Productivity and the New Economy: A Review

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Introduction:

The performance of the economy in the last half of the 1990s was one of the best in US economic history. Figures 1 through 4 in the appendix track common measures of economic performance over this period. The table below summarizes the charts in the appendix.

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<tbody>
<tr>
<td>GDP</td>
<td>3.1%</td>
<td>3.9%</td>
<td>25.8%</td>
</tr>
<tr>
<td>CPI</td>
<td>5.8%</td>
<td>2.6%</td>
<td>-55.9%</td>
</tr>
<tr>
<td>Unemployment</td>
<td>6.7%</td>
<td>4.8%</td>
<td>-28.4%</td>
</tr>
<tr>
<td>Productivity (Output per Hour)</td>
<td>1.4%</td>
<td>2.4%</td>
<td>71.4%</td>
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Source: Bureau of Labor Statistics (BLS) and Bureau of Economic Analysis (BEA)

As the table indicates, there was a considerable change in economic performance between the periods 1970-1994 and 1995-2000. This remarkable turnaround in the last half of the 1990’s led many to believe the economy had entered a new economy. One in which the old fundamentals no longer applied. A surprising number of economists accepted this new economy theory and publicly supported it. The surprising prosperity of the US economy, possible a result of the increased productivity, helped push stock market prices to the highest levels ever seen.

Towards the end of 2000 the prosperity of the US economy came to a rather abrupt halt. Since the beginning of 2001, GDP has fallen from an average of 4.1% for the year 2000 to –0.4% at the end of the 3rd quarter in 2001. Unemployment has increased from an
average rate of 4.0% in 2000 to 5.4% at the end of the 3rd quarter in 2001. The stock market has seen its lowest levels in 2001 since the start of the expansion in 1991.

This rapid change in the US economy has lead to a heated issue in current economic debate. Was the prosperity seen in the last half of the 1990’s a sign of a fundamental shift in how the US economy works? Or was it another short run spike in economic growth followed by an expected downward revision? What of this notion that we had entered a “new economy”? Many economists to this day still support the theory that the economy has changed (although not as much as previously thought). Accurately explaining what caused the rapid expansion in economic growth during the 1990’s has become one of the more important macroeconomic problems facing today’s economists.

This paper will attempt to give readers a better understanding of the issues involved in this current economic debate. After this introductory section, Part II will examine the theories put forth to explain what caused the prosperity in the US economy during the 1990s. I will pay particular attention to the “new economy” theory mentioned earlier. Part III will discuss some various techniques used by economists in regards to this theory of the new economy. Part IV examines the potential implications of productivity growth. Part V provides a summary of the issue.
Part II: Theories

To account for the economic performance of the 1990’s economists have pointed to many alternatives for possible explanations. In this section I will mention a few. Of course this is not an exhaustive list, however, these theories represent a large portion of the literature of this subject. One of the more prominent theories is the idea that the economic performance was caused by a remarkable increase in the level of investment in Information Technology (IT). The Federal Reserve has been particularly interested in this New Economy theory as two of their economists noted in a recent paper. “In an effort to reduce costs, to better coordinate large scale operations, and to provide new or enhanced services, American firms have been investing in information technology at a furious pace. Indeed, business investment in computers and peripheral equipment, measured in real terms, has jumped more than four fold since 1995.” (Oliner and Sichel 2000). The basic idea behind the New Economy theory is that the huge investment in IT is directly responsible for the robust productivity rates witnessed from 1995-2000. More importantly, the IT investment and resulting productivity gains are not merely a short run phenomenon but will have a lasting long run effect on productivity rates. If true then this could have significant implications for possible future economic performance as well as guidelines for making policy decisions.

Some of the most well known economists have endorsed this New Economy idea. Alan Greenspan, for example has been quoted numerous times for his endorsement of this theory. “A perceptible quickening in the pace at which technological innovations are
applied argues for the hypothesis that the recent acceleration in labor productivity is not just a cyclical phenomenon or a statistical aberration, but reflects at least in part, a more deep seated, still developing shift in our economic landscape.” (Greenspan 1999).

Of course not all economists accepted the New Economy theory. Some very prominent professors, including Robert Solow and Robert Gordon, have been skeptical of this idea. Dr. Solow, for example, pointed out that computers had not contributed significantly to productivity statistics even though they have been in production and use since the 1970s. His now famous quip, “if the computer is so important how come we see the computer everywhere but in the productivity statistics?” has been used widely to question the legitimacy of the importance of IT in the economy. Dr. Solow’s question has considerable merit when one realizes the productivity slow down from 1970 to 1994 coincides with the period when IT began to be heavily used by businesses in the US.

Adding to this “productivity paradox” was the research done at the micro level that suggested investment in IT could improve a company’s productivity. In a paper written in 2000, Drs. Brynjolfsson and Hitt of MIT and the University of Pennsylvania wrote, “Information Technology, defined as computers and as well as related digital communication technology, has the broad power to reduce the costs of coordination, communications, and information processing.” (Brynjolfsson and Hitt, 2000). Their paper estimated that rates of return on investments in computers and networks could be almost fifty percent per year on a company basis.
If the above estimates are true then why did we not see these gains in an aggregate level until the last half of the 1990s? Dr. Paul David of Stanford offered the following as an explanation. In 1990, Dr. David noted that several decades passed before the invention of the electric motor significantly changed the US economy. Dr. David called this a Diffusion effect. According to his research, it naturally takes time to switch from the established technological regimes to their successor regimes (In the case of electric motors, from steam engines to electric ones) such is the case with computers.

Drs. Stephen Oliner and Daniel Sichel of the Federal Reserve Board echoed Dr. David’s work in 1994 when they concluded there was no productivity paradox, just unrealistic expectations. According to their 1994 work, Sichel and Oliner state the contributions made by IT would not show in the aggregate statistics because IT equipment still represented a small fraction of the total capital stock until the early 1990s. If one agrees with the works on Sichel, Oliner, and David then there really wasn’t a productivity paradox to begin with. Instead IT only needed time to become significant enough to effect the productivity statistics on an aggregate level.

The idea of a New Economy is of course not the only theory to explain the prosperity of the 1990s. As mentioned earlier, one of the more notable skeptics of the New Economy theory has been Robert Gordon, professor of economics at Northwestern University. Dr. Gordon has argued in numerous papers that the acceleration in productivity growth is not due to a new economy, “Examined more closely, the productivity revival, however impressive, does not provide any evidence of a “broad” new economy revolution created
by the benefits of computers and other electronic equipment…” (Gordon 1999). Instead
Dr. Gordon points to three alternative theories to explain the economy’s performance.
The first is the improved methods for measuring price deflators. According to Dr.
Gordon’s research, in 1993 and 1994 the Bureau of Labor Statistics (BLS) discovered a
“formula bias” that accounted for a .5% overstatement in the CPI per year. Since CPI is
used in the deflation of business sector output a reduction in that deflation would increase
the amount of output produced. In addition to the formula discovered by the BLS, there
was also a shift in the measured deflators on medical care services. In 1993, the BLS
began using the PPI instead of the CPI to measure inflation on medical care services.
Gordon estimates over the period 1995-2000 PPI for hospital services rose 2.39% slower
than the CPI for those same services on an annual basis. When combining the result of
these measurement adjustments Gordon concludes, “When the base estimate of 0.37
percent measurement is added to the .10 percent medical care effect we arrive at a sum of
0.47 percent for the effect of all measurement changes on productivity growth…”
(Gordon 1999). This means almost half of the increased productivity (almost 1 percent)
can be accounted for by these measurement changes.

To account for the remaining difference, Gordon points to the explosion in
manufacturing durables and the procyclical behavior of productivity. Gordon’s research
provides estimates of output per hour by two major sectors of the economy:
Manufacturing Durables (ex: computers) and Manufacturing Nondurables. A summary
of Gordon’s chart is provided below.
This shows the increase in productivity was limited only to one particular sector of the economy and has no long term effects on the economy as a whole.

Gordon’s final theory suggests the productivity growth was the result of the rapid expansion in the economy not the cause of it. He argues that productivity, as measured by output per hour, will naturally increase when the economy is in an expansion. This increase, however, would not last once the economy slowed and could not have a fundamental change in how the economy works as the New Economy theory has suggested.

Other researchers have put forward other theories to explain the prosperity. In October 2001, McKinsey and Company, a private business consulting firm, published a report its researchers had done on productivity. Some of the conclusions of this report mirrored Dr. Gordon’s ideas. Mainly the notion that the productivity performance was contained in a few sectors of the economy (namely semi conductors and computer manufacturing). The report also pointed to managerial and technological innovations that improved the basic operations of the firm for providing the bulk of the productivity acceleration. For example, in the retailing sector, McKinsey and Company argued the success of volume retailers, such as Wal-Mart, forced competitors to switch managerial philosophies to take

<table>
<thead>
<tr>
<th>Output per Hour</th>
<th>1972-1995</th>
<th>1995-1999</th>
<th>Difference</th>
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<tbody>
<tr>
<td>Durable Sector</td>
<td>3.05</td>
<td>6.78</td>
<td>3.73</td>
</tr>
<tr>
<td>Nondurable Sector</td>
<td>2.03</td>
<td>2.05</td>
<td>0.02</td>
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Source: Gordon 1999 Table 1
advantage of the economies of scale Wal-Mart had discovered. This led to a more
efficient and therefore more productive retail sector. In short Mckinsey and Company
concluded that while IT was a tool in the prosperity of the 1990s it played more of a mid
range rather than a major role in the productivity gains of the 1990s.

Having defined some of the theories economists have used to explain the prosperity of
the 1990s we can now turn our attention to some of the techniques they have used to
justify their claims.

Part III: Techniques

Economists have offered many types of analysis to either prove or disprove the New
Economy theory. In 2000, Oliner and Sichel offered a neoclassical growth accounting
framework first developed by Robert Solow in 1957 where the growth in output (Y) in a
given year is contributed by the growth in computer hardware, computer software,
communication equipment, other capital, labor hours, labor quality, and multifactor
productivity.

\[ Y = \alpha_c K_c + \alpha_{sw} K_{sw} + \alpha_m K_m + \alpha_o K_o + \alpha_1 (L+q) + MFP \]

Where:
Y = Growth in Output
K_c = Computer hardware
K_{sw} = Computer software
All the variables are expressed as log differences. The income shares are defined as output elasticities for each input. Using data provided by the BLS and BEA, Oliner and Sichel estimate the contribution of each variable by multiplying the income share and the growth of each variable in order to obtain the amount each component of IT contributed to output. MFP in this context is used as a catch all. It measures the growth in the output that is not accounted for by increases in the remaining other variables in the model. It was the researchers hypothesis that the bulk of the output increase seen in the 1990s could be contributed by the IT variables in their model. The result of their research indicates their original hypothesis was correct. The model estimated that almost two thirds of the increased productivity was attributable to the rapid investment in IT during the last half of the 1990s.

Other economists followed similar techniques for estimating IT’s affects on productivity. However, there are many areas of disagreement concerning how to measure IT. For example, in Whelan 2000, Dr. Whelan, who is another economist at the Federal Reserve Board, used a similar model to the one used in Oliner and Sichel 2000. It was based on the Solow growth accounting framework mention above but Dr. Whelan derives his own expression for the optimal life service of computers and thus for the rate of
depreciation for computers. This differs from Oliner and Sichel, who relied on the BLS methodology for estimating depreciation. Dr. Whelan estimates for depreciation leads to an increase in the contribution of computers to overall output. Thus increasing the estimates of the Oliner and Sichel report. Which estimate is more accurate?

Another example of a different approach comes from Dr. Michael Kiley also of the Federal Reserve Board. In 1999, Dr. Kiley developed a framework for estimating the contributions from IT but added another factor to his model. He hypothesized that investing in new technology entails “adjustment costs” which are meant to capture any additional costs due to the disruption of a firm’s normal business activities. As a result, Dr. Kiley’s growth accounting model includes a negative variable that subtracts the additional costs from the additional output generated from investments in IT. The result of his model shows that the adjustment costs incurred more than cover any additional output generated by IT resulting in a net negative effect on output for the economy. Should these models include variables that account for “adjustment costs”? Are Dr. Kiley’s estimates for these costs accurate?

A final example of methods used to measure productivity growth is offered by Dr. William Nordhaus of Yale University. In a series of papers in November of 2000 Dr. Nordhaus gave a different formula to estimate productivity growth. The reason behind the different equation is due to his belief that the existing measures of productivity do not do an adequate job of reflecting economic welfare. The formula and its components are summarized below.
\[ g(A_t) = s_{it} g(A_{it}) + (s_{it} - s_{it}) g(A_{it}) + R_{it-1} w_{it} \]

\(g(A_t)\) is the dependent variable and measures productivity growth. The first term on the right hand side is called the pure productivity effect. This term is a fixed weighted average of the productivity growth rates of different sectors of the economy. This term measures the sum of the growth rates of different industries weighted by base year nominal output shares of each industry. The second term on the right hand side measures the differences in productivity growth and the changing shares of different industries over time. The final term reflects the effect on productivity due to changing shares of employment. This effect is the sum of the changes in output shares of different industries weighted by their relative productivity levels. An example of this is the movement from low productivity agriculture to high productivity industry.

Having defined a new estimate for productivity growth that better accounted for effects on the welfare of the economy, Dr. Nordhaus further dissented from the research techniques of those mentioned above by utilizing data from the Bureau of Economic Analysis (BEA) rather than from the Bureau of Labor Statistics (BLS). According to Dr. Nordhaus the advantage of using BEA data as opposed to the data provided the BLS is “The data are internally consistent in that both inputs and outputs are income-side measures of value added, whereas the usual productivity measures combine expenditure-side output measures with income-side input measures. The advantage of the unified income-side measures is that they present a consistent set of industrial accounts.” (Nordhaus 2000).
Using the new model and dataset described above Dr. Nordhaus estimates that the new economy had a significant impact on productivity growth in the late 1990’s. He estimates the new economy was responsible for approximately 48 percent of the total increase in productivity. While the general conclusion is similar to that of Oliner and Sichel, it is not nearly as robust. Which estimate is more accurate? The main issue here is of course what is the best way to measure the impact IT may have had on the prosperity of the US economy. As these brief examples have shown there is little consensus on the best way to do this. Economists disagree on the best model to use, the best way to define the variables used and what variables should be used to best estimate the impact of IT. It is important to have established methodology if economists want to understand the new economy’s impact on the prosperity of the US and how this might change the potential future performance the US economy.

Part IV: Implications

Determining how to most accurately measure productivity rates and how the new economy has impacted those growth rates will be one of the biggest challenges facing macroeconomists in the near future. As Paul Krugman put it, “Productivity isn’t everything, but in the long run it is almost everything.” Productivity will have an effect on almost every part of the economy so understanding IT’s contribution in the 1990’s will be crucial. For example, the growth rate in productivity is the primary determinant of how fast real wages can and will grow. In the long run, productivity growth and real wage growth must correspond. If it is assumed that productivity growth trend has
increased then companies could offer higher wages without the fear of lowering profitability of the company. Since most people receive the lion’s share of their income from wages and salaries the growth in productivity will determine the growth in the wages and salaries they will earn in the future. If the productivity gains made in the 1990’s are real and sustainable then we can expect to see growth in real wages in the long run. One can predict the multiplicative effect this would have on the prosperity of the US. The higher wages would put more money in the hands of the consumer, help boost consumer confidence and enable them to spend more. Consumer spending currently accounts for almost two thirds of GDP so the benefit of higher wages is obvious. At the same time we could expect to see an increase in business investment as well. As stated earlier, the productivity gains would allow businesses to offer higher wages to employees without risk of hurting their profit margins. If the productivity gains made in the 1990’s are real and sustainable then we can expect these higher wages to coexist with an increase in business investment. This is exactly what happened during the last expansion. As these examples illustrate, productivity gains can have a significant impact both on consumers and businesses. Understanding if the productivity gains are real and sustainable cannot be overstated. If this effect is truly a long run phenomenon then it could be the key to bringing the US economy back to the prosperity of the 1990s.

There are of course other important implications of productivity growth. The above analysis describes the impact directly to the economy but productivity has other indirect affects that must be addressed. One obvious affects are potential changes to monetary and fiscal policy. The central job of both monetary and fiscal policy is to balance the
demand for goods and services with the economy’s supply. Policy makers use what is called the trend growth rate to estimate this balance. Trend growth rate is the sum of the growth rate of hours of work and the growth of output per hour. For example, if productivity grew at 1.5 percent per year and the labor force grew at 0.5 percent then the trend growth rate would be 2.0 percent. The trend growth rate is sometimes referred to as the economy’s “speed limit” because it sets the amount of growth possible in the economy (as measured by GDP) without risking a rise in inflation. By extending our example a little we can see the influence of productivity on federal policy. If productivity growth increased from 1.5 to 2.5 percent, as was the case in the 1990’s, the trend growth rate would increase from 2.0 to 3.0 percent. Meaning the economy could grow 50 percent more without risk of higher inflation. How does this change affect policy decisions for monetary and fiscal policy? For monetary policy it would mean a “loosening of reigns” so to speak. If the economy started to expand and productivity growth was increasing then the Federal Reserve would not have to increase interest rates as soon as it would have in the past. For fiscal policy is would also have a loosening effect. Tax and spending acts would not have to be enacted to curb demand or supply.

Another important measure of economic performance used in policy decisions could be affected by the productivity growth. Some economists have suspected that productivity gains could result in a possible reduction on the Non-Accelerating Inflation Rate of Unemployment (NAIRU) or the natural rate of unemployment. At the start of the 1990s, most economists estimated the natural rate of unemployment was between 6.5 and 7.0 percent. If the rate of unemployment fell below that it was assumed inflation would
increase. Thus a Federal Reserve that wished to avoid recession by maintaining or lowering the rate of inflation could not afford to let the unemployment rate fall below the 6.5 percent rate. As we reached the mid 1990s, and unemployment fell to 6 percent, inflation did not start to increase. In fact the unemployment rate fell below 4 percent before there were any signs of an increase in the rate of inflation. Does this mean the Fed can allow a lower rate of unemployment before they have to consider the impacts to inflation? Can more people afford to work and therefore generate more output and more spending before the threat of inflation sets in. The potential economic gains if this were true are enormous.

It is noteworthy to point out in this analysis that all of the potential benefits of IT’s affect on productivity is suspect. As parts II and III clearly demonstrate, there is no consensus on how the new economy has changed potential prosperity of the US economy. There is not even a consensus on how to most accurately model productivity itself even before the advent of the new economy. Economists now scramble not only on how to model productivity but also on how to clearly define the variables to account for the new economy’s potential effect. There does appear to be some agreement that IT did have some kind of impact of the economy in the 1990’s. Even Robert Gordon concedes the computer industry, even if only in the manufacture of computers, had a positive affect on the prosperity of the US in the 1990’s. However, when it comes to the exact effect or if the new economy will continue to increase trend growth rates the only answer economists seem to have is; it depends. It depends on how you define the new economy. It depends on the model you use to measure productivity. It depends on the other
variables you input into your model. Clearly this is a debate that will continue because the significance to the prosperity of the US demands no less.

Part V: Conclusion

This paper has strived to provide a background into the complicated issue of the new economy’s affects on the prosperity of the US in the 1990’s. While this paper does not provide all of the theories, techniques, and implications of the issue it does point out some major themes. If economists are to fully understand the new economy and it’s potential effects then there must exist some consensus on how to measure IT and what is the appropriate model to predict future effects. This may mean an adjustment of current techniques or it may mean developing new accounting processes to fully measure the new economy. At this point none of the experts can offer a clear indication of what has happened in the 1990’s or what may happen in the future. However, it is clear there are important implications to consider so work will continue on developing better ways to measure the new economy.
References


