**CENTRE FOR THE STUDY OF LIVING STANDARDS**

# CONFERENCE ON SERVICE SECTOR PRODUCTIVITY AND THE PRODUCTIVITY PARADOX

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Dinner Speaker: **Paul Davenport,** President, University of Western Ontario

## "The Productivity Paradox and the Management of Information Technology"

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The slowdown in measured productivity growth rates in most industrial countries after 1973 is more than a little irritating to many professional economists. For the two decades before 1973 we associated multi-factor productivity growth largely with advances in knowledge, and now we find MFP growth declining when new knowledge and its application to production seems to be exploding world wide. Particularly disconcerting is the fact that the slowdown occurs in the midst of dramatic changes in computing and information technology which were expected to increase productivity in a wide variety of occupations. The productivity paradox is in fact closely related to the effective use of information technology. The issues at hand are best understood in the context of the **Knowledge-Based Economy**, and I should begin by saying what I mean by that term.

The Knowledge-Based Economy has arisen in advanced industrial countries over the last two decades. In some sense human economic activity has always been knowledge-based, as parents even in pre-historical times passed techniques of gathering and hunting to their children. The period since 1750 has seen an extraordinary interaction among science, technology, and economic growth, as advances in chemistry, physics, and engineering have led to waves of new products and processes which are breathtaking compared with the centuries that proceeded it. So what is special about the economy in recent decades that it deserves the label "the Knowledge-Based Economy?"

I believe that there are two characteristics of our current economy which allow us to demarcate it from what came before. Both have been explored by Peter Drucker (1988 and

1993): the growing number of workers involved in knowledge discovery and application, and our unprecedented ability to store knowledge and retrieve it rapidly using the information technology available over the last two decades.

While there are many technological advances evident since 1975, those in four areas seem most important in defining the technological basis of the Knowledge-Based Economy: information technology, communications, biotechnology, and new materials. All are based on the manipulation of physical or biological material at the molecular or sub-molecular level in ways that were not possible just 50 years ago. These technologies have created a remarkable demand for highly educated workers, not only to advance and manage the technologies themselves, but to serve as experts in the finance, production, and marketing of the new products and services which the technologies produce.

The extraordinary demand for what Drucker calls “knowledge workers” is evident in the strong relative demand for post-secondary graduates over the last decade or two, in which rising numbers of graduates have seen their relative income and employment status actually improve, as compared to high school graduates. Let me take an example from Ontario: from 1988 to 1996, employment in the Province increased by about 400,000; employment for post-secondary graduates increased by a million, and employment for all other categories of workers declined by 600,000. This shift continued trends evident since the 1970’s, in which a growing share of post-secondary graduates among employed workers has taken place with no decline, and in some cases even an improvement, in their relative salaries and employment rates.

Equally important in defining the Knowledge-Based Economy is our ability to store and retrieve information. Some 5000 years ago the Sumerians began writing, an innovation which allowed man to set down his thoughts and financial accounts. Slightly over 500 years ago, the invention of moveable type in Germany led to an extraordinary increase in printed materials and, over several centuries, to the growth of literacy and what we now call mass communication. Over the last 50 years, the development of the silicon-based computer chip, and its use to store and transmit information in computers and similar information technology devices, are profoundly changing the way we use knowledge in production, and, more slowly, the way we organize our firms.

With this context of the Knowledge-Based Economy in mind, let me turn now to the productivity paradox, that apparent contradiction between the deceleration in measured productivity growth rates over the last two decades and the extraordinary growth of information technology during the same period. Why, as Robert Solow (1987) put it a decade ago, can you "see the computer age everywhere but in the productivity statistics"?

Peter Howitt (1996) has shown that the very nature of the Knowledge-Based Economy creates problems of productivity measurement for several reasons: we measure R&D very poorly as an investment good; knowledge produces new goods creating severe difficulties for real output series; and we do little to estimate the effect of new knowledge on the obsolescence of existing capital and knowledge. Measurement problems are most severe in the service sector, where quality change may often elude us altogether. Moreover, as Griliches (1966, p. 6) has pointed out, the output of a service (e.g., teaching and learning) may often depend on the input (effort, ability, education) of the consumer, which further complicates measuring the output of services.

One school of thought, well represented at this conference, would say that there is no productivity paradox because there is no productivity slowdown. The apparent slowdown is entirely the result of an over-estimate of price inflation in the measurement of consumer goods, caused by a failure to recognize quality change. Indeed this point of view can be firmly situated in the context of the Knowledge-Based Economy: it is precisely the extraordinarily rapid change in product quality and design and the frequent introduction of new products made possible by the new economy, which account for the mis-measurement. While itis recognized that there was some over-estimate of price changes before the mid-1970's, this point of view can assert that it was no accident that an **increase** in the over-estimate of price inflation occurred just as the Knowledge-Based Economy was coming into its own.

I find this point of view reasonable, but not compelling. I read the evidence to say that we have over-estimated price inflation and under-estimated output growth since World-War II (and indeed before) because our methods for price deflation miss a lot of quality change. I do not find it plausible that an increase is such mis-measurement since 1973--during a period when we have devoted more resources to reducing such mis-measurement in our national accounts agencies--can account for the dramatic reduction in multi-factor productivity growth evident right across the OECD countries. To take the price of light as an example, Nordhaus shows that we have been underestimating productivity growth in the production of light by a wide margin for at least two centuries.

Some of the work in this area exhibits what appears to be a zeal to show that we are as good as previous generations: darn it, says the 50-year-old economist, that multi-factor productivity is not going to decline during my watch! We need to understand that if the MFP residuals mean anything, they refer not to performance, but to potential: in some periods, a given degree of human effort and investment simply produces higher growth rates. A recent paper by Paul David traces MFP growth in the US over the last two hundred years: he finds significant variation over the decades, which like all the residuals since Solow's 1957 paper we can measure but not fully explain. There is no normative conclusion to be had here: it would be wrong to say that low residuals mean poor performance.

So I think there **is** a paradox, and that the best explanation to hand is that which arises from the study of electricity by Paul David (1990): it sometimes takes decades to get full advantage of fundamental technical changes, of changes in general purpose technologies which effect how we live and work in a wide variety of ways. David shows the protracted period necessary for the economy to get full benefit from the application of electricity to life and work. I would suggest that we are experiencing a similar lag with regard to the productivity effects of information technology, biotechnology, and other advances associated with the Knowledge-Based Economy.

Paul David's hypothesis leads to our second issue, that of how we can use information technology more effectively. Notice that this is an important question regardless of our interpretation of the productivity paradox. For example, even if there has been no reduction in properly measured MFP, we can still ask the question: how can we accelerate the productivity gains of the Knowledge-Based Economy? Indeed, we can turn the Solow paradox in a different direction: given the revolution in information technology, why hasn't productivity growth **increased** during the last two decades, and what can we do to accelerate it?

I approach this second question by imagining that we are involved in an extraordinary society-wide effort of learning by doing. Advanced industrial society has shown remarkable efficiency in the application of science to computer chip production, cutting the real cost of such chips by about 50% a year over two decades. That same society has shown no such efficiency in learning how to effectively manage and apply the information made possible by the chips.

This theme is at the heart of a volume of essays by French business economists on the productivity paradox, edited by Marie Christine Monnoyer and currently being reviewed for publication. I was asked to write an introduction to the volume, and found myself reading a dozen papers on how businesses in France and other countries were managing the changes in information technology. In general, the businesses clearly considered investment in information technology to be like any other investment--it must earn some minimum rate of return. There are extraordinary obstacles in calculating the rate of return from the firm's point of view, however: how long a period should the calculation involve, how do you identify the true cost savings, are there improvements in service quality or market penetration which the new technology allows? These are very difficult questions, even at the firm level, and many firms seem unsure whether their information technology investments have paid them their normal rate of return, or indeed any net return at all.

If the calculations are difficult, there is widespread agreement on **why** the returns are not higher: the effective use of information technology requires an investment in human capital that can far exceed the direct cost of the technology, and most firms find that the required investment in people takes a long time. We should think here of a **learning** process which can not be rushed, analogous to the evolutionary theory of economic change of Nelson and Winter (1982, p. 404), who argue that "the process of institutional development is an evolutionary process . . . It is a groping, incremental process, in which the conditions of each day arise from the actual circumstances of the preceding day and in which uncertainty abounds." You can buy and install the software and hardware in a month; the groping for new organizational structures, and the development of human capital to make the technology work, takes much longer.

The fundamental principle would appear to be this: **organizations can use information technology effectively only if they change their internal structures and polices in response**

**to it.** Most of the productivity improvement which will come from the introduction of information technology in firms will require fundamental and difficult changes in internal organization, and that takes time. Those who prefer the old ways of doing things can slow down the benefits of information technology considerably, often in ways that are invisible to senior management, so the effective use of information technology requires leadership rather than command, and a broad ownership of information technology innovation right across the organization. At the same time, however, information technology can facilitate organizational change by allowing new methods of sharing information and the growth of partly autonomous work teams, accountable not only for their own projects but for a knowledge of everyone else's.

As Peter Drucker (1988) points out, the "information-based organization" (to use his term) must shift from the command-and-control style which has dominated large companies over the last 50 years to one which recognizes knowledge specialists who have knowledge not known to the traditional boss and who must have a degree of independence if they are to serve the company effectively. Drucker suggests that large businesses in 20 years (after 1988) will not resemble those of 1988, bur rather may resemble institutions like hospitals, universities, and symphony orchestras. Given the tendency of many to assume that universities are among the most inefficient organizations on the planet, it is interesting to see Drucker offer them as a model for the future. Universities have in fact dealt for decades with precisely the management problem which defines Drucker's information-based organization, that of coordinating the efforts of specialized knowledge workers whose knowledge of particular areas is far superior to that of senior management.

As the popular writer Nuala Beck (1992, p. 144) puts it: "Pay for performance, and the development of work teams where the role of boss and employee have become blurred beyond all recognition, will eventually lead to a management and accounting revolution." That blurring of roles undermines traditional hierarchies, and firms who are very protective of those hierarchies face special obstacles in the effective use of information technology. For example, in France it is clear that unions as well as senior management can be apprehensive about information technology's long-term impact on traditional authority in the firm: if the role of workers and bosses becomes blurred, what is the role of traditional collective bargaining?

So the productivity effects of information technology take a long time to show up because we humans take a long time to adapt our organizational structures to get the full benefit of the new technology. Those structures are part of what Dick Lipsey (1996a and 1996b) calls the “facilitating structure,” which stands between technological changes embodied in science and blueprints, and actual measured economic performance. Lipsey notes the extraordinary changes in plant layouts and management organization produced over many decades by the introduction of electricity into business in the first half of this century. The half century beginning around 1980 will witness similar dramatic changes from the introduction and spread of information technology, many of which we can not currently imagine.

It follows that the time investment in information technology can be lengthy and burdensome, and thus to an individual firm the whole information technology project can appear quite risky in terms of its effects on company profits. Part of the investment is required to focus the firm’s efforts on the acquisition of information which is useful, which contributes to knowledge. As a former university librarian of Yale puts it (cited in Breivik and Gee, 1989, p. 19): “We’re drowning in information and starving for knowledge.”

Which brings us back to the Knowledge-Based Economy. The full impact of information technology on long-term productivity is surely delayed as we grope through the process of determining what, among the almost endless amount of information to which we now have access, really effects the bottom line. We are still learning to harvest the extraordinary fruit of the trees we have planted in information technology, communications, biotechnology, and new materials. That harvest, as it occurs over the coming decades, will be a very rich one, and it will more than justify the dislocations and anxiety currently produced by the Knowledge-Based Economy.

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