

**The Role of Technology
in the National and Regional Economy**

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**Launch of Mass High Tech-Bentley College
New England Technology Stock Index
Smith Academic Technology Center
Bentley College
Waltham, Massachusetts**

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Good evening. I would like to thank Pat Flynn for inviting me to be part of tonight's program, and to congratulate her, Bentley College and the Mass High Tech Council on the introduction of the New England Technology Stock Index. Timing is everything as they say, and some may view the timing of a new stock index focused on the most rapidly dropping portion of the market as a bit off, but I think it may be a good place to start. And what better place to introduce and manage this new stock index but the Smith Academic Technology Center, with its incredible facilities, managed with Bentley's commitment to educating students to compete at the intersection of business and technology? As a matter of full disclosure, I must point out that I am a Bentley trustee, and view this Center with no small amount of pride, but even given that bias it is a wonderful place.

Tonight I want to explore the following questions: What can we learn by reflecting on the success of the U.S. economy in recent years? What, if anything, is the tie-in to today's theme of technology? And what is the impact of firms in Massachusetts included in this new index?

Let me start with some perspectives on the national economy. Given the sharp slowdown of last year, and the halting pace of this year, it is easy to lose sight of how extraordinary the last several years have been--and to realize we may still be in the longest period of economic growth in recorded U.S. history. If the past is an indicator, this expansion should have ended before now, for any one of a variety of reasons. Not very long ago, in fact, conventional economic wisdom--based on historical experience--held that the U.S. economy could not sustain growth in excess of 2.5 percent with unemployment rates below 5.5 percent without experiencing a substantial upturn in inflation. But, for most of the past several years, we have managed to grow faster than this conventional "speed limit"--without significant price pressures to the benefit of many of our citizens.

Why have the last few years been different? I want to focus on this question--not the period of slower growth now facing the U.S. economy--because of the lessons it may teach us about growth in the future. One lesson could involve the importance of helpful public policies, such as a commitment to public deficit reduction. Another, and the one I want to highlight tonight is the critical role of

productivity improvements. Throughout the 1980s, and even during the early years of this expansion, growth in productivity--or output per work hour--averaged about 1-1/2 percent per year. But beginning in 1996, productivity growth just about doubled. Astonishingly, in 1999 and early 2000 productivity grew at a pace in excess of 5 percent; even with the sharp fall off in economic growth in the last half of 2000, productivity still grew at better than 2 percent, or more than its previous average.

This acceleration of productivity growth enabled the U.S. economy to achieve the longest period of expansion ever recorded. Higher rates of productivity growth allowed the economy to continue to grow rapidly despite an ever more limited supply of available labor. Higher rates of productivity growth also helped firms absorb some of the cost pressures associated with low unemployment rates.

Productivity is important in a long-term context. It is as close as we can reasonably come to an unqualified economic benefit. It has the potential to make everyone better off. Productivity increases the size of the economic pie. As a result, productivity growth is the most important long-term determinant of the country's standard of living. If

the economy's output can increase, using the same amount of effort, everyone can benefit.

And, like the magic of compound interest, small differences in productivity growth can yield large cumulative results over time. After twenty years, the difference between the 1.4 percent annual rate of productivity growth in the 1980s, and the 2.6 percent rate of the last half of the 1990s, will produce a 35 percent higher level of real national income. Put another way, this higher rate of growth-if sustained--means that the nation's standard of living would double in approximately half the time.

Can this good fortune continue? Clearly that is a major question. There is no doubt that some portion of the 1996 to early 2000 productivity growth was simply the result of that phase of the business cycle--demand was strong and, in the short run, resources simply have to work harder to create the desired supply of goods and services. This so-called "cyclical" productivity growth slows as demand slows, bringing with it no long-lasting change. In contrast, change in the underlying capacity of the economy – that is, structural productivity growth – is the result of evolving improvements in the efficiency of underlying economic processes. The key to this type of

long-lasting productivity growth lies in investment in the means of production, in technological change and in education of the workforce.

What portion of the strong productivity growth in the latter part of the '90s is cyclical, and what portion is structural? That's a difficult question to answer precisely. But two factors lead me to take a measure of comfort that structural productivity continues to grow faster than historical norms. One factor involves the fact that I mentioned before--even with sharp drop-offs in demand in the last of 2000, productivity growth remained above the average of the '70s and '80s. Second, anecdotally, business people everywhere in New England constantly tell me they are focused on working harder and smarter to meet the challenge of global competition. This desire to remain competitive clearly is at the heart of productivity growth.

A central engine that supports this competitive drive is the novel efficiencies that have resulted from what is called the Information Revolution. In just a few short years, the growth of computers and the Internet have changed much about the way that business is done. Earlier methods of data gathering and communication have been replaced by transactions that occur in "internet time." Of course,

computers first started to be used by businesses as long ago as the 1950s. But many have argued that new information technologies have only recently reached a mass critical enough to allow them to have a substantial impact on the economy.

They draw an analogy with electrification. Although Edison invented the incandescent light bulb in 1879, at the turn of the century only 3 percent of all residences had electric lighting. It took another twenty years or so to reach 50 percent. Though it would ultimately have a marked effect on our economy, the economic benefits of electrification did not show up until fairly late. By the same token, as this argument goes, the use of computers has only recently become so widespread so as to have a pronounced effect on our economy. Along these lines, one recent study credits computers for close to two-thirds of the economy's recent pickup in productivity.

Investments in technology are important, albeit uncertain with respect to the timing of their impact. Just as important over the long term are investments in human capital. A solid portion of the share of the increase in productivity over the past half century is due to improvements in the quality of human capital. Increasing educational attainment is a major component in this increased quality. Education,

innovation, creativity, even sheer effort: all of these are tied to the quality of the workforce. This quality must continue to improve, if continued improvements in productivity are to be seen.

Productivity growth is the key to our long-term national prosperity. Similarly, ongoing investments in innovation-oriented capital goods and in raising the quality of labor are crucial to Massachusetts' level of economic activity and growth path over the longer term. The late-90s pickup in productivity growth that the U.S. experienced did not occur worldwide. Indeed, many European countries saw a falloff in productivity growth in recent years from levels that were generally higher than those of the U.S. in the '70s and '80s. Some researchers find the variation in productivity growth among countries explained by variations in information technology spending; investments in human capital and an evolving culture of competition seem important to me as well.

It seems reasonable to believe that variations in productivity among regions within the U.S. may be similarly large and similarly important, especially to the degree that regions engage in different levels of total investment, specifically in information technology. Massachusetts, as a proxy for the region as a whole, has historically

stayed on the leading edge in term of local firms' investments in new technology. In addition, the Massachusetts economy is distinguished by its heavy involvement in producing investment goods in general, and information technology investment goods, in particular, for regional, national and global markets.

Recent reports by UMASS Lowell and the Mass Technology Collaborative provide evidence of the degree to which the Massachusetts economy is tied to technology. They document the pervasiveness of technology and innovation in the Massachusetts economy and how this state stacks up against others. And, importantly, they suggest that the downside of high-tech high salaries--which add to the high cost structure of the region--may not be a downside after all.

To summarize these new reports, Massachusetts has for decades had a high concentration of technology industries. But the nature of these industries has evolved over time. Once it was dominated by hardware manufacturing; today it is largely focused on high value added technology services, such as internet-based services, software and telecommunications. Two factors have been

important to this long term trend of technology intensity--capital investment, and the supply and development of knowledge workers.

In Massachusetts, research and development spending by federal and corporate sectors, as well as venture capital investments have supported the growth of technology. In particular, Massachusetts outperforms other, much larger, leading technology states in venture capital investment. And this investment is targeted towards a wide range of technologies that will, it is hoped, help ensure a diverse state economy in the future.

Massachusetts' workforce has been characterized as a "knowledge sector powerhouse." What does this mean? Massachusetts is far more specialized in knowledge creation sectors of service industries--higher education, management services, research engineering, even legal services--than many other states. Overall, Massachusetts' share of knowledge workers is 35 percent above the national average; for engineers, scientists, and architects--while we don't have enough--the share is better than 50 percent higher than the nation's. This primary resource has made it possible for the state to stay on the leading edge, attracting firms in these new technology areas and enabling--indeed improving--them to expand.

Finally, there is no doubt that the importance of knowledge workers has led to higher wages for knowledge industry clusters in Massachusetts relative to other industries in the state and higher wages than those industries on average nationally. Does this suggest this regional and state advantage of a highly skilled workforce could make local technology firms uncompetitive? Recent data suggests not. Such data documents that holding qualifications and quality constant, Massachusetts firms do not face a cost disadvantage from this higher pay. It is simply that Massachusetts has more of these knowledge workers at each firm than does the typical firm in the same industry nationwide--and benefits from the high value added of this more technologically advanced mix of workers.

In sum, strong productivity growth has been the key to U.S. economic growth. Technological advancement has played a critical role in this growth, and Massachusetts specifically and New England more generally play leadership roles in new technology industries. Such industries are key to the growth of the region, and the higher incomes that prevail in most places. Thus, we as a region both benefit from, and depend upon, regional technology businesses. This takes me to this important new technology stock index we're

now celebrating. In my view, this new index will add to the visibility of New England technology companies that are included in the index, enhance their investment appeal, all other things like the stock market being equal, and thus work to the advantage of all. Kudos to you Pat, to Bentley College, and to the Mass High Tech collaborative. Thank you.