Chapter Six
The Faster Accelerating Growth of the Knowledge-based Society

Economic Growth: The New Perspectives for Theory and Policy

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6.1 Look at the knowledge-based society in terms of economic growth patterns.

6.2 Look at characteristics of the knowledge-based society, focusing on new technologies and changed human behaviors.

6.3 Compare economic growth patterns of the knowledge-based society to those of the industrial society.

6.4 Summary

6.5 References
The Knowledge-based society in terms of the economic growth patterns

The differentiation of the economic growth pattern

Expectation about the different patterns of economic growth in the Knowledge-based society:

- IT-driven economic growth with increasing speed.
- Impact of the Bio-economy on the entire economy.
- Changing the value-creation mechanism from tangible-factor based to intangible, intellectual-factor based.
- Changing human behaviors with the growing population of elderly and digital natives.
Future technologies and a new humankind

New perspectives are needed to identify the economic growth patterns of the Knowledge-based society that would go further than the neo-Schumpeterian approach to the technological change and economic growth and would incorporate:

- Emerging technologies, in particular scientific knowledge-based technology and their impact on economic activity.
- Their co-evolution with humankind and society.
6-1 The Knowledge-based society in terms of the economic growth patterns

The factors influencing the economic growth pattern of the Knowledge-based society

Figure 6 - 1
The factors and their relationships influencing the emerging knowledge-based society
IT and rules of technological progress

What is IT?

- Technology for handling information, including the acquisition, storage, transmission, process display, and protection of information (Longley, 1985).
- The most fundamental convergence technology.
IT and rules of technological progress

Moore’s law (1965):
- States that the power of computing doubles every 18 months while the cost does not; hence, the cost of computing falls over time.

Characteristics of IT:
- Developing information systems to increase the benefit from the enhanced productivity of other industries.
- Network and tipping effect
  - Empirical finding by Shy (2001): the unique characteristics of software products of easy reproduction and network effects.
What is BT?

- Based on the life sciences.
- Technologies for improvement of plants and animals and using living organisms and/or substances to develop microorganisms for special purposes (U.S. Congress).
- The integration of natural sciences of the individual, the cell, a part of the cell, and the molecule for products and services (EFB).
6-2 Characteristics of the Knowledge-based society

BT and rules of technological progress

Carlson Curve (Carlson, 2003):
- Shows changes in the BT’s productivity and cost.

Figure 6 - 2
*Productivity increase of DNA synthesis and sequence analysis, compared with Moore’s law*
6-2 Characteristics of the Knowledge-based society

BT and rules of technological progress

Carlson Curve (Carlson, 2003):

- Shows changes in the BT’s productivity and cost

Figure 6 - 3

*Base Sugar Synthesis and Sequence Analysis Cost*
What is NT?

- Technological manipulation of matter on an extremely small scale known as the nano-scale.
- Three main advantages of NT:
  - Promote convergent development for IT and BT and providing immense possibilities in divergent fields;
  - Particularly suited to efficiency and miniaturization;
  - Forecasted to provide breakthroughs via research on the atomic and molecular levels into the basic structure of materials.
6-2 Characteristics of the Knowledge-based society

NT and rules of technological progress

NT as a role in fostering the continuous development of IT

Figure 6 - 4

Moore’s Law Ending
6-2 Characteristics of the Knowledge-based society

NT and rules of technological progress

NT as a role in fostering the continuous development of IT

Figure 6 - 5

Semiconductor features size reduction aspect and the role of NT
6-2 Characteristics of the Knowledge-based society

NT and rules of technological progress

NT as a role in fostering the continuous development of IT

- Moore’s law can be sustainable only if it is converged with NT because the large price increase of chip manufacturing device will make the business unprofitable.

Figure 6 - 6

Semiconductor price decrease and tool cost increase
6-2 Characteristics of the Knowledge-based society

Impacts of IT, BT, and NT in the economic and social perspectives

Convergence in existing industrial technology and IT is improving many industries (Appendix 6.A2).

IT has resulted in new industries of manufacturing and services.

BT contributes to productivity increase and added value through process replacement or technology convergence:

- For example, acryl-amide production
Impacts of IT, BT, and NT in the economic and social perspectives

NT delivers efficiencies and productivity improvement to traditional industries, being profitably applied to sustainable development issues.

New industrial areas created by IT-BT-NT convergent technologies:

- For example, Bio-informatics based on BT-IT convergence; nano-sensors based on IT-NT; bio-sensors and bio-chips based on BT-IT-NT.
6-2 Characteristics of the Knowledge-based society

New humankind: Digital natives
Net generation, Generation Y, or the Digital native:

- Human life changed with the change from analogue to digital at the beginning of the 21st century.

Characteristics of digital natives:

- most of the members were born after 1980;
- had sent and received at least 200,000 messages in texts and e-mails and had spent at least 100 hours using mobile phones and playing video games;
- accepts information rapidly, performs different tasks simultaneously, expects instantaneous compensation, and tends to think that work should be more fun than being serious.
6-2 Characteristics of the Knowledge-based society

New humankind: Digital natives

Six features of digital natives, positive on the society

Table 6-1  The Characteristics of Digital native

<table>
<thead>
<tr>
<th>Characteristics:</th>
<th>References:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Y1) Innovativeness</strong></td>
<td>(Tapscott, 1999)</td>
</tr>
<tr>
<td></td>
<td>(Tapscott, 2009)</td>
</tr>
<tr>
<td>-Active in using new technology, challenging</td>
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<tr>
<td>-Open and horizontal thinking</td>
<td></td>
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<tr>
<td><strong>Y2) Collaboration</strong></td>
<td>(Tapscott, 2009)</td>
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<td></td>
<td>(Howard, 2001)</td>
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<tr>
<td></td>
<td>(Giurgiu and Barsan, 2008)</td>
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<tr>
<td>-Active cooperation through various media</td>
<td></td>
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<td>-Cooperation with firm for better products and</td>
<td></td>
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<tr>
<td>services</td>
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<td><strong>Y3) Cyberspace Respect</strong></td>
<td>(Jeff, 2009)</td>
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<td></td>
<td>(Gartner, 2008)</td>
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<tr>
<td>-Shows respect in cyberspace</td>
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<tr>
<td>-Regards online experience as important as offline</td>
<td></td>
</tr>
<tr>
<td><strong>Y4) Fun</strong></td>
<td>(Tapscott, 2009)</td>
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<tr>
<td>-Pursues entertainment and pleasure</td>
<td></td>
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<tr>
<td>-Regards life quality highly</td>
<td></td>
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<tr>
<td><strong>Y5) Customization</strong></td>
<td>(Silveira at al., 2001)</td>
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<tr>
<td></td>
<td>(Tapscott, 2009)</td>
</tr>
<tr>
<td>-Pursues differentiated products and services</td>
<td></td>
</tr>
<tr>
<td>-Pursues various projects and customization</td>
<td></td>
</tr>
<tr>
<td><strong>Y6) Immediate Response</strong></td>
<td>(Tapscott, 2009)</td>
</tr>
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<td></td>
<td>(Solomon, 2009)</td>
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<tr>
<td>-Fast information exchange through instant</td>
<td></td>
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<td>interaction and real time response</td>
<td></td>
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<tr>
<td>-Favours information sharing</td>
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New humankind: Active seniors

Six features of active seniors, positive on the society

<table>
<thead>
<tr>
<th>Table 6-1 The Characteristics of Active seniors</th>
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</thead>
<tbody>
<tr>
<td>Characteristics:</td>
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<tr>
<td>O1) Healthy life</td>
</tr>
<tr>
<td>-Pursues healthy life</td>
</tr>
<tr>
<td>-High demand for food/exercise control and</td>
</tr>
<tr>
<td>health care services</td>
</tr>
<tr>
<td>References:</td>
</tr>
<tr>
<td>(Wolfe and Snyder, 2003)</td>
</tr>
<tr>
<td>(Friis, 1991)</td>
</tr>
<tr>
<td>O2) Wealthy</td>
</tr>
<tr>
<td>-High income level</td>
</tr>
<tr>
<td>-Well prepared for elderly life</td>
</tr>
<tr>
<td>-High purchasing power</td>
</tr>
<tr>
<td>References:</td>
</tr>
<tr>
<td>(Iyer and Eastman, 2006)</td>
</tr>
<tr>
<td>(MGI, 2008)</td>
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<td>(Silver Business in Japan, 2010)</td>
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<td>O3) Personal development</td>
</tr>
<tr>
<td>-Tries to continue an independent life</td>
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<tr>
<td>-Lifelong education</td>
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<tr>
<td>-High interest in cultural life and youth</td>
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<tr>
<td>References:</td>
</tr>
<tr>
<td>(Leventhal, 1997) (Wolfe &amp; Snyder, 2003)</td>
</tr>
<tr>
<td>O4) Value consumption</td>
</tr>
<tr>
<td>-Positive consumption tendency for perceived</td>
</tr>
<tr>
<td>valuables</td>
</tr>
<tr>
<td>References:</td>
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<tr>
<td>(Schiffman, 1972) (Schiffman and Kanuk, 1987)</td>
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<tr>
<td>(Gilly and Zeithaml, 1985)</td>
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<tr>
<td>(Zeithaml and Gilly, 1987)</td>
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<tr>
<td>(Silvers, 1997) (Healy, 2004)</td>
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<td>O5) Working desire</td>
</tr>
<tr>
<td>-Desires continuous labour activity</td>
</tr>
<tr>
<td>References:</td>
</tr>
<tr>
<td>(MGI, 2008)</td>
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<tr>
<td>O6) Relation</td>
</tr>
<tr>
<td>-Tries to build relationships with new people</td>
</tr>
<tr>
<td>Increases leisure activities, such as</td>
</tr>
<tr>
<td>religion/hobby/friendship</td>
</tr>
<tr>
<td>References:</td>
</tr>
<tr>
<td>(Leventhal, 1997) (Schiffman and Sherman, 1991)</td>
</tr>
</tbody>
</table>
New humankind: Active seniors

‘New-Age Elderly’, economically active population with economic power, self-confidence, and high control of their own lives.

In US, mostly from the baby-boomer generation, born between 1945 and 1964, different from silent generation.

- Silent generation: born between 1925 and 1944, and earns lower income.
Value-creation system of the knowledge-based society

The value-creation system of the traditional industrial society:

- Virtuous cycle of expanded reproduction:
  Expands every cycle by capital accumulation and technology innovation, increasing supply and demand.
- Creates accelerating economic growth.
- Fundamentally different from the simple reproduction system of the agricultural society.

In Knowledge-based society, transformation of the indigenous value creation system of the industrial society is expected to create new value through increasing dependence on IT, BT, and NT.
IRS production of the knowledge-based society

The increasing-returns-to-scale (IRS) production function: a certain trend in which the more the units of the input factor, the greater the output per unit of the input factor.

- IRS appears due to the substitution of material capital for knowledge capital;
- and its self-reinforcing nature in the process of knowledge accumulation as the driving force.
The fundamental difference of the knowledge-based society from the industrial society:

- Introduction of a new type of production function by the increasing rate of intangible factors, especially knowledge input.
  - Production function of knowledge input shows IRS production (Romer, 1986).
  - Knowledge factors to offset the decreasing return from physical capital (OECD, 1996).
  - Non-zero-sum effect of knowledge or information factor (Bontis et al. 1999).
  - Theoretically, characteristics of capital stock transform to an increasing marginal return above the threshold level of the rate of intangible capital (Ray et al. 2001).
6-3 Economic growth patterns of the Knowledge-based society

IRS production of the knowledge-based society

Figure 6 - 7

Expanded Reproduction System of the knowledge-based society
Economic force of the new humankinds

Technological innovation and productivity improvement resulted from:

- The Digital Natives’ characteristics of innovativeness, collaboration, and customization.
- The Active Seniors’ characteristic such as wealth and value consumption

Existing demand expansion resulted from:

- The Active Seniors’ characteristics of working desire, personal development, and relation.
Economic force of the new humankinds

New demand creation resulted from:

- The Digital Native’s characteristics of cyberspace respect and fun.
- The Active Senior’s characteristic of healthy life and wealth.

Expected reproduction system circulation speeds improvement resulted from:

- The Digital Native’s immediate responsive characteristics.
6-3 Economic growth patterns of the Knowledge-based society

Economic force of the new humankinds

Figure 6 - 8
The Impact caused by each Characteristic of the New Humankind to the Expanded Reproduction System of the Knowledge-based Society
The time-output relationship in the Knowledge-based society

The shift of input-output relationships from different DRS production functions over time:

Figure 6 - 9
Time-output Relationship with DRS Production Functions and Technical Progress
The time-output relationship in the Knowledge-based society

The shift of input-output relationships from different DRS and IRS production functions

Figure 6 - 10

Comparison of the Time-Output Relationships from the Shift of DRS and IRS Production Functions in the Case of the Same Technical Progress Rate (Appendix 6B)
The time-output relationship in the Knowledge-based society

The shift of input-output relationships from different IRS production function over time

The output curve from IRS production functions shows faster accelerating growth than the line from DRS production functions.
The time-output relationship in the Knowledge-based society

The knowledge-based society includes two types of production functions, DRS and IRS.

The acceleration of net output increase over time in this society will be faster than the speed observed in the traditional industrial society following only DRS production.

The more the economy based on the IRS production function expands, the faster the acceleration of economic growth will be.
The time-output relationship in the Knowledge-based society

In addition to the technological and production characteristics of the knowledge-based society, the social aspect characterized by the new humankind will accelerate economic growth.

Figure 6 - 12

Faster Acceleration of Output Growth in the Knowledge-based Society
The time-output relationship in the Knowledge-based society

Figure 6 - 13
Comparison of Output Growth between the Agricultural Society, the Industrial Society, and the Knowledge-based Society
6-4 Summary

- The knowledge-based society is differentiated from the industrial society by the emergence of a fundamentally new mode of production with rapidly increasing intangible input and output.
- The development of IT, BT, NT, and their convergent technologies improves the efficiency of the traditional industries and encourages the emergence of new industries because of rapid technical progress and IRS production functions, which increase the knowledge input and output in the economy.
- The foregoing characteristics of the knowledge-based society contribute to the growth and expansion of IRS economy.
- In addition, the new humankind, Active Seniors and Digital Natives, enable more accumulation of profit and capital, more technology innovation, more supply and new demand, and faster circulation of the expanded reproduction system, thereby accelerating the economic growth of the knowledge-based society over that of a traditional industrial society.
6-5 References


• EU KLEMS 2009. EU KLEMS Growth and Productivity Accounts. (http://www.euklems.net)

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• Groningen Growth and Development Centre (2005). 60-Industry Database. (http://www.ggdc.net)


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- World Development Indicators (2008), Database, February 2008 (http://www.worldbank.org)