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ABSTRACT

Used properly, the term "new e-conomy" is warranted. Since 1995, there has been a wave of innovation associated with both the production and use of information technology that has been translated into improved US economic performance. In particular, there has been a substantial acceleration in trend total factor productivity growth. Most of this acceleration actually took place outside of the computer sector. Almost none of the acceleration was cyclical. There is now clear supportive evidence of an acceleration of productivity in service industries that are major purchasers of information technology such as finance and wholesale and retail trade. These gains reflect not only increased investment in information technology but also complementary innovations in business organization and policy. To be sure, as evidenced by recent financial market volatility, there have been speculative excesses, but these should not obscure the fundamental gains that have been made.

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DO WE HAVE A NEW E-CONOMY?

By Martin Neil Baily and Robert Z Lawrence*

In the 1990s IT became hot. The stock market took off, powered by technology companies. Productivity took off, increasing to a 3 percent a year rate after 1995. And there has been substantial evidence presented suggesting that the productivity acceleration is linked to IT (Stephen Oliner and Daniel Sichel (2000) and Erik Brynjolfsson and Lorin Hitt (2000)). Everyone was talking about a new e-conomy.

In the second half of 2000 the economic situation changed, with slower overall growth and weakness in the stock market, particularly in technology stocks. The idea of a new e-conomy seemed less compelling.

In this paper we will argue that, correctly understood, there is a new e-conomy. In particular, there has been a substantial structural acceleration of total factor productivity (TFP) outside of the computer sector. And there is clear supportive evidence of an acceleration of productivity in service industries that are purchasing IT.

I. The Shifting Productivity Trend

Output data that averages the income and product measures of the private nonfarm business sector reveals that labor productivity accelerated by 1.6 percentage point from 1995 through 2000, compared to the growth in the prior period, starting in 1973. How much of this *acceleration* was cyclical? Almost none. The strong business cycle of the 90s elevated the level of productivity by about 2 percentage points above trend both in 1995 and 2000. This means the cycle had almost no effect on productivity growth over this period and implies there was a

structural productivity acceleration also of about 1.6 percentage point (see also Susanto Basu, John Fernald and Matthew Shapiro (2000)).

A standard growth decomposition (Council of Economic Advisers (2001)), shows that about 0.6 percentage point of this acceleration was the result of capital deepening from computer, communication and software capital. About 0.2 percentage point came from TFP acceleration within the computer hardware industry. And 1.0 percentage point came from faster TFP growth in goods and services industries other than the computer hardware industry. These sources account for more than the total acceleration because non-IT capital services grew more slowly after 1995, decelerating productivity.

The findings confirm that indeed the IT sector was a major contributor to the recently improved productivity performance. A small contribution came directly from computer production. A larger contribution came from the productive use of IT capital by the industries that invested in the IT capital. And then, beyond the quantifiable effects of IT, there was a large residual TFP acceleration. Some of this likely was the result of innovations that were enabled or facilitated by IT. Some came from unrelated innovations.

It is hard to resolve definitively the issue of how large the role of IT has been in the residual TFP acceleration, but looking at growth by industry can cast additional light on the issue. Where has the productivity acceleration taken place?

II. Faster Growth in IT-Using Industries

Consistent annual data on gross domestic income (GDI) originating by industry (equal to gross value added) and full-time equivalent employment by industry are now available from 1987-1999 from the Bureau of Economic Analysis. Table 1 uses these data to show labor productivity growth by industry from 1989-95 and 1995-1999. The pre-95 period used starts at

1989 to minimize cyclical effects. The pattern of labor productivity by industry reflects both shifts in capital accumulation and shifts in TFP. (Future work will look at industry TFP measures.)

The table reveals that services (non goods-producing) industries account for much of the acceleration of labor productivity, a finding sharply different from the conclusion reached by Robert Gordon (2000). (Andrew Sharpe (2000), by contrast, gives results closer to those reported here). Large service industries such as wholesale and retail trade, finance and business services have all had increases in labor productivity growth greater than for the economy as a whole. There has been much discussion of the importance of supply-chain management improvements enabled by IT (see Litan (2001) for example). And it is striking that wholesale and retail trade increased their productivity growth by well over 4 percentage points after 1995. Finance is a sector that has invested heavily in IT. It achieved strong productivity growth pre-1995 and even stronger growth post-1995. Business services, another heavy IT user has shifted from negative growth pre-1995 to solid positive growth post-95.

Some claimed that measurement problems explained why pre-95 productivity growth in services was sluggish. However, as in the years prior to 1973, these problems have not prevented the detection of substantial gains recently.

Durable manufacturing had stellar productivity growth before 1995 and even more stellar growth afterwards, but other goods-producing industries did less well. Overall, the post-95 productivity acceleration in goods industries was less that that in the private industry total.

Some service industries might have been expected to show IT-related improvements that did not do so, but the Addenda to Table 1 shows support for the view that IT has helped growth. The industries were ranked by IT intensity based on their IT spending relative to value added.

They were then divided into two, the less and the more intense IT users. The intense IT using industries showed much faster labor productivity growth over the entire period 1989-99, and showed about a 50 percent larger acceleration after 1995.

The deflators available for intermediate goods and services are often inadequate, so that productivity in one industry can be overstated at the expense of another. The deflators used in final expenditure may also be incorrect so that productivity growth in the aggregate may be incorrectly measured. Thus it is dangerous to read too much into any one specific number.

However the overall pattern of the industry data is important. Prior studies found little evidence of IT's contribution to growth outside of high-tech manufacturing (see for example TFP estimates through 1996 by Dale Jorgenson and Kenneth Stiroh (2000)). The results in Table 1 do not prove that innovations enabled by IT are boosting productivity in service industries. But they are certainly consistent with that view and give support to the micro evidence of a positive impact of IT on the broader economy.

III. A Wave of Innovation

It appears that the acceleration of productivity over the past five years is structural. It may last a short time or a long time—that remains to be seen. But regardless of the future of productivity, the economy has changed in this expansion and new technology has played a substantial role in this transformation.

Despite the recent stock market weakness, the overall increase in corporate valuation has been astounding. Tobin's Q towards the end of 2000 was around two, compared to values at or below unity at the start of the decade. The market is signaling that the accumulation of intangible capital, including knowledge capital, may be as important as tangible capital.

The improved economic performance and increased valuation of intangible capital has coincided with a wave of both creation and adoption of innovation. One sign of this is the surge in R&D spending. According to data from the National Science Foundation real private R&D has risen rapidly since the mid-1970s, but it took off in the late 90s, rising 8 percent a year from 1995-99. The fact that patents granted soared after 1995, suggests the growth in R&D has been productive. There has also been a surge in the production of IT, rising by a factor of 13 between 1992 and 2000 in real terms. Employment has also increased sharply in industries providing computer, data processing and communications services.

What has generated the increased pace of innovation and its translation into improved economic performance? Clearly a necessary condition is that the technological opportunities had to be there, but this is not a sufficient condition. More was needed.

There has been heightened competition in an increasingly deregulated economy facing strong international competition. IT innovation is driven by the demand for improved technologies in the using industries. The U.S. has competitive service industries, often on a global scale, and this encourages them to seek out new technologies to improve their own productivity. Almost seventy percent of all IT products are purchased by wholesale and retail trade, finance and telecommunications. If the new e-conomy were entirely the result of a random surge in the flow of innovation, then all countries should have had similar changes together. The new technologies are available globally. In practice the U.S. has been well ahead of most of the industrial countries and competitive markets in using industries provide a reason.

Companies are outsourcing parts of the value chain to concentrate on core competencies—extending the benefits of comparative advantage. R&D is an example of this. Large companies can face bureaucratic obstacles to creativity and innovation in their in-house

R&D efforts. In response, the amount of R&D done in small companies is increasing, so are technology alliances and acquisitions. Twenty three percent of all privately-employed scientific researchers in 1999 worked in companies with fewer than 500 employees, up from 16 percent in 1993. The number of companies in the IT area more than doubled between 1990 and 1997.

At the same time, IT often involves production with high fixed costs and low marginal costs, so that achieving a large market share in the area of core competence is often essential. Companies are achieving this in different ways, but one sign that it is occurring is that both the number and total value of mergers and acquisitions have exploded.

New forms of financing have contributed to the changes in organization. R&D is risky and historically this made it difficult for small companies to get funding for technology development. The rapid growth of venture capital has alleviated this problem, facilitating the increase in small-firm R&D noted above. The growth of the IPO market has also provided a way for young companies to access the capital market.

When innovations occur in one area, it can bring benefits. But when complementary innovations occur together the effects can be greatly increased. The combination of rapid advances in computing power, software and communications capabilities form such a set of complementary innovations. Large amounts of data can be processed and presented in a way non-technical personnel can use and then transmitted to remote locations within the same firm or to other firms.

Supply chain management is a clear example of how complementary innovations have helped productivity and performance. A retail purchase is the last step in a long chain that includes raw material suppliers, component manufacturers, assemblers, wholesalers and retailers. These are linked in a chain that involves ordering, invoicing, sorting, loading and unloading, and

shipping. Each step uses resources and creates potential mistakes, shortages or excess inventories. New management systems, facilitated by IT, have improved supply chain management by eliminating steps and reducing paperwork, fluctuations in production and inventory (see for example, Roy Shapiro (2000) and Richard Wise and David Morrison (2000)).

The policy environment in this expansion has contributed to the creation of the right environment for growth and innovation. Policies to maintain domestic competition and increase international competition have been stressed. Funds have been provided to support basic research and education. And most importantly, the policy of fiscal discipline has lowered interest rates and encouraged high R&D and investment.

IV. The Internet and the Dot.Com Bust

The collapse of many Internet companies has caused some to argue that the new e-conomy has disappeared, but this is a misreading of what has happened. It is clear in retrospect that excessive optimism about the commercial potential of Internet-based companies resulted in some very foolish funding decisions.

For example, Kibu.com was set up to develop a web site geared to teenaged girls. It received $22 million in first-round financing to create a digital hangout for teens that would "empower girls while grabbing a piece of the highly coveted teenage demographic." (Lori Gottlieb 2000, p.1). After just 46 days of operation, the company folded. Perhaps the most famous case was Pixelon, started by David Stanley who is currently in jail in Virginia. Pixelon raised $30 million from some marquee investors, $16 million of which was spent on a star-studded launch party. The company declared bankruptcy having developed no product of its own (*The Industry Standard,* (December, 2000)).

The Internet spawned a frenzy of activity that fed on itself, following the classic pattern of speculative bubbles. Such an environment fosters bad decisions and outright fraud.

Despite many examples such as these, the fundamental changes in the economy that have taken place in this expansion have not disappeared with the dot.com collapse. The application of the Internet for commercial purposes has only very recently become important and has not been the main source of rapid economic growth in the 1990s. The innovations in supply chain management described earlier were already taking place before the explosive growth of the Internet took place, as companies developed their own internal networks. The Internet has been important and will be more so, going forward, lowering the cost of communication and allowing small companies to cut costs. But the Internet has not been the main story so far.

The volatility and disruption in financial markets in 2000 has been a barrier for companies that have good business plans and are now looking for funds. But this is likely to be a transitory problem. As of late December 2000, the price-earnings ratio of Nasdaq companies was close to 100, hardly a price of funds to discourage promising R&D or investments. The dot.com collapse will be beneficial in restoring the importance of investing where there is a reasonable promise of profitability.

V. Conclusion

Is there a new e-conomy? The business cycle is dead; all the old skills are obsolete; only new companies can survive; the rules of economics have all changed. These statements are all false and any "new e-conomy" based on assuming they are true does not exist. However, there has been a wave of innovation, much of it tied to IT, driving greatly improved economic performance in this expansion, affecting old and new firms. This statement is correct and in that sense there is a new e-conomy.

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Table 1: Labor Productivity Growth by Industry
GDI originating per full-time equivalent employee, average annual percent changes, selected periods.

	1989-95	1995-99	Difference
Private Industries[a]	0.88	2.31	1.43
Agriculture	0.34	1.18	0.84
Mining	4.56	4.06	-0.50
Construction	-0.10	-0.89	-0.79
Manufacturing	3.18	4.34	1.16
Durables	4.34	6.84	2.51
Non-Durables	1.65	1.07	-0.59
Transportation	2.48	1.72	-0.76
Trucking and Warehousing	2.09	-0.73	-2.82
Transportation by Air	4.52	4.52	0.00
Other Transportation	1.51	2.14	0.63
Communication	5.07	2.66	-2.41
Electric / Gas / Sanitary	2.51	2.42	-0.09
Wholesale Trade	2.84	7.84	4.99
Retail Trade	0.68	4.93	4.25
FIRE	1.70	2.67	0.97
Finance	3.18	6.76	3.58
Insurance	-0.28	0.44	0.72
Real Estate	1.38	2.87	1.49
Services	-1.12	-0.19	0.93
Personal Services	-1.47	1.09	2.55
Business Services	-0.16	1.69	1.85
Health Services	-2.31	-1.06	1.26
Other Services	-0.72	-0.71	0.01
Intense IT users	2.43	4.18	1.75
Less intense IT users	-0.10	1.05	1.15

Source: Council of Economic Advisors (2001), based on data from Bureau of Economic Analysis.
Note a: Not directly comparable to the non-farm business sector results reported earlier in this paper.