Introduction and overview

Guest editors

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> "[T]he actual productivity situation may not be as bad as some of the crude numbers indicate. In some sectors, such as communication, where we have good data, productivity is growing at a satisfactory rate ... In some areas, such as health and the criminal justice system, we may be facing sharply diminishing returns in spite of the many technological improvements that may have affected them. But unless we improve our measurements in this area, both in terms of the availability of basic statistics and improvements in the conceptual frameworks for their interpretation, we will never know."
>
> Zvi Griliches (1992)

> "What has all that computer power been doing, and where is the 'black hole' into which all those computers are disappearing?"
>
> Martin Neil Baily and Robert J. Gordon (1988)

> "Why so little competitive return--even a negative return--on so much effort?"
>
> Wickham Skinner (1986)

The papers in this special issue address different aspects of the theme "Service Sector Productivity and the Productivity Paradox."[1] The issue consists of four parts, with the papers arranged under the headings:

(1) The productivity paradox--what is it?
(2) Computer related measurement problems and the productivity paradox.
(3) Are new goods or new retail practices at the heart of the productivity paradox?
(4) Other service sector productivity measurement problems.

The papers map out the main avenues of thought and some of the empirical evidence economists have amassed on a topic that has captured the public imagination and influenced government policy agendas. We feel that, collectively, these papers provide the basis for a significant reformulation of thinking on the productivity paradox.

This English language introduction and overview, and the accompanying French language version of it, take the place of the individual paper abstracts appearing in regular issues of the *CJE*.

1. The productivity paradox--what is it?

Part 1 introduces the subject of this special issue with a paper by W.E. DIEWERT and KEVIN J. FOX entitled "Can measurement error explain the productivity paradox?" This paper explores the main characterizations and causes that have been advanced for the so-called productivity paradox. The authors also provide wide ranging descriptive evidence of the post-1973 productivity growth downturn. For 18 OECD countries, Diewert and Fox document that total factor productivity growth dropped from an average annual rate of 3.25% over the years of 1961-1973 to 1.09% over 1974-1992, and labour productivity dropped from an average annual rate of 4.41% over 1961-1973 to 1.81% over 1974-1992. They observe that:

> "The sudden decline in productivity growth in these industrialized countries after 1973 is clearly seen..., as is the subsequent lack of a recovery. This empirical observation, combined with our knowledge of the great advances in technology during this period, is what leads us to examine possible reasons for the 'productivity paradox'."

Diewert and Fox outline a number of specific mechanisms by which an increasing proliferation of new products and new processes together with existing statistical agency measurement procedures could have led to a systematic underestimation of productivity growth. This material underlines the importance of the *part 3* papers in this issue on the treatment of new goods.

The authors move on to suggest that an increasing proportion of business expenditures are actually consumption expenditures and that these classification errors have reduced measured productivity growth. They also take up a variety of other problems of measuring service sector outputs. They go on then to draw attention to the expected *pattern over time* of effects on measured productivity for each of the explanations considered. They conclude that *none* of the productivity measurement problems discussed in sections 2-5 of their paper could account for the *abrupt drop* in productivity growth after 1973, though some of those factors might help explain why measured productivity growth subsequently failed to recover.

In sections 6 and 7, Diewert and Fox turn their attention to other possible explanations of the post 1973 decline in measured productivity growth. They plot country-specific output price series for the same 18 OECD countries for which productivity growth rate figures were examined and note that "it is striking how inflation increased in OECD economies after 1973." They go on to discuss inflation related aspects of business cost accounting and taxation that might have interacted with business decision making in such a way as to *cause* a serious downturn in productivity. More specifically, they argue that historical cost accounting, high inflation and high rates of business income taxation interact to produce chaos in the inter-temporal allocation of resources which in turn can lead to productivity growth declines.

Diewert and Fox conclude that:

> "We believe that economic mismeasurement in general can help to explain the post-1973 productivity growth decline in OECD countries. In particular, we find that mismeasurement of business expenses in periods of high inflation may reduce productivity, and problems in accurately measuring relevant variables may mask a productivity growth recovery when inflation falls."

In the second paper in part 1, "The productivity paradox: evidence from indirect indicators of service sector productivity growth," EDWARD N. WOLFF takes as his starting point the oft stated position that:

> "The basic problem ... is how to measure productivity in an industry in which output is difficult to measure but inputs are relatively easily measured."

Wolff explains that:

> "Several economists have contended that the apparent poor performance of services in more recent years is due to increasing problems in the measurement of their output over time; not due to actual changes in productivity. I now construct some related measures of technological activity to investigate this issue."

Using U.S. input-output data for the period of 1958-1987 as well as decennial U.S. Census data for 1960-1990, Wolff provides indirect evidence at the all-industries level that productivity growth is positively related to research and development (R&D) intensity and knowledge spillovers from other industries, but negatively related to major restructuring of technology as reflected in changes in the occupational composition of industry employment. In general, Wolff finds that measured productivity growth is not significantly affected by the degree of computerization. He finds as well that the estimated coefficients for the service industry regressions are noticeably different from those for the all-industries regressions, and he interprets this as circumstantial evidence of mismeasurement of service sector output.

In addition to the new empirical research findings reported, Wolff's paper fulfills the function of introducing and motivating a number of the measurement problems addressed in other papers in this issue.

2. Computer related measurement problems and the productivity paradox

The four *part 2* papers examine ways in which the expansion of computers and other electronic information processing technologies might be causal or measurement-related elements in the productivity paradox.

In the lead paper of *part 2*, "The Solow productivity paradox: what do computers do to productivity?", JACK E. TRIPLETT lays out in non-technical terms the standard ways of characterizing and explaining the productivity paradox. Triplett critiques what he sees as the seven most common 'explanations.' This paper was written while the author was still Chief Economist

at the U.S. Bureau of Economic Analysis (the BEA). These are the insights of someone who played an important role from within the community of official statisticians in encouraging and shaping the hedonic methods now used for tracking the price movements for computers.

Triplett also articulates the connection between the treatment of computers in price indexes and the modern-day challenge of measuring the productivity of a nation. The paper serves to motivate the *part 2* papers in this issue on computer related productivity effects as well as some of the material in *parts 3* and *4* on new goods and other service sector measurement problems.

In introducing their paper, "Information technology and its impact on firm-level productivity: evidence from government and private data sources, 1977-1993," BILL LEHR and FRANK LICHTENBERG note that:

> "Some aggregate and industry-level studies have failed to detect a positive contribution to productivity growth from increased investments in computer technology. More recent studies utilizing firm-level data, however, have detected a significant contribution from information technology. This paper confirms the results of these latter studies using firm-level computer asset and financial data for non-agricultural firms during the period 1977-1993."

More specifically, Lehr and Lichtenberg use data from three sources: a private market research firm, the Census Bureau's Enterprise and Auxiliary Establishment Surveys, and Compustat. They find that computers -- especially personal computers -- have contributed to productivity growth and, in fact, have yielded excess returns relative to non-computer capital investments. They find, moreover, that the excess returns from computers first increased and then decreased over the period spanned by their data, having reached a peak in 1986 or 1987. Lehr and Lichtenberg find too that computers are complementary with skilled labour and that computers help reduce inventory levels.

GEORG LICHT and DIETMAR MOCH in their paper "Innovation and information technology services" find that the *type* of computer investment matters. They use German firm level data from the Mannheim Innovation Panel for the Service Sector and from International Data Corporation Deutschland. These authors provide evidence that investments in personal computers are an important source of productivity growth whereas investments in mainframe or midrange computers are not. They conclude that "Considering the enormous variety of computer equipment ranging from personal computers to mainframe computers, one should not be surprised to find that aggregation of computer capital matters." Licht and Moch also explore the impacts of investments in information technology on the quality dimensions of service sector production.

In the last *part 2* paper, titled "Information technology and labour productivity growth: an empirical analysis for Canada and the United States," SURENDRA GERA, WULONG GU, and FRANK C. LEE broaden the investigation beyond a single country, and focus on trade as a mechanism for acquiring new

technologies. Gera, Gu and Lee specify a production function relating industry output to six categories of inputs: labour input, information technology (IT) capital input, non-IT capital input, own R&D capital input, R&D capital embodied in purchases of domestic goods and services, and R&D capital embodied in foreign goods and services. Using OECD industry level data for Canada and the United States, the authors provide evidence that IT investments and international R&D spillovers -- particularly those from IT imports -- do contribute to higher labour productivity growth in Canadian industries. Their U.S. results are not as strong, but still support the core results for Canada that IT investments and R&D spillovers embodied in IT imports help boost productivity growth. One implication of this study is that ignoring trade in previous studies of productivity may have contributed to the productivity paradox.

3. Are new goods or new retail practices at the heart of the productivity paradox?

As already mentioned, the *part 1* paper by Diewert and Fox raises the issue of the treatment of new products and services which is the focus of the *part 3* papers. Diewert and Fox note that bringing new products to the market place entails fixed costs for producers including the cost of basic invention, the cost of designing capital equipment and retraining workers to produce the new products, inventory costs, and selling costs. Diewert and Fox call attention as well to the growing number of new products, making reference to the research of Leonard Nakamura on new product introductions in U.S. grocery supermarkets. They quote Nakamura's finding that "the number of items stocked in the average U.S. grocery supermarket has grown from 1281 in 1964, to 1831 in 1975, to 16,790 in 1992."

The paper by LEONARD I. NAKAMURA from which the above quote is taken is the first of the *part 3* papers. Titled "The measurement of retail output and the retail revolution," this paper focuses on the divergence in the movement over time of two different U.S. measures of retail food prices. Nakamura explains that, in addition to producing the Consumer Price Index, the U.S. Bureau of Labor Statistics (BLS) also publishes average price (AP) data for a selected group of foods. He notes that Marshall Reinsdorf, a BLS researcher, published an article in 1993 documenting that from 1980 to 1990 the CPI and AP series for comparable food products diverged by roughly 2 percentage points a year, with the CPI series rising faster than the AP series. Nakamura maintains that this divergence is partly due to the increasing use by business of market segmentation pricity schemes. The development of these has been facilitated by the growth of the information technologies and computing.

Nakamura reports that:

> "The computerization of retailing has made price dispersion a norm in the United States, so that any given list or transactions price of a product is an increasingly

> imperfect measure of its resource cost.... Food retailing is used as a case study to examine data problems in retail productivity measurement. Crude direct measures of grocery store output suggest that the CPI for food-at-home may have been overstated by 1.4 percentage points annually from 1978 to 1996. Food-at-home is the area of pricing with which economists and government statisticians have had the most experience; these goods are the ones for which we have the best data and on which we have concentrated most of our efforts in pricing. Errors in other areas of pricing are likely to be even larger."

Leonard Nakamura concludes that the CPI may have overstated price increases for food-at-home; hence estimates of productivity computed using the CPI may be understated.

The second paper in *part 3* is PETER HILL's "Tangibles, intangibles and services: a new taxonomy for the classification of output." Hill argues that in the economics literature the distinction between *goods* and *services* has become erroneously and unnecessarily confused with the distinction between *tangible* and *intangible* products. He notes that there is an important and fast growing class of intangible products in the form of entities that are recorded and stored on paper, films, tapes or disks. He maintains that these intangibles "have all the salient economic characteristics of goods and none in common with services." According to Hill, goods are entities of economic value over which ownership rights can be established and which can also be traded. On this basis, Hill argues that the traditional dichotomy between goods and services should be replaced by a three-way breakdown of tangible goods, intangible goods and services.

MICHAEL C. WOLFSON'S paper "New goods and the measurement of real economic growth," explains and explores the various ways in which a flow of new goods might lead to price measurement problems, and hence to problems in the measurement of 'real' (i.e. deflated) economic growth and productivity. Wolfson notes that empirical examinations of these problems typically focus only on the 'product cycle' biases arising from the price declines that occur between the time a commodity first appears on the market and the time when it is added to the price index commodity basket. However, new goods also can cause other sorts of problems for price level measurement. Wolfson explains that these include the effects of the expansion of the choice set on utility, and income associated effects on choice. In addition to explaining (and also providing references to the relevant economics literature), the meaning and potential seriousness of these problems is demonstrated using the Xecon simulation model. Within the context of alternative scenarios for the Xecon experimental simulation economy, Wolfson also shows how these problems are and are not dealt with using alternative measurement approaches, and that the impacts of new goods could vary systematically by income group within a population, or over time or among countries depending on differences in the general level of affluence.

4. Other service sector productivity measurement problems

The BART VAN ARK, ERIK MONNIKHOF and NANNO MULDER paper, "Productivity in services: an international comparative perspective," documents productivity performance in services for the five countries of Canada, France, Germany, the Netherlands and the United States. For each of these countries, estimates of levels of output and productivity relative to the United States are obtained for transport, communication and distribution. The estimates are based on the industry of origin approach, which has been applied in the International Comparisons of Output and Productivity (ICOP) project. The ICOP method makes use of data on industry outputs and inputs from production statistics and national accounts in combination with estimates of quantity relatives and purchasing power parities by industry. Van Ark, Monnikhof and Mulder consider a variety of possible explanations for the intercountry productivity gaps in services. They categorize the explanations into those having to do with capital intensity, scale and scope, innovation, and degree of regulation. Their evidence suggests that the effect of greater scale and the deregulation of markets are important for explaining the U.S. productivity advantage in services.

The van Ark-Monnikhof-Mulder paper distinguishes two main approaches to the study of inter-country productivity differences. These classifications are applicable for within country as well as between country productivity comparisons. They write:

> "The first is a case study approach. A specific industry is analysed in detail for output and input variables which are the most characteristic of the product and the production process. These case studies often make use of benchmarking techniques to compare the performance of individual functions of the production process…. The case study approach relies heavily on data obtained from individual establishments or enterprises in the industry, so that the performance of individual producing units (firms or establishments) can be compared to the best practice as well. At present there are only a limited number of such studies…."

The final paper in this issue makes use of this first approach. We introduce that paper after first dealing with the papers that adopt what Van Ark, Monnikhof and Mulder refer to as the second approach.

Van Ark, Monnikhof and Mulder write that:

> "The second approach … is called the sectoral approach. It measures and analyses output and productivity performance for individual sectors…, branches… and industries… in relation to the macro performance of the total economy."

The three papers in *part 4* following the van Ark-Monnikhof-Nanno one make use of this second approach. The first two are studies of the insurance industry, while the third is focused on the banking sector.

The first insurance industry study is titled "Total factor productivity growth in the Canadian life insurance industry: 1979-1989." In this paper, JEFFREY I. BERNSTEIN begins with descriptive information on the life insurance industry. Bernstein positions the service sector within the Canadian economy as a whole;

the finance, insurance and real estate (FIRE) sector within the service sector; insurance within FIRE; and life insurers within insurance as a whole. He goes on to explain the motivation for his paper as follows:

> "Measured productivity growth rates for services are generally lower than the rates obtained for manufacturing industries. However, this finding is suspect because of the difficulties in using official statistics to measure output of services industries. The purpose of this paper is to compute output, input, and productivity growth rates for the Canadian life insurance industry based on firm-level data obtained from the Office of the Superintendent of Financial Institutions (OSFI)."

This material shows how productivity measurement problems in the life insurance industry might have contributed to the measured productivity slowdown.

Bernstein goes on to produce total factor productivity growth estimates for the life insurance industry as a whole, which is why we treat his paper as an application of the second approach discussed by Van Ark, Monnikhof and Mulder. However, Bernstein's industry level estimates are, in fact, compiled from *firm level* data for outputs and inputs over the period of 1978 to 1989. Because Bernstein begins with firm level data and then creates the appropriate aggregates, he is able to take account of firm-specific differences that are usually explored only in case studies--that is, in the first of the two approaches discussed by Van Ark, Monnikhof, and Mulder. The firms for which Bernstein forms aggregates accounted for an average of 76 percent of all premiums and 81 percent of all assets for the Canadian life insurance industry over the period from 1978 to 1989.

Bernstein's findings suggest that service sector measurement problems may indeed be part of the explanation of the productivity slowdown and that some of these problems could be avoided by adopting his methodology. Bernstein also finds that the life insurance industry has had relatively favourable productivity growth. In fact, he finds that "the productivity performance of the Canadian life insurance industry is comparable to manufacturing industries."

MARK K. SHERWOOD in his paper "Output of the property and casualty insurance industry" examines the productivity of another, and smaller, segment of the insurance sector. He begins by developing two concepts of the output of the property and casualty insurance industry. Sherwood explains that "One concept is implicitly in the U.S. national accounts and in the 1993 System of National Accounts (SNA); the other concept is from the economics literature." For each of the two concepts, he discusses alternative methods for measuring the nominal value of insurance output, and gives an empirical comparison of different methods for converting the resulting nominal value of output into real output.

Many of the points Sherwood makes are a further elaboration of issues also raised in the previous paper by Bernstein. Sherwood presents evidence indicating

that the use of the national accounts concept for measuring insurance leads to an understatement of productivity growth. He argues for an improved treatment of risk and of excess capacity that is put in place to reduce risk, though Sherwood does not feel that measurement problems for the property and casualty insurance industry are important for explaining the productivity paradox. Because of the relatively small size of the property and casualty insurance industry and because there would be offsetting adjustments if the problems with the national accounts concept were remedied, Sherwood concludes that "The concept used by national income accountants to measure property and casualty insurance does not appear to contribute to an understatement of aggregate output growth." Nevertheless, some of the problems considered by Sherwood apply more generally.

"The productivity of the banking sector: integrating financial and production approaches to measuring financial service output" by DENNIS FIXLER and KIMBERLY ZIESCHANG focuses on measurement problems for the quantities of the outputs and inputs for banking. They revisit the conceptual framework for a financial firm. They consider the price of financial services and the accounting framework for the value of financial services output. They then construct benchmark rates for 1993-1996 using data from the U.S. Federal Deposit Insurance Corporation on the maturity structure of assets and liabilities of commercial banks, and also data on Treasury security interest rates, and consider the use of these rates for constructing an output index for commercial banking. Fixler and Zieschang argue strongly that accounting for changes in services characteristics is critical to obtaining a defensible banking services volume measure, and they raise a number of concerns having to do with the treatment of the banking sector in the national income and product accounts.

In the final paper of *part 4*, titled "Benchmarking and the measurement of best practice efficiency: an electricity generation application," W. ERWIN DIEWERT and ALICE O. NAKAMURA define and discuss a series of measures of efficiency that can be used by organizations striving to improve their productivity. The preferred measure -- a measure termed 'best practice efficiency' -- is the ratio of what is termed the best practice unit cost to the actual unit cost. Best practice unit cost for a plant in a particular year is computed using the actual input prices for the designated plant in that year and the input-output coefficients from the benchmarking reference sample of plants that result in the smallest hypothetical unit cost figure.

The best practice efficiency measure has the advantage of controlling for local input price conditions that a plant manager must take as given. In the Diewert-Nakamura study, the plants are in different countries with dramatically different relative price conditions. However, even in different regions or over time within the same country, relative prices can differ greatly. The approach taken in the Diewert-Nakamura study is a more precise way of controlling for plant-specific differences in relative prices than simply deflating by some general purpose price index. A further advantage is that this approach can control for price changes for

all input factors for which quantity and price data are recorded for the relevant plants or other operational units even if some of these inputs are 'new' goods in the sense that they have not yet been introduced into the market baskets for the corresponding official price indexes.

5. Concluding remarks

Many would trace interest in the 'productivity paradox' back to Solow's aphorism with which we began. We agree, however, with Triplett's observation that "Solow's aphorism gains its resonance from a different, though related, question: Will the growing investment in computers and information technology reverse the post 1973 productivity slowdown?" In other words, the interest in the paradox stems from keen interest in how the productivity of our national economies can be made to improve.

We feel that, collectively, the papers in this issue provide the basis for an important repositioning of thinking on the productivity paradox. The arguments and evidence in these papers confirm that there have indeed been problems in the measurement of outputs, inputs and prices that have distorted official measures of productivity, but that distortions in the *measurement of productivity* cannot account for the sharp post-1973 downturn in productivity growth in many countries. However, the proliferation of new goods and inflationary conditions combined with the problems of measuring outputs and inputs and prices that are documented in these papers could have interacted with problems in the design of business tax programs and business record keeping and decision making processes in such a way to have *caused* a downturn in productivity growth in the post-1973 period -- a downturn severe enough to more than wipe out the initial gains from business investments in computers and other information technologies in that period. If this is the case, we would expect to see improvements in productivity now in countries like Canada where inflation has been brought under control, though these improvements might be masked by productivity measurement problems.

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Notes

[1] "Service Sector Productivity and the Productivity Paradox" was also the title of the conference we jointly organized where these papers made up part of the program. The conference was funded by grants to the Centre for the Study of Living Standards (CSLS), from Statistics Canada, as well from the Atlantic Canada Opportunities Agency, Industry Canada and the Ontario Ministry of Finance. The conference was held in Ottawa, Ontario on April 11-12, 1997. The papers in the conference were chosen from submissions made in response to a widely distributed call for paper proposals. Authors of conference papers which it was felt would be of interest to the

CJE audience were contacted following the conference and urged to submit suitably revised versions of their papers for consideration for this special issue. All the papers included in this issue were subjected to an external review process and substantial revision after the conference, with final approval resting with the CJE editor. All expenses were paid for as part of the original funding for the conference grant.