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The empirical work assessing the impacts of information technology in terms of productivity, profit, and share value has been inconclusive to date. The inability to demonstrate that the benefits of investing in information technology exceed the costs has puzzled both information systems and economic researchers. This puzzle has been labelled the "productivity paradox" ( Roach, 1991; Brynjolfsson, 1993).

Recent work, using the firm as the level of analysis, has applied econometric methods to assess the payoff to spending on information technology ( Berndt and Morrison, 1995; Brynjolfsson and Hitt, 1993, 1995, 1996; Lehr and Lichtenberg, 1997; Lichtenberg, 1995; Loveman, 1994; Morrison and Berndt, 1991; Sabyasachi and Chaya, 1996; Weill, 1990; Weill, 1992). One component to performing such an analysis is the application of an appropriate price index that accounts for quality change over time in the inputs to production, in this case, information technology. Currently, there are no valid price indexes for IT. The often-cited works of Brynjolfsson and Hitt were forced to rely on a price index ( Gordon, 1990) that was both out-of-date (ending four years before their data begins) and developed for a different type of computer (mainframe), because this index was the best available. Despite the increasing importance of microcomputers to business, an appropriately specified price index covering the microcomputer has yet to be developed.

An input-cost index is used to transform nominal spending on computer hardware into constant, quality-adjusted dollars. Electronic computers have undergone rapid and sustained quality improvement since their introduction in the 1940s, so the need for a price index for this class of goods is especially acute. Two pioneering works on price indexes for microcomputers are ( Berndt and Griliches, 1990) and ( Berndt, Griliches, and Rappaport, 1995).

The theoretical basis for relating the price of a heterogeneous good (i.e., a good having more than one attribute) to the attributes of that good is the hedonic function. The approach of hedonics has become well-defined and well-accepted both theoretically and empirically. The challenges of this approach are to correctly specify the hedonic function, in terms of (i) choosing the attributes that are sources of user value and (ii) using the functional form that is appropriate to the good in question. The research discussed here extends the work of Berndt et al. in several ways.

In the specification of the hedonic function, two approaches are taken; the "technical" approach uses only objective, technical attributes of microcomputer systems (e.g., megabytes of RAM, processor clock speed), consistent with the literature to date. However, unlike previous work, empirical work (a Delphi survey) will be used to identify attributes creating user value, thus avoiding the problems associated with omission of relevant regressors and inclusion of irrelevant regressors. The second, "direct" approach, aims to identify higher level concepts, the "sources" of user value, such as system performance, for which technical attributes are, in fact, proxies. For example, system performance is determined by a host of technical attributes: the generation and clock speed of the CPU, the quantity of cache and primary memory, the speed and word length of the busses, and so on. Rather than these proxies, the direct approach will use benchmarks as a direct measure of computer performance. Surprisingly, the direct approach is the first known use of benchmarking in constructing a computer price index.

Given the intense levels of competition in the microcomputer industry, it is reasonable to expect that the hedonic function will demonstrate "t-identification," meaning that hedonic contours will be concave with respect to the origin. Unfortunately, work to date has customarily used semi-log or double-log functional forms, neither of which permit concave contours. The research discussed here will use a functional form that is sufficiently flexible to permit such contours.

The process of using the empirically estimated hedonic function to construct price indexes can be accomplished in several ways. Here, we apply a more advanced technique, namely, the combination of the imputation method with a superlative index. This approach is robust to measurement error and misspecification, and makes maximum use of available data ( Diewert, 1976; Triplett, 1989).

Following the construction of these price indexes, they will be applied to two streams of research on the productivity of IT: (i) firm-level estimates of production functions, and (ii) direct estimates of consumer welfare resulting from the fall in computer prices.

## *References*

References available upon request from the author (chwelos@commerce.ubc.ca).