POTENTIAL GROWTH OF THE JAPANESE AND U.S. ECONOMIES IN THE INFORMATION AGE

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ECONOMIES IN THE INFORMATION AGE*

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Japan's deployment of information technology (IT) is said to have lagged behind the U.S. throughout the “lost decade,” as the 1990s are often described. However, if we harmonize the national accounts for the two countries, the contribution of IT to economic growth turns out to be nearly identical. The gap between growth rates is partly explained by the failure of the Japanese economy to maintain aggregate demand growth, resulting in a decline in Non-IT investment and a fall in employment. The future growth of the Japanese economy depends on offsetting the ongoing decline in the working age population by rising participation rates and more rapid innovation.

How did Japan's economy differ from the U.S.?

Japan's average rate of economic growth fell precipitously from 4.4% in the 80s to 2.3% in the 90s. Looking at more recent trends, the growth rate for the first six months of this year shows signs of revival and the unemployment rate is falling. In marked contrast to Japan, the U.S. economy prospered in the latter half of the 1990s, when accelerated economic growth, supported by rising productivity from investment in IT, produced a “new economy.” Beginning in 2001 the U.S. growth rate collapsed, triggering a sharp global recession in the IT industry. However, according to the Bureau of Labor Statistics, productivity growth actually improved.

The speed of IT innovation is often expressed by Moore’s Law, which states that the density of transistors in a semiconductor chip doubles every 18-24 months. Drawn on by this overwhelming rate of technical change, the cost and performance advantages offered by computers and telecommunication equipment have continued to grow. According to the International Technology Roadmap for Semiconductors (ITRS), the rate of increase in the density of transistors on semiconductor devices before 1995 was set to sustain a three-year product cycle. After 1995 the industry shifted to a two-year product cycle, increasing the rate of innovation by 50 percent! Also, midway through the
1990s the Internet suddenly became widely available.

We have analyzed the responses of the Japanese and U.S. economies to the technology acceleration in 1995. The vibrant ascent of productivity growth in the U.S. resulted in a vigorous surge in IT investment during the last half of the 90s. Comparing the average annual rate of growth of U.S. labor productivity in the years 1989-1995 with 1995-2000, we see an increase of 0.75% per year. This can be broken down into three components -- an increase in capital input per hour worked or capital deepening, a rise in the growth of total factor productivity or output per unit of input, and an increase in labor quality, labor input per hour worked, due to a shift toward a better educated and more experienced labor force.

Capital input from IT in the U.S., including computer hardware, software, and telecommunication equipment, contributed 0.44% to the jump in capital deepening. If this is added to the 0.19% rise in TFP growth in the IT-producing industries, the resulting contribution of IT is 0.63%, so that 84 percent of the acceleration in the growth in U.S. labor productivity in the second half of the 1990s is explained by IT.

What about Japan? The speed of technical innovation expressed by Moore's Law can be seen in Japan as well as the U.S. It would be natural to expect that Japan, like the U.S., also experienced the phenomenon of the new economy. But, according to a new report by the Organisation for Economic Co-operation and Development (Pilat, 2003), Japan was slower in the deployment of IT than the U.S. As a consequence, Japanese growth was held back.

The OECD report uses the official national accounts without harmonizing the methodology. In order to compare the impact of IT on economic growth between Japan and the U.S., we have first developed comparable databases for both countries. Although the national accounts of the two countries conform to the United Nations System of National Accounts of 1993, several important differences exist in the application of the UN system. The most important of these is the measurement of IT investment.

**Japan undervalues IT investment**

First, the definition of “software” in Japan differs from the U.S. Only custom-made
software is treated as capital investment when Japan’s GDP is calculated. By contrast, U.S. investment includes not only custom-made software, but also pre-packaged software, like Windows or Office, as well as software developed in-house for specific applications, such as airline reservations systems. Capital investment in IT, based on Japan’s official statistics, is substantially underestimated. Since investment in software was some ¥4 trillion in 2000, this is not a trivial matter. We calculate that Japanese GDP was underestimated by close to one percent.

Second, there are important differences in the price deflators for IT equipment. As the pace of innovation accelerates, model changes in hardware and software become more and more frequent. As a consequence, the price index for IT must be calculated from sophisticated statistical models of the prices of successive upgrades of both hardware and software. Even though the U.S. and Japan use the same methodology in measuring IT prices, the resulting indexes are heavily influenced by the particular model of IT prices employed.

If we compare the official U.S. and Japanese computer-related price indexes, the rate of price decline from 1995 to 2000 was twice as fast in the U.S. Different methods for compiling price statistics exert a powerful influence on the Japanese growth rate. Since the rate of decline in IT prices is smaller in Japan, the growth rate of IT investment is lower and the contribution by this investment to Japanese growth is underestimated. If Japan’s growth rate for the last half of the 90s is calculated by U.S. methods, the annual rate of growth rises to 2.13 percent per year. More than half of this can be explained by rising productivity in the IT-producing industries and a surge in IT investment.

We have corrected discrepancies between the price statistics for the two countries and used the harmonized prices to analyze the sources of economic growth. The contribution of IT capital to economic growth in the latter half of the 90s was similar – 0.78 percent per year for Japan versus 0.97 percent for the U.S. The growth in total factor productivity in IT-producing industries during the second half of the 90s was actually higher in Japan than in the U.S. – 0.61 percent versus 0.44 percent. The total contribution of IT was 1.39 percent per year in Japan and 1.41 percent in the U.S. Despite the enormous difference between the growth rates of the Japanese and U.S. economies after 1995, the contribution of IT was almost identical!

What explains the difference in growth rates between the two countries? Labor input
made almost no contribution to growth in Japan throughout the 90s. Production was becoming more efficient, but demand was not rising fast enough to absorb the available supply. By contrast the growth of labor input in the U.S. far outstripped the growth of the labor force, resulting in a decline in the rate of unemployment and a rise in labor force participation rates. Another indication of slack demand in Japan is the anemic growth of Non-IT capital input, relative to the U.S.

The decline in per capita hours worked throughout the 90s distinguishes Japan from other industrialized countries. This decline has been analyzed in detail by Hayashi and Prescott (2002) and can be attributed to the widespread adoption of a five-day workweek and an increase in the number of national holidays. The working age population peaked in 1995 at 87.17 millions and hours worked per capita has continued to decline. Future demographic trends in Japan suggest that the decline in hours worked will accelerate sharply, even with no further decline in the workweek and stable employment rates.

Advances in efficiency by downsizing, as seen in the restructuring of private firms, is not the only way to cope with more rapid improvements in technology. Development of new products to stimulate demand is crucial as productivity rises, as Yoshikawa (2003) has emphasized. Effective this year, Japan has expanded tax incentives for research and development. Japan’s failure to implement this policy measure during the 1990s is an important reason for slack economic growth throughout the decade.

**Growth of Potential Output in Japan and the U.S.**

In all considerations of Japan’s future growth rate, the availability of sufficient labor is of paramount importance. Projections by the National Institute of Population and Social Security Research show that Japan’s working age population will decline at an annual rate of 0.63 percent during the decade 2002-2012. By contrast, the Bureau of the Census projects growth of the U.S. working age population at around 1.00 percent per year for the same period. The difference of 1.63 percent per year produces an enormous difference in potential economic growth in the two countries.

A second difference between the U.S. and Japan is the unemployment rate. The OECD reports standardized rates for the two countries of 5.4 percent for Japan and 6.2 percent for the U.S. in the second quarter of 2003. The OECD estimates natural rates of
unemployment for the two countries at 3.9 percent and 5.2 percent, respectively. These are the rates at which inflation will not accelerate. This implies that the U.S. could allow the unemployment rate to fall by one percent over the next decade with no rise in the inflation rate and the Japan could allow the unemployment rate to fall by 1.5 percent over the same period.

Since Japanese productivity growth has become highly dependent on investment in IT, an important issue is whether this is sustainable. The development of semiconductor technologies is becoming progressively more difficult and the pace of innovation could fall back to the two-year product cycle seen before 1995. The telecommunications industry is suffering from severe over-capacity worldwide, even though the demand for bandwidth is rising exponentially. The development of content for the communications industry may become a bottleneck. If the pace of IT innovation decelerates, its contribution to the long-term growth rate would become weaker and productivity growth would decline.

Table 1 gives growth projections for the U.S., using the methodology developed by Jorgenson, Ho and Stiroh (2003). The key assumptions are, first, that hours worked grows at the same rate as the working-age population for the next decade, plus 0.1 percent per year to allow for elimination of slack in the labor market. The second key assumption is that reproducible capital stock – plant, equipment and software, and inventories – rises at the same rate as output. Land remains fixed in supply. These assumptions characterize growth in the U.S. over periods longer than a typical business cycle.

We present three alternative growth scenarios for the U.S. – a base case, an optimistic case, and a pessimistic case. These three scenarios use a common set of assumptions for the growth of hours, the growth of labor quality, the share of capital in the national income, the share of IT output in the GDP, and the proportion of capital stock that is reproducible. The scenarios differ in assumptions about total factor productivity (TFP) growth in the IT-producing industries and the Non-IT industries. They also differ in assumptions about the growth of capital quality, defined as capital input per unit of capital stock. This reflects shifts in the composition of capital toward less durable assets like IT hardware and software.

For the U.S. the base case projection of potential output uses 1989-2000 averages of
growth rates in IT and Non-IT total factor productivity and capital quality. This reflects
the experience of the last half of the 1990s, dominated by the acceleration in TFP
growth in the IT-producing industries, as well as the first half of the 1990s, before the
acceleration took place. This is implied by the International Technology Roadmap for
Semiconductors, which projects a continuation of a two-year product cycle through 2007
and resumption of the three-year cycle after that.

The optimistic case for the U.S. uses 1995-2000 averages of growth in productivity and
capital quality for the decade 2002-2012. This is in line with productivity growth in the
U.S. since the recession of 2001. Even if this were to continue, U.S. growth would still
fall far short of the historical rate of 4.05 percent per year during the period 1995-2000,
when growth of hours worked at 1.99 percent was almost double the rate of labor force
growth. For the U.S. the pessimistic case involves a reversion to trends in productivity
before 1995. This implies a substantial slowdown in capital quality growth, reducing the
impact of IT investment.

The base case projection of U.S. productivity growth is 1.64 percent per year by contrast
with 2.06 percent per year from 1995-2000. The drop in projected growth of hours
worked from 1.99 percent per year to 1.10 percent pulls the base case projection of U.S.
GDP growth down to 2.74 percent per year, well below growth of 4.05 percent during
1995-2000. The optimistic case is for productivity growth of 2.38 percent per year, above
the growth rate for 1995-2000. This is the consequence of the increase in capital
deepening associated with slower growth of hours worked. Output growth would be 3.48
percent per year in the optimistic case. Finally, productivity growth in the pessimistic
case would be only 1.02 percent per year, well below the level before 1995. The
corresponding growth rate of GDP would be only 2.12 percent per year.

Table 2 presents our projections of Japanese economic growth for the decade 2002-2012.
We use the same methodology as for the U.S. However, hours are projected to decline at
the same rate as the working age population – 0.63 percent per year, partly offset by a
rise of 0.15 percent to allow for a decline in unemployment. Our base case for Japan
uses 1989-2000 averages for IT and Non-IT productivity growth and the growth of
capital quality. This was a period of very rapid productivity growth outside of the
IT-producing industries and reflects Japan’s continuing success in closing the
productivity gap with other industrialized countries. However, Jorgenson (2003) shows
that Japanese productivity was the lowest among the G7 nations in 2000, so that a
sizable gap remains.

Our optimistic case for Japan is based on the productivity averages of 1995-2000 for the IT-producing industries, just as for the U.S. These averages are combined with growth of Non-IT productivity and capital quality at the more rapid rates of 1989-1995. Finally, our pessimistic case is based on 1989-1995 averages for IT producing industries – the beginning of the so-called “lost decade.” These are combined with Non-IT productivity and capital quality growth at the slower rates of 1995-2000.

Our base projection of Japanese labor productivity is 2.86 percent per year, well above the U.S. This is not surprising, since Japanese labor productivity has grown faster than the U.S., even during the great American growth resurgence of the late 90s. The decline of hours worked in Japan will provide opportunities for capital deepening. In addition, growth of TFP in IT-production and the Non-IT sector will remain considerably higher in Japan than in the U.S. Finally, labor quality growth in Japan will continue at levels well above the U.S. These three components, together with elimination of the unemployment gap, will enable Japanese productivity growth to maintain the levels of the 1990s. Our optimistic projection of Japanese labor productivity growth is 3.12 percent per year, well above the U.S. projection of 2.38 percent per year. Finally, our pessimistic projection for Japan is 2.60 percent per year, far in excess of the projected U.S. growth rate of 1.02 percent.

We conclude that Japanese productivity growth will continue to close the gap with the U.S.; however, Japanese economic growth is likely to lag behind the U.S. This is implied by the projected decline in the working age population in Japan, even with a reduction in the unemployment rate and continued improvements in labor quality. Our optimistic projection for Japan is 2.63 percent per year for the period 2002-2012, substantially below the projection for the U.S. of 3.48 percent. Our pessimistic projection for Japan for the same period is 2.12 percent, the same as the U.S. projection. Finally, our base case projection of Japanese GDP growth is 2.38 percent per year, well below the projected U.S. growth of 2.74 percent!

The departure from the labor force of the mid-50s baby boomers is one of the primary sources of the projected fall in Japan's labor force over the next decade. In the longer run the declining birthrate is the big issue. Thus, in slowing the contraction of the labor supply, it is necessary to address the conflict between women's participation in the labor
force and measures to prevent a declining birthrate. While an increase in productivity will compensate for downsizing the labor force, strengthening labor force participation and the rate of innovation are crucial. Japan’s impressive success in developing and deploying IT during the 1980s and 1990s augurs well for efforts to promote successful innovation.

### Table 1: Output and Labor Productivity Projections

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<th>Pessimistic</th>
<th>Base-case</th>
<th>Optimistic</th>
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<tr>
<td>Output Growth</td>
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<td>Effective Capital Stock</td>
<td>1.72</td>
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#### Common Assumptions

| Hours Growth | 1.10 | 1.10 | 1.10 |
| Labor Quality Growth | 0.157 | 0.157 | 0.157 |
| Capital Share | 0.408 | 0.408 | 0.408 |
| IT Output Share | 0.042 | 0.042 | 0.042 |
| Reproducible Capital Stock Share | 0.811 | 0.811 | 0.811 |

#### Alternative Assumptions

| TFP Growth in IT | 7.29 | 8.60 | 10.16 |
| Implied IT-related TFP Contribution | 0.31 | 0.36 | 0.43 |
| Other TFP Contribution | -0.02 | 0.08 | 0.20 |
| Capital Quality Growth | 0.95 | 1.58 | 2.34 |
| Implied Capital Deepening Contribution | 0.64 | 1.10 | 1.66 |

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<th>Optimistic</th>
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<td>Capital Share</td>
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<tr>
<td>IT Output Share</td>
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<td>Reproducible Capital Stock Share</td>
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References


