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New paradigm of ICT productivity – Increasing role of un-captured GDP and growing anger of consumers

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ABSTRACT

The dramatic advancement of the Internet has led all nations to an information communication technology (ICT) driven development trajectory. This trajectory has resulted in bi-polarization between ICT growing economies and ICT advanced economies. While the former enjoys a virtuous cycle between ICT advancement and productivity increase, the later has fallen into a trap of a vicious cycle between ICT advancement and productivity decrease.

This paper identifies that this trap can be attributed to the two-faced nature of ICT in which advancement of ICT contributes to price increases due to functionality development while dramatic advancement of the Internet has resulted in price decreases due to freebies, easy copying and standardization.

Based on an empirical analysis of a customer preference shift from economic functionality to supra-functionality beyond economic value, this paper unveils the increasing conflict between captured GDP and un-captured GDP derived from the Internet advancement which promotes a freer culture, the consumption of which provides utility and happiness but cannot be captured through GDP data that measures revenue.

It was demonstrated that this conflict has led to an emerging growing anger of consumers which can be transformed into a springboard for new innovation leading to a trigger of innovation-consumption co-emergence.

1. Introduction

Dramatic advancement of the Internet beyond anticipation in terms of its diffusion speed and scope has led all nations of the world information communication technology (ICT) driven economic development trajectory (UNDP, 2007 [30]; McKinsey, 2011 [22]; WEF, 2012 [39]; MIC, 2012 [23]).

This trajectory has resulted in bi-polarization between ICT growing economies and ICT advanced economies (Zhao et al., 2013 [41], Watanabe et al., 2014a [36]). While the former economies enjoy a virtuous cycle between the advancement of ICT and increases in marginal productivity, the later economies have fallen into a trap of a vicious cycle between advances in ICT and decreases in marginal productivity.

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While a dramatic advancement of ICT provides strong anticipation of significant economic growth, contrary to such anticipation, economic growth engine, particularly in ICT advanced economies has disappeared resulting in the great stagnation (Cowen, 2011 [7]). This can be attributed to the two-faced nature of ICT in which advancement of ICT contributes to increase its marginal productivity and subsequent price increases due to new functionality development while dramatic advancement of the Internet has resulted in price decreases due to freebies, easy copying and mass standardization (Watanabe et al., 2014b [37]).

To date, significant numbers of analyses demonstrated the impacts of ICT advancement on socio-economy triggered by Nobel laurite Solow's "Productivity Paradox" (Solow, 1987 [27]) and reaction to it by Brynjolfsson (1993) [1]. This reaction was followed by more sophisticated models to tease out the relationship between ICT and productivity (Brynjolfsson and Hitt, 1996 [2], Lichtenberg, 1995 [16], Kraemer and Dedrick, 1994 [15], Dedrick and Kraemer, 2001 [8]).

By the late 1990s there were some signs that productivity in the workplace had been improved by the introduction of ICT, especially in the US. Brynjolfsson et al. found a significant positive relationship between ICT investments and productivity (Brymjolfsson and Hitt, 1998 [3], Brynlolfsson and Yang, 1999 [4]) prevailing popular consideration that there was no paradox (Triplett, 1999 [29]).

It was in the late of the first decade of this century a new paradox appeared to have emerged. This can largely be attributed to the third industrial revolution initiated by the dramatic advancement of the Internet (Rifkin, 2011 [26]). The Internet has transformed the way of peoples living, working, socializing and meeting, countries develop and grow. It has changed from a network for researchers to a day-to-day reality for billions people in two decades (McKinsey, 2011 [22]). Consequently, dramatic advancement of the Internet has changed computer initiated ICT world significantly. It has changed the entire system interactive, integrated and seamless. This interconnectedness is creating whole new opportunities for cross-industry relationships. The Internet promotes more free culture, the consumption of which provides utility and happiness to people but cannot be captured through GDP data that measure revenue (Lowrey, 2011 [17]).

Such a beyond anticipation issue derived from a dramatic advancement of the Internet and subsequence third industrial revolution inevitably emerged a new paradox of the advancement of ICT. Brynjolfsson, who first reacted to Solow's production paradox in 1993 (Brynjolfsson, 1993 [1]) raised the question: "Could technology be destroying jobs?" (Brynjolfsson and MaAfee, 2011 [5]). They then expanded to explore whether advancing ICT might be an important contributor to the current unemployment disaster. They concluded that the root cause was not a decline in innovation but an acceleration of innovation. Technological advancement had moved so fast that many people were loosing the race against the machine.

Cowen (2011) [7] analyzed similar problem. He argued that: "Contrary to the dramatic advancement of the Internet and subsequent ICT advancement, we were living through the consequence of a dramatic decrease in the rate of innovation." He argued that the consequence of slowing innovation was fewer new industries and less creative destruction, hence new jobs. He then suggested a possibility of the consequence of the two faced nature of ICT.

Notwithstanding such stimulating pioneering debates, particularly noteworthy suggestion of the two-faced nature of ICT, none has ever unveiled such nature and its impacts on the current great stagnation, particularly in ICT advanced economies (Ogden, 2012 [25], Watanabe et al., 2014b [37]).

Furthermore, while the sources of increasing discrepancy between captured GDP and un-captured GDP can partially be attributed to the shift of people's preferences from an economic functionality-driven preference captured by GDP to supra-functionality beyond economic value-driven functionality which cannot necessarily be captured by GDP (McDonagh, 2008 [21]) and this shift co-evolves with ICT advancement (Watanabe, 2009 [32]), none has ever analyzed this dynamism. Growing anger of consumers derived from increasing discrepancy in the transition (Watanabe, 2013 [35]) and a possibility of its transformation into a springboard for new innovation is another urgent issue to be solved.

In light of the significant consequence of the trap of the dramatic advancement of ICT in global economy both nations and firms that has been compelling their productivity decline resulting in the great stagnation in ICT advanced economies, its structural sources were analyzed first.

On the basis of an empirical analysis tracing the trend in marginal productivity of ICT and subsequent its prices in world ICT top leaders over the last two decades correlating with the effects of ICT, two faces of its advancement were identified.

Second, in light of the increasing role of un-captured GDP in correspond to increasing significance of supra-functionality beyond economic value in sustaining the consumption, substitution trend and its dynamism of supra-functionality beyond economic value for economic functionality as well as its co-evolution with ICT advancement were analyzed.

Since such a substitution and its co-evolution with ICT advancement can be typically observed in Japan which is extremely sensitive to institutional innovation against external shocks and crises (Hofstede, 1991 [11], Watanabe, 2009 [32]), an empirical analysis focusing on the shift in Japan's preferences over the last four decades and its correlation with the advancement of ICT was conducted.

Third, in light of the significance of growing anger of consumers as a consequence of increasing discrepancy between captured GDP and un-captured GDP in transition (Watanabe, 2013 [35]), and a possibility of transforming such anger into a springboard for new innovation, sources of the anger and its mechanism were analyzed.

On the basis of an empirical analysis on the general trend in marginal propensity to consume toward a post-excessive consumption society, possible option for

sustaining utility of consumption was identified thereby significance of harness the vigor of hidden counterparts, consumers was demonstrated and significance of innovation-consumption co-emergence was postulated.

This study is thus expected to explore significant insight in elucidating the institutional sources of the resilience in the transition from the paradigm of captured GDP to that of un-captured GDP.

Section 2 reviews global bi-polarization trends both in countries and global ICT firms. Section 3 elucidates trap of ICT advancement and its possible source. Section 4 analyzes new paradox of productivity focusing on the increasing discrepancy between captured GDP and un-captured GDP. Section 5 unveils growing anger of consumers. Section 6 briefly summarizes noteworthy findings, policy implications and also the points for future works.

2. Global bi-polarization

2.1. ICT driven logistic growth trajectory

Dramatic advancement of the Internet beyond anticipation in terms of its diffusion speed and scope has led all nations of the world, both advanced and growing nations, ICT driven economic development trajectory (UNDP, 2007 [30]; McKinsey, 2011 [22]; WEF, 2012 [39]; MIC, 2012 [23]).

McKinsey pointed out the significant feature of such trajectory as follows (Mckinsey, 2011 [22]):

(i) The Internet is big and continues to grow and reach everywhere,
(ii) The Internet is still in its infancy, and the weight of the Internet in GDP varies drastically, even among countries at the same stage of development,
(iii) The Internet is a critical element of growth,
(iv) The maturity of the Internet correlates with rising living standards,
(v) The internet is a powerful catalyst for job creation,
(vi) The Internet drives economic modernization, and
(vii) The impact of the Internet goes beyond GDP, generating astonishing consumer surplus.

Consequently, economic development trajectory of nations as well as global firms can be depicted by the following logistic growth function[1] (Zhao et al., 2013 [41], Watanabe et al., 2014a [36]):

$$W = \frac{N}{1 + be^{-aI}} \tag{1}$$

[1] Outcome of economic development can be depicted by the following logistic growth function initiated by time trend t (Griliches, 1957 [10]; Mansfield, 1958 [18]):$\frac{dW}{dt} = aW\left(1 - \frac{W}{N}\right)$ leading to $W = \frac{N}{1+be^{-at}}$Given that I is proportional to t (see Footnote[3]), this logistic growth function can be depicted by equation (1).

Table 1
ICT driven economic development trajectory in 100 countries (2011).

N	a	b	c	d	
57,239 (9.62)	1.68 (7.58)	2697.28 (9.80)	46,434 (14.54)	−12913 (−5.25)	adj. R^2 0.885

Y/P: GDP per capita, N: carrying capacity, NRI: Networked readiness index, D_1, D_2: dummy variables (D_1: 8 nations with extreme lower level of NRI than V/P (Qatar, Luxemburg, Kuwait, Brunei, UAE, Norway, Italy and Greece) = 1, other nations = 0; D_2: 8 nations with extreme higher level of NRI than V/P (Sweden, Israel, New Zealand, Finland, Jordan, Korea, Estonia and Malaysia) = 1, other nations = 0)and a, b, c, d: coefficients.

where W: outcome of economic development (e.g., GDP per capita (Y/P) for countries (Y: GDP and P: population), and sales (S) for global firms), I: proxy of ICT advancement, N: carrying capacity, and a, b: coefficients.

I can be represented by Networked Readiness Index NRI[2] for countries (WEF, 2012), and technology stock T[3] for global ICT firms (Watanabe et al., 2014a).

Thus, development trajectories in 100 countries and 500 global ICT firms[4] can be estimated as Table 1, Fig. 1 and Table 2, Fig. 2, respectively.

$$\frac{Y}{P} = \frac{N}{1 + be^{-aNRI}} + cD_1 + dD_2$$

Fig. 1 demonstrates that economic development trajectory of majority of 100 countries follows ICT driven logistic growth initiated by NRI.

$$S = \frac{N}{1 + be^{-aT}} + cD$$

Fig. 2 also demonstrates that development trajectory of majority of 500 global ICT firms follows ICT driven logistic growth initiated by ICT stock.

2.2. Bi-polarization in ICT economy

Since logistic growth trajectory can be developed to a bi-polarization trajectory as follows (Tokumasu and Watanabe, 2008 [28]), foregoing analysis suggests that ICT driven economic development trajectory in 100 nations and also in 500 global ICT firms split into bi-polarization as demonstrated in Figs. 3 and 4.

[2] Networked Readiness Index (NRI) measured by the World Economic Forum (WEF) measures worldwide advancement of ICT by computing following four dimensions:(i) Environment (Political and regulatory environment, business and innovation environment),(ii) Readiness (Infrastructure, digital content, and affordability),(iii) Usage (Individual usage, business usage and government usage), and (iv) Impact (Economic impact and social impact).

[3] Technology stock T at time t can be measured by the following equation:$T_t = R_{t-m} + (1 - \rho)T_{t-1}$ and $T_0 = R_{1-m}/(\rho + g)$, then, $T_t = R_t(1+g)^{1-m}/(\rho + g) \approx R_t(1 + (1 - m)g)/(\rho + g)$ When $g << 1$, $T_t \approx R_t/(\rho + g)$ and approximated proportional to time trend t (Watanabe, 2009 [32]).where R_t: R&D expenditure at time t, m: lead time between R&D and commercialization, ρ: rate of obsolescence of technology and g: growth rate of R&D expenditure at the initial stage.

[4] World top 500 firms by R&D expenditure in the field of ICT relevant manufacturing and services (not including fixed line and mobile telecommunications and their services).

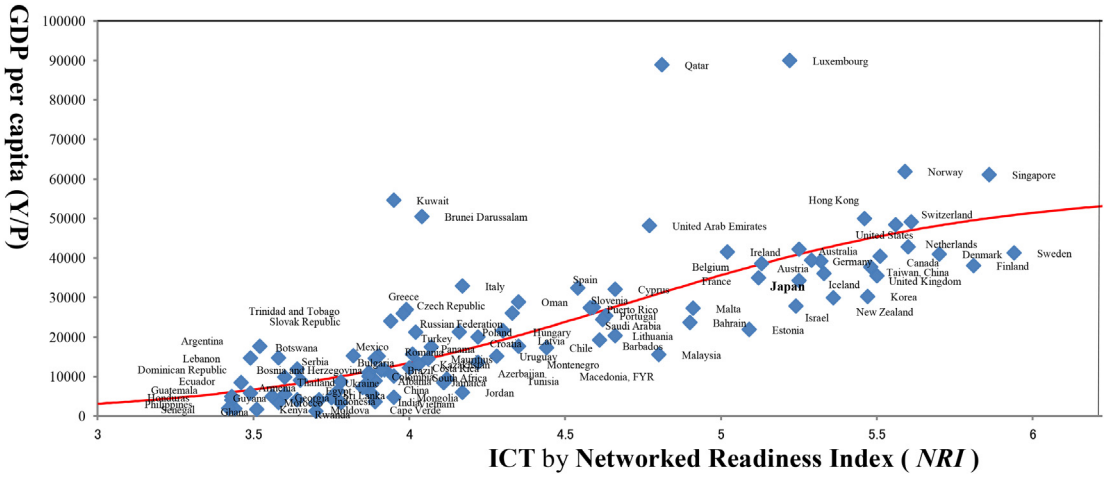


Fig. 1. ICT driven economic development trajectory in 100 countries (2011).
Sources: The Global Information Technology Report 2012 (World Economic Forum, 2012), World Economic Outlook Database (IMF, 2012).

Table 2
ICT driven development trajectory in 500 global ICT firms (2010).

N	*a*	*b*	*c*	
42,668	0.002	22.61	45,184	adj. R^2 0.885
(28.31)	(26.02)	(10.23)	(30.32)	

S: sales, *N*: carrying capacity, *T*: technology stock, *D*: dummy variables. (Hon Hai Precision, Hewlett Packard, Samsung Electronics, Dell, Apple, LG Electronics, Hitachi, Quanta Computers, Siemens, IBM = 1 and other 490 firms = 0), and *a*, *b*, *c*: coefficients.

$$\frac{dW}{dt} = aW\left(1-\frac{W}{N}\right) = \frac{aN}{1+be^{-at}}\left(1-\frac{1}{1+be^{-at}}\right)$$
$$= \frac{aN}{(1+be^{-at})}\cdot\frac{be^{-at}}{(1+be^{-at})} = \frac{aN}{(1+be^{-at})}\cdot\frac{1}{(1+be^{at})}$$
$$= \frac{aN}{\left(2+be^{-at}+\dfrac{1}{be^{-at}}\right)} \quad (2)$$

$$\frac{aN}{\dfrac{dW}{dt}} = 2+be^{-at}+\frac{1}{be^{-at}} \quad (3)$$

$$y = (1+x)+\left(1+\frac{1}{x}\right) \quad y\equiv\frac{aN}{\dfrac{dW}{dt}},\ x\equiv be^{-at} \quad (4)$$

Under ICT driven economy where ICT initiated logistic growth trajectory governs,

$$W = F(t) = F(I) \text{ and } \frac{dW}{dt} = \frac{dW}{dI}=\frac{\partial W}{\partial I}\cdot\frac{dI}{dI}=\frac{\partial W}{\partial I}.$$

Thus,

$$x = be^{-aI},\ y = \frac{aN}{\dfrac{\partial W}{\partial I}} \quad (5)$$

x and *y* in Figs. 3 and 4 signify ICT (*NRI* or technology stock) and marginal productivity of technology increase toward the origin of the coordinate axes.

Consequently, 100 nations have split into two economies as demonstrated in Table 3. While ICT growing 70 nations (nations with *NRI* ranking 31 to 100 in Table 3) have been enjoying a virtuous cycle between ICT advancement and its marginal productivity increases as generally anticipated (Zhao et al., 2009 [42]), ICT advanced 30 nations (*NRI* ranking 1–30) have fallen into a pit of a vicious cycle as ICT advancement decreases its marginal productivity against anticipation.

Similarly, high R&D intensive firms out of 500 global ICT firms (21 firms in 2010) have fallen in a pit of a vicious cycle between R&D investment centered by ICT and its marginal productivity as the former increase results in declining the later while remaining firms (479 firms in 2010) have been enjoying a virtuous cycle between them as R&D increase leads to productivity increase.

Table 4 demonstrates such contrast. ICT advanced firms represented by top 21 global ICT firms with respect to R&D investment in 2010 (high R&D intensive firms) including such ICT giant as Microsoft, Samsung and Nokia have fallen in a pit of a vicious cycle between their R&D investment increase and marginal productivity of technology decline.

2.3. Consequence of the bi-polarization

While a dramatic advancement in ICT provides strong anticipation of significant economic growth in ICT advanced economies, contrary to such anticipation, their economic growth engine has disappeared except Singapore (which ranks the world second by NRI in 2011). Fig. 5 traces trends in real GDP increase rate in countries in ICT advanced economies by comparing those in ICT growing economies such as BRIC over the last half century encompassing industrial society (1961–1990), information society (1991–2000) and after net bubble bursting (2001–2010).

Looking at the figure we note clearly that contrary to conspicuous economic growth in ICT growing economies, GDP growth rates in countries in ICT advanced economies in this century, particularly the latter half of the first decade

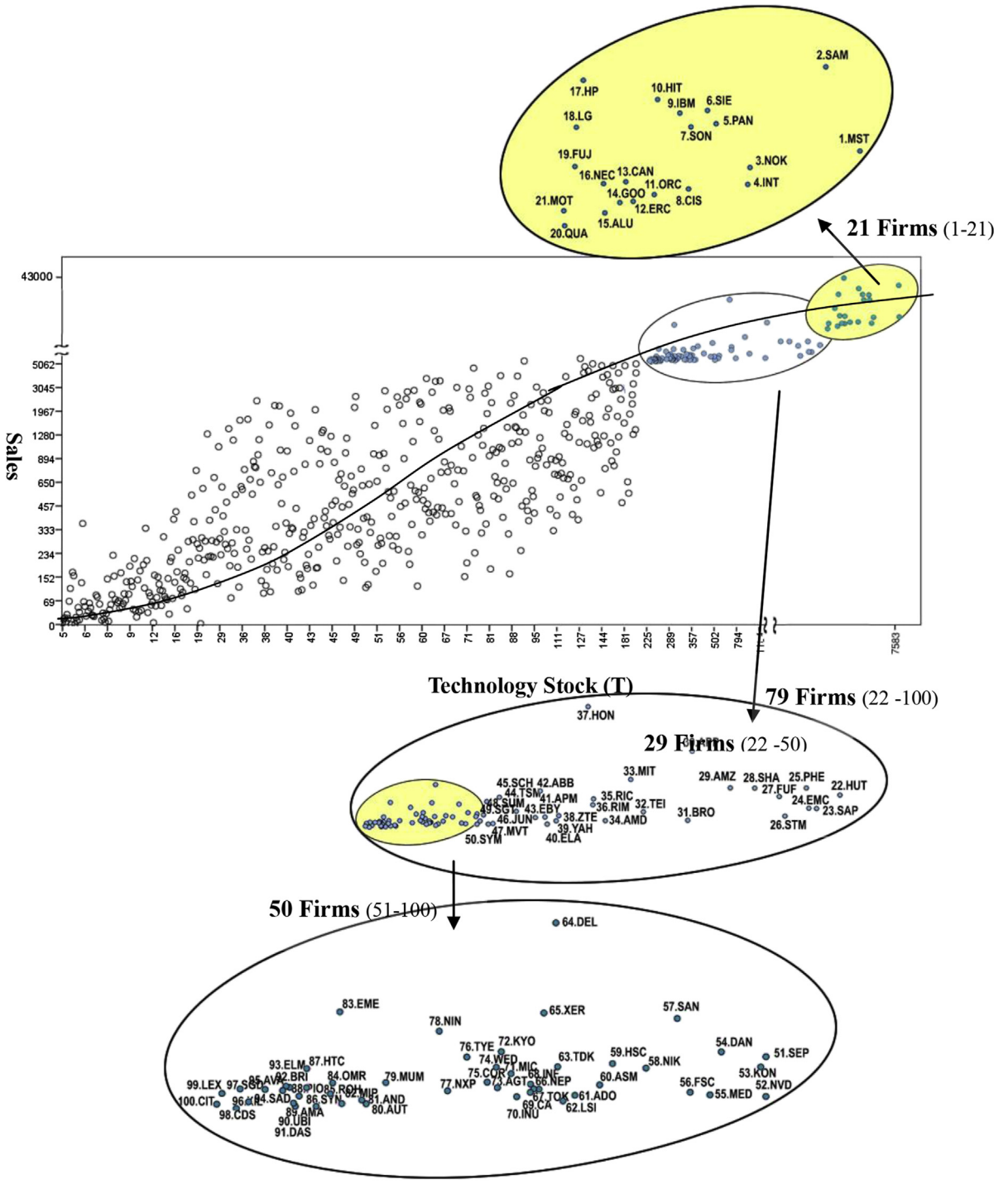


Fig. 2. ICT driven development trajectory in 500 global ICT firms (2010).
Source: Economics of Industrial Research and Innovation (EU, 2011).

of this century have demonstrated the great stagnation (Cowen, 2011 [7]) except Singapore.

Such a contrast is not only the great stagnation in national level but also in the competition market in global ICT firms. Fig. 6 demonstrates average growth rate of sales in top 100 R&D intensive firms over the period 2009–2011 (after the Lehman shock). Looking at the figure we note that while 62 firms out of top 100 R&D intensive firms maintained higher than 5% sales growth rate, only 10 out of 21 ICT advanced firms represented by high R&D intensive firms (HRIFs) maintained this level (ratio of HRIFs is 16.1%). 17 firms demonstrated between 5 and 0% sales growth rate

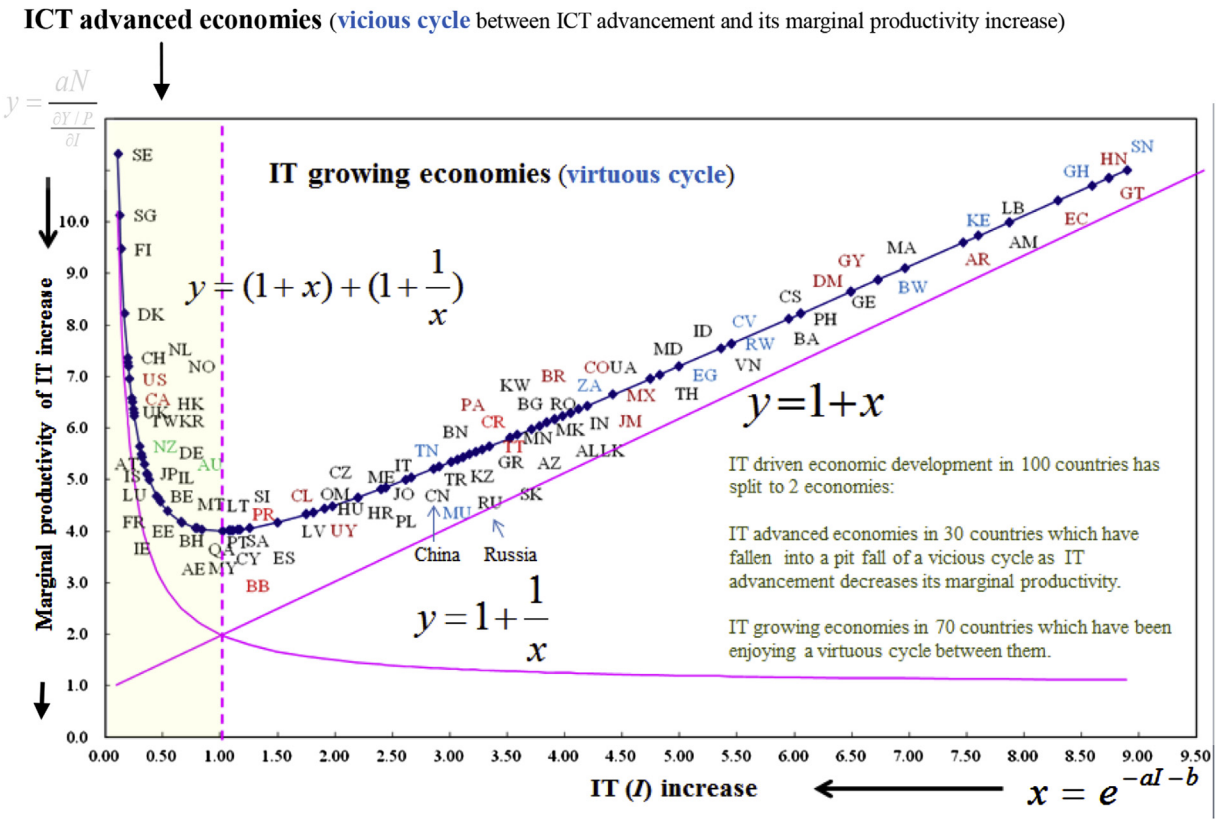


Fig. 3. Bi-Polarization of ICT driven economic development trajectory in 100 nations (2011).
Sources: Same as Fig. 1.

in which 4 firms are HRIF (ratio of HRIFs is 23.5%). 21 firms suffered negative growth including 7 HRIFs as Sony, Alcatel-Lucent, Siemens, NEC, Nokia, LG and Motorola (ratio of HRIFs is 33.3%).

This demonstrates that ICT advanced firms suffer more serious stagnation than ICT growing firms and also demonstrates great stagnation in ICT advanced firms as a consequence of bi-polarization.

3. Trap of ICT advancement and its possible source

3.1. Hypothesis

Foregoing analyses prompt us the following hypothetical view with respect to the structural source of the bi-polarization in ICT economy and its possible countermeasure.

3.1.1. Two faces of ICT

As reviewed in the preceding section, while advancement of ICT led ICT driven global economy, it resulted in bi-polarization between ICT advanced economies and ICT growing economies in both nations and global ICT firms. Under such circumstances, certain ICT advanced resilient[5] firms manage to maintain sustainable growth while the majority of ICT advanced firms suffer the great stagnation as a consequence of the trap of ICT advancement. Success in resilient ICT firms can largely be attributed to efficient functionality development by maximizing R&D profitability (e.g., Apple) and open innovation (e.g., Canon) while minimizing the possibility of risk taking by restraining elasticity of such profitability (e.g., Apple) and depending on spillover effect (e.g., Canon) (Watanabe et al., 2014a [36]).

Given that these business models enable resilient firms to maintain sustainable growth despite fatal nature of the great stagnation subsequent to the high dependency on the advancement of ICT centered by the dramatic advancement of the Internet with freebies, easy copying and mass standardization nature, two faces of ICT as illustrated in Fig. 7 can be postulated as a possible source of the trap of ICT advancement (Watanabe et al., 2014b [37]).

Advancement of ICT generally contributes to enhance prices of technology by increasing new functionality development. However, the dramatic advancement of the Internet reacts to decrease prices of technology due to its nature by freebies, easy copying and mass standardization as demonstrated in Figs. 8 and 9.

As demonstrated in Fig. 8, while the advancement of ICT driven by the dramatic advancement of the Internet emerges huge opportunities leading to price increases as typically observed in Amazon's growing empire (Fig. 9), it

[5] Here resilience can be defined as "*ability to transform external shocks into a springboard for further advancement by recovering from and adjusting smoothly through prompt and agile reaction*" (Watanabe et al., 2014a [36]).

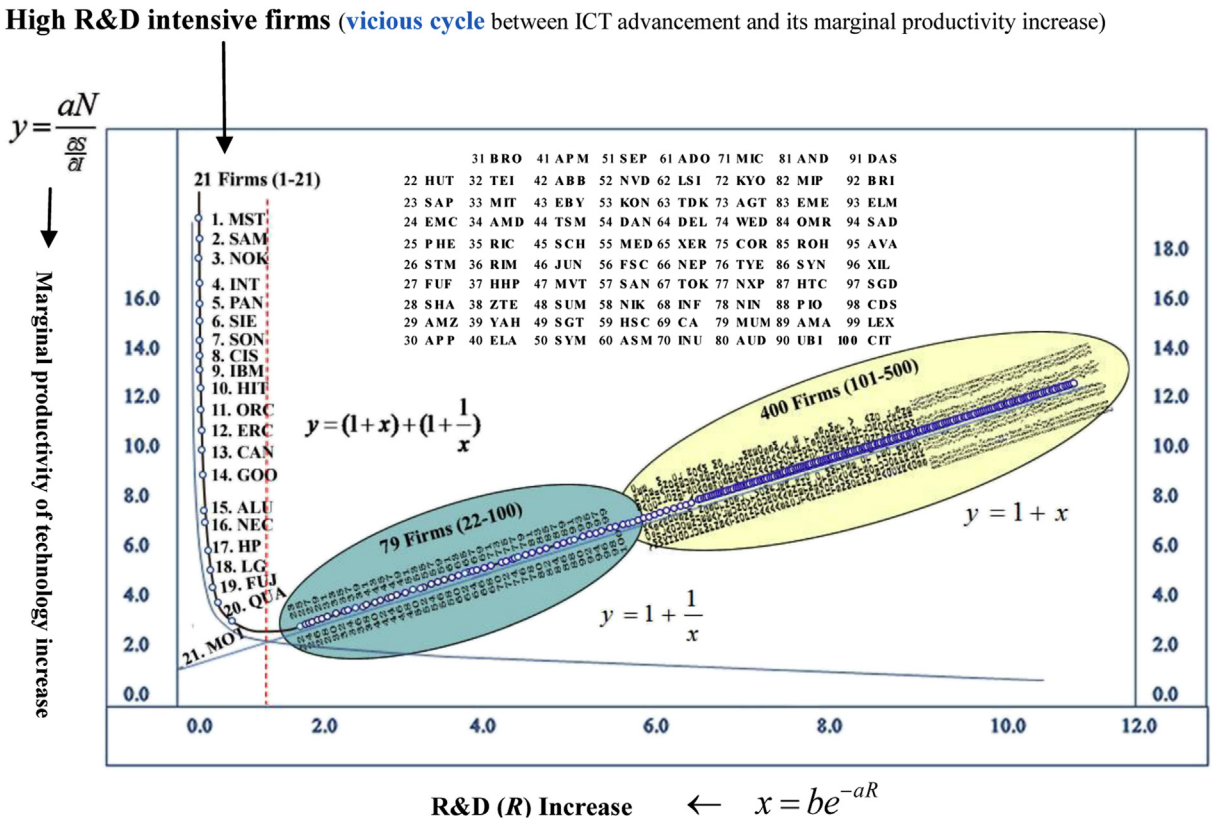


Fig. 4. Bi-polarization of ICT driven development trajectory in 500 global ICT firms (2010).
Source: Same as Fig. 2.

Table 3
Bi-polarization of development trajectories by networked readiness index in 100 nations (2011).

1 SE Sweden 5.94	26 MT Malta 4.91	51 CN China 4.11	76 MX Mexico 3.82
2 SG Singapore 5.86	27 BH Bahrain 4.90	52 TR Turkey 4.07	77 TH Thailand 3.78
3 FI Finland 5.81	28 QA Qatar 4.81	53 MU Mauritius 4.06	78 MD Moldova 3.78
4 DK Denmark 5.70	29 MY Malaysia 4.80	54 BN Brunei Darussalam 4.04	79 EG Egypt 3.77
5 CH Switzerland 5.61	30 AE United Arab Emirates 4.77	55 KZ Kazakhstan 4.03	80 ID Indonesia 3.75
6 NL Netherlands 5.60	31 LT Lithuania 4.66	56 RU Russian Federation 4.02	81 CV Cape Verde 3.71
7 NO Norway 5.59	32 CY Cyprus 4.66	57 PA Panama 4.01	82 RW Rwanda 3.70
8 US United States 5.56	33 PT Portugal 4.63	58 CR Costa Rica 4.00	83 VN Vietnam 3.70
9 CA Canada 5.51	34 SA Saudi Arabia 4.62	59 GR Greece 3.99	84 BA Bosnia and Herzegovina 3.65
10 UK United Kingdom 5.50	35 BB Barbados 4.61	60 TT Trinidad and Tobago 3.98	85 CS Serbia 3.64
11 TW Taiwan, China 5.48	36 PR Puerto Rico 4.59	61 AZ Azerbaijan 3.95	86 PH Philippines 3.64
12 KR Korea, Rep. 5.47	37 SI Slovenia 4.58	62 KW Kuwait 3.95	87 DM Dominican Republic 3.60
13 HK Hong Kong SAR 5.46	38 ES Spain 4.54	63 MN Mongolia 3.95	88 GE Georgia 3.60
14 NZ New Zealand 5.36	39 CL Chile 4.44	64 SK Slovak Republic 3.94	89 BW Botswana 3.58
15 IS Iceland 5.33	40 OM Oman 4.35	65 BR Brazil 3.92	90 GY Guyana 3.58
16 DE Germany 5.32	41 LV Latvia 4.35	66 MK Macedonia, FYR 3.91	91 MA Morocco 3.56
17 AU Australia 5.29	42 CZ Czech Republic 4.33	67 RO Romania 3.90	92 AR Argentina 3.52
18 JP Japan 5.25	43 HU Hungary 4.30	68 AL Albania 3.89	93 KE Kenya 3.51
19 AT Austria 5.25	44 UY Uruguay 4.28	69 IN India 3.89	94 AM Armenia 3.49
20 IL Israel 5.24	45 HR Croatia 4.22	70 BG Bulgaria 3.89	95 LB Lebanon 3.49
21 LU Luxembourg 5.22	46 ME Montenegro 4.22	71 LK Sri Lanka 3.88	96 EC Ecuador 3.46
22 BE Belgium 5.13	47 JO Jordan 4.17	72 ZA South Africa 3.87	97 GH Ghana 3.44
23 FR France 5.12	48 IT Italy 4.17	73 CO Colombia 3.87	98 GT Guatemala 3.43
24 EE Estonia 5.09	49 PL Poland 4.16	74 JM Jamaica 3.86	99 HN Honduras 3.43
25 IE Ireland 5.02	50 TN Tunisia 4.12	75 UA Ukraine 3.85	100 SN Senegal 3.42

1–30: ICT advanced economies (vicious cycle) and 31–100: ICT growing economies (virtuous cycle).
Source: The Global Information Technology Report 2012 (World Economic Forum, 2012).

Table 4
Bi-polarization in 500 global ICT firms in 2010 (Top 100 by R&D level order).

1 **MST** Microsoft	26 **STM**STMicroelectronics	51 **SEP** Seiko Epson	76 **TYE** Tyco Electronics
2 **SAM** Samsung Electronics	27 **FUF** FUJIFILM	52 **NVD** NVIDIA	77 **NXP** NXP Semiconductors
3 **NOK** Nokia	28 **SHA** Sharp	53 **KON** Konica Minolta	78 **NIN** Nintendo
4 **INT** Intel	29 **AMZ** Amazon.com	54 **DAN** Danaher	79 **MUM** Murata Manufacturing
5 **PAN** Panasonic	30 **APP** Apple	55 **MED** MediaTek	80 **AUT** Autodesk
6 **SIE** Siemens	31 **BRO** Broadcom	56 **FSC** Freescale Semiconductor	81 **AND** Analog Devices
7 **SON** Sony	32 **TEI** Texas Instruments	57 **SAN** Sanyo Electric	82 **MIP** Maxim Int. Products*
8 **CIS** Cisco Systems	33 **MIT** Mitsubishi Electric	58 **NIK** Nikon	83 **EME** Emerson Electric
9 **IBM** IBM	34 **AMD** Advanced Micro Devices	59 **HSC** Hynix Semiconductor	84 **OMR** Omron
10 **HIT** Hitachi	35 **RIC** Ricoh	60 **ASM** ASML	85 **ROH** Rohm
11 **ORC** Oracle	36 **RIM** Research In Motion	61 **ADO** Adobe Systems	86 **SYN** Synopsys
12 **ERC** Ericsson	37 **HON** Hon Hai Precisiion Ind.	62 **LSI** LSI	87 **HTC** HTC
13 **CAN** Canon	38 **ZTE** ZTE	63 **TDK** TDK	88 **PIO** Pioneer
14 GOO Google	39 **YAH** Yahoo!	64 **DEL** Dell	89 **AMA** Amadeus
15 **ALU** Alcatel-Lucent	40 **ELA** Electronic Arts	65 **XER** Xerox	90 **UBI** UBIsoft Entertainment
16 **NEC** NEC	41 **APM** Applied Materials	66 **NEP** NetApp	91 **DAS** Dassault Systems
17 **HP** Hewlett-Packard	42 **ABB** ABB	67 **TOK** Tokyo Electron	92 **BRI** Brother Industries
18 **LG** LG	43 **EBY** eBay	68 **INF** Infineon Technologies	93 **ELM** Elpida Memory
19 **FUJ** Fujitsu	44 **TSM** Taiwan Semiconductor	69 **CA** CA	94 **SAD** SanDisk
20 **QUA** Qualcomm	45 **SCH** Schneider	70 **INU** Intuit	95 **AVA** Avaya
21 **MOT** Motorola	46 **JUN** Juniper Networks	71 **MIC** Micron Technology	96 **XIL** Xilinx
22 **HUT** Huawei Technologies	47 **MVT** Marvell Technology	72 **KYO** Kyocera	97 **SGD** SunGard Data Systems
23 **SAP** SAP	48 **SUM** Sumitomo Technology	73 **AGT** Agilent Technologies	98 **CDS** Cadence Design Systems
24 **EMC** EMC	49 **SGT** Seagate Technology	74 **WED** Western Digital	99 **LEX** Lexmark
25 **PHE** Philips Electronics	50 **SYM** Symantec	75 **COR** Corning	100 **CIT** Citrix Systems

Source: Same as Fig. 2.

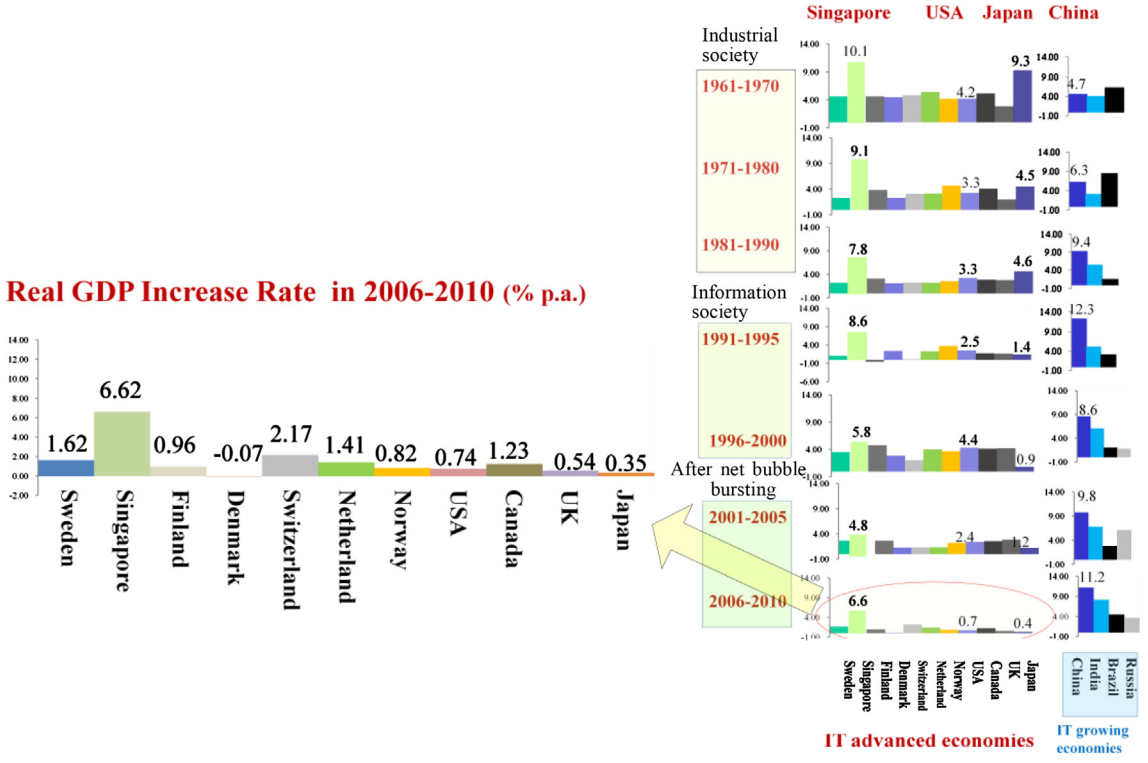


Fig. 5. Stagnation in economic growth in ICT advanced economies (2006–2010).
Source: World Economic Outlook Database (IMF, annual issues).

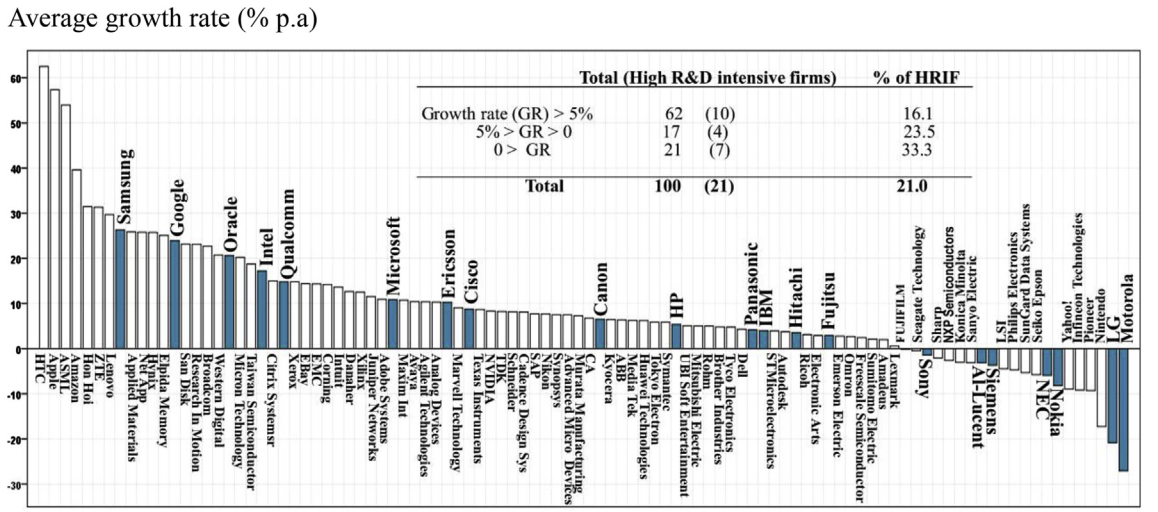


Fig. 6. Stagnation in sales growth in ICT advanced firms – sales growth rate of top 100 R&D intensive firms (2009–2011): average growth rate (% p.a). Source: Same as Fig. 2.

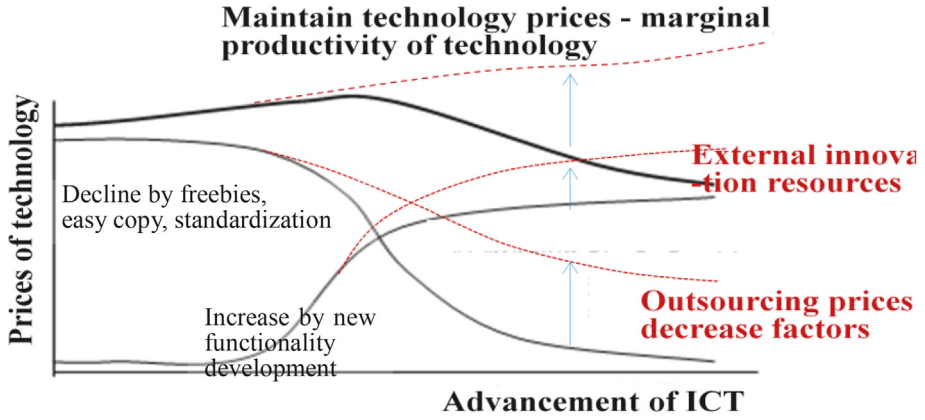


Fig. 7. ICT's identical two faces.

urges significant challenges against price decreases due to marginal productivity decline, innovator's dilemma and consumer preferences shift.

Consequently, prices of technology in highly ICT advanced economies may change to decreasing trend resulting in decreasing their growth rate as outlined in Fig. 10. This can be the structural source of the trap of ICT advancement compelling ICT advanced nations/firms suffering a vicious cycle between advancement of ICT and its marginal productivity[6] decline.

Given the foregoing circumstances, ICT advanced economies endeavor should focus on accelerating prices increase by means of successive efficient new functionality development while minimizing prices decrease factors by outsourcing them to other parties. Noteworthy accomplishments demonstrated by resilient global ICT firms support this postulate and provide us constructive suggestions supportive to constructing a new business model satisfying both efficiency and resilience in a global competitive market.

3.1.2. *Co-evolutionary acclimatization*

These accomplishments suggest the following co-evolutionary acclimatization system enabling both ICT advanced and growing economies harness the vigor of counterparts as a possible countermeasure to the trap of ICT (Watanabe, 2013). While ICT advanced economies enable further advancement of ICT, it results in declining its marginal productivity. Thus, such advancement should be addressed to the advancement of ICT growing economies which enjoy a virtuous cycle between its advancement and

[6] Given that the firms seek to profit maximum in the competitive market, marginal productivity of technology corresponds to relative price of technology (ratio of technology prices and prices of product).

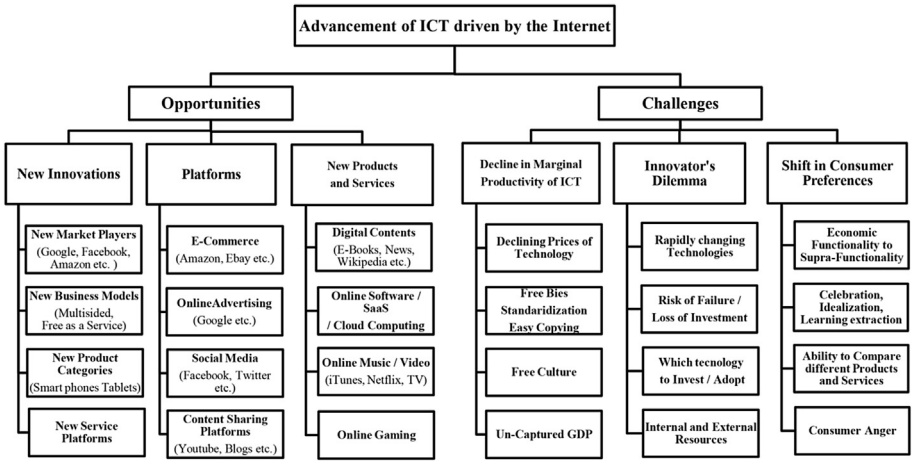


Fig. 8. Structure of the two faces of the advancement of ICT.

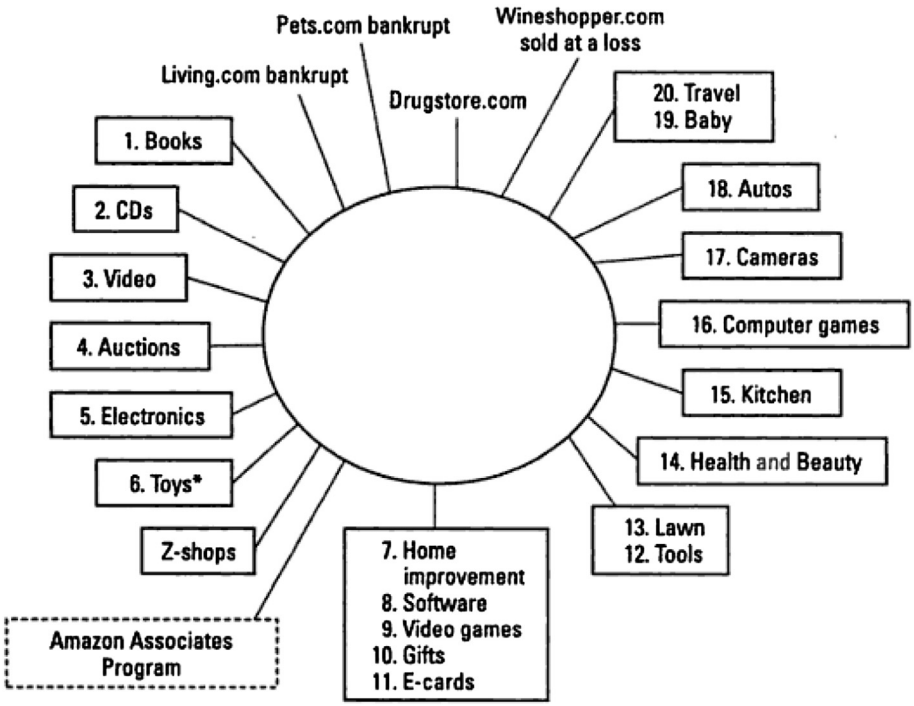


Fig. 9. Amazon's growing empire.
Source: Kenney, The Growth and Development of the Internet in the United States (2003) [14].

marginal productivity increase leading to sustainable growth as reviewed in Fig. 11.

3.2. Demonstration

Aiming at demonstrating the foregoing hypothetical view, an empirical analysis decomposing the prices of ICT was attempted.[7]

3.2.1. Measurement of ICT prices

Production function encompassing production factors contributing to GDP (Y) as labor (L), non-ICT capital services (n-ICT), ICT capital services (ICT), and other factors contributing to growth (T_r) can be depicted as follows[8]:

[7] This subsection is developed based on Watanabe et al. (2014b) [37].

[8] This production function concept and subsequent data for the analysis are based on "The Conference Board Total Economy Database™, *January 2013*, http://www.conference-board.org/data/economydatabase/. Retrieved 5 January 2014.

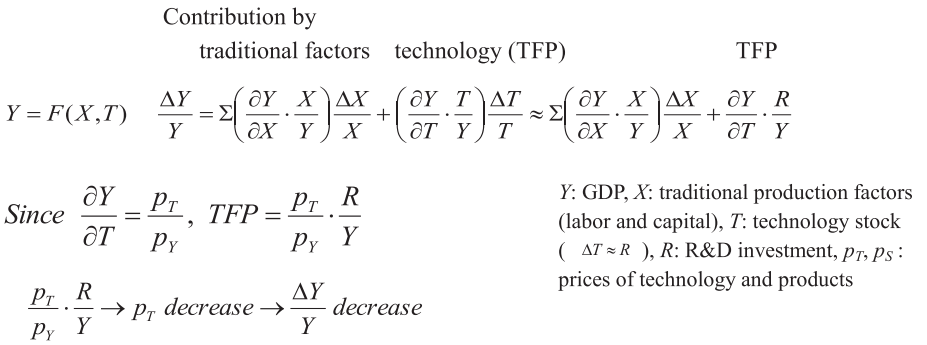


Fig. 10. Scheme of the great stagnation due to the decrease in technology prices.

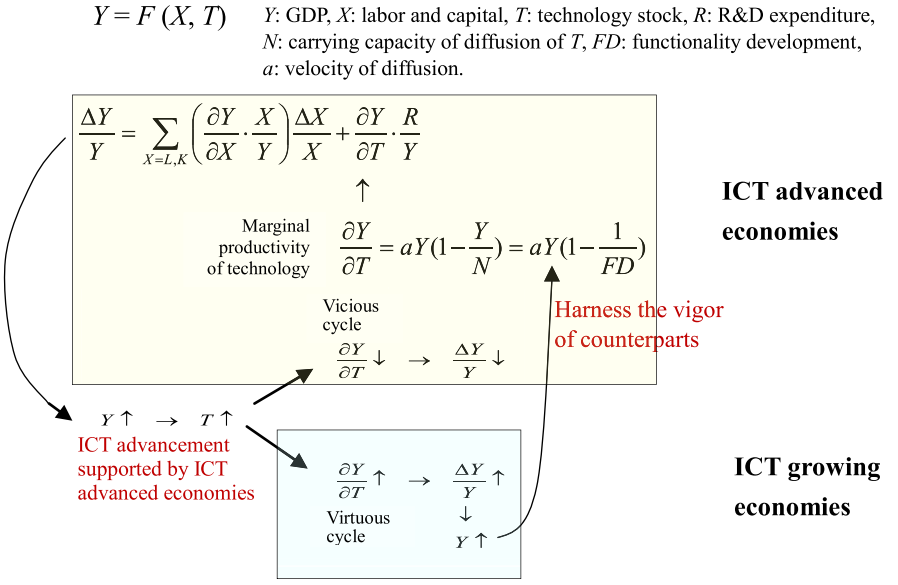


Fig. 11. Scheme of co-evolutionary acclimatization in global ICT firms.

$$Y = F(L,\ n - \mathrm{ICT},\ \mathrm{ICT},\ T_r) \tag{6}$$

where ICT encompasses capital services provided by assets derived from the advancement of ICT and embodying into computer hardware and equipment, telecommunication equipment, and computer software and services, while T_r accounts for the changes in output not caused by changes in other production factors.[9]

Contribution of ICT to GDP growth φ can be depicted as follows:

$$\varphi = \left(\frac{\partial Y}{\partial I}\cdot\frac{I}{Y}\right)\frac{\Delta I}{I} \tag{7}$$

where I denotes ICT and $\Delta I = \mathrm{d}I/\mathrm{d}t$.

From equation (7), marginal productivity of ICT can be depicted as follows:

$$\frac{\partial Y}{\partial I} = \frac{\varphi}{\frac{I}{Y}\cdot\frac{\Delta I}{I}} \tag{8}$$

This is equivalent to relative prices of ICT in the profit maximum behavior under the competitive circumstance as follows:

$$\frac{\partial Y}{\partial I} = p_I = \frac{p_{\mathrm{ICT}}}{p_Y} \tag{9}$$

Therefore, prices of ICT can be measured by equations (8) and (9). All data consisting of these equations are available in the database indicated in the footnote[8].

[9] While in the production function in Figs. 10 and 11 all stock of technological advancement including ICT capital services (excluding those services by obsolescent ICT) are treated by technology stock T, in the production function depicted by equation (6), with the aim to identify the identical contribution of ICT, ICT is treated independently by extracting from T in Figs. 10 and 11. Technology stock T_r in equation (6) accounts for the changes in output not caused by changes in other production factors including ICT and obsolescent ICT is categorized in *n-ICT*.

3.2.2. Decomposition of ICT prices

Given the ICT's identical two faces as illustrated in Fig. 7 and prices increase by new functionality development is governed by ICT advancement as a whole in a logistic growth way while prices decline is initiated by the increase in the Internet dependency in a reverse logistic growth way (Watanabe et al., 2001 [31]), trajectory of ICT prices can be depicted by the following equation:

$$p_I = \frac{N}{1+b_i e^{-a_i I}} + \frac{N}{1+b_j e^{a_j J}} \tag{10}$$

where J: dependency on the Internet, N: carrying capacity[10], a_i, a_j and b_i, b_j: diffusion velocity of I and J, and initial stage of diffusion of I and J, respectively.

Equation (10) can be developed as follows:

$$\begin{aligned}
\frac{p_I}{N} &= \frac{1+b_j e^{a_j J}+1+b_i e^{-a_i I}}{(1+b_i e^{-a_i I})(1+b_j e^{a_j J})} = \frac{2+b_j e^{a_j J}+b_i e^{-a_i I}}{1+b_j e^{a_j J}+b_i e^{-a_i I}+b_i b_j e^{-a_i I} e^{a_j J}} \approx \frac{2+b_j e^{a_j J}+b_i e^{-a_i I}}{1+b_i b_j+b_j e^{a_j J}+b_i e^{-a_i I}} \\
&= 1+\frac{1-b_i b_j}{1+b_i b_j+b_j e^{a_j J}+b_i e^{-a_i I}} \quad (\because a_i I = a_j J) \\
\frac{p_I}{N} - 1 &= \frac{1-b_i b_j}{1+b_i b_j+b_j e^{a_j J}+b_i e^{-a_i I}} \\
\frac{N}{N-p_I} &= \frac{1}{1-\frac{p_I}{N}} = -\frac{1+b_i b_j}{1-b_i b_j} - \frac{b_j e^{a_j J}}{1-b_i b_j} - \frac{b_i e^{-a_i I}}{1-b_i b_j} \approx -\frac{1+b_i b_j}{1-b_i b_j} - \frac{b_j}{1-b_i b_j}(1+a_j J) - \frac{b_i}{1-b_i b_j}(1-a_i I) \\
&= -\frac{1+b_i b_j+b_i+b_j}{1-b_i b_j} - \frac{a_j b_j}{1-b_i b_j} J + \frac{a_i b_i}{1-b_i b_j} I \equiv \alpha + \beta J + \gamma I
\end{aligned} \tag{11}$$

where

$$\alpha = -\frac{1+b_i b_j+b_i+b_j}{1-b_i b_j} = -\frac{(1+b_i)(1+b_j)}{1-b_i b_j}, \quad \beta = -\frac{a_j b_j}{1-b_i b_j}, \quad \gamma = \frac{a_i b_i}{1-b_i b_j}$$

3.2.3. Significance of two-faced nature of ICT

Since two-faced nature of ICT advancement can be considered the main source declining the marginal productivity of ICT and subsequent its prices decrease resulting in great stagnation particularly in ICT advanced economies, aiming at demonstrating its significant effects, an empirical demonstration of the actual repercussion of the advancement of ICT was attempted taking the world ICT top leaders, Finland and Singapore.

(1) Factors governing prices of ICT

Table 5 tabulates global ICT ranking in 2012 based on the state of the Networked Readiness Index (NRI) published annually by the World Economic Forum (see Footnote[2]).

Table 5 demonstrates that Finland and Singapore play leading role in the state of the advancement (development and effective utilization) of ICT and can be considered the world ICT top leaders.

Focusing on the ICT driven development trajectory in Finland and Singapore over the period 1994 and 2011, trends in prices of ICT were computed by utilizing equations (8) and (9).

Fig. 12 demonstrates the result of the computation using index (1990 = 100) based ICT intensity (I/Y). Looking at the figure we note that while prices of Finland steadily increased in 1994–1999, they turned out to declining trend from 2000. While they maintained plateaus state with slight up and down in 2001–2008, they changed to dramatic decline after the Lehman shock in 2008. While prices of ICT in Singapore demonstrated conspicuously high level in 1994–1997 with slight up and down as a general nature of the "Asian Tiger" (newly emerged economy), they changed to dramatic decline after the Asian financial crisis in 1997. Such a dramatic decline calmed down in 2001 and changed to slightly decreasing trend with certain up and down accessing to the similar level in Finland (Chew et al., 2011 [6]).

While dramatic declining trend in Singapore in the late 1990s can be considered as a consequence of the transition from newly emerged economy to developed economy together with the Asian financial crisis in 1997, notable decline in the latter part of the first decade of this century to the beginning of the second decade can be considered as a consequence of the great stagnation postulated by Cohen (2011) [7].

In order to demonstrate Cohen's hypothetical view, particularly two-faced nature of ICT resulting in declining the prices of ICT, effects of ICT advancement both of general increase in ICT stock as a whole and increase in the dependency on the Internet on the ICT prices change were next analyzed.

Fig. 13 illustrates trends in ICT stock in Finland and Singapore over the period 1990–2011. Looking at the Figure we note that ICT stock in both countries demonstrated steady increase with higher increase rate in Finland.

[10] Since the Internet has been playing a leading role in the whole ICT and providing significant impacts on the diffusion trajectory of ICT, carrying capacity of logistic growth in I and reverse logistic growth in J as well as their diffusion tempo ($a_i I$ and $a_j J$) were treated as behaved in the similar way($a_i I = a_j J$).

Table 5
Ranking of the networked readiness in 2012 (top 50 out of 144 countries).

1 Finland 5.98 (3)	16 Luxembourg 5.37 (21)	31 Saudi Arabia 4.82 (34)	46 Panama 4.22 (57)
2 Singapore 5.96 (2)	17 Iceland 5.31 (15)	32 Lithuania 4.72 (31)	47 Jordan 4.20 (47)
3 Sweden 5.91 (1)	18 Australia 5.26 (17)	33 Portugal 4.67 (33)	48 Montenegro 4.20 (46)
4 Netherlands 5.81 (6)	19 Austria 5.25 (19)	34 Chile 4.59 (39)	49 Poland 4.19 (49)
5 Norway 5.66 (7)	20 New Zealand 5.25 (14)	35 Cyprus 4.59 (32)	50 Italy 4.18 (48)
6 Switzerland 5.66 (5)	21 Japan 5.24 (18)	36 Puerto Rico 4.55 (36)	
7 United Kingdom 5.64 (10)	22 Estonia 5.12 (24)	37 Slovenia 4.53 (37)	
8 Denmark 5.58 (4)	23 Qatar 5.10 (28)	38 Spain 4.51 (38)	
9 United States 5.57 (8)	24 Belgium 5.10 (22)	39 Barbados 4.49 (35)	
10 Taiwan, China 5.47 (11)	25 UAE 5.07 (30)	40 Oman 4.48 (40)	
11 Korea, Rep. 5.46 (12)	26 France 5.06 (23)	41 Latvia 4.43 (41)	
12 Canada 5.44 (9)	27 Ireland 5.05 (25)	42 Czech Republic 4.38 (42)	
13 Germany 5.43 (16)	28 Malta 4.90 (26)	43 Kazakhstan 4.32 (55)	
14 Hong Kong SAR 5.40 (13)	29 Bahrain 4.83 (27)	44 Hungary 4.29 (43)	
15 Israel 5.39 (20)	30 Malaysia 4.82 (29)	45 Turkey 4.22 (52)	

[a]Ranking indicates the state in 2012 while the state in 2011 is indicated in parenthesis.
[b]Figure demonstrates the score of the Networked Readiness Index 2013 (the level in 2012).
Source: The Global Information Technology Report 2013 (World Economic Forum, 2013 [40]).

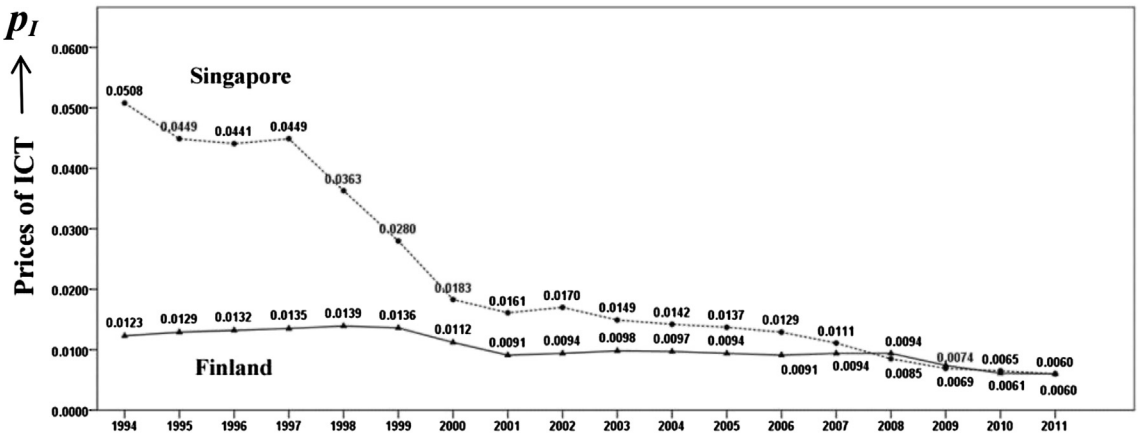


Fig. 12. Trends in the prices of ICT in ICT top leaders: Finland and Singapore (1994–2011). [a] Prices of ICT (relative prices of ICT) are computed by the following equation: $p_I = \frac{\varphi}{\frac{I}{Y}\cdot\frac{\Delta I}{I}}$ where φ: contribution of ICT to GDP growth (%: equation (2)), $\Delta I/I$: growth rate of ICT capital services (%), and I/Y: ICT intensity (ratio of ICT and GDP) using index (1990 = 100).

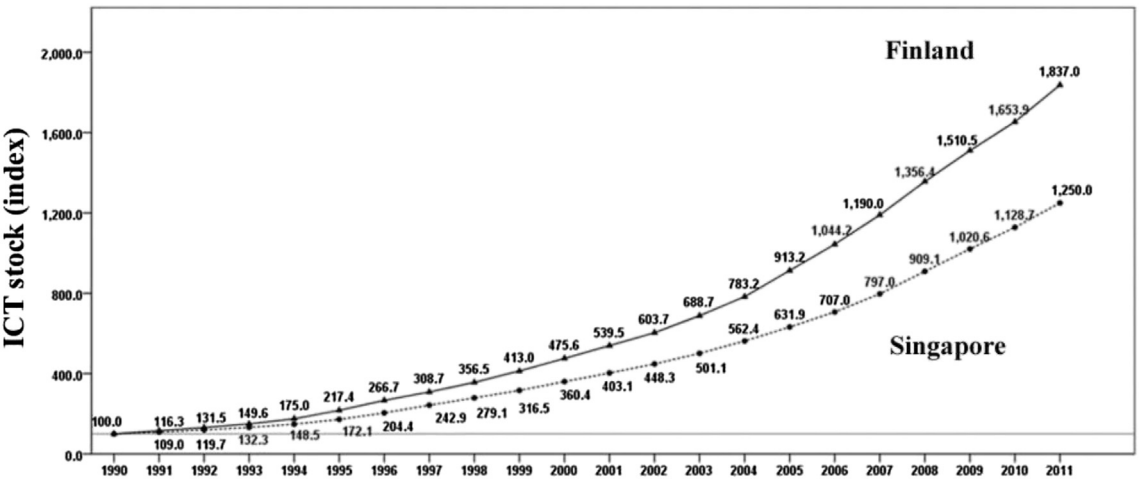


Fig. 13. Trends in ICT stock in ICT top leaders: Finland and Singapore (1990–2011) – index: 1990 = 100.
Source: "The Conference Board Total Economy Database™, January 2013, http://www.conference-board.org/data/economydatabase/. Retrieved 5 January 2014.

Similarly, Fig. 14 illustrates trends in the Internet dependency in Finland and Singapore over the period 1990–2011.

Fig. 14 demonstrates consequently high increase rate in the Internet dependency in ICT top leaders in 1994–2000 particularly in Singapore while it changed to low increase rate in 2001–2011.

(2) Two-faced nature of ICT in world ICT top leaders

On the basis of the foregoing analyses and observations, based on equation (11), effects of ICT stock and dependency on the Internet on the changes in ICT prices in ICT top leaders were analyzed. Figs. 15 and 16 together with the regression results demonstrate the results of the analyses in decomposing the trends in the prices of ICT into ICT driven logistic growth trajectory (I) and the Internet dependency attributable reverse logistic growth trajectory (J).

Looking at Fig. 15 we note that while the steady increase in ICT prices in Finland in 1994–1999 can be attributed to the advancement of ICT with new functionality development, their turning out to declining trend from 2000 can largely be attributed to the dramatic advancement of the Internet and subsequent increasing popularity of freebies, easy copy and standardization nature. Notwithstanding such effects, Finland maintained its ICT prices in plateaus state with slight up and down in 2001–2008. This can be attributed to the consistent increase in its ICT stock as demonstrated in Fig. 13 and subsequent increase in new functionality development. Dramatic decline in the ICT prices after 2008 can be attributed to the stagnation of ICT increase efforts under the global simultaneous stagnation due to the Lehman shock in 2008. Dramatic increase in prices declining feature of the Internet corresponding to this period accelerated to such a decline.

Similarly, looking at Fig. 16 we note that while advancement of ICT maintained steady increase in ICT prices in Singapore, increase in the Internet dependency changed to decline the prices. As reviewed earlier, dramatic decline in conspicuously high level of Singapore's ICT prices in the late 1990s can be considered as a consequence of the transition from newly emerged economy to developed economy together with the Asian financial crisis in 1997. While such a dramatic decline calmed down in 2001 and changed to slightly decreasing trend with certain up and down. This can be attributed to the balance between the positive effects of ICT advancement and the negative effects of the Internet dependency. Noting decline in the latter part of the first decade of this century to the beginning of the second decade can be attributed to the similar sources as Finland: global simultaneous stagnation and dramatic increase in prices declining feature of the Internet.

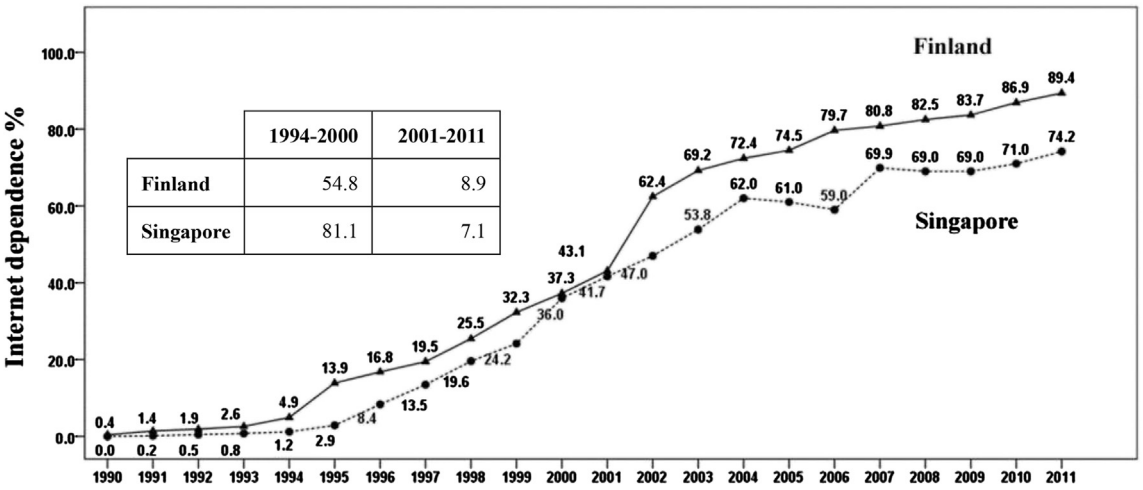
All these empirical analyses taking world most forefront two-faced nature of ICT advanced circumstances as world ICT top leaders demonstrated the hypothetical view that two-faced nature of ICT advancement has become evident as a consequence of the dramatic advancement of the Internet and this could be the source of bi-polarization between ICT advanced economies and ICT growing economies resulting in the great stagnation in the former economies.

4. New paradox of productivity

4.1. Un-captured GDP

4.1.1. Increasing role of un-captured GDP

The previously noted results demonstrate that the identical two faces of ICT could be the structural source of the trap of ICT advancement leading to new paradox of productivity that appears to have emerged in the latter part of the first decade of this century as reviewed in Section 1. Advances in ICT can largely be attributed to the dramatic advancement of the Internet, which has changed the computer-initiated ICT world significantly. The Internet promotes a freer culture, the consumption of which provides utility and happiness to people but cannot be



	1994-2000	2001-2011
Finland	54.8	8.9
Singapore	81.1	7.1

Fig. 14. Trends in the internet dependency in ICT top leaders: Finland and Singapore (1990–2011).
Source: World Telecommunication/ICT Indicators Database (UN, 2013).

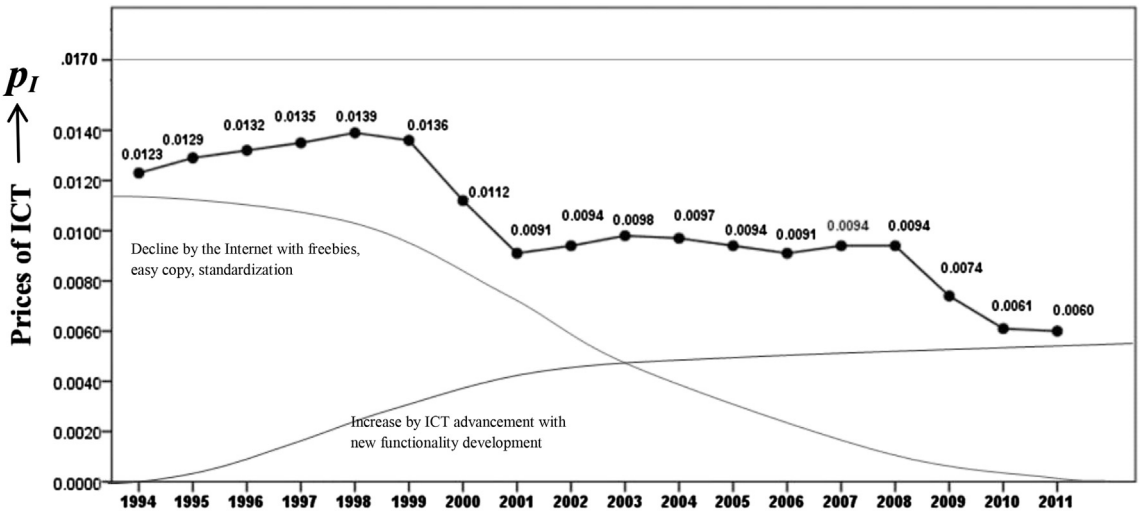


Fig. 15. Trends in the effects of ICT advancement and increase in the internet dependency to ICT prices in Finland (1994–2011).

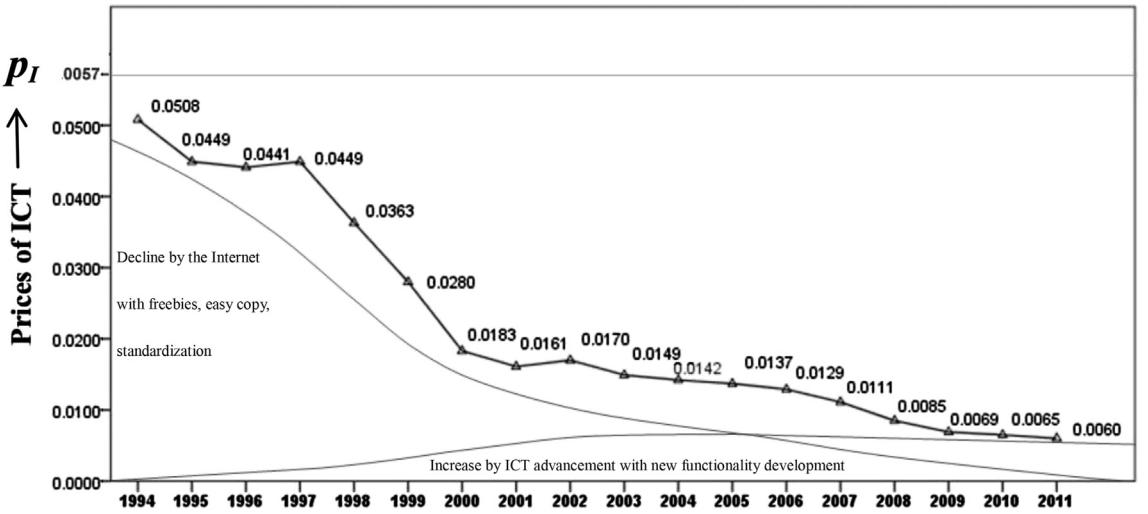


Fig. 16. Trends in the effects of ICT advancement and increase in the internet dependency to ICT prices in Singapore (1994–2011).

captured through GDP data that measure revenue (Lowrey, 2011 [17]).

Un-captured GDP has become the major source of consumers utility (happiness in consumption) and general happiness (JCO, 2012 [13]). As a consequence of historical change in the experience of nations, and in line with the general shift from a commodity-oriented society toward a service and information-oriented society, it is generally postulated that consumer preference has been steadily shifting from an economic functionality-driven preference (captured by GDP) to supra-functionality beyond economic value-driven preference. Here, supra-functionality beyond economic value encompasses social, cultural, aspirational, tribal and emotional values and they are not necessarily captured by GDP (McDonagh, 2008 [21]).[11] Such a shift can be clearly observed in Japan which is extremely sensitive to institutional innovation against external shocks and crises (Hofstede, 1991 [11], Watanabe, 2009 [32]). Fig. 17 illustrates this shift demonstrated by Japan's *Public Opinion Survey Concerning People's Lifestyles*[12] conducted annually by Japan's Cabinet Office (JCO).

Looking at Fig. 17 we note that contrary to a steady decline in people's preference in economic functionality (V),

[11] See Appendix 1 the concept of the supra-functionality beyond economic value.

[12] In this survey, personal preference for future life is chosen from three options: (i) Richness of the heart – spiritual happiness (*Since a reasonable level of material affluence has been achieved, future emphasis should be put on spiritual happiness and a comfortable life.*), (ii) Wealth of things – material affluence (*Emphasis should still be put on material affluence for future life.*), or (iii) Can not identify explicitly. While the second option corresponds to a preference for economic functionality, the first option corresponds to that of supra-functionality beyond economic value (Watanabe et al., 2011 [33]). See the detailed structure of the Survey in the Appendix 2.

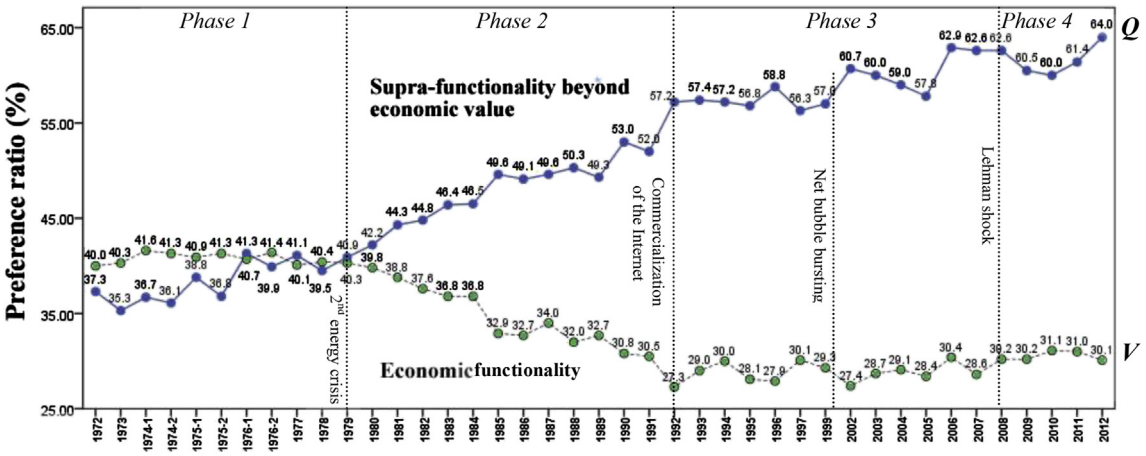


Fig. 17. Trends in the shift of Japan's preferences (1972–2012)[a]. [a]While it has not necessarily been recorded every year, it has been recorded more than once in certain years.
Source: National Survey of Lifestyle Preferences (Japan Cabinet Office, annual issues).

Table 6
Correlation between GDP and the shift of Japan's preferences (1972–2012).

$$\ln V = \underset{(17.36^*)}{6.335} - \underset{(-7.21^*)}{0.555} D_1 \ln Y - \underset{(-7.71^*)}{0.549} D_2 \ln Y - \underset{(-8.11^*)}{2.959} D_3 \quad \text{adj. } R^2\ 0.913,\ DW\ 1.09$$

$$\ln Q = \underset{(5.29^*)}{1.283} + \underset{(9.76^*)}{0.500} D_1 \ln Y + \underset{(10.73^*)}{0.507} D_2 \ln Y + \underset{(11.55^*)}{0.515} D_3 \ln Y \quad \text{adj. } R^2\ 0.972,\ DW\ 1.66$$

Y: GDP Index (1972 = 100), V: Economic functionality, Q: Supra-functionality beyond economic value, D: Dummy variables (D_1: 1972–79 (Phase 1) = 1, D_2: 1980–92 (Phase 2) = 1, D_3: 1993–2012 (Phases 3 and 4) = 1, other years = 0).
Figures in parenthesis indicate t-statistics (* means significant at the 1% level).

supra-functionality beyond economic value (Q) steadily increasing and exceeded V in 1979, the year of the 2nd energy crisis. While Q continues steadily increase, V declined to its lowest level in 1992, the year immediately after the commercialization of the Internet in 1991. It has stayed at a similar level since then. A decline in Q due to the Lehman shock in 2008 was followed by a sharp recovery. Consequently, a shifting trend from V to Q can be classified into four phases: *Phase 1* (1972–1979), *Phase 2* (1980–1992), *Phase 3* (1993–2008), and *Phase 4* (2009–2012).

Table 6 demonstrates that while elasticity of supra-functionality beyond economic value Q (which cannot necessarily be captured by GDP) exhibits a slight increasing trend, economic functionality V (which can be captured by GDP by its nature) has changed to stable independent of GDP after Phase 3 (after commercialization of the Internet in the beginning of the 1990s). These results demonstrate that while people's preferences have shifted in line with increased GDP, their inducement has shifted to un-captured GDP suggesting the prelude of the foregoing new paradox due to an Internet initiated ICT world.

4.1.2. Emergence of un-captured GDP substitution for captured-GDP

Aiming at identifying the emergence of un-captured GDP substitution for captured GDP, Table 7 analyzed this substitution by phases by means of the correlation between Q/V and Y[13] over the last four decades with dummy variables corresponding to four phases.

Table 7, first attempted to identify the phase when un-captured GDP effects emerged by comparing 3 models (phase 4, 3 and 2 emergence hypothesis, respectively) and identified that model 2 with phase 3 emergence hypothesis is statistically most significant suggesting that un-captured GDP effects emerged during the period 1993–2008.

Based on this suggestion, identification of the time when un-captured GDP effects substantially activated in shifting from V to Q (Q substitution for V) in Japan was attempted next by comparing 7 models with activation started from 1997 to 2003 (middle of Phase 3), respectively. The result of the comparison demonstrated that model D which hypothesized that un-captured GDP's substantial activation in V to Q shift started from 2000 is statistically most significant. This suggests that a co-evolution between ICT advancement (that increased un-captured GDP effects) and people's preferences shift from V to Q started toward activation from 2000, the year corresponding to the net bubble bursting and earlier than the timing of the emergence of a new ICT paradox which was considered in the late of the first decade of this century (Rifkin, 2011 [26]).

4.2. ICT advancement induced by people's preferences

Given the historical trend in people's preferences in shifting from economic functionality to supra-functionality

[13] Table 6 suggests the following correlation between Y and V and Q: $\ln V = a_1 + b_1 \ln Y$, $\ln Q = a_2 + b_2 \ln Y$ Partial differentiation with respect to $\ln Y$ leads $\frac{\partial \ln V}{\partial \ln Y} = \frac{\partial V}{\partial Y} \cdot \frac{Y}{V} = b_1$, $\frac{\partial \ln Q}{\partial \ln Y} = \frac{\partial Q}{\partial Y} \cdot \frac{Y}{Q} = b_2$ Taking the ratio leadsTaking balance of the first equations $\ln \frac{Q}{V} = (a_2 - a_1) + (b_2 - b_1) \ln Y$ thus, $\ln Y = \frac{1}{b_2 - b_1} \left[(a_1 - a_2) + \ln \frac{b_1}{b_2} + \ln \frac{\frac{\partial V}{\partial Y}}{\frac{\partial Q}{\partial Y}} \right]$ This demonstrates that the correlation between Y and Q/V depicts elasticity of Q substitution for V $\sigma = \frac{\partial \ln \frac{Q}{V}}{\partial \ln \frac{\partial V}{\partial Y} / \frac{\partial Q}{\partial Y}}$

Table 7
Effects of captured and un-captured GDP on the shift in Japan's preferences (1972–2012).

1) *Emergence of un-captured GDP effects by phases*

$\frac{Q}{V}=\frac{b_1}{b_2}\cdot\frac{\frac{\partial V}{\partial Y}}{\frac{\partial Q}{\partial Y}}$ and $\ln\frac{Q}{V}=\ln\frac{b_1}{b_2}+\ln\frac{\frac{\partial V}{\partial Y}}{\frac{\partial Q}{\partial Y}}$

Model 1 (Emerged in Phase 4)

$\ln(Q/V)=\underset{(-9.46^{*})}{-4.709}+\underset{(9.35^{*})}{0.983}\,D_1\ln Y+\underset{(10.19^{*})}{0.989}\,D_2\ln Y+\underset{(10.88^{*})}{0.998}\,D_3\ln Y+\underset{(10.84^{*})}{5.407}\,D_4$ adj. R^2 0.964 DW 1.36 AIC −225.93

Model 2 (Emerged in Phase 3)

$\ln(Q/V)=\underset{(-9.63^{*})}{-4.988}+\underset{(9.52^{*})}{1.042}\,D_1\ln Y+\underset{(10.33^{*})}{1.043}\,D_2\ln Y+\underset{(11.00^{*})}{5.700}\,D_3+\underset{(10.96^{*})}{5.685}\,D_4$ adj. R^2 0.964 DW 1.52 AIC −226.61

Model 3 (Emerged in Phase 2)

$\ln(Q/V)=\underset{(-1.06^{***})}{-2.387}+\underset{(1.04^{***})}{0.493}\,D_1\ln Y+\underset{(1.22^{***})}{2.749}\,D_2+\underset{(1.38^{***})}{3.099}\,D_3+\underset{(1.37^{***})}{3.084}\,D_4$ adj. R^2 0.863 DW 0.88 AIC −171.79

2) *Time when un-captured GDP effects activated*

$\ln\frac{Q}{V}=a+b_1D_1\ln Y+b_2D_2$

Model	D_1=1 other years = 0	D_2=1 other years = 0	a	b_1	b_2	adj. R^2	DW	AIC
A	1972–1996	1997–2012	−5.353	1.118	6.066	0.964	1.26	−227.74
			(−22.43)	(23.65)	(25.37)			
B	1972–1997	1998–2012	−5.275	1.102	5.994	0.964	1.26	−228.56
			(−23.19)	(24.52)	(26.28)			
C	1972–1998	1999–2012	−5.252	1.097	5.975	0.966	1.33	−230.16
			(−24.22)	(25.68)	(27.49)			
D	**1972–1999**	**2000–2012**	**−5.250**	**1.096**	**5.978**	**0.967**	**1.33**	**−231.35**
			(−25.18)	**(26.75)**	**(28.59)**			
E	1972–2000	2001–2012	−5.277	1.102	6.006	0.966	1.32	−230.96
			(−25.83)	(27.51)	(29.29)			
F	1972–2001	2002–2012	−5.323	1.111	6.048	0.966	1.30	−230.17
			(−26.38)	(28.16)	(29.87)			
G	1972–2002	2003–2012	−5.381	1.123	6.100	0.965	1.30	−229.60
			(−27.03)	(28.90)	(30.51)			

Y: G DP Index (1972 = 100), Q: Supra-Functionality beyond economic value, V: Economic functionality.
D indicates dummy variables.
D_1: 1972–1979 (Phase 1) = 1, other years = 0; D_2: 1980–1992 (Phase 2) = 1; D_3: 1993–2008 (Phase 3) = 1; D_4: 2009–2012 (Phase 4) = 1.
Figures in parenthesis indicate t-statistics (*, ***: significant at the 1% and the 10% level, respectively).
(However, we should note that this elasticity is always 1 as is the case of the Cobb–Douglas type production function).
Figures in parenthesis indicate t-statistics (all significant at the 1% level).

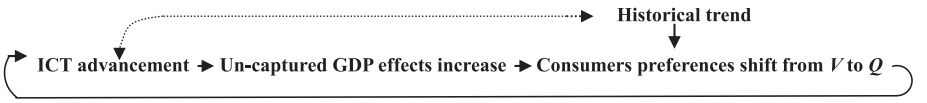


Fig. 18. Co-evolution between ICT advancement and consumers preferences shift.

beyond economic value in correspond to the advancement of ICT, and their co-evolutionary ICT inducement in an information society (Watanabe, 2009 [32]) as demonstrated in Fig. 18 and Table 8, based on the foregoing analyses, Table 9 demonstrates the role of people's preferences in inducing Japan's ICT advancement over the last two decades.

Table 9 demonstrates that people's preference on supra-functionality beyond economic value Q (which is not necessary captured by GDP) induces ICT advancement stronger than that of economic value V (which can be captured by GDP) with slightly increasing elasticity while V elasticity remains stable, just a very small vibration in the last two decades examined.

With such findings, Table 10 analyzes this correlation applying dynamic elasticity to Qin such a structure as (Watanabe et al., 2012 [34]).

Backward elimination method with 10% significant criteria and mean centric method was used in this correlation analysis. The result of the comparative analysis demonstrated that the second model with power 4 dynamic equation is statistically most significant. Fig. 19 demonstrates trend in this elasticity.

Looking at the figure we note that contrary to stable lower value in V elasticity to ICT, Q elasticity to ICT demonstrates higher value with dynamic changing trend. It continued to increase up until 2000 corresponding to the year when un-captured GDP effects activated as demonstrated in Table 7. This can be the engine driving Q substitution for V. However, it changed to decline from 2001 immediately after the bursting of the net bubble. While it continued slight decline up until 2007, it changed to

Table 8
Co-evolution between ICT advancement and consumers preference shift to supra-functionality beyond economic value in Japan (1990–2011).

$\ln Q=\underset{(46.08^{*})}{3.621}+\underset{(5.77^{*})}{0.085}\ln ICT_{-1}$ adj.$R^2$0.618 DW 1.54

$\ln ICT=\underset{(-4.79^{*})}{-22.413}+\underset{(5.94^{*})}{6.835}\ln Q_{-1}$ adj.$R^2$0.632 DW 0.94

Figures in parenthesis indicate t-statistics (*: significant at the 1% level).
ICT_{-1} and Q_{-1} indicate 1 year time-lag, respectively.

Table 9
Correlation between functionalities and ICT in Japan (1990–2011).

$$\ln ICT = \underset{(-2.65^{**})}{-21.473} + \underset{(1.66^{***})}{2.057}\, D_{11} \ln V + \underset{(1.69^{***})}{2.081}\, D_{12} \ln V + \underset{(3.79^{*})}{4.851}\, D_{21} \ln Q + \underset{(3.87^{*})}{4.906}\, D_{22} \ln Q + \underset{(3.91^{*})}{4.913}\, D_{23} \ln Q + \underset{(3.95^{*})}{4.944}\, D_{24} \ln Q - \underset{(-2.53^{**})}{0.281}\, D$$

adj.R^2 0.878 DW 0.99 AIC − 76.54

where ICT: ICT stock and D: dummy variables.
D_{11}:1990–2001 = 1;D_{12}:2002–2011 = 1;D_{21}:1990–2000 = 1;D_{22}:2001–2004 = 1;D_{23}:2005–2008 = 1;D_{24}:2009–2011 = 1;D:1993, 1994, 2006 = 1.
Figures in parenthesis indicate t-statistics (significant at the * 1%, ** 5%, and *** 10% level, respectively).

Table 10
Correlation between functionalities and ICT in Japan by dynamic elasticity (1990–2011).

$$\ln ICT = \underset{(-2.07^{**})}{-14.362} + \underset{(2.08^{**})}{2.307} \ln V + (\underset{(2.58^{**})}{2.957} - \underset{(-1.63^{***})}{4.400} \times 10^{-4} t^2 + \underset{(4.24^{*})}{1.190} \times 10^{-4} t^3) \ln Q - \underset{(-3.02^{*})}{0.286}\, D_1 \quad \text{adj. } R^2\ 0.894 \quad DW\ 1.39 \quad \text{AIC} - 80.66$$

$$\ln ICT = \underset{(-2.80^{*})}{-18.713} + \underset{(2.04^{**})}{2.068} \ln V + (\underset{(3.70^{*})}{4.226} - \underset{(-3.25^{*})}{0.003} t^2 + \underset{(2.92^{*})}{9.278} \times 10^{-5} t^3 + \underset{(3.28^{*})}{2.153} \times 10^{-5} t^4) \ln Q + 0.305 D_2 \quad \text{adj. } R^2\ 0.909 \quad DW\ 1.42 \quad \text{AIC} - 83.47$$

$$\ln ICT = \underset{(-4.61^{*})}{-30.810} + \underset{(2.65^{**})}{2.982} \ln V + (\underset{(5.51^{*})}{6.438} - \underset{(-2.63^{**})}{2.250} \times 10^{-3} t^2 + \underset{(2.44^{**})}{2.008} \times 10^{-5} t^4 + \underset{(1.98^{**})}{5.599} \times 10^{-7} t^5) \ln Q + \underset{(3.14^{*})}{0.527}\, D_3 \quad \text{adj. } R^2\ 0.870 \quad DW\ 1.61 \quad \text{AIC} - 75.66$$

D: Dummy variables (D_1: 1993, 1994, 1997=1; D_2: 2005, 2007, 2009 = 1; D_3: 2005 = 1, other years = 0).
Figures in parenthesis indicate t-statistics (significant at the *1%, **5%, and ***10% level, respectively).

increasing trend from 2008. Slight decline can be attributed to the bursting of the net bubble and global simultaneous stagnation derived from the sub-prime loan issues in the US while there existed strong inertia to increasing expectation to Q initiative. This emerged conflict in transition. Change to increasing trend from 2008 can be attributed to the transformation of such conflict into a springboard for new innovation toward a post excessive consumption society.

4.3. Emerging conflict in transition

All support the foregoing hypothetical view emerging new paradox of productivity derived from the two-faced nature of the Internet driven ICT advancement and subsequent increasing discrepancy between captured GDP and un-captured GDP.

This increasing discrepancy reveals the following significant implications:

(i) First, there exists a possible hypothetical view that a decrease in ICT prices could be in line with a consumer preference shift from economic functionality to supra-functionality beyond economic value.
(ii) Second, shifting from captured GDP to un-captured GDP could correspond to the transfer of production efforts. Traditionally, all production efforts have been attributed to producer motivation as they can in turn obtain a compensating return. However, certain production efforts, particularly in cerebration, idealization and learning extraction efforts have been transferred from producers to consumers, which justify freebies to both producers and consumers.[14]

(iii) Third, under such shifting and transferring circumstances, there emerges conflict in the transition leading to an emerging growing anger of consumers (Watanabe, 2013 [35]).

(iv) Fourth, there emerges a possible new innovation transforming such anger into a springboard for new innovation.

Fig. 20 illustrates this transition dynamism.

Elucidation of this transition dynamism, particularly of the emergence of conflict in this transition and a possible transformation of such conflict into a springboard for new innovation, will be a crucial subject for resilience, which inevitably highlights the significance of analysis of consumer anger. This analysis leads to the analysis of innovation-consumption co-emergence.

Since consumption shares more than 60% of GDP in most countries, its sustainable growth despite beyond anticipation issues would be crucial. However, contrary to such anticipation, it has been strongly warned the increasing consumption haters among Japanese consumers, particularly among young generations due to nonexistence of goods and services corresponding to their sincere requirement (Matsuda, 2010 [19], 2012 [20]). This demonstrates protest to producers which cannot satisfy their requirement in the foregoing transition. At the same time they are irritating themselves being remains consumers unable to produce their desiring goods and services by themselves. Accumulation of more knowledge than producers depending on the advancement of the Internet accelerates such protest resulting in growing anger of consumers.

Given that resilience incorporates assimilation, the capacity for using a shock as a trigger for renewal and improvement (Ilmola et al., 2013 [12]), this consumers anger can be transformed into a springboard for new innovation. This anticipation prompts us a significance of innovation-consumption co-emergence which corresponds to co-evolutionary acclimatization as illustrated in Fig. 11 suggesting to harness the vigor of hidden counterparts, consumers.

[14] This is natural to producers as they depend certain due efforts on consumers efforts while consumers have not explicitly realized their contribution.

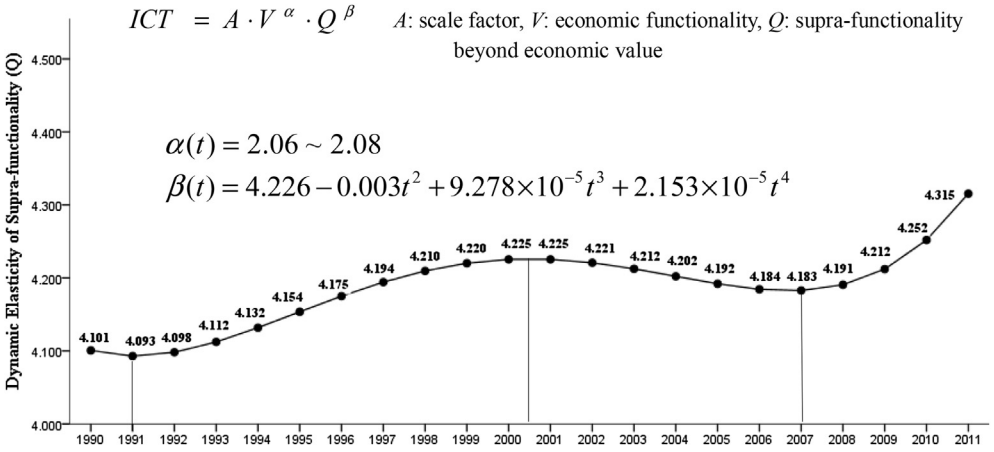


Fig. 19. Trends in elasticity of functionalities to ICT in Japan (1990–2011).

5. Growing anger of consumers

5.1. Shift to a post-excessive consumption society

Foregoing emerging conflict in the transition revealed explicitly by decline of marginal productivity of ICT and subsequent its prices decrease provides significant impacts on its users by growing their angers to producers and also to themselves as being remained consumers as illustrated in Fig. 21 (Watanabe, 2013 [35]).

Global simultaneous stagnation triggered by the US oriented sub-prime loan issues in 2007 and subsequent Lehman shock in 2008 has reminded us a possibility of a post-excessive consumption society. Table 11 summarizes correlation between GDP (Y) and household final consumption expenditure (C) in 6 countries including ICT top leaders, Finland and Singapore over the period 1990–2012. Looking at the Table we note that their coefficients have changed to declining trend from 2007 (US and Germany) or 2008 (Finland, Singapore, Japan and UK) corresponding to the sub-prime loan issue and subsequent Lehman shock in 2008. Since this coefficient depicts marginal propensity of consume ($\partial C/\partial V$), Table 11 suggests that marginal propensity of consume in these countries changed to declining trend after the global simultaneous stagnation as demonstrated in Table 12.

Foregoing observation supports a possibility of the emergence of post-excessive consumption society (Matsuda, 2010 [19], 2012 [20]) in which consumers increasing initiative in innovation game is anticipated (McDonagh, 2008 [21], Watanabe, 2009 [32], Watanabe et al., 2011 [33]). Such an increasing consumers initiative accelerates a

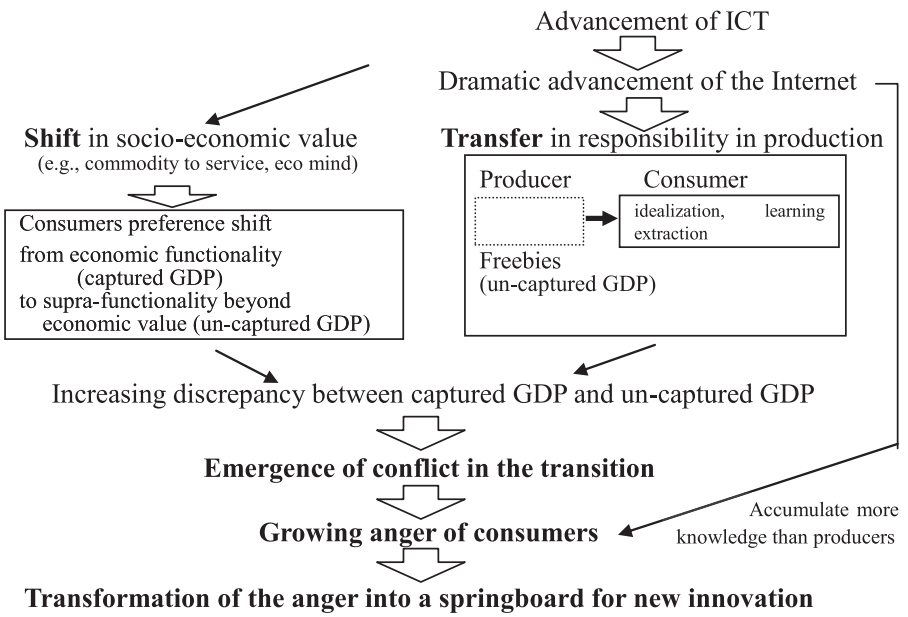


Fig. 20. Transition dynamism in new paradox of productivity and its impact on consumers.

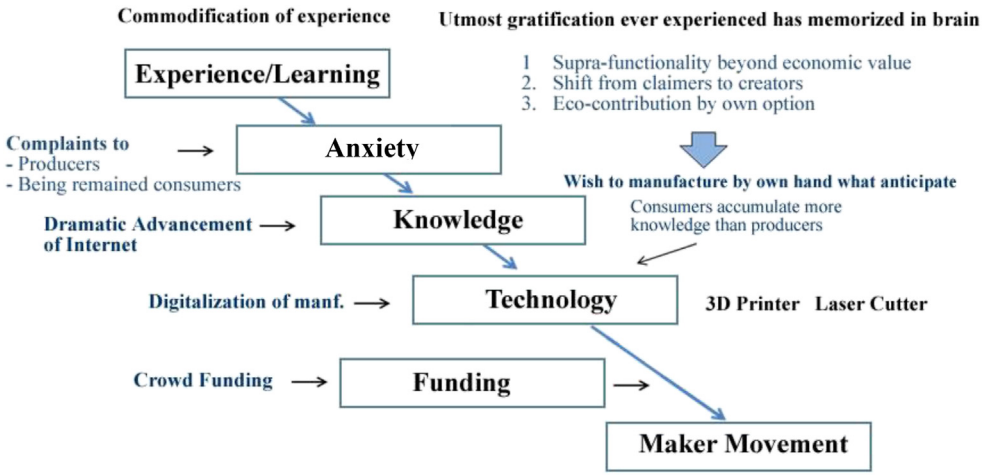


Fig. 21. Growing anger of consumers.

shift of their preference from economic functionality to supra-functionality beyond economic value encompassing social, cultural, aspirational, tribal and emotional value (Watson and McDonagh [38], 2004, McDonagh, 2008 [21], Watanabe, 2009 [32]) as reviewed in the preceding Section.

As postulated by Nobel laurite in Economics Modigliani, people never forget utmost gratification of consumption ever experienced that has memorized in the brain and affects consumers preference in consumption (Modigliani, 1965 [24]). Such experience can be subject to socioeconomic paradigm. As reviewed in the preceding Section, as a consequence of historical change in nations experiences, in line with the general shift in commodity oriented society to service and information oriented society, it is generally postulated that consumers preference has been steadily shifting from economic functionality driven preference to

Table 11
Correlation between GDP and final consumption in selected 6 countries (1990–2012).

Finland

$$C = \underset{(6.068^{*})}{9718.980} + \underset{(32.808^{*})}{0.416}\, D_1Y_1 + \underset{(2.097^{**})}{0.226}\, D_2Y_2 + \underset{(2.056^{**})}{35484.176}\, D_2 + \underset{(3.165^{*})}{2263.987}\, D \quad \text{adj.}R^2\ 0.990,\ DW\ 1.32$$

D indicates dummy variables

D_1: 1990–2007 = 1, *other year* = 0; D_2: 2008–2012 = 1; D: 1991, 2006, 2012 = 1

Singapore

$$C = \underset{(2.939^{*})}{42293.395} + \underset{(26.082^{*})}{0.317}\, D_1Y_1 + \underset{(4.138^{*})}{0.213}\, D_2Y_2 - \underset{(-2.547^{**})}{37093.567}\, D_1 + \underset{(2.359^{**})}{6700.379}\, D \quad adj.R^2\ 0.986,\ DW\ 1.05$$

D indicates dummy variables

D_1: 1990–2007 = 1, *other years* = 0; D_2: 2008–2012 = 1; D: 2002 = 1

Japan

$$C = \underset{(1.87^{**})}{120152469.362} + \underset{(25.12^{*})}{0.591}\, D_1Y_1 + \underset{(2.68^{**})}{0.340}\, D_2Y_2 - \underset{(-2.02^{***})}{131023751.720}\, D_1 - \underset{(-4.12^{*})}{7145417.823}\, D \quad \text{adj.}R^2\ 0.978,\ DW\ 1.41$$

D indicates dummy variables

D_1: 1990–2007 = 1, *other years* = 0; D_2: 2008–2011 = 1; D: 1991, 2007, 2008 = 1

USA

$$C = \underset{(-11.45^{*})}{-656297.750} + \underset{(132.12^{*})}{0.735}\, D_1Y_1 + \underset{(7.21^{*})}{0.641}\, D_2Y_2 + \underset{(1.08^{***})}{1253670.120}\, D_2 - \underset{(-6.52^{*})}{138390.806}\, D \quad \text{adj.}R^2\ 0.999,\ DW\ 1.34$$

D indicates dummy variables

D_1: 1990–2006 = 1, *other years* = 0; D_2: 2007–2011 = 1; D: 1991, 1998, 1999, 2000 = 1

Germany

$$C = \underset{(1.50^{***})}{48320.565} + \underset{(33.44^{*})}{0.549}\, D_1Y_1 + \underset{(12.01^{*})}{0.442}\, D_2Y_2 + \underset{(2.14^{**})}{200373.730}\, D_2 - \underset{(-4.91^{*})}{33538.105}\, D \quad \text{adj.}R^2\ 0.990,\ DW\ 1.56$$

D indicates dummy variables

D_1: 1990–2006 = 1, *other years* = 0; D_2: 2007–2012 = 1; D: 2006, 2007, 2008 = 1

UK

$$C = \underset{(-8.63^{*})}{-121860.377} + \underset{(58.05^{*})}{0.706}\, D_1Y_1 + \underset{(1.70^{***})}{0.372}\, D_2Y_2 + \underset{(1.46^{***})}{458633.357}\, D_2 \quad \text{adj.}R^2\ 0.995,\ DW\ 1.00$$

D indicates dummy variables

D_1: 1990–2007 = 1, *other years* = 0; D_2: 2008–2012 = 1;

C: Household final consumption expenditure, Y: GDP.
(Finland: Euro, Million, base year 2000; Singapore: Singapore Dollars, Million, base year 2005; Japan: Yen, Million, base year 2005; USA: US Dollars Million, base year 2005; Germany: Euro Million, base year 2000; UK: Pound Sterling Million, base year 2009).
Figures in parenthesis indicate t-statistics (significant at the *1%, **5%, ***10% level, respectively).
Source: National Accounts Official Country Data (United Nations Statistics Division, annual issues).

Table 12
Marginal propensity to consume in selected 6 countries.

	1990–2007[a]	2008–2012[b]
Finland	0.42	0.23
Singapore	0.32	0.21
Japan	0.59	0.34
USA	0.74	0.64
Germany	0.55	0.44
UK	0.70	0.37

[a] 1990–2006 in US and Germany.
[b] 2007–2012 in US and Germany.

supra-functionality beyond economic value driven preference (McDonagh, 2008 [21]; JCO, 2012 [13]).

Under such circumstances consumers desires have been shifting (i) from economic value to supra-functionality beyond economic value, (ii) from claimers to creators, and (iii) to eco-contribution by own option. Consequently, consumers complaints to producers and also to themselves as being remained consumers have been growing. In parallel with such increase, consumers wish to manufacture by own hand what they anticipate has dramatically increased. Dramatic advancement of the Internet has enabled consumer accumulate more knowledge than producers. Their consumption mode has changed to *AISCEAS*:

Attention → Interest → Search → Comparison →
Examination → Action → Share

Maker movement enabled by digitalization of manufacturing, advancement of 3D printers and laser cutter has accelerated the foregoing change in consumers preference and subsequent consuming style and behavior. New stream of emerging economies also impacting on consumers growing anger by realizing them the beauty of frugality and also suppliers simultaneous start up in new sales. Furthermore, increasing publicity of crowd funding enables consumers start-up for manufacturing by themselves.

Foregoing observation supports a possibility of the emergence of a post-excessive consumption society (Matsuda, 2010 [19], 2012 [20]) in which consumers increasing initiative in innovation game is anticipated (McDonagh, 2008 [21], Watanabe, 2009 [32], Watanabe et al., 2011 [33]). Such an increasing consumers initiative accelerates a shift of their preference from economic functionality to supra-functionality beyond economic value encompassing social, cultural, aspirational, tribal and emotional value (Watson and McDonagh, 2004 [38], McDonagh, 2008 [21], Watanabe, 2009 [32]).

5.2. Harness the vigor of hidden counterparts

Foregoing consumers growing anger can be transformed into a springboard for new innovation in a resilient system (Watanabe, 2009 [32], Ilmola et al., 2013 [12]). This anticipation prompts us a significance of innovation-consumption co-emergence which corresponds to co-evolutionary acclimatization as illustrated in Fig. 11. This concept suggests us to harness the vigor of counterparts, and in this case, hidden counterparts are consumers.

Given a post-excessive consumption society with the foregoing consumers preference shift, their satisfaction can be measured by the following utility function:

$$U = U(\mathrm{FD}) = U(V, Q) \tag{12}$$

where FD: functionality development, V: economic functionality, Q: supra functionality beyond economic value.

Equation (12) can be developed as follows:

$$U = U(V,Q) = \frac{\partial U}{\partial V}\cdot V + \frac{\partial U}{\partial Q}\cdot Q = \frac{\partial U}{\partial C}\cdot\frac{\partial C}{\partial V}\cdot\frac{\partial V}{\partial I}\cdot I\cdot\left(\frac{\partial I}{\partial V}\cdot\frac{V}{I} + \frac{\partial I}{\partial Q}\cdot\frac{Q}{I}\right) \tag{13}$$

Fig. 22 analyzes the structure of utility: satisfaction of consumers in a post-excessive consumption society.

Fig. 22 demonstrates that (i) marginal utility, (ii) marginal propensity to consume, (iii) marginal productivity of ICT, (iv) ICT stock, and (v) elasticity of economic functionality as well as supra-functionality beyond economic value to ICT govern utility in a post-excessive consumption society.

Since marginal utility incorporates declining nature governed by the Law of diminishing marginal utility, Table 13 summarizes trends in other governing factors before and after the emergence of a post-excessive consumption society in Japan.

Looking at the table we note that, with declining marginal propensity to consume and marginal productivity of ICT, while direct economic growth and exogenous ICT increase may decrease utility by decreasing consumption and growth, endogenous ICT emergence induced by the elasticity of supra-functionality to ICT plays a leading role in

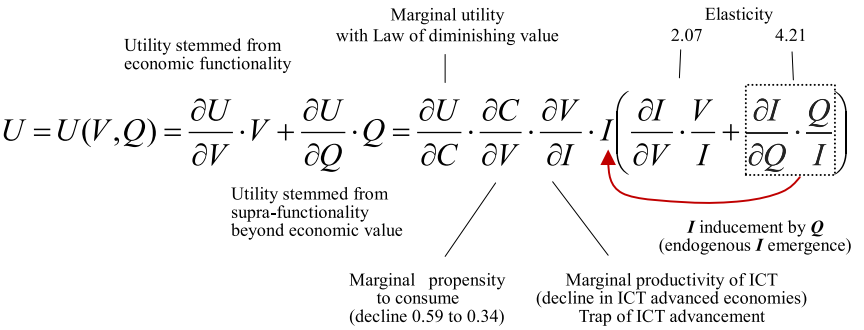


Fig. 22. Structure of utility in a post-excessive consumption society.

Table 13
Comparison of governing factors of utility before and after the emergence of a post-excessive consumption society in Japan.

	1990–2007	2008–2012	
Marginal propensity to consume $\partial C/\partial V$	0.59	0.34	
Marginal productivity of ICT $\partial V/\partial I$	0.025	0.011	Average ICT prices
ICT stock I	7.18	7.77	Average growth rate (% *p.a*)
Economic functionality elasticity $\frac{\partial I}{\partial V}\cdot\frac{V}{I}$	2.06*	2.08**	*1990–2001 **2002–2011
Supra-functionality elasticity $\frac{\partial I}{\partial Q}\cdot\frac{Q}{I}$	4.17	4.24#	#2008–2011

increasing utility notwithstanding such a constrained environment.

Based on the foregoing analyses, Fig. 23 demonstrates dynamism leading to ICT driven resilient development trajectory in overcoming multi-constrained environment with declining marginal propensity to consume and marginal productivity of ICT.

This figure based on the ICT driven production function as depicted in equation (6) analyzes the whole innovation value chain encompassing ICT driven production, diffusion and consumption functions with the understanding that ICT advances proportional to time *t*, and consumption is subject to utility governed by both economic functionality and supra-functionality beyond economic value.

Triggered by the enhancement of elasticity of supra-functionality to ICT, increased functionality development (FD) induces marginal productivity of ICT increase which contributes to economic growth. Developed economy enables further ICT advancement which increases FD leading to constructing a virtuous cycle between innovation, diffusion and consumption in a way of innovation-consumption co-emergence, and harnessing the vigor of counterparts, "hidden" consumers.

Thus, innovation-consumption co-emergence could lead a resilient business toward a post-excessive consumption society. This co-emergence concept corresponds to a concept of co-evolutionary acclimatization as illustrated in Fig. 11 (Watanabe, 2013 [35]).

6. Conclusion

In light of the significant consequence of the dramatic advancement of information and communication technology (ICT) in global economy both nations and firms that has led to bi-polarization between ICT growing economies and ICT advanced economies and has been compelling productivity decline in ICT advanced economies resulting in the great stagnation, structural sources of the trap of the ICT advancement were analyzed.

Following the empirical analyses of the consequence of the dramatic advancement of ICT in 100 countries as well as 500 global ICT firms, on the basis of an empirical analysis decomposing the prices of ICT in world ICT top leaders, Finland and Singapore, two faces of ICT advancement were identified and their impacts on ICT users were analyzed.

In addition, based on an empirical analysis on customers preference shift from economic functionality to supra-functionality beyond economic value, conflict between captured GDP and un-captured GDP derived from the advancement of the Internet and its consequence of emerging growing anger of consumer was unveiled.

Noteworthy findings include:

(i) Sources of the recent great stagnation in ICT advanced economies both nations and firms can be attributed to a trap of ICT advancement.
(ii) This trap can be attributed to the two-faced nature of ICT advancement incorporating price increases due to functionality development and price decreases due to freebies, easy copying and standardization.

(iii) Two-faced nature of ICT increases discrepancy between captured GDP and un-captured GDP.

(iv) While this can be attributed to a consumer preference shift from economic functionality to supra-

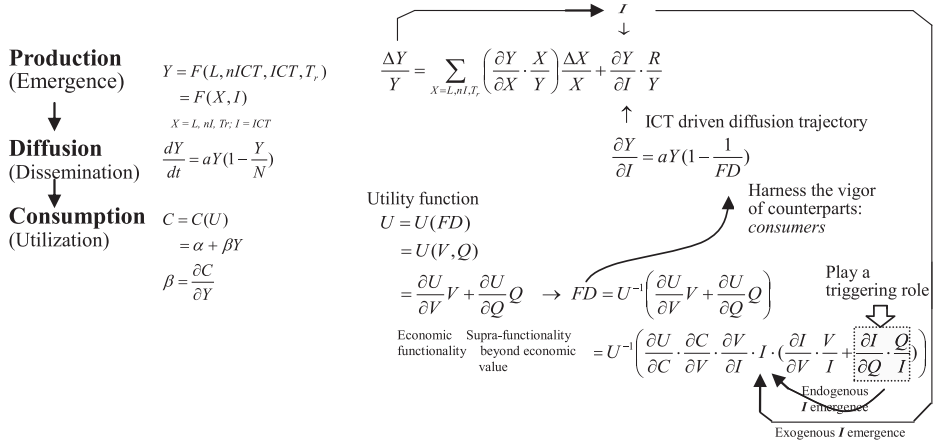


Fig. 23. Dynamism leading to ICT driven resilient development trajectory.

functionality beyond economic value, this shift cannot be captured through GDP.

(v) This conflict has led to an emerging growing anger of consumers demonstrated by declining marginal propensity to consume.

(vi) This anger can be transformed into a springboard for new innovation leading to innovation-consumption co-emergence.

(vii) Enhancing the elasticity of supra-functionality to ICT plays a key role in triggering this co-emergence.

These findings provide the following policy suggestions:

(i) Two-faced nature of ICT, particularly prices decreasing feature of the advancement of the Internet should be seriously taken into account for resilient business.

(ii) Given that freebies, easy copying and standardization are possible sources compelling the prices decrease by depending on the Internet, transferring dynamism of corresponding values should be traced.

(iii) Provided that supra-functionality beyond economic value plays a governing role for consumers, similar transferring dynamism of encompassed values should be traced.

(iv) Relationship between foregoing two noting stream should be analyzed.

(v) ICT's new face elastic enough to supra-functionality beyond economic value should be analyzed.

(vi) In this context, strategy for innovation-consumption co-emergence should be developed on a priority basis.

(vii) While a way to appease consumers growing anger may provide a constructive suggestion to this co-emergence, given that this anger remains intangible, the way to conceptualize voiceless voice of consumers anger should be taken seriously.

This study is thus expected to explore significant insight in elucidating the institutional sources of the resilience in the transition from the paradigm of captured GDP to that of un-captured GDP.

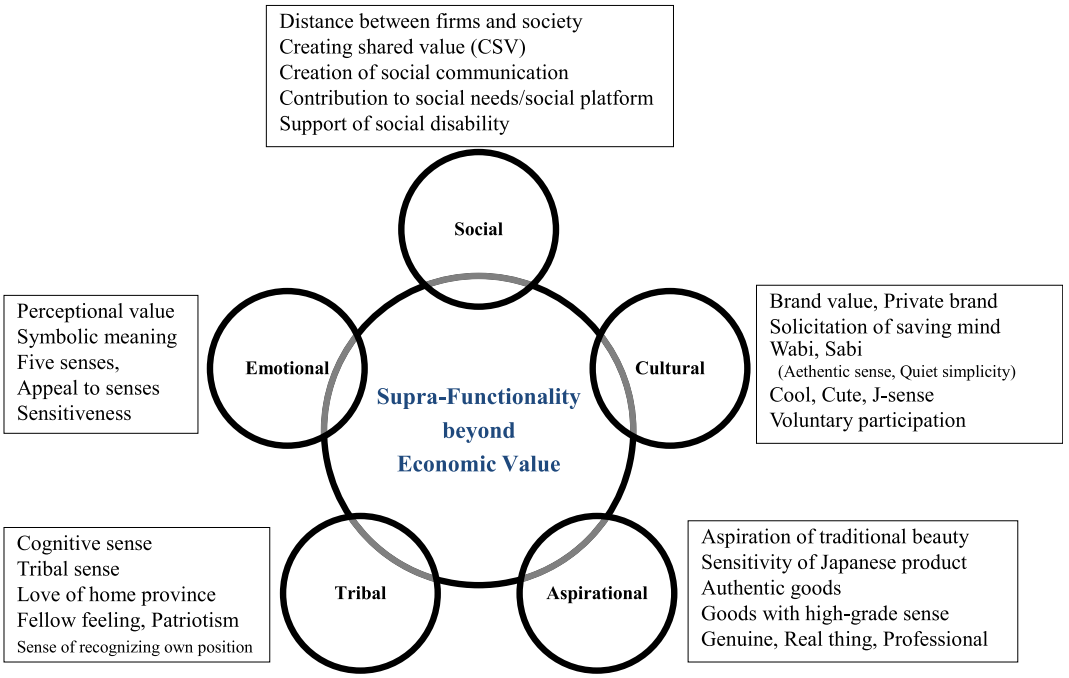
Points of future works are summarized as follows:

(i) In order to generalize the foregoing findings and policy suggestions, analyses of additional countries are expected to be conducted.

(ii) Comparative analysis of institutional factors governing the ICT prices trajectory and their attributing ICT advancement and dependency on the Internet should be conducted.

(iii) Interdisciplinary approach exploring a way to analyze innovation-consumption co-emergence should be attempted by integrating economics, psychophysiology and engineering.

Appendix 1. Basic concept of supra-functionality beyond economic value



Appendix 2. Public opinion survey concerning people's lifestyles

1. Conducted annually by Japan's Cabinet Office (JCO).
2. Samples of the Survey
   (1) Male and female living Japan with the age between 15 and 80.
   (2) 4000 samples extracted by two-stage stratified random method
3. Survey method

The questionnaires are left with respondents by means of door to door visit and pick up at a later date.

4. Survey period (in case of 2011 Fy survey)

10 days between March 21 and March 30, 2012.

5. Valid samples (in case of 2011 Fy survey)

2802 (valid samples ratio: 70.1%).

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