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Chapter 4

LASPEYRES, ERNST LOUIS ETIENNE*

W.E. Diewert

Laspeyres, Ernst Louis Etienne (1834–1913). Laspeyres was born at Halle, Germany, on 28 November 1834 and died on 4 August 1913 at Giessen, Germany.

From 1853 to 1857, he studied at the universities of Tübingen, Berlin, Göttingen and Halle. He received a law degree from the University of Halle in 1857. He studied at the University of Heidelberg from 1857 to 1859, and in 1860 he obtained his PhD from Heidelberg for the thesis, 'The Correlation between Population Growth and Wages'.

From 1860 until 1864 he worked as a lecturer at Heidelberg, where he wrote a history of the economic views of the Dutch (Laspeyres [1863]). In the following ten years, he taught at four different universities: 1864 – Basel; 1866 – the Polytechnic at Riga; 1869 – Dorpat; 1873 – Karlsruhe. Finally, from 1874 to 1900, he taught at the Justus-Liebig University at Giessen.

Laspeyres' main contribution to economics was his development of the index number formula that bears his name. Let the price and quantity of commodity n in period t be p_n^t and q_n^t respectively for $n = 1, \ldots, N$ and $t = 0, 1, \ldots, T$. Then the Laspeyres price index of the N commodities for period t (relative to the base period 0) is defined as

$$P_L \equiv \sum_{n=1}^{N} p_n^t q_n^0 \Big/ \sum_{n=1}^{N} p_n^0 q_n^0.$$

Laspeyres wrote his classic paper [1871] which suggested the above formula partly as an outgrowth of his empirical work on measuring price movements in Germany and partly to criticize the index number formula of Drobisch [1871]. Using the notation defined above, the Drobisch price index for period t is defined as

$$P_D \equiv \Big(\sum_{n=1}^{N} p_n^t q_n^t \Big/ \sum_{n=1}^{n} q_n^t\Big) \Big/ \Big(\sum_{n=1}^{N} p_n^0 q_n^0 \Big/ \sum_{n=1}^{N} q_n^0\Big).$$

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Laspeyres criticized this formula by showing that the index generally changed even if all prices remained constant (i.e. P_D does not satisfy an identity test to use modern terminology). An even more effective criticism of P_D is that it is not invariant to changes in the units of measurement (whereas P_L is invariant). Laspeyres did not write any further papers on index number theory. He wrote papers on economic history, the history of economic thought and on topical economic issues of his time; see Rinne [1981].

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Chapter 5

INDEX NUMBERS*

W.E. Diewert

The index number problem may be phrased as follows. Suppose we have price data $p^i \equiv (p_1^i, \ldots, p_N^i)$ and quantity data $x^i \equiv (x_1^i, \ldots, x_N^i)$ on N commodities that pertain to economic unit i or that pertain to the same economic unit at time period i for $i = 1, 2, \ldots, I$. The *index number problem* is to find I numbers P^i and I numbers X^i such that

$$P^i X^i = p^i \cdot x^i \equiv \sum_{n=1}^{N} p_n^i x_n^i \quad \text{for } i = 1, \ldots, I. \tag{1}$$

P^i is the *price index* for period i (or unit i) and X^i is the corresponding *quantity index*. P^i is supposed to be representative of all of the prices p_n^i, $n = 1, \ldots, N$ in some sense, while X^i is to be similarly representative of the quantities x_n^i, $n = 1, \ldots, N$. In what precise sense P^i and X^i represent the individual prices and quantities is not immediately evident and it is this ambiguity which leads to different approaches to index number theory. Note that we require that the product of the price and quantity indexes, $P^i X^i$, equals the actual period (or unit) i net expenditures on the N commodities, $p^i \cdot x^i$. Thus if the P^i are determined, then the X^i may be implicitly determined using equations (1), or vice versa.

Each individual consumes the services of thousands of commodities over a year and most producers utilize and/or produce thousands of individual products and services. Index numbers are used to reduce and summarize this overwhelming abundance of microeconomic information. Hence index numbers intrude themselves on virtually every empirical investigation in economics.

Index number theory splits naturally into two divisions, depending on the size of I. If $I = 2$, so that there are data for only two time periods or two economic units, then we are in the realm of *bilateral index number theory* while if $I > 2$, then we are in the realm of *multilateral indexes*. Bilateral approaches are considered in Sections 1–5 below and multilateral approaches are considered in Sections 6–10.

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