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The Choices During Recession: Responding with Experience Rather than Introduction of New Technology

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After floundering for well over a decade, the Japanese economy is at last showing signs of recovery. The lion's share of attempts to analyze this prolonged slump point to the declining rate of growth for the Total Factor Productivity (TFP), which includes advances in technology and other areas impossible to explain in terms of capital stock, labor supply and other aspects.

In this report, I examine corporate activity in the 1990s from the standpoint of the quality of capital. In doing so, I consider the situation from two perspectives: (1) the number of years elapsing since the use of the capital (vintage), an area believed to be a factor in the decline in productivity; and (2) the information technology (IT) that has gained attention for its significance in generating new technology opportunities from the 1990s.

Improved Productivity Even with Old Capital

In order to gauge the effects of "vintage" and "IT capital" on productivity, I have presumed the following formula based on the Cobb-Douglas Production Function. Factors used in this formula include added value production output (NY), labor supply prepared from the number of workers and hours of labor (L), capital stock (K), the average vintage of overall capital stock (V) and IT capital stock excluding software.

$$\log\left(\frac{NY_{it}}{L_{it}}\right) = \beta_0 + \beta_1 * \log\left(\frac{K_{it}}{L_{it}}\right) + \beta_2 * V_{it} + \beta_3 * \log\left(\frac{IT_{it}}{K_{it}}\right)$$

The subscript "i" expresses industry, while "t" refers to years.¹

The anticipated results are that the effects of a rise in vintage will exert a negative impact on productivity ($\beta_2 < 0$), while an increase in the percentage of capital stock comprised of IT capital stock (hereafter referred to as the "IT capital ratio") means that

¹ The data was taken from the JCER Database (2004) prepared by the Japan Center for Economic Research (JCER). Used for vintage was the "Vintage Capital and Renewal Investment Cycle" mimeo by Tsutomu Miyagawa and Sumio Hamagata (2005), prepared on the basis of the JCER Database.

large amounts of new technology are being used and productivity rises, with the effects of the IT capital ratio thus being positive ($\beta_3 > 0$).

The chart shows the estimated effects when targeting all industries (private sector).² Estimation Formula 1 assumes that the vintage and IT capital ratio remained fixed throughout the entire period, while Estimation Formula 2 considers the possibility that effects will change during certain time spans, with the overall period divided into three sections.

**Impact on Production by Capital Vintage and IT Capital Ratio
(1980~2002; number of data: 23 industries)**

Explained variable: Labor productivity

| | Estimation Formula 1 | Estimation Formula 2 |
|-----------------------------------|----------------------|----------------------|
| Explanation variable | Coefficient | Coefficient |
| Constant | -0.040 | -0.047 |
| Capital labor ratio | 0.581 *** | 0.685 *** |
| Vintage (entire period) | -0.017 * | |
| Vintage (1980~86) | | -0.044 *** |
| Vintage (1987~94) | | 0.014 |
| Vintage (1995~) | | 0.035 *** |
| IT capital ratio (entire period) | 0.089 *** | |
| IT capital ratio (1980~86) | | 0.039 * |
| IT capital ratio (1987~94) | | 0.146 *** |
| IT capital ratio (1995~) | | 0.223 *** |
| Adjusted R-squared | 0.62 | 0.68 |

Note: Estimation method: Random effect model using panel data; statistical significance: *** = 1%, ** = 5%, * = 10%

Examining Estimation Formula 1, while the results are as expected, the statistical significance of the vintage coefficient is low, making it difficult to conclude that clear effects exist.

Turning to Estimation Formula 2, although the vintage effects reveal the anticipated negative results for the 1980~86 period, the effects for 1987~94 are positive at a statistically insignificant level, while from 1995 on there is a positive effect at a significantly high level. As this indicates, the way in which the impact surfaces changes with time. The effects of the IT capital ratio, on the other hand, remain in positive territory throughout the entire period of measurement, with those effects growing increasingly pronounced in recent years. From 1995, in fact, the value is close to six-fold compared to

² Because this does not include intermediate input, there is a possibility that estimates are excessive for the effects of both vintage and the IT capital ratio.

the level for 1980~86.

I believe that these results make it feasible to construe a conspicuous polarization in recent years between industries that are prolonging the existence of old capital, and those that come to possess new capital hand in hand with new technology.

Postponing Outlays in New Technology

I wish to present three reasons for arriving at an interpretation of this type.

First, deserving attention is the existence of a mix of effects that function to both lower and raise productivity within vintage as an indicator. When considering vintage as a gauge for expressing the quality of capital, it is hypothesized that productivity steadily declines as capital ages. However, when taking into account replacement investment, capital repairing or other circumstances, it is difficult to believe that productivity would simply continue to decline. Prone to be overlooked here is the fact that under the assumption that capital will grow obsolete and bottom out, there is also the possibility that a further increase in vintage will prompt a rise in productivity through gradual improvements in capital and the learning effects of the accumulated experience of engaging in production that uses such capital.

Secondly, both investment for the sake of maintaining old capital and investment accompanying the introduction of new technology are treated equally as vintage information, and are not regarded as being qualitatively different. If investment accompanying the introduction of new technology results in major advances in productivity, then the impact of old capital on productivity will decline, with the measurable impact of vintage, including that of old capital, reduced.

Thirdly, investment accompanying new technology is considered to be a replacement for old capital. At this time, however, old capital with greater negative effects due to the rise in vintage will be higher in the order of replacement priority. This point also moves in the direction of diminishing the negative effects of vintage. As supporting evidence, confirming the coefficient of correlation using the average values for estimated periods for both vintage and IT capital ratio by industry, we find that 1980~86 is -0.27 , 1987~94 is -0.23 and from 1995 is -0.41 . In this way, the negative correlation between the rise in the IT capital ratio and the decline in vintage rises in the period from 1995.

In other words, the positive effects of vintage in industries that choose to prolong the existence of capital, together with the declining impact of vintage in industries that introduce IT capital with high productivity, can be said to have generated the estimated results in this report.

Potential for Powerful Growth with New Investment and Introduction of New Technology

While this report is based on industry-specific data, analysis using financial data for individual companies³ has generated results which suggest that in industries where capital investment activity is stagnant, negative trends such as regression in new technology, weakened moves toward replacement investment and other tendencies will lead to a decline in productivity growth. At the outset of this report, I mentioned how the decline in the TFP growth rate is pointed out as a factor behind the slump of the Japanese economy. When also considering the results of the company-level analysis, the so-called “lost decade” may be viewed as an era when the worsening in the economic environment was dealt with through the learning effects of the accumulated experience of prolonging the lifespan of old capital⁴, as well as a period when the choice was not made to use technology with high productivity to implement major improvements in the quality of capital.

There is also the view that Japan had already shifted into the status of a low growth economy. However, I believe it can be said that, accompanying improvements in the economic environment, if companies which have refrained from investment abandon the stance of seeking to prolong existing capital in favor of carrying out positive investment in new technology, the Japanese economy harbors the potential to continue to exhibit powerful growth from here on as well.

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³ “Capital Vintage, Research and Development and Productivity,” “Surmounting the Lost Decade ~ Themes Of the New Japanese Economy,” Joji Tokui, Tomohiko Inui, Katsuaki Ochiai, 2006, Japan Center for Economic Research.

⁴In addition to curbing new investment, there is also the possibility that productivity declines were avoided by placing excessive burdens on workers.