average price changes for those products.] (Paasche, quoted in Laspeyres (1883) p.796) But Laspeyres understood that his formula and Paasche's would have different results. Laspeyres mentioned that there is the question of whether the appropriate basket of goods should be the earlier period's quantities or the later period's, and added that the best weighting scheme might be some average over the whole period. But Laspeyres concluded that controversy over weighting schemes at that time was pointless. "*Wir haben keine genügende Statistik der durchschnittlichen Konsumtion irgend eines Landes, weder aus der Gegenwart noch aus irgend einem zurückleigenden Zeitpunkt"* [We don't have

enough statistics on average consumption for any country, neither in the present nor for any past time.](Laspeyres, (1883) p. 796)

Laspeyres added figures to his price reports in 1901, but not weights to his indexes. From 1885-1901, Laspeyres had no publications because he was involved in a mammoth number-crunching project: “Statistical attempts to answer the question of escaping the tax burden” (1901a); and (the related) “Prussian prices of farm products from 1821-1895” (1901b).

The first 1901 article (1901a) analyzed 1.7 million observations of prices from cities with taxes and cities without taxes on commodities and compared the prices in the taxed and untaxed cities and prices in each city over time to see (1) whether consumer prices rose by the amount of the tax (and rose at the time the tax was enacted), (2) whether the price movements differed in taxed and untaxed cities, and (3) whether after the taxes were (almost completely) lifted in 1875, prices fell back again to where they were before taxation (or to where they would have been without taxation). Since he was showing changes in individual prices from taxes, he did not apply his index formula.

In 1901b, which includes figures of the cumulative distribution around the mean of prices for individual products and product categories, Laspeyres claimed to be the first to approach the questions: How do farm goods prices, which are used in published price averages for provinces and for the state, over decades

and longer periods, relate to their long-term averages? Is this relationship similar within or between categories of goods? Do these relationships change over time? He analyzed 10 farm products from 60 (in the earlier time) to 120 Prussian towns over a 75-year period, for a total over 60,000 observations. His price index for all 10 products is calculated like the 1864 index of Hamburg prices, by indexing the prices and then averaging them without weights. (Laspeyres (1901) p. 51) But Laspeyres's real attention in this work was on the cumulative distribution function of prices, rather than price index issues. He showed these distributions by drawing the figures, as well as using various kinds of tabular analysis.

IV. Conclusion

Laspeyres considered the important controversy to be over geometric versus arithmetic averaging. In this debate, he was firmly on the side of arithmetic averaging because the key function as he saw it was to measure purchasing power. Price data were much more available than quantity or expenditure data, so which weights used were (in practice) more a matter of data availability than theoretical preference. So Paasche weighting (end-period) and Laspeyres weighting (first-period) were less consequential differences than the similarities from both using arithmetic averaging. Laspeyres's statement that some average weight over the whole period anticipates the Fisher Ideal Index among other improvements on the basic formula and practice.

Geometric means have not vanished in price index theory, though the most widely-used formula still uses Laspeyres's first-period weights. Still, modified Laspeyres indexes like the CPI are still facing geometric means as potential replacements. U.S. CPI indexes are being reported in geometric means, as well as the traditional modified Laspeyres versions.

Modified Laspeyres indexes like the CPI are still facing geometric means as potential replacements. Research on price indexes is concerned with arithmetic versus geometric averaging (McClelland and Reinsdorf (1999)), dispersion of prices (McClelland (1996)), correct size of weights (Young (1993)), application to cost-of-living measures (Moulton (1996)), which index correctly matches buyer substitution behavior as relative prices change (Young (1992) and (1993), Landefeld and Parker (1995)), and aggregation of heterogenous prices (Kokoski, Moulton and Ziescheng (1996)).

A repeated concern of Laspeyres was the problem of how to adjust for different quality goods, either from quality changes over time or differences in the same good at different places.(Laspeyres 1864, 1871, 1883) Quality change and the entry of new goods is still a subject of research. See Abraham et al. (1998), Boskin et al. (1998), Deaton (1998) and Nordhous (1998). This might be an interesting angle for further research.

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