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# Trend Productivity in the New Economy: a Survey

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**Table of Contents**

**TABLE OF CONTENTS** ....... **2**

**LIST OF TABLES IN TEXT** ....... **4**

**LIST OF TABLES IN APPENDIX** ....... **6**

**LIST OF CHARTS** ....... **6**

**ABSTRACT** ....... **8**

**EXECUTIVE SUMMARY** ....... **9**

**1. INTRODUCTION** ....... **11**

**2. THE COMPUTER PRODUCTIVITY PARADOX** ....... **13**

2.1. THE PUZZLE ....... 13
2.2. THE "COMPUTERS ARE NOT THAT IMPORTANT" HYPOTHESIS ....... 13
2.3. THE "EXISTENCE OF LAGS" HYPOTHESIS ....... 14
2.4. THE "MISMEASURMENT" HYPOTHESIS ....... 14
2.5. REVISION OF THE NATIONAL ACCOUNTS ....... 16

**3. WHAT IS NEW IN THIS "NEW ECONOMY"?** ....... **19**

3.1. DEFINITION OF THE NEW ECONOMY ....... 19
3.2. OVERALL PRODUCTIVITY TRENDS IN THE UNITED STATES ....... 20
3.3. THE PRODUCTIVITY EXPERIENCE OF THE MANUFACTURING SECTOR ....... 24
3.4. THE PRODUCTIVITY EXPERIENCE OF THE SERVICE SECTOR ....... 26

**4. ALTERNATIVE VIEWS OF THE NEW ECONOMY** ....... **28**

4.1. OVERVIEW ....... 28
4.2. THE ADVOCATES' CASE ....... 28
***4.2.1. Oliner and Sichel (2000)*** ....... *29*
***4.2.2. Whelan (2000)*** ....... *31*
***4.2.3. Jorgenson and Stiroh (2000)*** ....... *32*
4.3. THE SKEPTICS' CASE ....... 34
***4.3.1 Gordon (2000)*** ....... *35*
4.4. COMMENTS BY THE OPPOSING SIDES ....... 37
4.5. THE DEBATE CONTINUES ....... 38
4.6. THE PRODUCTIVITY-ENHANCING POWER OF THE INTERNET ....... 40

**5. THE CANADIAN PRODUCTIVITY EXPERIENCE** ....... **41**

5.1. PITFALLS IN INTERNATIONAL PRODUCTIVITY GROWTH COMPARISONS ....... 41
5.2. OVERALL PRODUCTIVITY TRENDS IN CANADA ....... 42
***5.2.1. Multifactor Productivity Trends*** ....... *45*
5.3. THE PRODUCTIVITY EXPERIENCE OF THE MANUFACTURING SECTOR ....... 46
5.4. THE PRODUCTIVITY EXPERIENCE OF THE SERVICE SECTOR ....... 47
5.5. INVESTMENT IN MACHINERY AND EQUIPMENT ....... 48
5.6. CANADIAN PRODUCTIVITY PROSPECTS FOR THE NEXT DECADE ....... 50

**6. THE EUROPEAN PRODUCTIVITY EXPERIENCE** ....... **52**

6.1.OVERVIEW ... 52
6.2. PRODUCTIVITY TRENDS IN THE EU ... 52
6.3. INVESTMENT IN INFORMATION TECHNOLOGY ... 54
6.4. EUROPEAN PRODUCTIVITY PROSPECTS ... 55

**7. IMPLICATIONS OF THE NEW ECONOMY ... 55**

**8. CONCLUSION ... 57**

**List of Tables in Text**


| | |
|---|---|
| Table 1 | Previously Published and Revised Real GDP Estimates, U.S. |
| Table 2 | Nonfarm Business Sector, U.S., Output, Labour Productivity and Productivity Elasticity |
| Table 3 | Manufacturing Sector, U.S., Output, Labor Productivity and Productivity Elasticity |
| Table 4 | Growth Rates of Value Added Per Worker Employed, U.S. |
| Table 5 | Estimates of Output per Hour in the Non-Manufacturing Business Sector - Growth Rates, U.S. |
| Table 6 | Estimates of Contributions to Labor Productivity Growth in the Nonfarm Business Sector by Oliner and Sichel |
| Table 7 | Estimates of the Contributions to Business Sector Productivity by Karl Whelan |
| Table 8 | Estimates of Contributions to Labor Productivity Growth by Jorgenson and Stiroh |
| Table 9 | Contribution from Computer Hardware to Output Growth: Comparison of the Different Studies. |
| Table 10 | Estimates of the Decomposition of Growth in Output Per Hour, into Contributions of Cyclical Effects and Structural Change in Trend Growth by Robert Gordon |
| Table 11 | Jorgenson and Stiroh, Versus, Oliner and Sichel: Alternative Estimates of the Sources of Acceleration in Labour Productivity. |
| Table 12 | Estimates of the Sources of Acceleration in Labour Productivity by Robert Gordon |
| Table 13 | Productivity and Related Variables in the Total Economy, Canada |
| Table 14 | Business Sector, Canada: Real Output, Labor Productivity and Productivity Elasticity |
| Table 15 | Multifactor Productivity Growth Rates, Canada |
| Table 16 | Manufacturing Sector, Canada: Output, Labour Productivity and Productivity Elasticity |
| Table 17 | Growth Rates of Value Added Per Worker Employed, Canada, 1989-98 |

Table 18 Business Investment in Machinery and Equipment and Total Investment in Machinery and Equipment as Percentage of GDP, Canada: Current and Constant Dollars

Table 19 Growth of Real GDP Per Employed Person for Selected European Countries

Table 20 IT (Including Communication Equipment) Contribution to Output Growth, U.S., Canada and Various European Countries

**List of Tables in Appendix**


| | |
|---|---|
| Table A1 | Sources of GDP Per Capita Growth in Canada and the U.S. |
| Table A2 | Value Added Per Employed Person: Growth Rates by Industry, U.S., 1981-98 |
| Table A3 | Changes in Employment Share by Sector, U.S., 1979-99 |
| Table A4 | Gross and Net GDP for Total Economy, U.S. |
| Table A5 | Productivity in the Total Economy and Manufacturing: U.S. |
| Table A6 | Value Added per Person Employed (using persons engaged in production), U.S |
| Table A7 | Business Sector, U.S. – Output, Labour Productivity and Productivity Elasticity |
| Table A8 | Real GDP by Industry, U.S. (SIC basis) in Chained 1996 Dollars |
| Table A9 | Persons Engaged in Production by Industry, U.S. |
| Table A10 | Value Added Per Worker Employed, U.S. |
| Table A11 | Productivity in the Total Economy and Manufacturing: Canada |
| Table A12 | Growth of Real GDP per Employed Person for the Majority of European Countries |


**List Of Charts**


| | |
|---|---|
| Chart 1 | Previously Published and Revised Real GDP Estimates in the United States |
| Chart 2 | Business Sector and Non-Farm Business Sector, US: Output Per Hour |
| Chart 3 | Manufacturing Sector, US: Output Per Hour |

| | |
|---|---|
| Chart 4 | Total Economy, Canada: GDP per Employed Person |
| Chart 5 | Business Sector, Canada: Real Output Per Hour |
| Chart 6 | Manufacturing Sector, Canada: Output Per Hour |
| Chart 7 | Business Investment in Machinery and Equipment, Canada: In Current and Constant Dollars |
| Chart 8 | Investment in Machinery and Equipment as Percentage of GDP, Canada: In Constant and Current Dollars |

## Abstract

This paper reviews the newest developments in our understanding of the New Economy. An emphasis is placed on the American economy, given its role as the leading advanced economy. The paper presents the different views of economists regarding this "unprecedented" performance. The evidence suggests that the United States success story is due to technological progress in the computer industry which has accelerated significantly in recent years. The difference is the extent by which these new technologies have permeated the economy. The Canadian and European economies are also placed under examination, and their performances are compared to that of the United States. The most recent evidence suggests that the Canadian and European economies will see a significant pick-up in productivity growth over the next decade. In Canada, the productivity numbers for 2000 point to a revival in productivity growth. Labor productivity growth rate (business sector output per hour) is expected to be in the 2.0-2.5 percent range in Canada over the next decade, a doubling of the rate of growth experienced in the 1980s and the 1990s.

## Executive Summary

The objectives of the paper are the following.

- ♦ Provide an overview of the notion of the New Economy and previous explanations for the computer productivity paradox.
- ♦ Examine the acceleration in U.S. economic growth since 1995, and determine to what extent this remarkable performance can be contributed to structural changes in information technology, and the degree by which current trends are sustainable.
- ♦ Examine the contrasting views of the advocates and sceptics of the New Economy on the extent by which information technology has permeated the economy.
- ♦ Explore the contrast in behaviour of the Canadian and the European economic performance and assess whether or to what degree the U.S. productivity performance is likely to be realized in these countries.

The recent U.S. economic performance has brought extensive attention to the "New Economy" phrase. Information technology has played a significant role in the United States success story. Productivity growth, which is the key determinant of rising living standards, has surged in recent years. When productivity growth accelerates the economy can enjoy robust economic growth rates, without accelerating inflation.

Prior to 1973 the U.S. economy had experienced rapid growth in labour productivity, but post-1973 economic performance indicated an abrupt decline in productivity growth rates despite the advent of the computer revolution. As a result many economists pursed alternative explanations for the then famous computer productivity paradox, "We see computers everywhere but in the productivity statistics," which was observed by Robert Solow in 1986. Explanations ranged from mismeasurement issues and possibility of lags in realization of productivity, to the belief that computers although "new" were just not that important of an innovation to have a major impact on productivity growth. Because of measurement issues such as the treatment of software as an investment, in October 1999 the United States Department of Commerce released a major revision of the national income accounts which considerably changed the historical data. Productivity growth estimates had been raised, much in favour of New Economy Advocates, who now have more evidence to support their claims.

Following the release of these revised output figures coupled with evidence of a strong U.S. economy, many New Economy sceptics turned into converts. The point of disagreement between the two groups is not on the role of information technology in boosting the economy's overall productivity, but on the sustainability of recent productivity trends and the extent to which this technological revolution has been incorporated into the economy.

The research undertaken by a number of New Economy advocates, such as Daniel Sichel and Stephen Oliner and Dale Jorgenson and Kevin Stiroh, argue that the use of computers and other information technology products made an important contribution to the acceleration in productivity after 1995.

Oliner and Sichel estimate that the growing use of all information technology capital by all companies in the nonfarm business sector accounts for almost half the recent rise in productivity. They further attribute about a quarter percentage point to the computer industry's own production processes. Together these factors contribute to about two-thirds of the recent rise in labour productivity growth since 1995.

The conclusions drawn by Jorgenson and Stiroh who recently became New Economy converts, are much in line with those of Oliner and Sichel. Although Jorgenson and Stiroh believe that technological progress in the computer producing sector has lifted productivity for the entire economy, unlike Oliner and Sichel, they found little evidence of MFP spillover to the IT using industries.

Robert Gordon, who has been the most outspoken New Economy sceptic, grants all the credit in productivity growth to the computer-manufacturing industry. According to him, once adjustments for the cyclical component of productivity are made, not much evidence is found in increasing productivity for the computer-using sectors. It should be noted that his results for the computer producing industry are much in line with those of Oliner and Sichel and Jorgenson and Stiroh. The debate still continues. Sceptics view the productivity surge as a blip, whereas optimists view these as permanent changes, providing a rationale for raising the United States growth speed-limit.

The Canadian and European productivity experiences differ from that of the U.S. since 1995, in that these economies have not experienced the acceleration in productivity growth of the United States. Recently in Canada there seems to be evidence of higher productivity growth. The main difference between the Canadian and the U.S. economy lies in the manufacturing sector, the Canadian sector showing relative deterioration. In our view, it is likely there will be a significant pick-up in productivity growth over the next decade. Output per hour growth for the business sector is expected to be in the 2.0-2.5 percent per year range, in Canada over the next decade, a doubling of the rate of growth experienced in the 1980s and the 1990s. This is due to a reversal of most of the factors that impeded productivity growth in the second half of the 1990s. The high-tech sector has recently been enjoying very rapid growth, which is expected to continue into the foreseeable future. Real machinery and equipment investment skyrocketed in the second half of the 1990s whose productivity payoff would be felt throughout the economy, within the coming years. Furthermore, Statistics Canada is considering adopting the methodology followed by the U.S., of treating software as an investment. In this case productivity growth would receive a boost from statistical revision.

Conversely, Europe outpaced the U.S. in terms of productivity growth in the post-war period, up till 1995. However, since 1995 productivity growth in Europe has shown no acceleration. In our view Europe, just like Canada, will see a significant pick-up in productivity growth over the next decade.

The diffusion of information technology and especially, the Internet throughout the economy clearly has some way to go. This is especially true for Canada and Europe. The fact that high-tech industries are proportionally more important in the United States tends to skew the productivity numbers in their favour. The recent revival in productivity growth for the European countries is a sign of better productivity prospects for the future. Just as there is a lag between Canada and the U.S. regarding productivity gains, there is perhaps a greater lag for Europe.

# TREND PRODUCTIVITY AND THE NEW ECONOMY[1]

## 1. Introduction

The patterns manifested by the American economy seem rather unusual for a country that is already considered the world productivity leader in most sectors. It is generally thought that countries that lag behind the U.S. are the ones with greater potential for productivity improvement and thus high productivity growth figures for these countries would not cause much surprise. In this era, the message that is unveiled by the United States indicates that perhaps countries with the most developed economic environment have a greater ability to extract more output from given resources and thus, the United States "unprecedented" growth performance should be awarded a closer look.

The most widely used measure of productivity is labour productivity, which measures the amount of output produced per unit of labour input. It is usually defined as real GDP per hour worked. Though it is relatively easy to calculate, this term is a partial productivity measure, for it relates output to only one input of production. Labour productivity could rise either because of more skilled labour or more intensive use of capital. Hence, partial productivity measures do not provide a good estimate of the overall productivity of all factors of production.

A broader measure of productivity is multifactor productivity (MFP), also referred to as total factor productivity (TFP) or the Solow Residual. The concept of MFP has emerged from the neo-classical growth framework. This term is not observed directly, but can be measured indirectly. MFP measures describe the relation between output and a wide set of inputs. Thus if outputs grow faster than inputs there has been an improvement in MFP. Put differently, MFP growth, measures the growth rate of output that is not explained by changes in the quantity and quality of production inputs. As indicated by Sargent and Rodriguez (2000) in some cases MFP could be preferred over labour productivity measures, and in others labour productivity might prove to be more useful because MFP depends on arbitrary assumptions, while labour productivity growth is more closely related to trends in living standards.

Our understanding of the determinants of productivity has increased in the recent past, but much remains unclear, such as the precise contribution of each factor to productivity growth, particularly where markets are non-competitive and factor returns are not equalized across sectors.

Productivity growth is a key ingredient for success for any society because of its beneficial effects on the economy. It is the key determinant of living standards and economic well-being. When productivity grows, it is able to single-handedly, blunt inflation.

Growth in GDP per capita can be decomposed into different components. One element is a demographic factor such as the share of the working age population to the total population, the other is the employment rate and the rest is captured by labor productivity[2].

For the United States, the growth rate of GDP per capita rose from 1.43 percent to 3.56 percent per year from 1989-96 period to 1995-2000 period, (**Table A1** in appendix). This 3.56 percent rise in real GDP can be decomposed into a 2.83 percent rise in output per worker, which is considerably higher than the 1.34 percent growth during the 1989-96 period. The rate of growth of the share of employment to the total population has also slightly contributed. It has increased from 0.09 percent in 1989-96 period to 0.71 percent for the 1996-2000 period. Consequently, the absolute contribution of productivity to living standards has increased in the United States in the 1996-2000 period, but surprisingly the relative contribution has significantly declined, revealing the stagnation of the employment rate in the first half of the decade.

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[1] This paper was prepared for the Economic Policy Institute.

[2] Growth in GDP per capita = working age population / total population (+) number of workers / labour force (+) output / worker

The size of the United States long-term rate of productivity growth will also determine the depth of any economic down-turns. A high rate of productivity growth would allow taxes and interest rates to be cut during recessions without accelerating inflation.

The paper's objectives are to provide an overview of the notion of the New Economy; to examine the acceleration in U.S. economic growth after 1995 and to determine to what extent IT has contributed to the U.S economy's remarkable performance; to assess the degree to which current trends are sustainable in the U.S. and transferable to Canada and Europe and to examine the contrasting views of the advocates and sceptics of the New Economy.

However before preceding, an overview of the so-called computer productivity paradox along with various explanations of the paradox is presented. In section three the New Economy is defined and the overall as well as sectoral productivity trends in the United States is presented. In section four, the contrasting views of the advocates and sceptics of the New Economy are examined, followed by sections five and six which provide an examination of the Canadian and European productivity experience. Finally the policy implications of the New Economy are provided followed by concluding remarks.

## 2. <u>The Computer Productivity Paradox</u>

### 2.1. The Puzzle

The famous productivity puzzle was noted by Nobel-prize-winning economist Robert Solow, who observed in 1986, "We see computers everywhere but in the productivity statistics." In this single sentence, he had precisely summarized his stand on productivity. In the 1980s and first half of the 1990s recent years, the billions of dollars devoted to the information technology had been thought to be the force behind economic growth, yet the readily available government data failed to support this fact. There just seemed to be too little correlation between investments in IT and productivity, as well as profitability, at the industry or enterprise level.

Prior to 1973 the economy had experienced rapid growth in labor productivity, but post-1973 data showed an abrupt decline in productivity growth. This was completely unforeseen by economists. During the 1980s the service sector hardly showed any gains in productivity despite an extraordinary burst of spending on computing equipment. **Table A2** (see appendix) provides estimates of labor productivity by industry. The data are constructed using real value added and employment figures from the Bureau of Economic Analysis (BEA). For the 1981 to 1989 period, services, as well as finance, insurance and real estate experienced a decline in productivity growth of 0.16 and 0.12 percent per year respectively.

During the 1990s, a vast number of researchers tried to explain this "IT paradox", as many researchers explored and evaluated different explanations. Explanations can be grouped into three basic types: the belief that computers although "new" were just not that important of an innovation to raise productivity growth, to lags in realization of productivity, and, mismeasurment issues.

### 2.2. The "Computers are not that Important" Hypothesis

Jack Triplett (1999) has been a proponent of this view. He has argued that the paradox has gained acceptance among economists because they have been mistakenly counting new innovations on an arithmetic scale when they should be looking at a logarithmic scale. He further elaborated on this statement by indicating that in order for the productivity figures to be influenced by this unusual flow of innovations, the *rate* and not the *number* of new product and new technology introductions should be greater than in the past. Otherwise all that these new products are doing is keeping productivity growth constant, simply preventing it from further reductions.

It could also be the case that perhaps computers are less productive than they are thought to be. Although computers help cut the costs of obtaining information, there are costs associated with the operation of computer systems which could be underestimated. In the end, the net benefits of IT may be low.

Another supporter of the above hypothesis is Robert J. Gordon, who has build on this issue by comparing the IT revolution to the inventions of the past. In, "Does the 'New Economy' Measure up to the Great Inventions of the Past?" Gordon (1999) asserts that economists seem to have gotten carried away by the power of the internet, and that the "Internet fails the hurdle test as a Great Invention." He compares computers and the Internet to the Great Inventions of 1860-1900, which he divides into five clusters: electricity including electric light and electric motors, the internal combustion engine, modern industrial chemistry, telecommunications, and more sophisticated urban infrastructure, such as indoor plumbing.

He assesses the different ways each invention resulted in growth in productivity. The electric light for example, extended the length of the day for reading, entertainment and other activities. The electric motor and internal combustion engine directly enhanced the productivity of many industries for they allowed faster and more flexible movement. Modern industrial chemistry such as petroleum refining accounted for physical rearrangement of molecules in ways that change materials into more productive structures. Telecommunications allowed the formation of new entertainment industries which were not comparable to any of the previous inventions, and thus had a significant impact on the everyday life of the average family.

As for the computer, it has generated effects whose main feature is convenience, such as the ATM machine. But in Gordon's view, these are just "second-order" inventions and thus far less important than the general-purpose technologies of the past. He clearly indicates that, "Compared with these, the information technology (IT) 'revolution', which dates back to the first commercial mainframe computer in 1954, is smaller-scale and less important than the real revolution caused by the earlier cluster of ''real inventions."

### 2.3. The "Existence of Lags" Hypothesis

The second explanation for the productivity paradox hypothesizes that the productivity gains of IT will be fully realized, but with a lag. Paul David (1990;1991) has compared the computer revolution with the evolution of electricity. Initially many factories were reluctant to use electric power due to high start-up costs and the need to re-organize of the work-place. However, the older methods of generating power had many disadvantages. Therefore over time, more and more manufacturers began to realize that shifting procedures would enable them to operate more efficiently and thus boost productivity. It thus took many years for the productivity payoff of electricity to be felt.

It was argued that the same lag could apply to information technology. After all, as a result of these innovations new products have been created and firms have been faced with new ways of conducting business. By taking into account that new products involve certain fixed costs - such as the retraining of the work force-, during the adjustment process the benefits have not yet arrived and thus are not there to be captured by economic statistics. The notion is well expressed by Nakamura (2000) who notes, "the true value of new products usually matures with experience, and because economic agents invest in new product systems only over time - and in doing so enhance their value -, it takes a long time to know how valuable any given piece of creativity is."

Although investment in computers and other information technology equipment rose rapidly in the 1970s and 1980s with no discernible effect on productivity, computers are much more universal today and thus, are changing the conduct of business in fundamental and productivity-enhancing ways. The benefits multiply as more firms remodel and employ the new technology. More computers are thus linked together and with the escalating usage of the Internet and e-commerce, network effects become apparent. As a result, the value of these new products accelerates, in return increasing the value to the participators of the network. Patience is required to see the full impact of these restructurings on the productivity figures. It is a gradual process. As firms modify their internal structures, the structure of the economy is successively altered.

### 2.4. The "Mismeasurment" Hypothesis

From another perspective, many economists believed that output is simply poorly measured. They postulated that IT has had and will continue to have a real and significantly positive impact on overall service-sector performance but that traditional measures of productivity simply could not capture many of the productivity-enhancing effects of these sophisticated equipment. This mismeasurement hypothesis has many facets.

One argument that supports the mismeasurement story, was put forward by Federal Reserve Chairman, Alan Greenspan (June, 2000). In a speech, he pointed out that when GDP is calculated by adding up all output across the economy, smaller numbers are obtained, than when adding up all incomes across the country. In theory however, the expenditure based and income based GDP should provide identical results. However, in reality they differ by the statistical discrepancy. It is generally agreed that expenditures are more reliably measured than income and thus the Bureau of Economic Analysis has employed the expenditure approach.

Mismeasurement of output prices can have substantial effects on measured productivity growth. In the manufacturing sector where real output is relatively well measured, measurement flaws are less serious. Nevertheless they still do exist. If the sole role played by information technology were to raise the quantity of products produced from given inputs, the statistical agencies would be faced with minor problems. However, in the case of the computer revolution, it is not only the quantity of computers produced that is increasing but their quality is consistently being improved. These "new" products and "new" ways of undertaking business have a great chance of going unmeasured.

In order to improve the quality of real output data of the computer sector, the Bureau of Economic Analysis in 1987, introduced hedonic computer price indexes. As better computers were being produced, price differences between the "old" and the "new" models were far smaller than the quality improvement between the different models.

Hedonic methods involved regression analysis which related observed prices to the certain characteristics of computers, such as memory or speed, in order to account for these quality improvements of information technology products. In the absence of these indexes price changes would be overstated and thus output measurements and productivity growth would be understated. These quality adjustments have positive consequences for productivity measurement. As a result of the utilization of these indexes, it became apparent that in sectors where output is tangible, such as in the manufacturing sector, productivity gains had been substantial.

Outside these sectors however, the evidence seemed to be rather puzzling. As noted by Griliches (1994), based on the 1987 Industrial Classification System, more than 70 percent of information technology investment was concentrated in the finance, insurance, real-estate, and service sectors. Yet the productivity data for these sectors had shown no such gains.

If an information technology revolution is to exist, it should not be limited to one sector of the economy. The economy as a whole, should benefit from these new innovations. Productivity gains, should thus become apparent in business-sector services, which are heavy users of IT. Such industries include financial and insurance services, as well as other types of business services. Unfortunately due to conceptual problems with the definition of nominal output as well as the construction of deflators, the measurement of output in these sectors is notoriously difficult, and thus the performance of this sector is likely to be grossly understated.

Another facet of the mismeasurement problem that is presented by many economists implies that important elements of service quality simply cannot be captured by existing data. Until our statistical definitions can be broadened to incorporate these benefits into measures of nominal output, our productivity statistics would be understated. They thus argue, that it is not appropriate to use these data as a basis for judging the impact of service-sector investments in IT on the sector's productivity performance. Although there is also likely to be deterioration in quality of products of particular industries, they are more than offset by improvements in quality elsewhere.

In regard to productivity of the overall economy, if the mismeasurement problem is the story, it does not seem to be a good one. At least not until it can be proven that either the degree of mismeasurement has increased as compared with previous years, or the sectors where output is poorly measured have significantly grown in size in such a way so as to impact the economy-wide output measures.

It should be noted that the Bureau of Economic Analysis does not estimate aggregate GDP by summing the output of industries in the final demand categories. They instead start with an aggregate GDP measure and then allocate a preexisting total measure of output to particular industries. Thus, when it comes to the overall picture, the extent to which a measurement error affects aggregate output depends on whether and how much the error affects final expenditure measures (Mishel, 1998). As most service industries produce intermediate inputs for manufacturing or other service industries, any error in measuring the output of these industries, by definition, does not appear in final demand categories and thus has no effect on the overall level of output, and thus the economy-wide productivity figures.

Mishel (1998) argues that the explanation for the productivity paradox should be based on the actual mismeasurement growing over time, rather than the service sector growing in size. He points out that even though the share of business sector service output has grown in size (**see Table A3**), the difference in aggregate productivity measures between the 1960s and 1990s due to the growth of these hard to measure services is just 0.1 percent annually.

Overall, it is agreed that more accurate output measurement of the service sector could have substantial impacts on productivity measures. Nevertheless disagreements on the extent of this impact prevail.

Because of the above measurement limitations, generalizing from current aggregate productivity statistics, on the impact of information technology and e-commerce on overall service-sector performance, is likely to be misleading. As a result, great attention was brought to reviewing these measurement shortcomings associated with the business-service sectors. It was believed that the development of appropriate measures would result in an upward revision of the productivity data, which would in part resolve the so-called computer productivity paradox.

### 2.5. Revision of the National Accounts

Government statistical agencies have recently pursued new measurement initiatives, resulting in significant improvements of the published macroeconomic data. On October 28, 1999, the Bureau of Economic Analysis of the U.S. Department of Commerce, released a major revision of the national income accounts which considerably changed historical data (Seskin, 1999) [3].

The BEA recognised software as an investment and also improved the measures of financial sector output to reflect product change. In addition to output, there are issues surrounding the measurement of labour input. As argued by Roach (1998), in regard to working hours issues such as differences between actual time worked and paid, work effort and vacation days, especially in regard to white collar workers who work long hours, is likely to result in an underestimation of the amount of time worked. However, in comparison to output measures, labour input is easier to measure, thus any of the above measurement errors would likely show up in real output and ultimately productivity figures.

Before the October 1999 changes, the BLS had already made significant improvements in its measurements of the consumer price index resulting in a definitional change of this index[4]. Clearly any upward bias in the measurement of the consumer price

[3] The definitional changes in GDP included, a) recognition of business and government expenditures for software, including own-account production of software, as investment, b) reclassification of government employee retirement plans, c) modified treatment of private noninsured pension plans, d) reclassification of certain transactions as capital transfers and d) redefinition of the value of imputed services of regulated investment companies. (Moulton, Parker and Seskin, 1999, p 7-20)

The most basic aspect of the CPI included incorporation of a new set of expenditure weights for each item index would be linked with a corresponding downward bias in the measurement of real growth. The agency's actions resulted in lower inflation figures than were previously employed in order to deflate nominal output. Gordon (2000a) estimates that the revisions reduced the upward bias in the CPI to a range of 0.65 percent down from the previous 1.1 percent which applied to the period 1995-96.

**Table 1** provides the revised as well as the previously published real GDP growth estimates from 1973 to 1998. **Chart 1** paints a more coherent picture of the difference revision has made on output and hence productivity growth from the 1970s to the 1990s. The upward revisions to the growth of real GDP seem to be concentrated in the period since 1980. For the period 1980-89, real GDP figures were revised up by an average of 0.29 points per year (from 3.09 percent to 3.38 percent), and the period 1990-95 underwent an upward revision of 0.46 percentage points per year (from 1.97 to 2.43 percent). This pace continued in the 1996-98 period, which experienced an increase of 0.50 percentage points (from 3.90 to 4.40). It is evident that the revision has resulted in significantly faster growth than was shown in the previously published real GDP growth estimates.

The outcome supports New Economy proponents for the revised numbers provide some evidence of the early impact of the Information Revolution, and thus presents an improved picture of the past two decades.

The newly revised GDP numbers have better captured output gains as compared to the previously published data. As output gains translate on a one-for-one basis into productivity gains, it is not a surprise that the old data showed long-term growth in productivity, or output per worker for the total economy, slumping to a 1.4 percent annual rate in the mid-1970s, remaining well into the 1990s. The new data show that output per worker, started to grow faster in the 1980s and steadily picked up speed in the 1990s, mainly since 1995. As a result estimates of average growth in output per hour in the nonfarm business economy have also been changed, and have been raised for 1996-1998 period as compared to the pre-1995 data. These statistics will be discussed later in the paper.

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strata category from the Consumer Expenditure Survey data. About half of the sampled and priced item strata underwent a definitional change. Some of these changes included: The introduction of computer – assisted data collection for commodities and service samples. The introduction of new geographic sample and item structure. The introduction of revised hospital services item structure and sample, as well as new housing sample and estimator into CPI (Greenlees and Mason, 1996).

**Table 1: Previously Published and Revised Real GDP Estimates, U.S.**

| | (percent change from preceding period) | | | (Indexes: 1972=100) | | |
|---|---|---|---|---|---|---|
| | **Previously published** | **Revised** | **Revision** | **Previously published** | **Revised** | |
| **1972** | | | | 100.0 | 100.0 | |
| **1973** | 5.8 | 5.7 | -0.1 | 105.8 | 105.7 | |
| **1974** | -0.6 | -0.3 | 0.3 | 105.2 | 105.4 | |
| **1975** | -0.4 | -0.3 | 0.1 | 104.7 | 105.1 | |
| **1976** | 5.4 | 5.2 | -0.2 | 110.4 | 110.5 | |
| **1977** | 4.7 | 4.5 | -0.2 | 115.6 | 115.5 | |
| **1978** | 5.4 | 5.7 | 0.3 | 121.8 | 122.1 | |
| **1979** | 2.8 | 3.4 | 0.6 | 125.2 | 126.2 | |
| **1980** | -0.3 | 0.0 | 0.3 | 124.9 | 126.2 | |
| **1981** | 2.3 | 2.5 | 0.2 | 127.7 | 129.4 | |
| **1982** | -2.1 | -1.9 | 0.2 | 125.1 | 126.9 | |
| **1983** | 4.0 | 4.2 | 0.2 | 130.1 | 132.3 | |
| **1984** | 7.0 | 7.3 | 0.3 | 139.2 | 141.9 | |
| **1985** | 3.6 | 3.9 | 0.3 | 144.2 | 147.5 | |
| **1986** | 3.1 | 3.4 | 0.3 | 148.6 | 152.5 | |
| **1987** | 2.9 | 3.5 | 0.6 | 153.0 | 157.8 | |
| **1988** | 3.8 | 4.2 | 0.4 | 158.8 | 164.4 | |
| **1989** | 3.4 | 3.5 | 0.1 | 164.2 | 170.2 | |
| **1990** | 1.2 | 1.7 | 0.5 | 166.1 | 173.1 | |
| **1991** | -0.9 | -0.2 | 0.7 | 164.6 | 172.7 | |
| **1992** | 2.7 | 3.3 | 0.6 | 169.1 | 178.4 | |
| **1993** | 2.3 | 2.4 | 0.1 | 173.0 | 182.7 | |
| **1994** | 3.5 | 4.0 | 0.5 | 179.0 | 190.0 | |
| **1995** | 2.3 | 2.7 | 0.4 | 183.1 | 195.2 | |
| **1996** | 3.4 | 3.7 | 0.3 | 189.4 | 202.4 | |
| **1997** | 3.9 | 4.5 | 0.6 | 196.8 | 211.5 | |
| **1998** | 3.9 | 4.3 | 0.4 | 204.4 | 220.6 | |
| **1999** | … | 4.5 | … | … | 230.5 | |
| | | | | **Average annual rates of growth** | | |
| | | | | | | **Difference** |
| **1973-79** | | | | 2.85 | 3.00 | 0.15 |
| **1980-89** | | | | 3.09 | 3.38 | 0.29 |
| **1990-95** | | | | 1.97 | 2.43 | 0.46 |
| **1996-98** | | | | 3.90 | 4.40 | 0.50 |

**Source:** Seskin, Eugene P. (1999) "Improved Estimates of the National Income and Product Accounts for 1959-98: Results of the Comprehensive Revision." Survey of Current Business, December, p. 17

Until recently many economists believed that potential growth slowed around 1990, but new figures suggest otherwise. Rather, the slowdown in productivity growth observed in the early and mid 1990s now seems transitory, perhaps reflecting the relative weakness of the initial phase of the expansion following the 1990-91 recession. This may have given the false impression that there had been a permanent slowdown in productivity and potential output growth.

With the release of the new statistics, it seems that the computer productivity paradox had been resolved. As Gordon (2000c, p.1-2) indicates, " Economists struggling to explain Solow's paradox, looked up from their word processors to discover that, before they had satisfactorily explained it, the paradox had been rendered obsolete both by data revisions and by the exploding rates of productivity growth registered in 1998 and 1999." Yet this was not the end of dispute between the proponents and the skeptics of the New Economy. The new evidence had brought the debate to a whole new level.

## 3. What is New in this "New Economy"?

### 3.1. Definition of the New Economy

A quick glance at the recent data on the U.S. economy indicates that something peculiar is afoot. The notion of the New Economy has been employed to indicate that perhaps our understandings of the rules and principles that underlie an economy's behaviour have significantly changed in ways that are different from those of the "old economy". The question simplifies to whether the current period of change is fundamentally different in some way from earlier periods.

The term New Economy is rather an elusive concept and thus is subject to different interpretations. What is clear is that the concept is closely tied to the effects of technological progress, in particular the linkage of a stronger non-inflationary growth and low levels of unemployment to the rising influence of information technology. There are different aspects and thus different definitions of the New Economy, which range from changes in trend productivity (the preferred definition used in this paper), alterations in our traditional business cycle, to even fundamental changes in the Phillips Curve framework[5].

The New Economy proponents argue that the economy is now different or new as characterized by a significantly higher "long-term" or trend productivity, which has been brought about by the extensive application of IT across a wide range of sectors, resulting in a restructuring of economic activities. The skeptics argue that the recent productivity surge is transitory and does not usher in a 20-25 year period of strong productivity growth.

[5] This has made many economists less comfortable about the old relationship between inflation and unemployment depicted by the traditional Phillips Curve. This framework which shows a negative link between the level of unemployment and wage growth, seemed to work very well in the early 1980s and 1990s. Yet in the past few years, what actually happened worked against the Phillips Curve framework, beyond what analysts could have imagined would be feasible. Many analysts are of the view that there has been a decline in the NAIRU and thus there has been an inward shift of the Phillips Curve.

The recent peculiar behaviour of the economy has also raised questions about the whole notion of the business cycle, altering the perspective many economists have on the business cycle. As a rule of thumb, upswings are followed by downswings. While it can not be denied that the U.S. economy has until recently been enjoying a record expansion in the second half of the 1990s, there is no evidence to support the extreme claim that the traditional understanding of business cycle forces are dead. From a historical perspective business cycles are unlikely to be gone for good. Despite talks of the New Economy, all business cycles, whether "new" or "old", represent fluctuations in the economy around full-employment output, brought about simply by, as Federal Reserve Chairman, Alan Greenspan puts it, "human nature".

Under this view, the same forces that create the conditions for faster growth in the long run also lead to instability and turbulence in the short run. There is the possibility that perhaps New Economy recessions will be less severe from the recessions of the past twenty-five years. In the past, productivity plummeted as businesses could not cut costs and boost efficiency fast enough when demand plunged. This time around, economic agents can respond more promptly to changes in the economic environment by taking advantage of new technology to aggressively revamp their operations at the earliest indications of a slow down, thus keeping productivity high. With better inventory control and less rigidity, the extent of fluctuations in the business cycle has possibly been reduced, but certainly not eliminated.

The Economic Report of the President (2001, p 23) defines the New Economy by "the extraordinary gains in performance - including rapid productivity growth, rising incomes, low unemployment, and moderate inflation – that have resulted from this combination of mutually reinforcing advances in technologies, business practices, and economic polices".

With regard to the New Economy, Alan Greenspan has warned economists to beware when talking about this concept (Sicilia, and Cruikshank, 2000, p.193-5). He implies that there is nothing new about human nature, nor are the fundamentals of economics analysis any different than they were at the peaks of previous cycles. He acknowledges that the arguments of the proponents of the New Economy who mark the association of inflation-free growth to computerization and globalization, and who imply that information technologies play a major role in explaining sustained growth, due to their worldwide capacity to respond to demand, does in fact have some merit. Yet it all depends on how one views the New Economy. He adds that, "from this view certain aspects of the country's recent unusual behavior might seem to qualify as new, but from a historical perspective, not much is "new" in its fundamental nature." Although Greenspan does endorse the shift in thinking he warns that caution must be taken when talking about the New Economy.

### 3.2. Overall Productivity Trends in the United States

Since 1995, productivity growth has accelerated in the United States. This became apparent as output growth revealed remarkable strength, while unemployment fell to its lowest level in thirty years[6]. It was not expected that the U.S. economy could generate substantial increases in employment for every single year since 1995 without putting upward pressure on the level of prices. Yet unemployment has fallen beyond levels which in the eyes of most economists are consistent with stable inflation in the medium term. The core consumer price index has only risen two and a quarter percent over the last twelve months in 2000, indicating that inflation has shown no signs of perturbing the economy.

[6] Gross and net domestic product exhibit similar patterns (see Table A4 in appendix). In both measures GDP growth increased by 1.2 percentage points from the eighties to the first half of the nineties. In the second half of the nineties, both gross and net GDP accelerated by about 1.5 percentage points as compared with the first half of the decade.

According to the Council of Economic Advisors, the increase in productivity after 1995 is noteworthy because it occurred when the economy was already at a high point of resource utilization. Statistical estimates indicate that almost none of the post 1995 productivity acceleration has been cyclical (Economic Report of the President, 2001, p 27). It is suggested that "by 1995, strong demand had already pushed actual productivity about two percentage points above where it would have been otherwise. From 1995 through 2000, the cyclical component of productivity edged up only slightly relative to its trend, so that actual productivity grew only slightly faster." Furthermore, the estimates suggest that there has been a structural acceleration in productivity since 1995 of slightly less than 1.6 percentage points.

One of the main factors that lies behind these extraordinary gains is technological innovation. From 1995 to 2000, the ratio of firm's market value to the cost of replacing its underlying tangible capital – Tobin's q – has risen considerably as compared with the 1990-95 period (Economic Report of the President, 2001, p 137). This indicates that in recent years a larger part of the firm's value is derived from intangible capital. Although computers had existed for many years, the sustained investment in information technology began to pay off in the 1990s where a number of simultaneous advances in this high-tech sector allowed these technologies to be combined in ways so as to significantly increase their economic potential.

In addition, the Federal Reserve Board has been rather aggressive in probing the limits of the non-accelerating inflation rate of unemployment (NAIRU). This resulted in robust demand growth and allowed the increase in potential output arising from the IT revolution to manifest itself as actual output. The low unemployment rate has given employers an additional incentive to substitute capital for labour, resulting in full utilisation of human resources, much to the benefit of labour productivity.

As labour productivity continued to surge, economists began to question the stylized facts of productivity growth behavior across the business cycle. Productivity growth usually picks up early, as the economy expands, and slows later into the expansion. For the U.S. economy however, there did not seem to be such a "late expansion".

**Table A5** (in appendix) provides data on labor productivity and other related variables. A look at the growth rates in productivity provides ample evidence for the productivity surge since 1995. The series on real value added is produced by the BEA and the statistics for the number of employed persons in the total economy is obtained from the Economic Report of the President (2000), based on the Household Current Population Survey[7].

According to the data, real value added per person employed advanced at a 2.7 percent average annual pace in the 1995-2000 period, more than twice as fast as the 1.2 percent in the 1989-95 and 1.2 percentage point higher than the 1.5 percent rate of the 1981-89 period. The latest productivity news shows a stunning 3.7 percent average annual growth for the year 2000.

According to the most widely used official aggregate productivity measure, the series on non-farm business sector output per hour produced by the Bureau of Labor Statistics (BLS), productivity increased at a 0.90 percent average annual rate from 1989 to 1995. During the 1995 to 1999 period this figure advanced at a 2.9 percent average annual rate and a stunning 4.3 percent annual rate in 2000. This is illustrated by **Table 2. Chart 2** captures the post-1995 acceleration of output per hour in the business and

[7] Value added per employed worker is also calculated using persons engaged in production from establishment surveys (see Table A6 in appendix). Using this measure, in the first half of the 1990s, productivity grew at a rate of 1.1 percent, and in the second half by 1.9 percent. These measures are slightly lower than those calculated in Table A5.

nonfarm business sectors, showing remarkable strength from 1997 onwards. Data for the business sector show very similar trends and are provided by **Table A7** in the appendix.

**Table 2: Nonfarm Business Sector, US : Output, Labour Productivity and Productivity Elasticity**

| | Indexes 1992=100 | | Annual rates of change | | |
|---|---|---|---|---|---|
| | Output per hour | Output | Output per hour | Output | Productivity Ealsticity |
| **1949** | 41.0 | 22.3 | …. | …. | …. |
| **1973** | 80.3 | 61.8 | …. | …. | …. |
| **1981** | 86.6 | 74.5 | …. | …. | …. |
| **1989** | 95.9 | 98.1 | …… | …… | …. |
| **1990** | 96.3 | 98.8 | 0.42 | 0.71 | 0.58 |
| **1991** | 97.0 | 97.1 | 0.73 | -1.72 | -0.42 |
| **1992** | 100.0 | 100.0 | 3.09 | 2.99 | 1.04 |
| **1993** | 100.1 | 103.0 | 0.10 | 3.00 | 0.03 |
| **1994** | 100.6 | 107.0 | 0.50 | 3.88 | 0.13 |
| **1995** | 101.2 | 110.2 | 0.60 | 2.99 | 0.20 |
| **1996** | 103.7 | 114.8 | 2.47 | 4.17 | 0.59 |
| **1997** | 104.9 | 119.9 | 1.16 | 4.44 | 0.26 |
| **1998** | 110.4 | 129.0 | 5.24 | 7.59 | 0.69 |
| **1999** | 113.2 | 135.1 | 2.54 | 4.73 | 0.54 |
| **2000** | 118.1 | 142.8 | 4.33 | 5.70 | 0.76 |
| | | | **Year over Year** | | |
| **2000Q1** | 116.2 | 140.7 | 3.84 | 6.11 | 0.63 |
| **2000Q2** | 118.0 | 142.9 | 5.26 | 7.05 | 0.75 |
| **2000Q3** | 118.8 | 143.7 | 4.76 | 5.97 | 0.80 |
| **2000Q4** | 119.5 | 144.0 | 3.37 | 3.67 | 0.92 |
| | **Average annual rates of growth** | | | | |
| **1949-73** | | | 2.84 | 4.34 | 0.65 |
| **1973-81** | | | 0.95 | 2.36 | 0.40 |
| **1981-89** | | | 1.28 | 3.50 | 0.37 |
| **1989-95** | | | 0.90 | 1.96 | 0.46 |
| **1995-99** | | | 2.84 | 5.22 | 0.54 |
| **1995-2000** | | | 3.14 | 5.32 | 0.59 |
| | **Quarterly growth at annual rates** | | | | |
| **2000Q1** | | | 1.74 | 5.29 | 0.33 |
| **2000Q2** | | | 6.34 | 6.40 | 0.99 |
| **2000Q3** | | | 2.74 | 2.26 | 1.21 |
| **2000Q4** | | | 2.38 | 0.84 | 2.84 |

Source: Output per hour and output data are obtained from the BLS:
1948-97 are obtained from http://www.bls.gov/news.release/prod3.t02.htm, Feb 1999
1998-2000Q4 are obtained from http://www.bls.gov/news.release/prod2.t02.htm, last modified, March 6 2001
*****Productivity elasticity is calculated as productivity growth divided by output growth.

### 3.3. The Productivity Experience of the Manufacturing Sector

A glimpse at the data on the manufacturing sector reveals one of the main sources of the economy wide productivity revival. The information technology sector is highly productive and thus as a result has boosted the productivity of the overall economy. Thanks to production in this sector, not only for the higher quantity but also for the superior quality of computing equipment that sent computer prices plunging. Lower prices for computing equipment, coupled with the policy by the Federal Reserve Board to test the limits of the NAIRU, gave employers additional incentives to substitute capital for labor, which had become scarce. This encouraged "capital deepening", which is defined as the rapid rate of increase in capital input in the economy, faster than the increase in labor input.

The series for value added per hour worked for the manufacturing sector is obtained from the BLS and provided by **Table 3**. Productivity estimates for manufacturing have also been constructed from the real output and labor input series compiled by the BEA for the manufacturing sector, and are provided by **Tables A2** and **A5**. The difference between the two tables is in terms of the employment estimates. Table A2 uses persons engaged in production and Table A5 uses estimates from the Economic Report of the President. The two sources exhibit similar trends for productivity growth in the manufacturing sector. The discussion that follows refers to the BLS data.

As the data along with **chart 3** illustrate, there has been a substantial acceleration in manufacturing productivity growth in the last decade. For the year 2000, output per hour in this sector increased at a pace of 7.6 percent per year. From 1995 to 2000, output per hour advanced at a 5.2 percent average annual rate, over two percentage points higher than the 1989-95 period.

The Economic Report of the President (2001) reveals that in 2000, the information technology sector accounts for about 8.3 percent of U.S. output, as compared with 5.8 percent in 1990. It can not be denied that this wave of technologies has become by far, the fastest growing component of the manufacturing sector.

**Table 3**: **Manufacturing Sector, US: Output, Labour Productivity and Productivity Elasticity (Indexes: 1992=100)**

| | Indexes 1992=100 | | Annual rates of change | | |
|---|---|---|---|---|---|
| | Output per hour | Output | Output per hour | Output | Productivity elasticity |
| **1949** | 33.7 | 26.7 | …. | …. | …. |
| **1973** | 61.9 | 68.3 | …. | …. | …. |
| **1981** | 71.2 | 76.0 | …. | …. | …. |
| **1989** | 90.7 | 97.1 | …. | …. | …. |
| **1990** | 93.0 | 97.5 | 2.54 | 0.41 | 6.16 |
| **1991** | 95.1 | 95.5 | 2.26 | -2.05 | -1.10 |
| **1992** | 100.0 | 100.0 | 5.15 | 4.71 | 1.09 |
| **1993** | 102.2 | 103.6 | 2.20 | 3.60 | 0.61 |
| **1994** | 105.3 | 109.1 | 3.03 | 5.31 | 0.57 |
| **1995** | 109.4 | 113.8 | 3.89 | 4.31 | 0.90 |
| **1996** | 114.7 | 118.8 | 4.84 | 4.39 | 1.10 |
| **1997** | 120.0 | 125.7 | 4.62 | 5.81 | 0.80 |
| **1998** | 124.3 | 130.7 | 3.58 | 3.98 | 0.90 |
| **1999** | 131.5 | 137.2 | 5.79 | 4.97 | 1.16 |
| **2000** | 140.9 | 145.4 | 7.15 | 5.98 | 1.20 |
| | | | **Year over Year** | | |
| **2000Q1** | 137.7 | 142.8 | 6.83 | 6.33 | 1.08 |
| **2000Q2** | 139.8 | 145.6 | 7.37 | 6.98 | 1.06 |
| **2000Q3** | 142.1 | 146.9 | 7.73 | 6.37 | 1.21 |
| **2000Q4** | 144.0 | 146.3 | 6.67 | 4.2 | 1.59 |
| | **Average Annual growth rates** | | | | |
| **1949-73** | | | 2.57 | 3.99 | 0.64 |
| **1973-81** | | | 1.77 | 1.34 | 1.31 |
| **1981-89** | | | 3.07 | 3.11 | 0.99 |
| **1989-95** | | | 3.17 | 2.68 | 1.18 |
| **1995-99** | | | 4.71 | 4.79 | 0.98 |
| **1995-2000** | | | 5.19 | 5.02 | 1.03 |
| | **Quarterly growth at annual rates** | | | | |
| **2000Q1** | | | 8.24 | 7.01 | 1.18 |
| **2000Q2** | | | 6.24 | 8.08 | 0.77 |
| **2000Q3** | | | 6.75 | 3.62 | 1.86 |
| **2000Q4** | | | 5.46 | -1.62 | -3.36 |

Source: BLS: Data for years 1949-1997 are obtained from http://www.bls.gov/news.release/prod3.t03.htm
Data for years 1998-2000Q4 are obtained from http://www.bls.gov/news.release/prod2.t03.htm, data revised on March 6, 2001.
*****Productivity elasticity is calculated as productivity growth divided by output growth.

### 3.4. The Productivity Experience of the Service Sector

The majority of IT equipment that are produced are used in the service sector, where firms in recent years have invested heavily in information technology. Indeed, investment in information technology in financial services and wholesale and retail trade more than doubled from 1995 to 2000. Almost 70 percent of all information technology products are purchased by the wholesale and retail trade, finance and telecommunications industries. In 1999 business spending on information technology equipment and software was responsible for more than 11 percentage points of the 14 percent real growth in total equipment and software spending by all businesses (Economic Report of the President, 2001, p 25).

To the proponents of the new economy, it is no accident that the improved productivity performance and the healthy degree of non-inflationary growth has coincided with this explosion in the application of computing technologies. If there has been an acceleration in technological progress there should be a broadening of productivity gains to these IT-using service sectors.

The productivity data for the service and goods sectors are constructed from the real output and labor input series compiled by the BEA. These are presented by **Table 4**, which represents a slight transformation of **Table A2**.

**Table 4: Growth Rates of Value Added per Worker Employed, U.S.**

| | % Average compound growth rates | | | |
|---|---|---|---|---|
| **Industry Title** | **1981-89** | **1989-95** | **1995-99** | **(1995-99)- (1989-95)** |
| **Total Economy** | **1.38** | **1.11** | **1.98** | **0.87** |
| **Goods Sector** | **3.18** | **2.20** | **3.23** | **1.03** |
| Agriculture, forestry, and fishing | 3.60 | 0.01 | 5.18 | 5.17 |
| Mining | 8.02 | 4.71 | 4.01 | -0.70 |
| Construction | 0.64 | -0.13 | -0.03 | 0.09 |
| Manufacturing | 3.74 | 3.14 | 4.41 | 1.28 |
| **Service Sector** | **0.48** | **0.54** | **2.29** | **1.75** |
| Transportation and public utilities | 2.21 | 2.59 | 1.66 | -0.93 |
| Wholesale trade | 3.37 | 2.85 | 8.19 | 5.35 |
| Retail trade | 1.61 | 0.91 | 5.20 | 4.29 |
| Finance, insurance, and real estate | -0.12 | 1.64 | 2.86 | 1.22 |
| Services | -0.16 | -0.79 | 0.28 | 1.07 |
| Government | 0.33 | 0.28 | 0.69 | 0.41 |

Source: Data for GDP are obtained from the Bureau of Economic Analysis, 2000. Release date: December 2000. http://www.bea.doc.gov/bea/uguide.htm#_1_14, GDP data for 1998 and 1999 are obtained from http://www.bea.doc.gov/bea/dn2.htm (see appendix, **Tables A8, A9** and **A10** ).

**Note**: a) Because of the use of non-additive chain indices for real output as well as the independent derivation of GDP and industry GPO estimates, industries total GDPs do not sum to the economy-wide total. As a result, the total economy productivity growth rate in the 1995-99 period is less than both the goods sector and service sector productivity growth rates.

b) Chained-dollar GDP aggregates for the "goods" and the "services" sectors have been obtained by summing the chained-dollar industry estimates in each respective group. This is a close approximation, although a better approximation would be obtained by a "Fisher of Fishers" aggregation.

The data clearly emphasise the significant role the service sector has played in fuelling the productivity revival. After many decades of stagnant growth, there now appears to be a renaissance in service sector productivity. Real value added per person employed in the broadly defined service sector advanced at a 2.3 percent average annual pace in the 1995-99 period, up nearly five-fold from the 0.5 per cent rate of the 1981-89 and 1989-95 periods.

A more disaggregated analysis of this sector illustrates that four of the six basic service sector industries have undergone at least a one percentage point increase in labour productivity growth between the 1989-95 and 1995-99 periods. The growth rate of output per worker in wholesale trade accelerated 5.4 points, in retail trade 4.3 points, in finance, insurance and real estate 1.2 points and in services (personal, business and other services) 1.1 points. Even government enjoyed improved productivity growth, up 0.4 points, although the estimates of real output for government are not appropriate for productivity calculations as they are largely estimated on the basis of inputs. The only service sector industry that did not enjoy faster productivity growth after 1995 was transportation and public utilities (which includes communication), experiencing a 0.9 point fall-off.

Although, productivity growth in the goods sector continues to outperform that in the service sector at 3.2 per cent versus 2.3 per cent per year in the 1995-99 period, goods sector productivity accelerated 1.0 percentage point after 1995, whereas productivity in the service sector accelerated 1.8 percentage points.

Because the available GDP and employment data for the various industries provided by the BEA only go to 1999, we have constructed estimates for productivity growth rates for the non-manufacturing business sector (NMBS), which is primarily the service-producing industries (88% of total NMBS employment was in services in 1999). This has been done using the productivity data compiled by the BLS for the manufacturing and the business sectors for 2000.

Since the manufacturing sector's share of business sector employment is about 17 percent, a simple formula is used to calculate estimates for productivity growth for the non-manufacturing business sector (see **Table 5**). From 1989-95 to 1995-2000 productivity growth in NMBS accelerated 1.7 percentage points.

**Table 5: Estimates of Output per Hour in the Non-Manufacturing Business Sector – Growth Rates, U.S.**

Average annual rates of growth

| Year | Business Sector | Manufacturing Sector | Non-Manufacturing Business Sector |
|---|---|---|---|
| **1989-1995** | 1.20 | 3.17 | 0.71 |
| **1995-1999** | 2.67 | 4.85 | 2.13 |
| **1995-2000** | 2.98 | 5.33 | 2.39 |

Source: Data for output per hour are obtained from the BLS. Business sector data are obtained from http://www.bls.gov/news.release/prod2.t01.htm, and manufacturing sector data are obtained from http://www.bls.gov/news.release/prod2.t03.htm, data revised on March 6, 2001 (Tables 3 and A7).

Until recently, it was believed that most of the productivity gains were taking place in the IT-producing sector and that the productivity-enhancing impact of IT was not spreading to the IT-using sectors. With the renaissance of productivity growth in these IT-using service industries such as wholesale and retail trade as well as financial institutions which are heavy users of information technology, it now appears that the acceleration of productivity growth is broadly based. The lags between IT investment and productivity appear to have ended as firms and workers have now learned to use these new technologies in an effective manner.

The large IT investment in wholesale and retail trade and the very strong increases in productivity in these two industries support the IT story. Information technology has made such firms more productive by changing their ways of doing business. It is not only the adaptation of these technologies that has resulted in a productivity boost for such firms, but the application of these technologies to each firm's unique business so as to enhance the efficiency of labour and other factors of production. As pointed out by the Economic Report of the President (2001, p 26), "a growing body of evidence now shows that the wide-spread application of information technologies has stimulated remarkable improvements in production processes and other business practices outside the information technology sector". The service sector productivity drought is over, at least for the second half of the 1990s, and possibly into the future.

## 4. <u>Alternative views of the New Economy</u>

### 4.1. Overview

Following the release of the newly revised output figures coupled with the evidence of a strong U.S. economy, many New Economy skeptics turned into converts. Yet skeptics still remain. The point of disagreement between the two groups is not on the role of IT in boosting the economy's overall productivity, but the issue of sustainability of current productivity trends. The Council of Economic Advisors are of the view that business cycle dynamics played only a minor role in the post-1995 productivity acceleration. They indicate that the traditional cyclical rebound from the 1990-91 recession played itself out by 1995, as unutilized labour was put back to work. Hence they estimate that the level of productivity had risen about two percent above trend by 1995, and that it went up only slightly above trend from 1995 through 2000 (Economic Report of the President, 2001).

The proponents of the New Economy, which we define as an upward structural shift in long-term productivity growth, point to the recent strong productivity experience of the U.S. The productivity surge, which traditionally takes place at the beginning of the business cycle when the economy expands, has endured even at the end of the cycle. Moreover, the extensive investment in IT technologies has resulted in higher productivity for the IT-using sector. This broadening of productivity gains since 1995 augurs well for the acceleration of technological progress in the economy and indicates that such long-term productivity gains are within the realm of possibility.

The skeptics argue against the New Economy view by indicating that the productivity gains are highly concentrated in the IT-producing sector. They view the U.S. productivity experience as a short-term phenomena by indicating that the great price decline of computers and related information technology products has resulted in diminishing marginal productivity. By comparing these new technologies to the general purpose technologies of the past, they point out that IT is relatively far less crucial.

### 4.2. The Advocates' Case

*"At macroeconomic advisors, initially we viewed the acceleration of productivity as a transitory cyclical event because our then current econometric models suggested so. However, nearly three years later, the persistence of strong productivity growth sheds increasing doubt on that interpretation."* – Macroeconomic Advisors, 1999

For most of the 1990s most economists rejected the notion of a New Economy as characterized by a higher trend productivity growth. With the acceleration of productivity growth in both the service and goods sectors since 1995, they became converts. In the process, economists have been hard pressed to understand the contribution of the technological revolution to this phenomenal growth.

An overwhelming body of analysis suggests that the IT-using sector has played a major role in fueling economy-wide productivity growth. The substantial usage of the Internet and e-commerce must also not be excluded. Many analysts are of the view that it is these technologies that have improved efficiency in virtually all sectors of the economy. The following is a survey of the views of the advocates of this "new era" and their beliefs on how information technology has permeated the overall economy.

### 4.2.1. Oliner and Sichel (2000)

Daniel Sichel and Stephen Oliner (2000), two economists at the Federal Reserve Board in Washington known for their work on analyzing the economic impact of computers, have re-assessed the role played by information technology in influencing the productivity statistics. The paper "The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?" is much like their previous research, in which a neoclassical growth model is utilized to examine the growth contribution of computers and related inputs. Oliner and Sichel (1994) and Sichel (1997), based on the available evidence, found that through the early 1990s computers should not have been expected to make significant contributions to output growth, simply because at the time, computing equipment represented only a small fraction of the total capital stock.

However, things have changed since their earlier research. The stock of computer equipment has increased dramatically and seems to be earning greater returns than in previous years. Furthermore, the computer-producing sector seems to have achieved a higher degree of efficiency. In their previous work, they had concentrated on calculating the growth contribution of information technology through computer hardware and software. In their new research they decided to increase the complexity of their work by including communication equipment, which would provide a better understanding of the role of information technology on the economy.

Their work is divided into two main sections, the first of which analyses the impact of the *use* of information technology on output and productivity growth, and the second of which estimates the impact of the *production* of computers to growth.

Their data sets are obtained from the Bureau of Economic Analysis (BEA) and the BLS. In order to estimate the contribution of the use of information technology by companies of all sorts, they use the BLS productive capital stocks and methodology, and thus estimate the separate growth contribution of computer hardware, software, and communication equipment.

Their current results reproduced below in **Table 6**, are somewhat different from their previous research, which had shown a relatively small impact of information technology on real output and labour productivity growth through the early 1990s. Although the years 1991-95 saw an average annual output growth rate of around 3 percent and labour productivity growth of 1.6 percent, computer hardware and software, each only accounted for a fifth of a percentage point per year of that growth. Communication equipment had a lesser impact. It contributed only 0.05 percentage point per year during the above period.

Things looked different during the second half of 1990s. The contribution of information technology capital to output growth swelled. The contribution of computer hardware to output growth for the years 1996-99 was now about 0.6 percentage point per year, two and a half times greater than the 1991-95 period. Overall, the contribution of all information technology capital (hardware, software and communication equipment) to output growth, was about 0.9 percentage points, which is a remarkable increase as compared with the previous period.

Capital deepening related to information technology capital accounted for 0.5 percentage points of the 1.1 percentage point increase in labor productivity from the first half of the nineties to the second half, thus accounting for nearly half of the total increase in labour productivity. MFP accounted for the rest of the increase. In the second half of the nineties, the contribution of other capital to labor productivity growth fell 0.2 percentage points as compared with the 1974-90 period due to substitution of capital.

**Table 6: Estimates of Contributions to Output and Labor Productivity Growth in the Nonfarm Business Sector by Oliner and Sichel**

| | Average annual rates of change | | | |
|---|---|---|---|---|
| | 1974-90 | 1991-95 | 1996-99 | (96-99)-(91-95) |
| 1.Growth rate of output | 3.13 | 2.82 | 4.90 | 2.08 |
| Contributions to output: | | | | |
| 2. Labor hours | 1.15 | 0.82 | 1.51 | 0.69 |
| 3.Information technology capital | 0.51 | 0.54 | 1.08 | 0.54 |
| 4. Hardware | 0.28 | 0.24 | 0.62 | 0.38 |
| 5. Software | 0.11 | 0.23 | 0.31 | 0.08 |
| 6.Communication equipment | 0.12 | 0.07 | 0.15 | 0.08 |
| 4.Growth rate of labor productivity | 1.43 | 1.61 | 2.66 | 1.05 |
| Contributions to labour productivity (percentage points), (5+11+12): | | | | |
| 5. Capital deepening | 0.81 | 0.60 | 1.09 | 0.49 |
| 6. Information technology capital | 0.45 | 0.48 | 0.94 | 0.46 |
| 7. Hardware | 0.26 | 0.22 | 0.58 | 0.36 |
| 8. Software | 0.10 | 0.21 | 0.26 | 0.05 |
| 9. Communication equipment | 0.09 | 0.05 | 0.10 | 0.05 |
| 10. Other Capital | 0.36 | 0.12 | 0.16 | 0.04 |
| 11. Labor quality | 0.22 | 0.44 | 0.31 | -0.13 |
| 12.Multifactor productivity | 0.40 | 0.57 | 1.25 | 0.68 |
| Contributions to MFP productivity from each sector, (12+13+14): | | | | |
| 12. Computer sector | 0.12 | 0.13 | 0.22 | 0.09 |
| 13. Semiconductor sector | 0.08 | 0.13 | 0.41 | 0.28 |
| 14. Other nonfarm business | 0.20 | 0.30 | 0.62 | 0.32 |
| 15. Computer sector plus computer-related semiconductor sector | 0.17 | 0.21 | 0.47 | 0.26 |

Source: Sichel and Oliner (2000), Tables 1,2 & 4.

A look at the computer producing sector, defined as the sector that produces IT capital, indicates that technological advance in this sector, including the production of the embedded semiconductors, appears to have made important contributions to the surge in multifactor productivity growth. It must be noted that in the analysis, the category "computer production" does not only include the assembly of computers but also the production of the semiconductor chips. As Oliner and Sichel indicate, including the latter term is important because any advances in chip technology ultimately accounts for a large share of computer-sector productivity gains.

In order to arrive at more precise estimates, they divided the nonfarm business sector into three areas. One produces computers, the other semiconductors, and the last consists of all other nonfarm industries. After solving for the three sectoral MFP growth rates, they find that the contributions from computer and semiconductor producers had considerably moved up during 1996-99, reaching 0.22 and 0.41 percentage points per year respectively (**Table 6**). Their values during 1991-95 had each been 0.13 percentage points per year.

Oliner and Sichel point out, that these increases are mainly due to the sharp decline in the relative prices of computers and semiconductors during this period, which their framework depicts as an increase in MFP growth. This is because in order to estimate MFP growth, they use what is called a "dual" method, which uses data on the prices of output and inputs, rather than their quantities to calculate MFP growth. Through an example, they explain why this method can be implemented. If output prices for a certain good such as semiconductors drops sharply over time, while input prices remain stable, then MFP growth in semiconductor production must be rapid compared to other sectors. If this did not hold, semiconductor producers would be driven out of business due to the lower prices of their outputs and unchanged input costs.

Overall, their results indicate that information technology has been the primary force behind the rapid gains in productivity after 1995. They attribute about a quarter percentage point of the overall acceleration in productivity to the computer industry's own production processes. They also estimate that the growing use of information technology capital by all other companies in the nonfarm business sector, accounts for almost half the recent rise. Together these factors contribute to about two-thirds of the recent rise in labour productivity growth since 1995. The growth in other capital services explains less that 0.05 percentage point of this acceleration, while MFP growth in the remainder of the nonfarm business sector makes up for the rest.

It should be noted that their analysis (as well as the ones that follow) excludes the impact of IT chips embodied in non-computer technologies such as automobiles and trucks. Any productivity-enhancing effects from the use of IT chips by these "other" industries would not be accounted as the contribution of IT to productivity growth. By including the productivity effects of IT chips in non-computer sectors, not just the part that feeds into the computer industry, would give more credit to the influence of information technology on overall productivity.

Their analysis however, depends heavily on the assumptions behind the neoclassical framework. Under this model businesses are rational and thus always make optimal investment decisions. This implies that all types of capital earn the same competitive rate of return at the margin, net of depreciation and other costs associated with owning each asset. Although in reality deviations from this assumption are likely to apply, it is however, a satisfactory approximation of reality. Their paper has suggested that there is not, and never was, any productivity paradox and time had proved it. Technological innovation has in fact been the primary force behind the resurgence of productivity growth.

#### 4.2.2. Whelan (2000)

As the research piles up, it is increasingly difficult to find economists who deny that something structural is afoot. The debate is how great that effect is. Karl Whelan (2000) of the Federal Reserve Board in New York undertook a similar study using the same methodology employed by Oliner and Sichel. In his paper, he provides a micro-economic foundation of the growth accounting framework. Whelan derives an expression to account for technological obsolescence, which occurs when a productive machine is retired while still retaining their productive capacity.

He indicates that the standard NIPA capital stocks are inappropriate for growth accounting because they do not account for technological obsolescence, and argues that the basic Solow vintage model is inconsistent with technological obsolescence, for it predicts that firms never choose to retire a machine that retains productive capacity. From his perspective, this situation does not apply to computers. Rather, he uses an augmented version of the vintage model that allows for technological obsolescence in the following way.

Computer systems are complex technologies and need technical support and maintenance, and thus any computer hardware investment is backed up with additional costs on maintenance and support. Thus in the new model, the computer is retired, once its marginal cost falls below its support costs, but until then, the computing equipment remain fully productive. In such a way does the model capture the phenomenon of technological obsolescence. This concept is slightly different than that utilized by Oliner and Sichel who assumed that older vintages of computers become less productive with age, even if they remain in perfect physical condition.

The results obtained by Whelan are much in line with those of Oliner and Sichel (**Table 7**). He verifies that during the years 1996-98, computers have become a more important part of capital input. Through his research, he further demonstrates that the combination of productivity gains in the computer producing sector and the effect of computer capital accumulation have accounted for almost all of the recent acceleration in productivity growth over the second half of the 1990s, as compared to the previous years.

**Table 7: Estimates of the Contribution of Computers to Business Sector Productivity by Karl Whelan**

| | 1974-95 | 1996-98 | (96-98) – (74-95) |
|---|---|---|---|
| Growth in Labour Productivity | 1.16 | 2.15 | 0.99 |
| Effect of Computer Capital Accumulation | 0.30 | 0.76 | 0.46 |
| Effect of Computer TFP Growth | 0.20 | 0.47 | 0.27 |
| Total Computer-Related Effect | 0.50 | 1.23 | 0.73 |
| All Other Factors | 0.66 | 0.92 | 0.26 |

Source: Whelan (2000), Table 5.

The period under consideration ranges from 1973 to 1998. From 1996 to 1998 productivity advanced at a 2.15 percent average annual rate, one percentage point higher than the 1974-95 growth rate. Whelan estimates that computer capital accumulation and computer sector MFP growth together account for 1.23 percentage points a year of the 2.15 percentage growth in the business sector productivity over 1996-98, which exceeds the 1974-95 value by 0.7 percentage points. The contribution of other factors to productivity growth is estimated to have accelerated by 0.26 percentage points. However, he suggests that this figure most likely overstates the effect of these factors, because the methodological changes in price measurement that were introduced into the GDP statistics were not integrated into earlier periods, thus resulting in an upward bias for these factors.

While the calculations should be interpreted carefully, the results once again confirm the claim that the main contributor to our generous productivity figures has been the information technology revolution.

#### 4.2.3. Jorgenson and Stiroh (2000)

Similar views are shared by Dale Jorgenson of Harvard University and Kevin Stiroh of the Federal Reserve Bank of New York, who have recently become New Economy converts. In a recent paper, “Raising the Speed Limit: U.S. Economic Growth in the Information Age” (2000), they lay out their findings and make a clear case for raising the U.S. economic speed-limit. They hold technological progress in the information technology producing sector as well as the greater investment and use of these high-tech equipment by the business-service sectors, responsible for the recent growth resurgence.

They indicate that the tech sector has realized greater efficiency gains, and thus has become so much more productive over the past decade, and grown so much as a percentage of the economy, that it has lifted productivity for the entire economy. However, they found little evidence of MFP spillover to the IT using industries, and thus they provide a note of caution. “The evidence is clear that computer-using industries like finance, insurance, real-estate and other services have continued to lag in productivity growth. Reconciliation of massive high-tech investment and relatively slow productivity growth in service industries remains an important task for proponents of the New Economy position” (Jorgenson and Stiroh, 2000, p 128).

The analysis by Jorgenson and Stiroh implies that the greatest gains in productivity growth have come from technological progress rather than labor quality or capital investment. As found by Oliner and Sichel (2000), the absolute contribution to productivity growth from labor quality fell in the second half of the 1990s by about 30 percent, as compared with the first half of the decade.

**Table 8** demonstrates their results. From 1995 to 1998 the growth in average labour productivity showed a 2.4 percent average annual rate, up one percentage point from the 1.4 percent rate of the 1990-95 and 1973-90 periods, and only 0.6 percentage point lower than the 1959-73 period. Capital deepening accounted for almost half this increase, which was also the result obtained by Oliner and Sichel (2000). Moreover, the contribution of TFP to labor productivity during 1995-98 period was one percent, nearly three times greater than the 1973-90 and 1990-95 periods. For the 1990s, the contribution of TFP is further decomposed. Their estimates indicate that the production of IT accounts for 0.4 percentage point of TFP growth for the 1995-98 period, compared with 0.25 percentage point for the first half of the decade.

Jorgenson and Stiroh find that TFP growth increased from 0.36 percentage points per year, during 1990-95, to 0.99 percentage point, on average, for the years 1995-98. This mainly reflects the sharp decline of computer prices, which began in 1995 due to greater competition in the semiconductor market. As noted by the authors, this decline averaged 28 percent per year from 1995 to 1998. As a result, the economy experienced massive computer investments as, according to Jorgenson and Stiroh, "firms and households substituted towards relatively cheaper inputs."

**Table 8: Estimates of Contributions to Labor Productivity Growth in the Nonfarm Business Sector * by Jorgenson and Stiroh**

| | Average annual rates of change | | | | |
|---|---|---|---|---|---|
| Variable | 1959-73 | 1973-90 | 1990-95 | 1995-98 | (95-98)-(90-95) |
| Growth of private domestic output (Y) | 4.33 | 3.13 | 2.74 | 4.73 | 1.99 |
| Growth in hours (H) | 1.38 | 1.69 | 1.37 | 2.36 | 0.99 |
| Growth in ALP (Y/H) | 2.95 | 1.44 | 1.37 | 2.37 | 1.00 |
| Contributions to ALP (percentage points): | | | | | |
| Capital deepening | 1.49 | 0.91 | 0.64 | 1.13 | 0.49 |
| Labor quality | 0.45 | 0.20 | 0.37 | 0.25 | –0.12 |
| Total factor productivity (TFP) | 1.01 | 0.33 | 0.36 | 0.99 | 0.63 |
| Sectoral contributions to TFP (percentage points): | | | | | |
| Information technology | - | - | 0.25 | 0.44 | 0.19 |
| Computers | - | - | 0.16 | 0.32 | 0.16 |
| Software | - | - | 0.05 | 0.08 | 0.03 |
| Communications | - | - | 0.04 | 0.04 | 0.00 |
| Non-information technology | - | - | 0.11 | 0.55 | 0.44 |

* Jorgenson and Stiroh employ a broader concept of output than the other studies. In their output series, they include imputed service flows from owner-occupied housing and consumer durables.

Source: Jorgenson and Stiroh (2000), Tables 3 & 5.

In order to form a basis of comparison to the above studies, Jorgenson and Stiroh find that during 1995-98, computer hardware accounted for 0.36 percentage point annually to output growth, (**Table 9**). This estimate is less than that found by Whelan, and the estimate suggested by Oliner and Sichel. They argue that the reason for this divergence is likely due to the fact that they employ a broader concept of output than is employed by either Oliner and Sichel or Whelan. As a result computer hardware has a smaller income share. They also assume that machines only become productive with a lag. This makes their results lagged by one year, and thus their estimates for growth reflect lower rates.

**Table 9: Contribution from Computer Hardware to Output Growth: Comparison of the Different Studies**

| Study | Previous Period | | Current Period | |
|---|---|---|---|---|
| | Years Covered | Contribution* | Years Covered | Contribution* |
| 1. Oliner and Sichel | 1974-95 | 0.27 | 1996-99 | 0.62 |
| (Nonfarm Business Sector) | | | 1996-98 | 0.58 |
| 2. Whelan (Business Sector) | 1980-95 | 0.37 | 1996-98 | 0.82 |
| 3. Jorgenson and Stiroh ( Nonfarm Business Sector)** | 1974-95 | 0.17 | 1996-98 | 0.36 |

*Percentage points per year

**Jorgenson and Stiroh employ a broader concept of output than the other studies. In their output series, they include imputed service flows from owner-occupied housing and consumer durables.

Source: Oliner and Sichel (2000), Table 3.

All in all, Jorgenson and Stiroh's motto is, "as long as high-tech industries keep innovating and improving their productivity, the economy should be able to sustain the high rate of productivity growth, and thus the virtuous circle of an investment-led expansion will continue" (Jorgenson and Stiroh, 2000, p.128).

### 4.3. The Skeptics' Case

*" If anything is clear, it is that however unimportant the computer is today in generating productivity growth, we can be sure that at the margin it was* ***more*** *important a decade ago and will be* ***less*** *important a decade hence, simply because continuing exponential declines in the cost of computer power push incremental increases in computer power into lower and lower productivity uses."* - Robert Gordon (1999)

Even though advocates of the "new-era" have presented their case clearly, not all economists have become New Economy converts. Skeptics remain, though their numbers has been seriously reduced. The shorter size of this section as compared with the previous one, qualifies as proof.

Skeptical types generally have a pessimistic view of the Internet, indicating that much internet activity is simply a waste of time. They argue that even if the Internet does transform the way businesses do business, it does not mean they will enjoy outstanding profits. Much of the benefit of the Internet is simply re-distributed and mostly accrues to consumers in the form of greater convenience and perhaps a different channel of entertainment.

### 4.3.1 Gordon (2000)

Robert Gordon of Northwestern University, has been the most outspoken New Economy skeptic. In a widely cited paper (Gordon, 1999) he pointed out that the recent surge in labor productivity growth was entirely due to the computer-manufacturing industry. He also noted that the low payoff to computer investment in most parts of the economy where computers are used indicates that the Solow paradox is still pertinent.

Gordon (2000b) supports his findings by indicating that the so-called new inventions fall short of the innovations of the past. His idea is well expressed in the paper, "The 'One Big Wave' in U.S long-term Productivity Growth". As the title indicates, he sees the economy evolve through out time, as one "big wave". He paints the picture by implying that, "MFP growth exhibits a symmetric wave that peaks in 1928-50 and slows gradually moving backwards to 1870-91 and forward to 1972-96." He lays out the hypothesis that the wave peaked during these years due to important inventions that occurred at around the same time. He does not believe that the wave would rise again, at least not any time in the near future.

In regard to the Internet, Gordon has a more pessimistic view of its productivity-enhancing effects as compared with other analysts. Since many economists view the year 1995 as the year when productivity growth took off, Gordon asserts that for the past five years, the growth in demand for computers should have increased relative to the decline in computer prices. But his data suggest otherwise. Furthermore, when compared to the electric light and electric motors, computers experienced a greater rate of price decline, which indicates that they are diffusing into the economy at a faster rate than these previous inventions. Also, since they were relatively more reliable from the beginning, diminishing returns are likely to set in much faster.

He acknowledges that the Internet provides information and entertainment more cheaply, but much of its use involves a duplication, rather than a replacement of existing activities. This disqualifies the Internet as a "first-order" invention, and thus makes it different from the inventions of the past, which created brand new products and new activities. The other down-sides of the Internet as far as businesses are concerned is that the development of web sites and maintenance and upgrading costs of computers are more likely to raise costs than revenues. Such investments by companies in computer infrastructure are driven by the need to protect market share against competitors. He suggests that humans unlike computers have not been faced with exponential growth in speed or memory. Even if it takes the computer less time to open and save files, human beings can only think and type at a certain rate. He then points out to the growing evidence of the usage of the Internet for personal purposes when on the job. It thus serves as a distraction to workers and could reduce their productivity levels.

He also notes that, "computers are less pervasive than is generally thought, because there are real limitations to the replacement of human beings by computers" (Gordon, 2000c, p.32). Many human actions cannot be replaced by computer power. Computer usage itself requires human contact. Besides, many services require the presence of human beings, such as doctors, nurses, professors, and lawyers to name a few. Computers however powerful they might be, they simply cannot replace the need for a human body and brain.

As Gordon approaches the end of his paper, he makes an effort to re-emphasize the idea that was previously pointed out by Triplett. As implied earlier, it is simply not enough that a greater number of products exist than before. What economists should look at is the *rate* of new product creation and not the *numbers* of new products.

The question that undoubtedly passes the minds of many at this point would be why does Gordon reach a conclusion that is somewhat different from most economists? First of all, Gordon's paper was written before the newly revised economic data were published, and thus showed a substantially lower growth in productivity for the overall economy. The paper's conclusion has since been modified with the release of the revised NIPA statistics in 1999 and by employing the new figures, his results for the computer producing industry are much in line with those of Oliner and Sichel. However, he still sees little, if any, productivity growth in the nonfarm business sector excluding durable manufacturing, which is where computers end up (Gordon 2000d). This is a different conclusion than that obtained by most New Economy advocates. **Table 10**, summarizes his findings.

**Table 10: Estimates of the Decomposition of Growth in Output Per Hour, into Contributions of Cyclical Effects and Structural Change in Trend Growth, 1995:4-1999:4 by Robert Gordon**

Percent per year

| Item | Nonfarm Private business (NFPB) | NFPB excluding computer hardware Manufacturing | NFPB excluding durable manufacturing |
|---|---|---|---|
| 1.Actual growth in output per hour | 2.82 | 2.42 | 2.05 |
| 2.Contribution of cyclical effect | 0.54 | 0.55 | 0.62 |
| 3.Growth in trend (line 1 minus line 2) | 2.28 | 1.87 | 1.43 |
| 4.Trend, 1972:2 to 1995:4 | 1.47 | 1.25 | 1.19 |
| 5.Acceleration of trend (line 3 minus line 4) | 0.81 | 0.62 | 0.24 |
| 6.Contribution of change in price measurement | 0.14 | 0.14 | 0.14 |
| 7. Contribution of labor composition effect | 0.05 | 0.05 | 0.05 |
| 8.Structural acceleration in labor productivity (line 5 minus lines 6 and 7) | 0.62 | 0.43 | 0.05 |
| 9.Contribution of capital deepening | 0.33 | 0.33 | 0.33 |
| 10.Contribution of MFP growth in computer and computer-related semiconductor manufacturing | 0.29 | 0.19 | ---- |
| 11.Structural acceleration in MFP (line 8 minus lines 9 and 10) | 0.00 | -0.09 | -0.28 |

Source: Gordon (2000d) p.219.

Although the new figures provide a more plausible picture of the economy, Gordon still rejects the idea of a New Economy. His final estimates are based on cyclical adjustments which he describes as follows: "The decomposition of the recent productivity acceleration between cycle and trend is accomplished by specifying a value for the hours growth trend (*h**) and then conducting a grid search to find the output growth trend (*y**) that optimizes the fit of the equation explaining the relation of *h-h** to *y-y**" (Gordon, 2000d, p.218).

After this decomposition, Gordon attributes 0.5 percentage points of the 2.8 percent annual productivity growth in the nonfarm private business sector, to cyclical effects, and the remaining 2.3 percentage points to trend growth, which is 0.8 percentage point faster than the 1972-95 trend. He then explains that a small part of this acceleration in trend growth is attributed to changes in price measurement methodologies and to a slight acceleration in the labor composition effect. The remaining 0.6 percentage point is attributed to structural acceleration in labor productivity, of which 0.3 points are accounted for by capital deepening and the other 0.3 points are the resulting effects of the acceleration of MFP in computer and computer-related semiconductor manufacturing.

After subtracting output and hours in computer manufacturing from the NFPB sector (column 2 in **Table 10**), structural acceleration in labour productivity is 0.19 percentage point less than the total NFPB economy. MFP in this sector faces a structural deceleration of 0.09 percentage point, indicating that spillover effects on MFP in the part of the economy that excludes computers are absent.

Furthermore, the disturbing fact remains that in the greater bulk to the U.S economy which constitutes nonfarm business services (third column of **Table 10**) there is only a 0.05 percentage point per year acceleration in cyclically adjusted productivity growth. In plain words, this is almost nothing. There is no MFP growth acceleration outside the computer industry. These sectors were just not hit by the great miracle.

Whether he uses the new or the old figures, Gordon's stand on productivity is clear. "The optimists declare the arrival of a "new economy" in which the benefits of the hi-tech revolution and globalization will bring about a revival of rapid growth, but in my view the remorseless progression of diminishing returns has left the greatest benefits of the computer age in the past, not awaiting us in the future" (Gordon, 2000b, p.45).

### 4.4. Comments by the Opposing sides

In response to Gordon's findings, most Federal Reserve economists, including Oliner and Sichel who try to explain the surge in *actual* productivity and not cyclically adjusted productivity are suspicious of his adjustment techniques for the business cycle. They note that "Separating cycle from trend is difficult, particularly in the midst of an expansion."

They add that the entire rise in actual productivity growth cannot be entirely due to the production of computer hardware by the computer-manufacturing industries. The use of computers should also be credited as contributing to the acceleration in productivity after 1995. Gordon's reply is that output grew more than trend in the 1990s, and so productivity must have grown faster than trend since the economy benefited from falling unemployment. Even recently, the economy has been growing faster than the new higher speed-limit, thus some of the recent rise will turn out to be transitory.

Although there seems to be a distinct contrast between Gordon's papers and those of Jorgenson and Stiroh and Oliner and Sichel, Gordon implies that there is in fact little disagreement between the three papers (**Table 11** and **12**). He adds that his research on cyclical effects does not effect the paper's decomposition of input growth into the relative contributions of IT capital, non-IT capital, labor hours, and labor composition. What his research implies however, is that the post-1995 TFP acceleration is likely to be partially temporary due to the onset of diminishing returns which by shifting down the cost curve, rapidly shifts down firms' demands for IT products, and moves them to lower marginal utility uses.

**Table 11:** Jorgenson and Stiroh versus Oliner and Sichel: Alternative Estimates of the Sources of Acceleration in Labor Productivity.

(Percentage points per year)

| | Jorgenson and Stiroh (2000) * 1995-98 | Oliner and Sichel (2000) 1996-99 |
|---|---|---|
| Labor productivity (Nonfarm Business Sector) | 1.0 | 1.0 |
| Capital deepening | 0.5 | 0.5 |
| Information technology | 0.3 | 0.5 |
| Other | 0.2 | 0.0 |
| Labor quality | -0.1 | -0.1 |
| Multifactor productivity | 0.6 | 0.7 |
| Production of IT | 0.2 | 0.3 |
| Other | 0.4 | 0.4 |

* Jorgenson and Stiroh employ a broader concept of output than Oliner and Sichel. In their output series, they include imputed service flows from owner-occupied housing and consumer durables.

Source: Sichel (2000),p.223

**Table 12:** Gordon: Estimates of the Sources of Acceleration in Labor Productivity.

(percentage points per year)

| | Contribution to productivity Increase |
|---|---|
| Actual acceleration in labor productivity, 1972-95 to 1995-99 | 1.4 |
| Trend acceleration (including CPI adjustment) | 0.7 |
| | |
| Contribution from: | |
| Capital deepening | 0.3 |
| Labor quality improvement | 0.1 |
| Multifactor productivity | 0.3 |
| Production of IT | 0.3 |
| Other | 0.0 |

Source: Sichel (2000),p.223

The story told by the first two papers is broadly similar. The only difference is in regard to the estimate of the contribution of IT to the acceleration in labor productivity. Oliner and Sichel find the value of this contribution to be 0.5 percentage point, considerably larger than the 0.3 percentage point estimated by Jorgenson and Stiroh.

Gordon's numbers for the contribution of IT to growth are much in line with the other two studies. In regard to capital deepening and MFP growth from the production of computers, his estimates do line up closely to the other papers. The reason why they do not match closely with the numbers in **Table 11** is due to the fact that Gordon considers a different time period than the other two studies. The difference lies in the fact that Gordon attributes all of the acceleration in MFP to the IT producing sector and leaves nothing to the non-computer economy. Jorgenson and Stiroh and Oliner and Sichel find that MFP growth elsewhere in the economy accounts for 0.4 percentage point of the total acceleration.

### 4.5. The Debate Continues

Economists take strong stands in supporting their views. By reviewing the different views of the importance of information technology, it is clear that much room remains for debate. New Economy advocates criticize Gordon's belief that IT does not measure up to the inventions of the past. They assert that information technology has in fact, some advantages over previous technological revolutions. For example, railways solely affected the movement of goods, whereas the Internet is not restricted to such a limited selection of the economy. The Internet has just a lot more to offer. It affects most spheres of activity of firms and households. It is a new form of communication, an efficient information system, a new marketplace and a new means of distribution.

A second factor is that patience is required until new technology lifts productivity growth. Gordon's patience has long ran out, as he asserts in his papers that all the benefits of information technology were in the past, not awaiting us in the future. He sees the great reductions in the prices of computers as one support for his argument.

Conversely, productivity optimists indicate that the rapidly falling prices could be seen as a positive factor. It is true that their prices have fallen more rapidly than any previous technology, but that does not mean the benefits of computers have already arrived. The computer revolution did start 50 years ago with the invention of the transistor, but economic history suggests that productivity gains from new enabling technologies diffuse only gradually across the economy. The rapid price decline accelerated only recently, after 1995, and set off the extensive spread of the Internet which encouraged firms to adopt this new technology more quickly. By looking at the productivity picture through this light, it can be said that most of the economic benefits of these new technologies are still ahead of us and not behind.

Another factor that enters the debate is the business cycle adjustments employed by Gordon. Advocates of the New Economy argue that cyclical adjustments might provide biased results due to difficulties in separating cycle from trend, especially in the midst of an expansion. Moreover, the information revolution is likely to have affected the cyclical behavior of the economy in ways not yet fully comprehensible. As a result, any cyclical adjustments could have a negative impact on the importance of information technology in the economy at large.

Furthermore, they indicate that as the years pass and productivity growth continues to surge, it is becoming increasingly implausible to assert that these changes are simply one-time developments or a simple cyclical phenomenon.

Another point of discrepancy is in regard to the permanence of these developments. Lawrence Klein (2000), professor emeritus of economics at the University of Pennsylvania and a Nobel prize winning economist, believes that policymakers have underestimated the impact of technology on productivity and that productivity gains should continue for another ten years. The Economic Report of the President (2001, p 77), projects structural productivity to grow at 2.3 percent annual rate from 2003 to 2007 and 2.1 percent from 2007 to 2011.

On the same lines, Alan Greenspan stated, "We cannot know the precise directions in which technological change will take us. As in the past, out economic institutions and our work force will strive to adjust, but we must recognize that adjustment is not automatic. All shifts in the structure of the economy naturally create frictions and human stress, at least temporarily. However, if we are able to boost our investment in people, ideas and resources as well as in machines, the economy can readily adapt to change and support ever-rising living standards of living" (Sicilia and Cruikshank, 2000, p 218). On the same lines the Council of Economic Advisors points out that, "expansions do not die of old age. The current situation of low inflation, high productivity growth, and lean inventories reveals no sign of an end of the expansion, although growth is expected to moderate" (Economic Report of the President, 2001, p 79).

Skeptics on the other hand, view the productivity surge as just a blip. Peter Dungan, Steve Murphy and Thomas Wilson (2000, p.1), indicate that, "We do not project that the industrial economies (or at least the North American ones) are now undergoing or are about to undergo a structural shift in which computer and communication technology will lead to permanently higher long-term productivity growth."

By observing the different approaches taken by economists on this topic, a definitive answer to the question of whether the U.S. economy has entered a new era of sustainable growth or whether it has been benefiting from temporary or cyclical influences is not possible at this stage. However, the recent evidence on the U.S. economy which points to increased productivity growth for the computer-using sector of the economy, as well as the arguments put forward by the proponents of the New Economy, augurs well for an economy characterized by a significantly higher trend productivity growth.

### 4.6. The Productivity-Enhancing Power of the Internet

*"In this new century, where the economy is based on ideas rather than physical capital, success will go to companies that partner their way to a new future. At InfoSoft Media, we believe that these technologies - Internet and e-commerce- ARE the future of the Internet. Through these channels your company can now benefit from enhanced productivity, reduction in procurement costs and thus, an increase in efficiency."*

- InfoSoft Media

The above quote is from an advertisement by a firm that specialises in bringing as they say, "total e-business" solutions. As is indicated above, the gains in productivity at the economy level are a mere reflection of greater efficiency and increased productivity at the firm level. InfoSoft Media is not alone. The fact that many such firms are joining the "e-competition" everyday serves as proof for the great demand for these "new" products. By this time nearly every single existing company, regardless of their size, has its own web site. They simply can not afford to be left out. Firms invested heavily in these new technologies, adopting new computers, new communication modes and new software, in the process generating a whole new range of industries and market places. The outcome for the economy is increased price transparency, for at a touch of mouse click, buyers and sellers are able to compare prices. This fact, along with substantial reductions in the costs of acquiring information, induces the economy to obey - at least to a greater extent than previously - the assumptions behind perfect competition, and thus inevitably moves closer to the textbook version of the model.

The productivity gains may not derive much from the traditional tasks of computers, such as word processors and worksheets, but from the more recent wide application of the Internet. There are extensive costs associated with improving the speed and memory of computers, as well as the rapid investment in "newer" versions due to high depreciation of older but still productive computers. That is a fact. It is also true that there are huge marketing and other technical costs of setting up an on-line business. Yet there is also a bright side. As argued by most New Economy advocates, it more than makes up for the downsides. The Internet is seen as transforming the conduct of business by providing new channels that were previously unheard of. By permitting organisational changes, both labour and capital would be used more efficiently. Not only is there a reduction in transaction costs and the optimal size of firms, but smaller companies finally have a chance to be heard.

Indeed, the biggest economic impact of the Internet is likely to be due to business-to-business (B2B) e-commerce. Although its application in 1990 was non-existent, its emergence was extremely rapid. First came the entrepreneurs who figured out how to encrypt messages, conduct safe financial transactions in cyberspace, and advertise one to one. Electronic cash gained acceptance around 1998. Then came businesses selling everyday consumer goods. First high-tech products such as software, then true information products like securities. The number of secure web servers for e-commerce in the United States rose from 7,513 in 1997 to 65,565 in 2000 (Economic Report of the President, 2001, p 102). Soon everything begins to be sold in cyberspace.

By using the World Wide Web, it becomes easier and more efficient for companies to track down cheaper suppliers. Once orders are made, buyers can easily check the status of their transactions. This does not mean that telephone, or customer-facing transactions are eliminated. What it means is that by moving some customers on-line, firms are able to obtain not only a larger number, but also more satisfied customers.

The biggest savings of B2B e-commerce are likely to be due to e-procurement which simply declines the overall cost of businesses. A recent report by Martin Brookes and Zaki Wahhaj (2000), at Goldman Sachs, estimate that possible savings from on-line purchasing vary from 2% to 40% depending on the industry. British Telecom, on the other hand, suggests that procuring goods and services over the Internet, can cut the average cost of processing a transaction by about 90%. Unfortunately due to lack of hard data on the importance of Internet usage and the level of e-commerce transactions, studies in this field are rare, but are recently increasing. In 1999 for example, Statistics Canada conducted a survey on the usage of e-commerce and the Internet, that covered most of the economy (Statistics Canada: The Daily, August 10,2000).

According to Oliner and Sichel (2000) who looked at the contribution of e-commerce to MFP growth, there are many different estimates of the volume of e-commerce transactions depending on the definitions of what factors should be included in such a measure. This grossly reduces the reliability of any results. Since these estimates lie within a wide range, Oliner and Sichel choose the upper-bound of this range, which is $112 billion for B2B e-commerce and $23 billion for business to consumer e-commerce.

They then indicate that if these transactions only represent shifts in the distribution of channels with no influence on cost savings, MFP would not be effected. However, if as a result of e-commerce, these firms experience efficiency gains, which by referring to another study, they give this factor a value of 10 percent, these cost savings represent only 0.2 percent of output. They further assume that these savings accrued during 1996-99, and thus calculate the impact of e-commerce on MFP growth to be considerably less than 0.1 percentage point per year. This estimate however indicates that e-commerce has played only a minor role in influencing productivity.

Nevertheless, as mentioned before their results must be taken with caution, due to the uncertainties involved in the estimation of the volume of e-commerce. Even so as they conclude, “all indications are that the volume of e-commerce will continue to grow rapidly in coming years, raising the possibility of more substantial efficiency gains in the future” (Oliner and Sichel, 2000, p.25).

A reduction in procurement costs is just one means through which firms can benefit. The other advantage of e-commerce is that companies are no longer constrained by geographical locations. Through their web sites they are able to provide interested buyers with detailed information about their products. Besides, companies are no longer constrained by their size, for they can offer a greater variety of products on-line. This allows for tighter inventory control, so that firms can cut the size of their stocks or even eliminate them.

There are yet other cost-saving services the internet provides. As indicated by the Economic Report of the President (2000), a large number of sales are in some way influenced by the Internet. Using an example they validate their point. “Many consumers research their purchases, such as automobiles or books, online before buying them offline, through traditional outlets. By one estimate, roughly $50 billion in offline sales was influenced by the Internet in 1998.”

Overall, due to the wide reach of the Internet and the extensive use of e-commerce and e-retail the industrial and economic environment are faced with greater flexibility, reduced transaction costs, enhanced access, improved efficiency and lower barriers to entry. Although e-commerce transactions constitute a small fraction of overall commerce and thus a small share of GDP, the prospect that these are constantly growing in size and are gaining a sizable share, may have a profound impact on the economy. It is not a surprise that many economists, as well as the Chairman of the Federal Reserve, believe that these new innovations are productivity enhancing. The Internet can thus lift the economy’s safe speed-limit. The study by Brookes and Wahhaj (2000), suggests that in the rich economies, B2B e-commerce is able to reduce average prices by about 4 percent, and permanently increase the level of output in the long term, by about 5 percent. They further assert that over half of this output increase would come through within ten years.

There are many strong believers when it comes to the productivity-enhancing power embedded in the Internet. Sam Kinney (2000) clearly summarizes the beliefs of most New Economy believers. “The Internet’s power is now being felt. Its ability to help make markets more efficient will cause it to penetrate into virtually every corner of the economy. And because markets don’t tend to migrate from efficient to inefficient, we can expect that the Internet is a one way street. There will be no going back.”

## 5. The Canadian Productivity Experience

### 5.1. Pitfalls in International Productivity Growth Comparisons

Prior to observing the productivity experience of the Canadian economy and providing a basis of comparison to the U.S. productivity experience, it must be noted that any measurement issues that existed when observing a single economy worsen when international comparisons are made. At the international level, data problems limit the possibility of making reliable comparisons of growth performance across countries. Different national statistical agencies adopt different methodologies and data definitions. As a result, international comparisons become very difficult to make on a consistent and meaningful basis.

The first of these output measurement issues is concerned with the independence of output from input measures (Scarpetta, Bassanini, Pilat and Schreyer 2000, p.85). Since productivity is measured using data on the output of the economy, any measurement error occurring in output measurements would be reflected in the productivity figures. In principle, output and input indices are calculated and constructed independently. Yet dependence between the two can occur, especially when the output series are based on input measures. Input-based estimation is more frequent in industries in the service sector of the economy, particularly the non-marketed sector. By construction, either productivity growth in these sectors would be zero, or would reflect any assumptions made by statisticians. This downward bias brought about by the use of inputs has different effects in different countries, depending on the incidence of use, and thus could hinder cross-country comparisons.

The second issue in output measurement involves the use of chained or fixed-weighted index numbers. A choice of these indexes must be made when comparing price or quantity of two different periods. In the fixed-weight index, the first or last observation is chosen as the base. In the chain index, the base changes every period as the chain is applied by linking either price or quantity indices for consecutive periods. Much of the literature supports the use of chained indices for they are able to capture changes in relative price structures. For example, in the case of information technology products, rapidly changing prices can render fixed weights obsolete resulting in significant biases in the measurement of prices and quantities. To date, only a small number of countries such as the United States have adopted chain-weighted indices. The results for these countries are not consistent with countries that employ fixed-weight indices.

Countries also differ strongly in their statistical treatment of quality improvement in IT goods. Hence the last of these measurement issues is concerned with the construction of computer deflators. The sharp drop in computer prices in the United States reflects the use of hedonic methods, whereas the slight decline or even increase in the prices of computers and related equipment in many European countries may be due to a failure of adjustment for these quality changes. This method is not employed by some countries because the construction of these hedonic price deflators can be quite costly.

Furthermore in revising the national accounts, the decision by the United States to treat software as an investment good, led to a significant boost in their productivity growth figures, especially for the 1995-99 period. Canada and Europe have not yet adopted this methodology. Consequently, the growth rate of output of the countries that continue to treat software expenditure as an intermediate good rather than as an investment, is likely to exhibit a downward bias, which is in turn reflected in the productivity measures.

As a result of these measurement issues present at the international level, the comparability of output measures is far from perfect, for the superior statistical methodologies employed by the U.S. have rendered their productivity data less comparable now than they formerly were to data for other countries. Hence, international comparisons of output and productivity growth have to be treated with substantial caution and should only serve as rough benchmarks.

### 5.2. Overall Productivity Trends in Canada

By looking at productivity growth trends in Canada and the United States, one can easily see that they had gone through similar phases in the past. Both economies experienced robust productivity growth after the Second World War up till 1973. Both then experienced a slower trend productivity growth. However, much has changed during the 1990s. The Canadian productivity experience in this decade, particularly since 1995, is in great contrast to that of the United States. It is clear that this side of the border has not experienced the productivity miracle of the U.S. Yet recent evidence points to the likelihood of Canada entering the New Economy of higher trend productivity in the near future.

Although the Canadian economy did pick up speed in the second half of the 1990s, the increase in output has almost entirely been accounted for by increased employment not productivity gains. This development in itself is not necessarily bad –some may even say it is positive- as employment growth is highly desirable as it reduces the unemployment rate and labour market slack and has marvelous effects on governments' fiscal position. Nevertheless it does raise the question of why productivity growth was so poor, particularly in contrast to the U.S. experience.

This is illustrated by **Table 13** (more detail is provided by **Table A11** in appendix). The productivity data are constructed by the Centre for the Study of Living Standards (CSLS) from real GDP and labour input data compiled by Statistics Canada. Real GDP accelerated 2.2 percentage points to a 3.7 percent average annual growth rate between 1995 and 2000 from only 1.5 percent rate in the 1989-95 period (**Chart 4**). Between these periods, employment growth accelerated 1.7 percentage points from 0.5 percent to 2.2 percent average annual rate. Productivity growth, in terms of GDP per worker, was up 0.4 percentage points, while GDP per hour decelerated by 0.4 percentage points.

The Canadian business sector productivity experience is in contrast to that of the United States. Statistics Canada data show that growth in output per hour in this sector in Canada actually decelerated in the second half of the 1990s, falling to 1.0 percent per year in the 1995-99 period from 1.2 percent in 1989-95 (**Table 14** and **Chart 5**). In contrast, the U.S. business sector advanced at a 2.7 percent average annual rate in the 1995-99 period, up from 1.2 percent in the 1989-95 period (**Table A7**).

The year 2000 reveals a stronger pattern in terms of output and productivity in the Canadian economy. The economy out-striped expectations by growing vigorously at an annual rate of 5.0 percent in the first half of 2000, reducing the unemployment rate to its lowest level in nearly a quarter century. Since during this period, unit labor costs have so far remained flat in Canada, the core inflation rate continues to be kept down and under control, well within the bottom half of Bank of Canada's 1 to 3 percent target range. So far the economy is not undergoing any acceleration in the rate of inflation, despite the fact that actual output growth has exceeded expectations.

The evidence supports the observation by John MaCallum (2000), the former Royal Bank's chief economist, that "economic indicators point to some rousing news about productivity." For the year 2000, productivity growth in terms of GDP per worker increased 2.03 percent, which is 0.8 percentage point higher than the 1995-99 period and over one percentage point higher than the productivity growth rate during 1989-95.

**Table 13: Productivity and Related Variables in the Total Economy, Growth Rates: Canada**

Average annual rates of change

| | GDP at market prices, millions 1992 $ (A) | Employed persons, thous. (B) | Total hours, millions (C) | GDP per employed person, $ | GDP per hour, $ |
|---|---|---|---|---|---|
| **1981** | 3.05 | 2.98 | 1.25 | 0.07 | 1.78 |
| **1982** | -2.94 | -3.1 | -3.62 | 0.16 | 0.71 |
| **1983** | 2.75 | 0.73 | 0.78 | 2.01 | 1.96 |
| **1984** | 5.67 | 2.48 | 2.82 | 3.12 | 2.78 |
| **1985** | 5.4 | 2.81 | 3.51 | 2.52 | 1.83 |
| **1986** | 2.64 | 3.11 | 2.92 | -0.46 | -0.27 |
| **1987** | 4.1 | 2.85 | 1.31 | 1.21 | 2.76 |
| **1988** | 4.86 | 3.16 | 4.79 | 1.65 | 0.07 |
| **1989** | 2.54 | 2.17 | 3.49 | 0.36 | -0.92 |
| **1990** | 0.27 | 0.75 | -0.76 | -0.48 | 1.04 |
| **1991** | -1.87 | -1.78 | -3.72 | -0.09 | 1.92 |
| **1992** | 0.91 | -0.71 | -2.29 | 1.63 | 3.28 |
| **1993** | 2.3 | 0.76 | 2.11 | 1.52 | 0.18 |
| **1994** | 4.73 | 1.98 | 3.28 | 2.7 | 1.4 |
| **1995** | 2.77 | 1.87 | 1.13 | 0.88 | 1.63 |
| **1996** | 1.54 | 0.79 | 1.42 | 0.74 | 0.12 |
| **1997** | 4.37 | 2.32 | 2.39 | 2 | 1.93 |
| **1998** | 3.31 | 2.66 | 1.78 | 0.64 | 1.51 |
| **1999** | 4.54 | 2.76 | 3.67 | 1.73 | 0.84 |
| **2000** | 4.68 | 2.60 | 3.37 | 2.03 | 1.27 |
| | | **Average annual rates of growth** | | | |
| **81-89** | 3.1 | 1.76 | 1.97 | 1.31 | 1.11 |
| **89-99** | 2.27 | 1.13 | 0.87 | 1.12 | 1.38 |
| **89-95** | 1.49 | 0.47 | -0.07 | 1.02 | 1.57 |
| **95-99** | 3.43 | 2.13 | 2.31 | 1.28 | 1.10 |
| **95-2000** | 3.68 | 2.22 | 2.52 | 1.43 | 1.13 |

Sources: Column A - Statistics Canada, GDP Data, CANSIM series D15721,2000; Columns B - CANSIM series D984670; column C - Statistics Canada, CANSIM Series D984764, 2000.

**Table 14: Business Sector: Canada, Real Output, Labour Productivity and Productivity Elasticity**

| | Indices (1992=100) | | Average annual rates of change | | |
|---|---|---|---|---|---|
| | **Real Output** | **Real output per hour** | **Real Output** | **Real output per hour** | **Productivity elasticity *** |
| **1949** | 18.6 | 29.8 | ….. | ….. | ….. |
| **1973** | 61.8 | 79.7 | ….. | ….. | ….. |
| **1981** | 80.1 | 87.8 | ….. | ….. | ….. |
| **1989** | 103.3 | 96.6 | ….. | ….. | ….. |
| **1990** | 102.7 | 96.6 | -0.57 | 0.01 | -0.02 |
| **1991** | 99.8 | 97.9 | -2.88 | 1.43 | -0.50 |
| **1992** | 100.0 | 100.0 | 0.23 | 2.10 | 9.13 |
| **1993** | 102.6 | 101.1 | 2.56 | 1.05 | 0.41 |
| **1994** | 108.4 | 103.2 | 5.69 | 2.17 | 0.38 |
| **1995** | 110.8 | 103.7 | 2.19 | 0.48 | 0.22 |
| **1996** | 113.4 | 103.6 | 2.35 | -0.14 | -0.06 |
| **1997** | 119.3 | 106.1 | 5.25 | 2.44 | 0.46 |
| **1998** | 123.2 | 106.6 | 3.27 | 0.46 | 0.14 |
| **1999** | 129.1 | 108.1 | 4.75 | 1.39 | 0.29 |
| | **Average annual rates of growth** | | | | |
| **1949-73** | 5.13 | 4.18 | | | 0.82 |
| **1973-81** | 3.30 | 1.22 | | | 0.37 |
| **1981-89** | 3.23 | 1.19 | | | 0.37 |
| **1989-95** | 1.17 | 1.20 | | | 1.03 |
| **1995-99** | 3.90 | 1.03 | | | 0.26 |

Source: Statistics Canada- Aggregate Productivity Measures, June 2000
*Productivity elasticity is calculated as productivity growth divided by output growth.

#### 5.2.1. Multifactor Productivity Trends

Multifactor productivity trends for the business, service and manufacturing sectors, have recently been estimated and provided by Statistics Canada (**Table 15**).

In 1999, multifactor productivity in the business sector advanced at a 1.5 percent annual rate, more than twice the annual average of the 1988-99, 1979-88 and 1973-79 periods. While this increase fell short of the 2.8 percent growth rate in 1997, it was 1.4 percentage points higher than the 0.1 percent in 1998.

**Table 15: Mutifactor Productivity Growth Rates, Canada**

Average annual growth rates

| | Business Sector | Service Sector | Manufacturing Sector |
|---|---|---|---|
| **1961-66** | 2.9 | 1.9 | 4.6 |
| **1966-73** | 2.3 | 2.3 | 2.7 |
| **1973-79** | 0.6 | 0.8 | 1.7 |
| **1979-88** | 0.4 | 0.2 | 1.4 |
| **1988-99** | 0.7 | 0.2 | 1.6 |
| **1997** | 2.8 | 1.9 | 4.1 |
| **1998** | 0.1 | 0.6 | 0.6 |
| **1999** | 1.5 | 0.8 | 3.6 |

Source: Statistics Canada (2000)

In manufacturing, the 1999 multifactor productivity gain was also impressive, reaching 3.6 percent annual rate, six times higher than the growth in 1998, and at least two percentage points higher than the growth rate during 1988-99 and 1973-79 periods. The service sector also experienced a slight increase in multifactor productivity from 1998 to 1999, although considerably less than the growth in 1977, it ranks higher when compared to the 1979-88 and 1988-99 periods.

Overall productivity growth during the 1988-99 period increased at an average of 0.7 percent annual rate, slightly higher than the previous two periods. Although it is below the average 2.3 and 2.9 percent annual increase of the 1966-73 and 1961-99 periods, it does represent an improvement on the 0.6 percent gain during 1973-79 and 0.4 percent rise during 1979-88 periods.

### 5.3. The Productivity Experience of the Manufacturing Sector

The main difference between the Canadian and the U.S. productivity growth in the 1990s lies in the performance of the manufacturing sector, the Canadian sector showing significant relative deterioration. The series for value added per hour worked for this sector is obtained from the Aggregate Productivity Measures series produced by Statistics Canada and is provided by **Table 16**. A second series has been constructed by the CSLS from the real value added and labour input series (LFS) produced by Statistics Canada (see **Table A11** in the appendix). The discussion that follows will be referring to **Table 16**.

**Table 16: Manufacturing Sector, Canada: Output, Labour Productivity and Productivity Elasticity**

| | (Indexes 1992=100) | | Annual rates of change | | |
|---|---|---|---|---|---|
| | Output | Output per hour | Output | Output per hour | Productivity elasticity |
| **1949** | 21.2 | 25.0 | …. | …. | …. |
| **1973** | 76.0 | 70.3 | …. | …. | …. |
| **1981** | 88.1 | 77.8 | …. | …. | …. |
| **1989** | 112.6 | 93.7 | …. | …. | …. |
| **1990** | 108.6 | 95.7 | -3.53 | 2.18 | -0.62 |
| **1991** | 99.0 | 95.3 | -8.91 | -0.47 | 0.05 |
| **1992** | 100.0 | 100.0 | 1.06 | 4.99 | 4.72 |
| **1993** | 104.6 | 104.5 | 4.61 | 4.50 | 0.98 |
| **1994** | 113.2 | 109.9 | 8.23 | 5.20 | 0.63 |
| **1995** | 118.1 | 111.0 | 4.33 | 0.97 | 0.22 |
| **1996** | 119.8 | 109.5 | 1.45 | -1.33 | -0.91 |
| **1997** | 128.1 | 112.8 | 6.91 | 3.01 | 0.44 |
| **1998** | 133.1 | 112.5 | 3.86 | -0.28 | -0.07 |
| **1999** | 141.3 | 115.2 | 6.22 | 2.38 | 0.38 |
| **Average annual growth rates** | | | | | |
| **1949-73** | | | 5.46 | 4.40 | 0.81 |
| **1973-81** | | | 1.86 | 1.28 | 0.68 |
| **1981-89** | | | 3.12 | 2.35 | 0.75 |
| **1989-95** | | | 0.80 | 2.87 | 3.59 |
| **1995-99** | | | 4.59 | 0.93 | 0.20 |

Source: Statistics Canada: Aggregate Productivity Measures, June 2000

The data show a deceleration of 1.94 percentage points in the growth rate for labor productivity in the Canadian manufacturing sector from the 1989-95 period to 1995-99 period, falling from 2.87 percent per year to 0.93 percent. Productivity growth is much weaker throughout the 1973-81 period, at 1.28 percent, compared to the 4.40 percent per year in 1949-73 period. This is a substantial contrast to the average 3.0 percent rate of productivity growth in the U.S. manufacturing sector since 1973.

As indicated by Centre for the Study of Living Standards (CSLS, 1999), the differences in the 1990s are concentrated in the two industry groups involved in the production of computers and computer parts, notably semiconductor manufacturing, computer hardware and telecommunications. It is in these industries where the United States continues to have an edge over Canada in productivity. Once these sectors are excluded the superior productivity performance of the United States evaporates. In particular, the fact that high-tech industries are that much larger in the U.S. and constitute such a huge portion of U.S. economic output can tend to distort the productivity numbers in their favor.

### 5.4. The Productivity Experience of the Service Sector

The productivity behavior of the Canadian service sector differs from that of its southern neighbor. **Table 17** breaks down the total economy into different industries. The productivity data provided by this table are constructed by the CSLS, based on Statistics Canada Labour Force Survey and GDP data.

**Table 17: Value Added Per Worker Employed, Growth rates, 1989-98, Canada**
Estimates of GDP per employed worker, by Industry, in constant 1992 dollars,

| | | % Average compound growth rates | | |
|---|---|---|---|---|
| | | **1989-95** | **1995-98** | **(1995-98)-(1989-95)** |
| T001 | **All Industries** | 0.94 | 0.83 | -0.11 |
| T008 | **Goods Producing Industries** | 1.95 | 1.30 | -0.65 |
| T009 | **Services Producing Industries** | 0.67 | 0.72 | 0.04 |
| A | **Agricultural and Related Service Ind.** | 3.13 | 2.32 | -0.80 |
| B | **Fishing and Trapping Industries** | -4.00 | 3.90 | 7.90 |
| C | **Logging and Forestry Industries** | -5.15 | 3.43 | 8.58 |
| D | **Mining (Inc. Milling), Quarrying and Oil Wells** | 4.85 | 3.51 | -1.34 |
| E | **Manufacturing Industries** | 2.55 | 1.14 | -1.40 |
| F | **Construction Industries** | -1.36 | 2.23 | 3.59 |
| G | **Transportation and Storage Industries** | 1.64 | 2.48 | 0.83 |
| H | **Communication and Other Utility Industries** | 2.28 | 0.77 | -1.52 |
| I | **Wholesale Trade Industries** | 2.01 | 2.56 | 0.55 |
| J | **Retail Trade Industries** | 0.52 | 2.66 | 2.15 |
| K | **Finance and Insurance Industries** | 2.79 | 6.68 | 3.90 |
| L | **Real Estate Operator and Ins. Agent Ind.** | 1.32 | 1.82 | 0.50 |
| M | **Business Service Industries** | -1.05 | -2.50 | -1.45 |
| N | **Government Service Industries** | 2.57 | -0.10 | -2.67 |
| O | **Educational Service Industries** | -0.98 | -0.75 | 0.22 |
| P | **Health and Social Service Industries** | -1.08 | -1.51 | -0.44 |
| Q | **Accommodation, Food and Beverage Serv.** | -2.13 | 0.81 | 2.95 |
| R | **Other Service Industries** | -1.53 | 0.24 | 1.77 |

Source: Centre for the Study of Living Standards – based on Statistics Canada Labour Force Survey and GDP Data

Service producing industries have not undergone any acceleration in productivity growth between the 1989-95 and 1995-98 periods. A more disaggerated analysis of this sector illustrates that three out of the twelve service industries have undergone at least a one percentage point decrease in labour productivity growth between the 1989-95 and 1995-98 periods. In addition productivity growth for health and social service industries also decelerated by 0.4 percentage points. The average annual growth rate in output per worker in communication and other utility industries decelerated 1.5 points, in government services 2.67 points and most importantly in business services 1.5 points. The latter industry has exhibited negative productivity rates for both the first and second half of the decade, falling from –1.0 percent per year to –2.5 percent.

However the data point to substantial gains in productivity in the finance and insurance industries, which experienced an increase in productivity growth of 3.9 points from the 1989-95 period to 1995-98 period. On the same lines productivity growth in retail trade accelerated 2.15 percentage points. These figures are greater than the 2.6 percent acceleration in productivity for finance, insurance and real estate in the United States between the two periods. The productivity growth acceleration in accommodation, food and beverage industries as well as other service industries were also rather impressive in Canada.

### 5.5. Investment in Machinery and Equipment

For the first half of the 1990s, Canada's machinery and equipment investment was much weaker than in the United States, and this lackluster performance failed to produce, with a lag, a revival of service sector productivity in the second half of the 1990s. However, in the second half of the decade real machinery and equipment investment skyrocketed and thus seems to be highlighting the recent push for Canadian higher productivity figures.

**Table 18** provides data on business investment in machinery and equipment in both constant and current dollars. Real investment growth during the 1995-99 period advanced at an astounding 14.3 percent per year, much higher than the 2.1 percent for the 1989-95 period and the 6.6 percent for the 1981-89 period (also see **Chart 7**). For the first half of 2000, real investment growth revealed a stunning 16 percent annual rate.

Business investment in machinery and equipment as percentage of GDP, in both constant and current dollars are also exhibited by **Table 17** and illustrated by **Chart 8**. Canadian businesses have also made substantial purchases of information technology products since 1996. In the first half of 2000, real investment in machinery and equipment reached 10.6 percent of GDP, up from 6.4 percent in 1995 and 6.1 percent in 1989.

In the second half of the 1990s many more businesses have been investing in information technology and computerizing their operations. According to a survey by the Bank of Canada, which covered 140 companies that were broadly representative of the Canadian business sector, 65 percent of Canadian businesses invested in these new technologies in the 1990s. This is 50 percent higher than the level of the previous decade. Undoubtedly, the productivity payoff from this investment will be felt in coming years throughout Canada.

**Table 18: Business Investment in Machinery and Equipment and Total Investment in Machinery and Equipment as Percentage of GDP, Canada: Millions of Current and Constant 1992 Dollars**

| | Business investment | | Total investment as % of GDP | |
|---|---|---|---|---|
| | **Constant dollars** | **Current dollars** | **Constant dollars** | **Current dollars** |
| **1981** | 23588 | 27677 | 4.48 | 5.36 |
| **1982** | 19889 | 25064 | 3.93 | 5.06 |
| **1983** | 19517 | 24361 | 3.78 | 4.82 |
| **1984** | 20830 | 25688 | 3.87 | 4.93 |
| **1985** | 23992 | 28830 | 4.21 | 5.19 |
| **1986** | 26595 | 31918 | 4.57 | 5.59 |
| **1987** | 30696 | 36001 | 5.06 | 6.03 |
| **1988** | 36411 | 41899 | 5.71 | 6.67 |
| **1989** | 39216 | 44942 | 6.06 | 7.02 |
| **1990** | 37476 | 42594 | 5.82 | 6.66 |
| **1991** | 37678 | 38918 | 6.05 | 6.26 |
| **1992** | 38652 | 38652 | 6.18 | 6.18 |
| **1993** | 36858 | 37678 | 5.82 | 5.94 |
| **1994** | 40348 | 42568 | 6.03 | 6.33 |
| **1995** | 44292 | 46486 | 6.40 | 6.67 |
| **1996** | 48561 | 48599 | 6.91 | 6.81 |
| **1997** | 59981 | 60699 | 8.08 | 8.02 |
| **1998** | 65357 | 65618 | 8.54 | 8.36 |
| **1999** | 75557 | 70353 | 9.56 | 8.60 |
| **2000*** | 87444 | 75910 | 10.63 | …. |
| | **Average annual growth rates** | | | |
| **1981-89** | 6.56 | 6.25 | | |
| **1989-95** | 2.05 | 0.56 | | |
| **1995-99** | 14.28 | 10.91 | | |
| **1995-2000** | 14.57 | 10.31 | | |

* Annual estimate based on growth rate in first half of 2000.
Source: Statistics Canada, Cansim database, D15424 and D15457, D15440 and D15410
http://www.statcan.ca/datawarehouse/cansim.cansim.cgi

### 5.6. Canadian Productivity Prospects for the Next Decade

The New Economy view is becoming increasingly popular among Canadian economic policy makers. Paul Martin (see Finance Canada, 2000), the Minister of Finance indicated in a recent speech that, "rapid advances in technology are fundamentally altering our economy and creating the possibility of tremendous new job creation and prosperity".

Former Bank of Canada Governor Gordon Thiessen seems to be more pessimistic about the impact of the New Economy than the Department of Finance. This is apparent in the Bank's choices about setting the speed limit on the pace of growth. While the Department of Finance believes that the economy can expand at an annual pace of 3.5 percent or more without sparking inflation, the Bank of Canada has set a much more cautious speed limit of 2.75 percent. The reason is apparent in Thiessen's statement about the future prospects of the New Economy (Bank of Canada, 2000). "It is possible that the investment boom we have witnessed in Canada since 1996 will increase productivity growth and capacity more quickly than we are allowing for. There is a good deal of anecdotal evidence that some of the American experience (burgeoning investments in technology leading to robust productivity gains) is being replicated in Canada. Until recently, there had been little evidence of this in our official, economy-wide productivity statistics. But there was a significant gain in productivity in the data for the second quarter of this year that were released recently." However he indicated, "it remains to be seen whether or not this is a trend."

This does not mean that the Bank of Canada is rejecting the New Economy, but what it means is that as Canada's central bank and thus the guardian of sound economic practice, their main objective is to keep inflation low. Unlike the Federal Reserve Board, the Bank of Canada seems less willing to probe the limits of the NAIRU and push down the unemployment rate until inflation accelerates. The economic growth objective appears to receive lower weight relative to the low inflation objective in the conduct of monetary policy in Canada than in the United States.

In support of the New Economy view embraced by the Department of Finance and to a certain degree, the Bank of Canada, a strong case can be made that the New Economy characterized by strong trend productivity growth is finally arriving on this side of the border, occasioned by a reversal of most of the factors that have impeded productivity growth in the second half of the 1990s.

- The first of these factors concerns the high technology sector. This sector, although much smaller than the U.S., is now enjoying much rapid growth, almost four times faster than the overall economy (Finance Canada, 2000). There is evidence now that an investment boom in the high technology sector is creating conditions for the improved productivity that would allow the economy to expand without inflation. Indeed high tech industries are fueling rapid growth in many urban centres such as Ottawa and Kitchener-Waterloo.

- Real machinery and equipment investment in Canada skyrocketed in the second half of the 1990s (**Table 18**), opening the doors to higher productivity payoffs as a result of this investment throughout the economy in the coming years.

- In addition, the unemployment rate, which in the 1990s remained higher in Canada than the United States, has given employers less incentive to substitute capital for labour and thwarted the positive productivity effects of full utilization of resources. However, in the first half of 2000 it has fallen below 7 percent and could go significantly lower if the economic growth remains robust, which would allow more productive use of labour.

- Moreover, Statistics Canada is considering following the U.S. lead in the treatment of software as an investment in the national accounts. Undoubtedly this would increase both past and future measured productivity growth figures.

We believe, the changes we are witnessing today will continue into the foreseeable future, which is supported by the most recent productivity numbers. In our view, the balance of evidence now suggests that Canada's productivity growth (business sector output per hour) would be in the 2.0-2.5 percent per year range over the next decade, if not for two decades, a doubling of the growth rate of the 1980s and 1990s.

What happens in the U.S. spills over to Canada, although often with a lag. Our productivity growth in the past has tracked or even exceeded the U.S. growth as the same forces are at play in the two countries. The factors that have produced an acceleration of measured productivity growth in the U.S. since 1995 are now beginning to operate in Canada. As noted above, these include rapid growth of high-tech industries, strong machinery and equipment investment, low unemployment and changes in statistical methodologies.[8]

[8] This view is shared by John M'Callum (Beauchesne 2000) who states, "the secret to success is the productivity miracle recently seen in the U.S. He says "there are a number of similarities between the U.S. and Canadian economies and the most encouraging similarity right now is that Canada may well be on the cusp of enjoying the productivity miracle recently seen in the U.S."

## 6. The European Productivity Experience

### 6.1.Overview

International comparisons of productivity growth rates have become more difficult than usual in recent years due to the statistical pitfalls that have previously been mentioned. The use of hedonic indices by the United States makes international comparisons of investment in information technology difficult. By failing to adjust for quality improvements of computers, real computer expenditure is underestimated. This in turn lowers the economy wide real investment, which lowers the overall real output measures, and hence productivity estimates. In Europe, only one country, namely France uses hedonic methods to adjust for changes over time in quality improvements of computers.

The usage or the lack of usage of this method would result in huge differences in productivity growth rates between countries. As indicated by The Economist (2000i), a study carried by the German Bundesbank concluded that if the statistical methods employed by the U.S. were applied to the whole EU area, then the annual growth rate in productivity over the past couple of years might be as much as half a percentage point higher. However the Economic Report of the President (2001, p 164) points out that even after correcting for the different statistical methodologies, investment and GDP growth remain far stronger in the United States than in Europe, and that the "success story of the U.S. economy is more than a statistical artifact".

As a result of these pitfalls a direct comparison of official figures could provide misleading results. But until all countries adopt similar methodologies in estimating output and productivity, the official figures are all that we have in forming a basis of comparison between the productivity experience of the EU countries and that of the United States and Canada.

As the official figures suggest, prior to 1973, European countries grew rapidly towards the much higher U.S. income levels. After 1973, this process continued at a slower pace and finally ended in 1995 when U.S. productivity growth began to exceed that of the EU. The recently strong U.S. growth has further widened the gap between its productivity levels and that of most other European countries. By observing the different economies, one may conclude that the features of the U.S. economy seem to be lacking in the EU area. One is rapid productivity growth and the other, high investment in IT.

### 6.2. Productivity Trends in the EU

For the past twenty years, Europe had revealed some impressive productivity gains, easily out-pacing the U.S. productivity growth rates. For the past two years however, labor productivity has decelerated in this part of the world. From 1973 to 1981 labor productivity growth, measured as output per worker, in France and Western Germany, averaged around 2 percent (**Table 19**). During the 1981-89 period, productivity growth in the EU Major 4, which consists of France, Germany, Italy and the United Kingdom advanced at a 2.1 percent average annual rate, 0.6 percentage points higher than productivity growth in the U.S. during this period.

Productivity growth for the majority of these European countries, was strong up till 1997 (See **Table A12** in the appendix for more detail). However, in 1998 and 1999 most of these countries experienced a drop in their productivity figures. During the 1990s, labor productivity, for the decade as a whole, was no more rapid in the U.S. than the EU major 4. But U.S. productivity growth accelerated relative to Europe's since the mid-1990s, exceeding the EU Major 4 by nearly one percentage point.

Productivity levels are also important when comparing the European productivity experience with the United States. If Europe is already enjoying high levels of productivity and thus is utilizing resources efficiently, then it will have lower productivity growth rates. In 1995 and 1999, all European countries, apart from Belgium exhibited productivity levels below that of the U.S.

The European unemployment rate has remained much higher compared to the U.S. This thwarts the positive effects on productivity of the full utilization of resources. Alan Greenspan has argued that labor market rigidities are likely preventing Europe from reaping the full productivity benefits of IT investment. Strict job protection laws, for example, make it more difficult for firms to layoff workers, reducing the likely cost-savings from IT investment.

While it is true that more efficient labor markets could deliver a double boost to European growth, in order to boost productivity growth, Europe may not need to wait until its labor markets are as flexible as those of the United States. After all, Europe's labor markets have not changed much in recent years, and the somewhat superior labour productivity performance in the EU area until 1995 may have been due to high labour costs which discouraged use of labour-intensive, low productivity techniques.

**Table 19: Growth of Real GDP per Employed Person for Selected European Countries**

| | France | Germany * | Italy | United Kingdom | Unweighted EU, Major 4 |
|---|---|---|---|---|---|
| **1973** | 35912 | N/A | N/A | 31356 | **N/A** |
| **1981** | 42561 | N/A | 42435 | 34217 | **N/A** |
| **1989** | 51015 | N/A | 51103 | 40426 | **N/A** |
| **1990** | 51837 | N/A | 51506 | 40353 | **N/A** |
| **1991** | 52870 | 42855 | 52422 | 39864 | **47003** |
| **1992** | 54609 | 46544 | 54673 | 42781 | **49652** |
| **1993** | 53353 | 46725 | 53492 | 42709 | **49070** |
| **1994** | 53850 | 49171 | 56357 | 43399 | **50694** |
| **1995** | 55152 | 51218 | 59104 | 43381 | **52214** |
| **1996** | 54714 | 51865 | 60295 | 45481 | **53089** |
| **1997** | 55622 | 53723 | 61140 | 46307 | **54198** |
| **1998** | 56722 | 55188 | 61726 | 46724 | **55090** |
| **1999** | 57232 | 55850 | 61849 | 47238 | **55543** |
| **2000** | 58034 | 57191 | 62715 | 48183 | **56531** |
| **Annual rates of change** | | | | | |
| **1989** | 2.5 | N/A | 3.0 | -0.3 | **NA** |
| **1990** | 1.6 | N/A | 0.8 | -0.2 | **NA** |
| **1991** | 2.0 | N/A | 1.8 | -1.2 | **NA** |
| **1992** | 3.3 | 8.6 | 4.3 | 7.3 | **5.9** |
| **1993** | -2.3 | 0.4 | -2.2 | -0.2 | **-1.1** |
| **1994** | 0.9 | 5.2 | 5.4 | 1.6 | **3.3** |
| **1995** | 2.4 | 4.2 | 4.9 | 0.0 | **2.9** |
| **1996** | -0.8 | 1.3 | 2.0 | 4.8 | **1.8** |
| **1997** | 1.7 | 3.6 | 1.4 | 1.8 | **2.1** |
| **1998** | 2.0 | 2.7 | 1.0 | 0.9 | **1.7** |
| **1999** | 0.9 | 1.2 | 0.2 | 1.1 | **0.9** |
| **2000** | 1.4 | 2.4 | 1.4 | 2.0 | **1.8** |
| **Average annual growth rates** | | | | | |
| **1973-81** | 2.15 | 1.96 | NA | 1.10 | **NA** |
| **1981-89** | 2.29 | 1.76 | 2.35 | 2.11 | **2.13** |
| **1989-95** | 1.31 | NA | 2.45 | 1.18 | **NA** |
| **1991-95** | 1.06 | 4.56 | 3.04 | 2.14 | **2.70** |
| **1995-99** | 0.93 | 2.19 | 1.14 | 2.15 | **1.60** |

| | | | | | |
|---|---|---|---|---|---|
| **1995-2000**** | 1.02 | 2.23 | 1.19 | 2.12 | **1.64** |

**Note:** * Growth rates for Germany for the periods 1973-81 and 1981-89 are based on former Western Germany. The growth rates from 1989 onwards, are based on Unified Germany.

**Data for the year 2000 are solely based on OECD projections.

**Source:** Data for 1973-98 are obtained from BLS, based on their International Comparisons of Foreign Labour Statistics Data, http://stats.bls.gov/flshome.htm.

Data for 1999-2000 are obtained from the OECD Employment Outlook, based on output and employment growth estimates.

### 6.3. Investment in Information Technology

The extensive use of information technology by businesses has spread rapidly in most European countries, and just like the United States and Canada there has been substantial changes in the way businesses operate, creating new opportunities for growth.

In a recent paper, Paul Schreyer (2000) points out that in the United States, the growth contribution of IT equipment for the 1990-96 period, amounted to about half of the entire contribution of fixed capital to output growth. In Canada and the United Kingdom, IT represented about 40 percent of the entire contribution of fixed capital to output growth. Conversely, the contributions to output growth for France, Germany and Italy have been far smaller and for Europe's Major 4, this contribution was only about 25 percent for the 1990-96 period (**Table 20**). As he indicates, this is not as much due to the lower rate of investment growth in IT, as to a lower income share of these IT capital goods, due to the lower size of IT capital stock.

**Table 20: IT (Including Communication Equipment) Contribution to Output Growth for U.S., Canada and Selected European Countries**

Total industries, based on harmonized ICT price index
Average annual rates of change, percentages

| | | France | Western Germany | Italy | United Kingdom | Europe Major 4 (unweighted average) | United States | Canada |
|---|---|---|---|---|---|---|---|---|
| **Growth of Output:** | 1980-85 | 1.7 | 1.4 | 1.4 | 2.1 | 1.65 | 3.5 | 2.8 |
| | 1985-90 | 3.2 | 3.6 | 3.0 | 3.9 | 3.43 | 3.3 | 2.9 |
| | 1990-96 | 0.9 | 1.8 | 1.2 | 2.1 | 1.50 | 2.7 | 1.7 |
| | 1996-98 | - | - | - | - | - | 4.6 | - |
| **Contributions (percent) from:** | | | | | | | | |
| ICT equipment | 1980-85 | 0.17 | 0.12 | 0.13 | 0.16 | 0.145 | 0.28 | 0.25 |
| | 1985-90 | 0.23 | 0.17 | 0.18 | 0.27 | 0.213 | 0.34 | 0.31 |
| | 1990-96 | 0.17 | 0.19 | 0.21 | 0.28 | 0.213 | 0.42 | 0.28 |
| Total capital | 1980-85 | 1.0 | 1.0 | 0.9 | 0.8 | 0.925 | 1.1 | 1.3 |
| | 1985-90 | 1.3 | 1.2 | 0.9 | 1.1 | 1.125 | 1.0 | 1.1 |
| | 1990-96 | 1.0 | 1.0 | 0.7 | 0.8 | 0.875 | 0.9 | 0.7 |

Source: Schreyer (2000), Table 4.

Overall, in absolute terms, for the time periods 1980-85, 1985-90 and 1990-96, the contribution of information technology equipment to output growth has been lower in Europe as compared to the United States and Canada. The relative contribution of IT to output growth has also been lower during the above three periods in comparison to the United States.

The data however, only go till 1996. Much has changed since then. A study undertaken for the French economy indicates that over the 1995-98 period, the contribution of IT capital to output growth was twice as high as compared to the 1990-95 period (see Cette, Mairesse and Kocoglu, 2000b). There is thus preliminary evidence of a speed-up in IT investment and a growing role of the IT producing industry in at least one European country, though generally starting from a lower level than in the United States.

### 6.4. European Productivity Prospects

The recent productivity slowdown experienced by most European countries is likely a transitory phenomenon. In fact Europe's productivity outlook looks very promising. As indicated by the Council of Economic Advisors (Economic Report of the President, 2001, p 162) "the same innovations that have raised economic performance in the United States would likewise be expected to raise foreign productivity and growth as those innovations are adopted abroad."

The productivity growth projections for the year 2000 (**Table 19**) are greater for all European countries as compared to 1999. Productivity growth in four major European economies is projected to advance at 1.8 percent, up from 0.9 percent in 1999. In Norway, Netherlands, Italy and Germany, productivity is expected to accelerate by more than one percentage point from 1999 to 2000. The rest of Europe, namely Austria, Belgium, Denmark, France, Sweden and the United Kingdom, are expected to experience more than half a percentage point acceleration in their productivity growth rates, in 2000.

Productivity growth thus appears to be accelerating in Europe. In our view Europe, just like Canada, will see a significant pick-up in productivity growth over the next decade. European productivity growth had for many years exceeded the U.S. growth. There is no reason to believe that this trend would not occur again particularly for countries that still have a significant productivity gap with the U.S. As information technology spreads rapidly throughout the world speeding up the diffusion of information, the process of catch-up for European productivity to that of the U.S may accelerate.

Some economists argue that the potential for cost savings and productivity gains from the Internet should be much bigger in Europe than in the United States. This is because the extensive use of the Internet and e-commerce increases the level of competition between firms, and thus aims directly at the greater inefficiencies (such as lack of competition) in these economies. Countries with longer supply chains are likely to see the biggest price reductions and the biggest gains in efficiency, as they face greater potential gains from the usage of new communication modes and means of distribution.

After all, if the U.S. can look forward to significant gains from IT and the Internet, then the rewards to other economies could be even bigger.

## 7. Implications of the New Economy

Economic policy plays a crucial role in fostering the growth of an economy. The provision of an appropriate framework paves the way for the economy to reap greater benefits from new technologies. The U.S Administration has "embraced policies and strategies based on fiscal discipline, investing in people and technologies, opening new markets at home and abroad, and developing an institutional framework that supported continued global integration" (Economic Report of the President, 2001 p 23).

The size of the United States long-term rate of productivity growth will determine the depth of any economic down-turns. A high rate of productivity growth would allow taxes and interest rates to be cut during recessions without accelerating inflation.

Although there is not likely to be a perfect policy setting, it does appear that in the United States, what Alan Greenspan considers "new" about the New Economy has led him to change a fundamental aspect of the U.S. economy. Recently, he decided to raise America's speed-limit to a little bit above three percent.

The speed limit for an economy is defined as the fastest economic growth rate of real GDP that will not ignite inflation. An economy can move to a higher potential growth path due to population growth, growth in the economy's capital stock, and technological change. This speed-limit can be calculated by a simple arithmetic formula. It is the sum of the growth rate of potential labour input and trend labour productivity.

In the first half of 1990s, conventional estimates placed each figure around 1% per annum, which brought the estimated growth trend to around 2% annual growth for the indefinite future. By observing the U.S. economy now it seems to have been re-energized, which places this estimate a little off the mark. There is some uncertainty about the growth rate of the labor force, for as history suggests it can not be perfectly forecasted. In the past few years however, this figure has in fact remained rather stable. Since productivity growth is far more volatile than the growth rate of the labor force, any argument about increasing the speed limit, largely centres on productivity growth.

Although it is true that measured productivity has more than doubled since 1995 as compared to the first half of the decade, shocks can cause potential GDP to oscillate as the economy adjusts to these fluctuations. It would be inappropriate for policy to attempt to offset these fluctuations. The task faced by the Central Bank is to identify structural shifts in potential GDP growth from cyclical fluctuations, and without doubt, this dramatically complicates monetary policy. In such case the Central Bank has to judge to what extent this higher productivity is based on structural changes, i.e. driven by information technology, and how much of it is temporary, i.e. subject to the ups and downs of economic growth. Only then, can it determine the new "sustainable" rate of growth.

By raising the speed-limit, Greenspan unveiled his perspective on productivity, indicating that the United States is experiencing a structural productivity revolution, due to technological advances. His recent actions revealed his thoughts. The country, which was always viewed as a mature, slow-growth economy, was no longer doomed to a growth rate of 2 to 2.5 percent. He supports his action by stating on June 13, 2000, that, "Most of the gains in the level and growth rate of productivity in the U.S. since 1995 appear to have been structural, largely driven by the irreversible advances in technology and its applications." In a more recent interview little seems to have been changed for he reasserts his stand on productivity by indicating that, "There is little evidence to undermine the notion that most of the productivity increase of recent years has been structural and that structural productivity may still be accelerating".

Many others argue that an essential factor for faster economic growth requires the strict application of policies that would maintain price stability. In reality computerisation and the extensive use of the Internet could also have an impact in boosting the demand side of the economy. If investors expect faster growth in output and profits and push up share prices, consumer demand might rise emanating from the increase in the wealth of households, and resulting in the so-called "wealth effect". They might be encouraged to spend more even before the increase in supply has evolved. Furthermore, higher share prices may also have a positive influence on investment, which could have a demand-side effect.

Due to a possibility of an increase in demand, even though it is believed that technological advances are expanding to the supply side of the economy, there can still be inflationary risks. If productivity growth levels off, monetary policy must respond to keep the rate of inflation at the new targeted level. However, due to the belief that technological progress has transformed the structure of the economy, a lesser degree of tightening would be appropriate.

The Federal Reserve realizes these risks. If this increase in demand overtakes the productivity-led boost to supply, the equilibrium price level and thus inflationary pressure could in fact rise in the short-term. It has been these risks that have led the Fed to follow a course of gradually increasing short-term interest rates.

## 8. Conclusion

The paper has shed light on the unprecedented resurgence in productivity growth in the United States since 1995. Some light has also been shed on the Canadian and European economies, which have not experienced the productivity miracle of the United States, at least not till very recently.

The proponents of the New Economy view defined as higher trend productivity due to the spread of information technology, point to faster productivity growth in the business sector and particularly in the service sectors as proof that the United States economy is being fundamentally revolutionized by globalization and technology. Skeptics on the other hand, indicate that due to the onset of diminishing returns, all the benefits of IT have already been realized and thus the recent U.S. productivity performance could prove to be a temporary phenomenon.

The diffusion of information technology and particularly the Internet, throughout the economy clearly has some way to go, especially in the case of Canada and Europe. It generally takes time for revolutionary technologies to move along learning curves and diffusion curves. As businesses restructure their operations, the extensive employment of information technology could result in further improvements in productivity growth. The rising investment in IT in recent years in both Canada and the EU will result in faster productivity growth over the next decade.

Appropriate economic policy is always important to foster growth but it becomes even more crucial at times of rapid technological change. The economic landscape has changed, and thus new policy regimes more consistent with the New Economy must be employed in order to ensure our potential productivity gains are translated into actual gains.

The concept of the New Economy is a controversial and much debated phenomenon amongst economists. Who will turn out to be right in the long-term? Only time can tell, for not even the best economic forecasters can provide a definitive answer regarding the behavior of the economy in the future. Until then, let us cherish the miracle that has added more spice to our old economic landscape in the process opening the doors to a more efficient and blooming economy.

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