2A02

# デジタル経済下での「イノベーション指標」の変容
## ーイノベーション・成長概念変容の構造解析と計測

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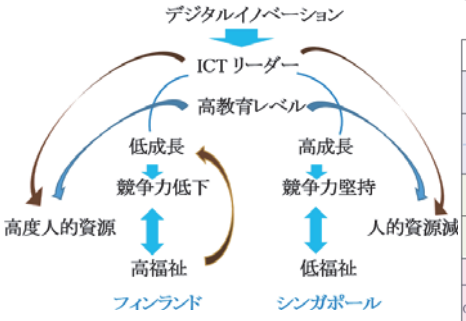
## 1. 序

Tapscott は、ベストセラー「デジタル経済」(1994) で、インターネットはデジタル経済を導き、ビジネスや日常生活を劇的に変えると洞察した。デジタル経済は、彼の洞察をはるかに超えて、従来の常識を覆し、在来の枠組みを越えて、想像を絶するスピードで進み続けている。インターネットは年々覚醒して、思いもしないソシアルエコシステムを創り出して、すべての生産要素を自己増殖的に席巻し、成長や競争力の概念を根底から変える (図 1-1)。

そのような渦中で、グローバル ICT リーダーは、限界生産性ゼロ社会に直面して、R&D 拡大と生産性低下のジレンマに直面する。それは、必然的にデジタル経済下でのネオ・オープンイノベーションともいうべき、新たなイノベーション資源の活用に導く (図 1-2)。

これらは、従来の「イノベーション指標」を根底から変える。その実相と国際対応の動きは前発表で示したとおりである。

本発表は、その認識に立脚して、昨・一昨年の報告をベースに、イノベーション・成長概念変容の構造解析と計測を試み、世界の IT リーダー及びグローバル ICT 企業の超克策にその裏付けを示した。

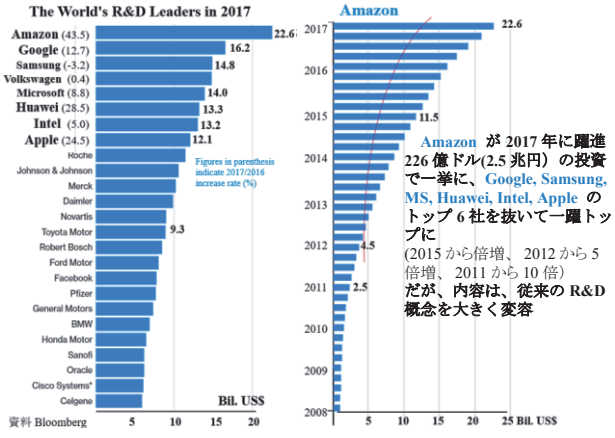



成長・競争力概念の変容
「高福祉・低成長」「低福祉・高成長」 構図の変容
高福祉の活力は成長回復のハイブリッド機能を内包

図 1-1. IT リーダーの投げかける課題.

・2016 世界ランク (< 2013 >)

| | | Finland | Singapore |
|---|---|---|---|
| Population (million) *2015 | | 5.5 | 5.5 |
| ICT (Rank out of 139) | | 2 <1> | 1 <2> |
| Quality of primary education (Rank out of 138) | | 1 <1> | 4 <3> |
| Quality of higher education system (Rank out of 138) | | 3 <2> | 2 <3> |
| Human capital (Rank out of 130) | | 1 <1> | 13 <3> |
| Global competitiveness (Rank out of 138) | | 10 <3> | 2 <2> |
| GDP per capita (1000 US$) *2015 | | 42.0 | 52.9 |
| GDP growth rate (% pa at fixed prices) Average | 2006-2013 | 0.57 | 5.85 |
| | 2014-2016 | 0.34 | 2.50 |
| Trust (Rank out of 21) *2013 | | 2 | 7 |
| Gender parity (Rank out of 144) | | 2 | 55 |
| Happiness (Rank out of 156) *2010-2012 state | | 7 | 30 |
| Inequality (GINI index) *2010 state | | 19 | 45 |
| GDP growth rate 2017-2018 | | 2.79 | 3.28 |




Amazon が 2017 年に躍進 226 億ドル(2.5 兆円) の投資で一挙に、Google, Samsung, MS, Huawei, Intel, Apple のトップ 6 社を抜いて一躍トップに
(2015 から倍増、 2012 から 5 倍増、 2011 から 10 倍)
だが、内容は、従来の R&D 概念を大きく変容

図 1-2. R&D 投資概念の変容.

## 2. デジタル経済の原動力

### 2.1 インターネットの新たな覚醒

#### (1) 自己増殖的席巻

インターネットは年々覚醒して、すべての生産要素を自己増殖的に席巻。

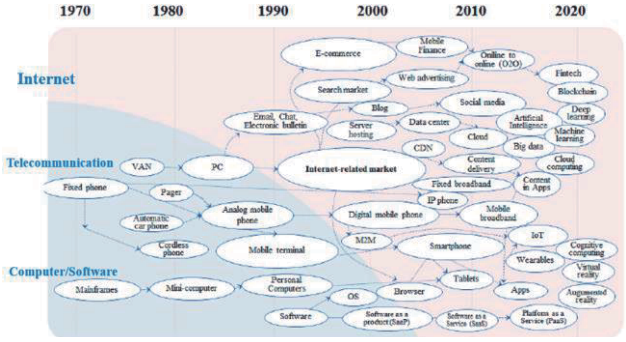
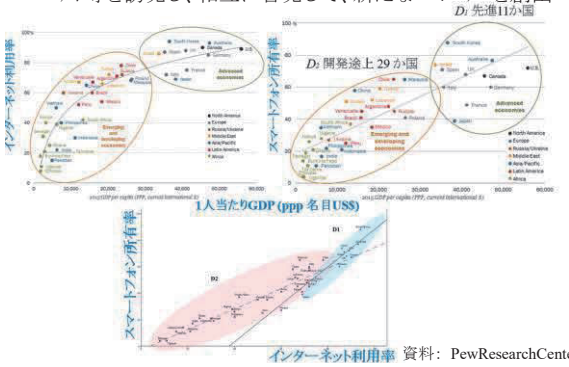



図 2-1. インターネットによる ICT 分野の自己増殖的席巻.

#### (2) ソシアルエコシステムの形成

スナホ等を誘発し、相互に啓発して、新たなエコシステムを創出




$$\ln SP = -0.941 + 1.153\, D_1 \ln ID + 1.147 \ln D_2\, ID \qquad adj.\ R2\ 0.933$$
$$(-4.31)\quad (22.66)\qquad (19.81)$$

図 2-2. 40 か国のインターネット利用率とスマホ所有率の相関 (2015).

#### (3) 同質技術ストックの形成

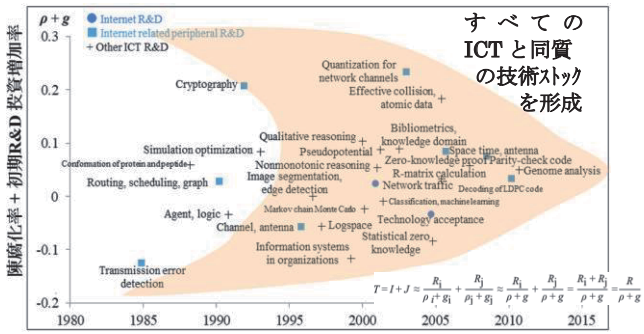



図 2-3. インターネット、ICT の陳腐化率・初期 R&D 投資増加率和の推移 (14,000 文献 1980-2015).

## 2.2 ICT の二面性

### (1) インターネットの導く限界生産性ゼロ社会

ICT は、そのストックの増大に伴う新機能に応じて価格を上昇させる一方、逐年インターネットの無料利用が広がり、価格を低下。その結果、ICT 価格総体は逐年低下するが、経済指標では計測されない「従来にないユニークなサービス」(Uncaptured GDP) を提供。

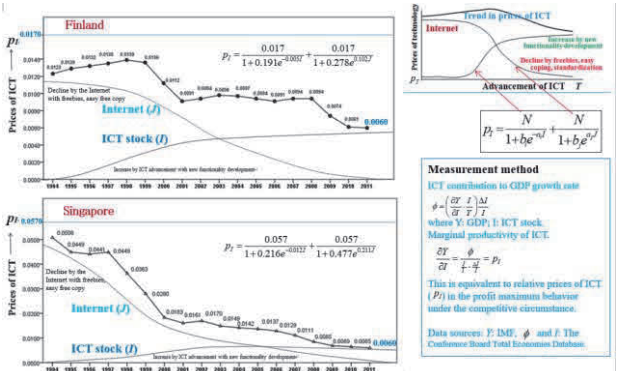



図 2-4. フィンランド・シンガポールの ICT 価格の推移 (1994-2011).

## 2.3 国民的選好の非貨幣消費へのシフト

軌を一にして、国民選好も経済価値を越えた「超機能」にシフト。

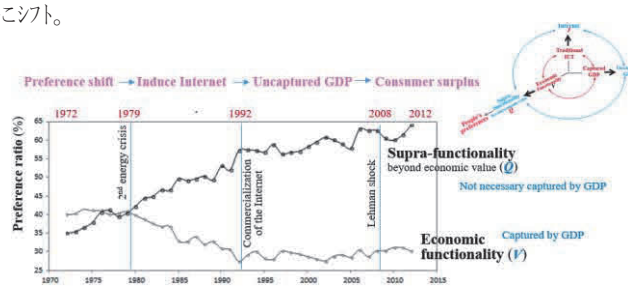



図 2-5. 日本の国民選好シフトの推移 (1972-2012).

## 2.4 イノベーション創出ダイナミズムの変容

### (1) インターネット・非計測 GDP・超機能の共進

その結果、インターネットの飛躍 → Uncaptured GDP (非計測 GDP)への依存 → 国民選好の超機能シフト →さらなるインターネットの躍進、の共進的イノベーションが進展。

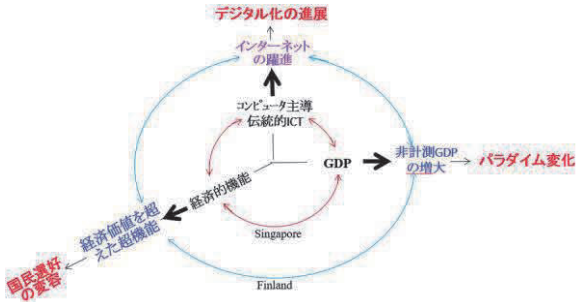



図 2-6. デジタル化イノベーション固有の 共進的メガトレンド.

### (2) R&D 主導イノベーション戦略の変容 ― 高 R&D 企業の対限界生産性低下戦略

| グローバルICT 500 企業 | 2005 | 2016 |
|---|---|---|
| 高 R&D 企業 ―悪循環 | 16 | 25 |
| 低 R&D 企業 ―好循環 | 484 | 475 |

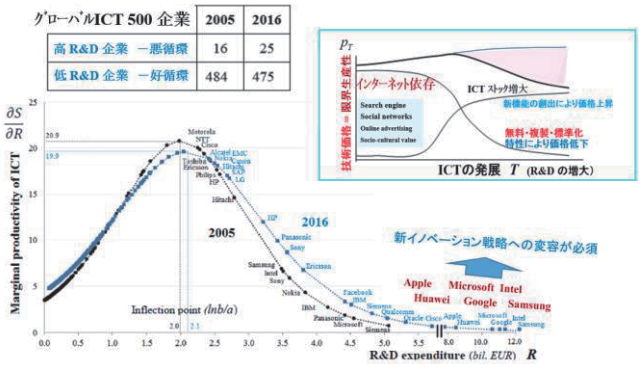



図 2-7. グローバル ICT 500 企業の R&D 主導発展軌道 (2005, 2016).

### (3) 自己増殖機能の覚醒・活性化

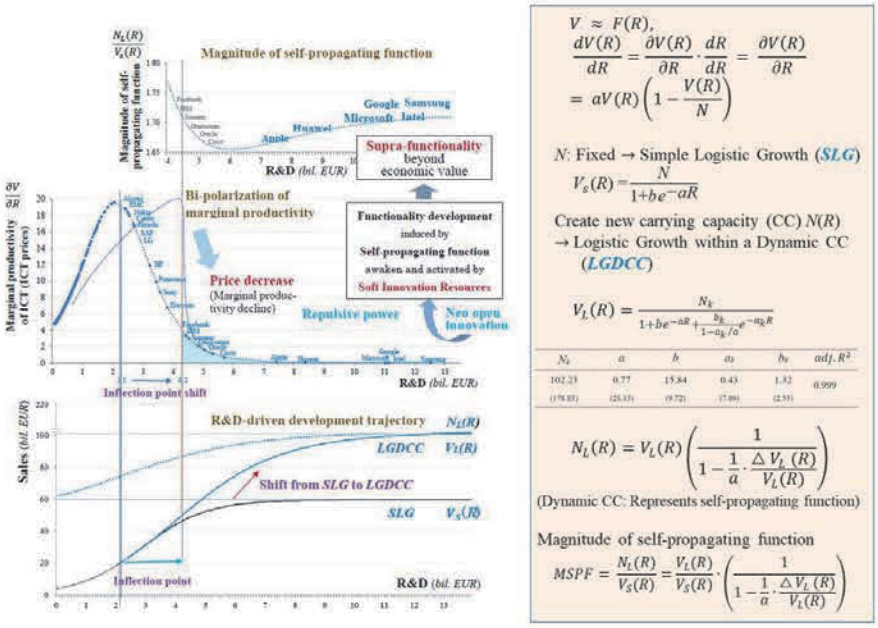



図 2-8. グローバル ICT リーダーの生存戦略 (2016).

デジタル経済下の世界競争に勝ち抜くためには、R&D の拡大を軸に、他に先駆けて革新的な新機能を創出することが不可欠。

しかるに、グローバル ICT リーダーは、ICT の二面性に伴う、R&D の拡大と生産性低下のジレンマに直面して、新たな破壊的イノベーションへの変容が喫緊の課題。

このため、デジタルイノベーション下のネオ・オープンイノベーションともいうべき、新たなイノベーションモデルへの変容に挑戦。

限界生産性の低下を来す R&D に依らない新たなイノベーション資源 (ソフトイノベーション資源) を発掘・開拓・活用して、それを梃に、ICT 固有の自己増殖機能を覚醒・活性化し、それに則って国民選好のシフトにそう超機能を創出。

それは、インターネットのさらなる革新を誘発して、「インターネット・非計測 GDO・超機能の共進」 にのっとった新たなイノベーションダイナミズムを創出。

### (4) ﾃﾞｼﾞﾀﾙｲﾉﾍﾞｰｼｮﾝ下でのﾈｵ･ｵｰﾌﾟﾝｲﾉﾍﾞｰｼｮﾝ

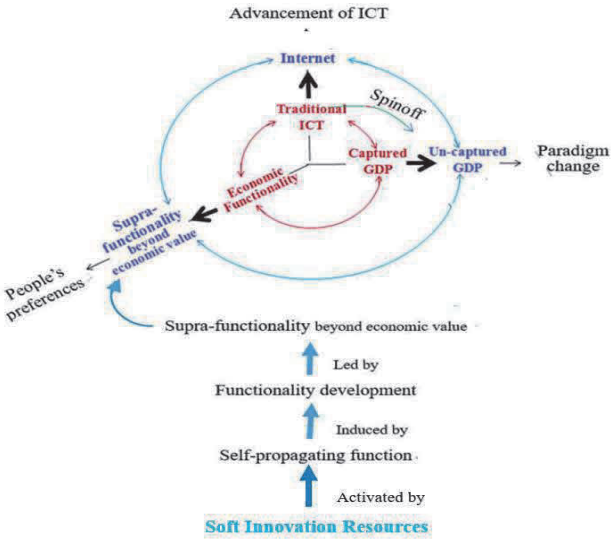



**図 2-9. ｸﾞﾛｰﾊﾞﾙ ICT ﾘｰﾀﾞｰの破壊的ﾋﾞｼﾞﾈｽﾓﾃﾞﾙ.**

限界生産性の低下を来すことになる R&D に依らないイノベーション資源（ソフトイノベーション資源）を活用して（ネオ・オープンイノベーション）、ICT 固有の自己増殖性を覚醒・活性化させることによって、国民選好のシフトに応える「経済価値を越えた超機能」を生み出して持続成長を維持。

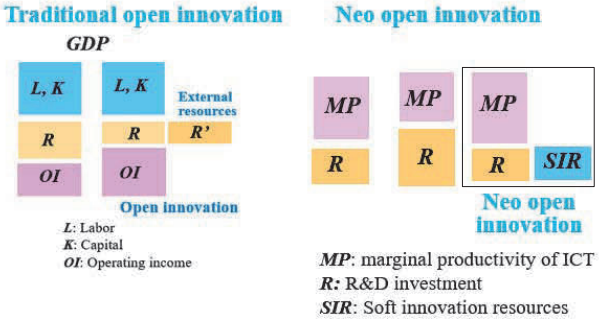



**図 2-10. ネオ・オープンイノベーションのコンセプト.**

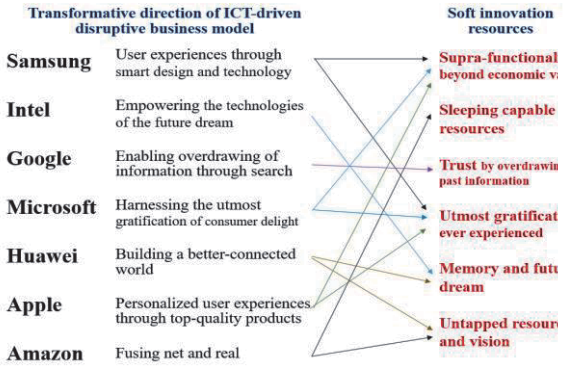


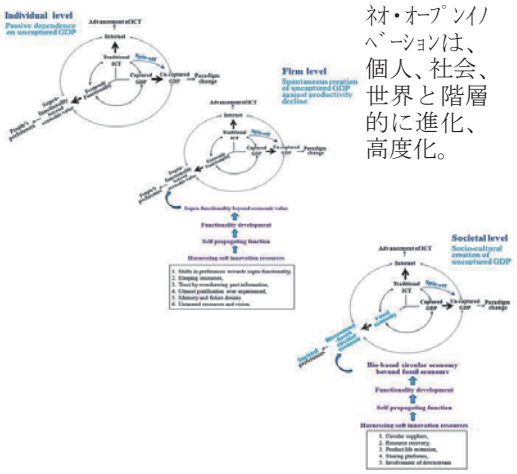

**図 2-11. グローバル ICT リーダーのネオ・オープンイノベーション - Soft Innovation Resources の活用.**

# 3. イノベーション指標の変容

– ｿﾌﾄｲﾉﾍﾞｰｼｮﾝ資源

## 3.1 共進的メガトレンドの発展

### (1) ｿﾌﾄｲﾉﾍﾞｰｼｮﾝ資源活用の高度化




ﾈｵ・ｵｰﾌﾟﾝｲﾉﾍﾞｰｼｮﾝは、個人、社会、世界と階層的に進化、高度化。

**図 3-1. ソフトイノベーション資源活用の高度化ステップ.**

### (2) ｻｰｷｭﾗｰｴｺﾉﾐｰ世界ﾘｰﾀﾞｰ UPM の先駆的挑戦

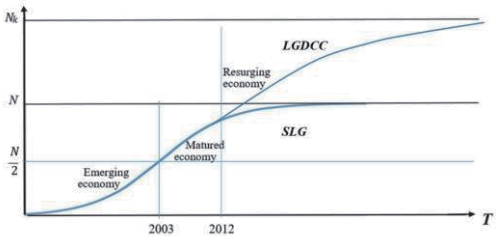



**図 3-2. UPM の率先する Co-evolutionary Coupling.**

## 3.2 ｿﾌﾄｲﾉﾍﾞｰｼｮﾝ資源の可視化・操作化

### (1) 可視化・操作化の 3 アプローチ

3 軸で、可視化・操作化にチャレンジ。

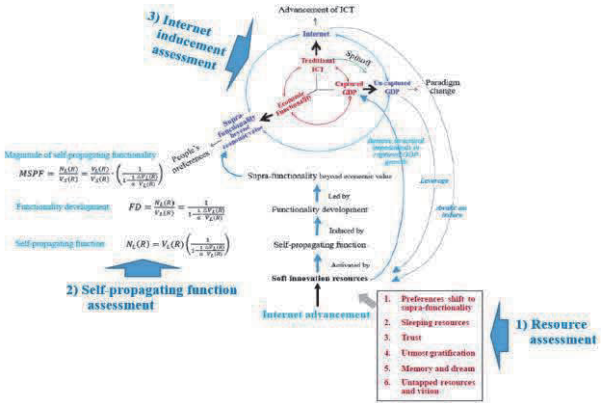



**図 3-3. ｿﾌﾄｲﾉﾍﾞｰｼｮﾝ資源可視化・操作化の 3 ｱﾌﾟﾛｰﾁ.**

### (2) 検　証

ｲﾝﾀｰﾈｯﾄ/ｽﾏﾎ に大きく依存することに注目して、その相関に視点を据えてｲﾝﾊﾟｸﾄ/ﾄﾚﾝﾄﾞを検証。

#### 1) イノベーション資源評価

#### (i) 休眠資源

**表 3-1 Correlation between Smartphone and Uber in New York** (Jun. 2013 – Sep. 2015)

$$\ln U_p = 12.07 - 2.17\, D_1 \ln SP - 2.16\, D_2 \ln SP - 0.16\, D \quad adj.\ R^2\ 0.954$$
(19.07) (-14.40) (-14.72) (-6.25) $DW$ 1.03

$U_p$: Price of Uber (US$/trip); $SP$: Smartphone share in the US telephone market (%).
$D$: Dummy variables; $D_1$: Jun. 2013 - Oct. 2014= 1, others = 0;
$D_2$: Nov. 2014 - Sep. 2015 = 1, others = 0; $D$: Jun. 2015 – Sep. 2015 = 1. others = 0.
The figures in parentheses indicate the t-statistics: all are significant at the 1% level.

#### (ii) トラスト

**表 3-2 Correlation between Internet Dependence and Trust in 20 countries** (2013)

$$\ln X = 2.59 + 0.32\, D_1 \ln ID - 0.18\, D_2 \ln ID - 2.14\, D_1 - 0.16\, D_a + 0.10 D_\beta$$
(4.94) (1.96)* (-1.35)** (-2.20)* (-5.25) (2.28) $adj.\ R^2$ 0.734

$X$: Level of trust in teachers to deliver a good education; $ID$: Internet dependence;
$D$: Dummy variables
$D_1$: Israel, Czech, Singapore, France, New Zealand, Germany, Korea, Switzerland, Japan, UK, Finland, Netherland = 1, others = 0
$D_2$: China, Turkey, Brazil, Italy, Greese, Portugal, USA, Spain = 1, others = 0
$D_a$: Korea, Japan = 1. others =0 $D_\beta$: USA, Spain = 1, others = 0
The figures in parentheses indicate the t-statistics: all are significant at the 1% level except * 5%, ** 10%.

#### (iii) 追憶・夢

**表 3-3 Correlation between Smartphone and Live Music in the US** (Jun. 2013 – Sep. 2015)

$$\ln LM = 1.34 + 1.13\, \ln SP - 0.02\, D_1 + 0.02\, D_2 \quad adj.\ R^2\ 0.996$$
(21.67) (77.85) (-2.46) (4.09) $DW$ 1.25

$LM$: Revenue of live music (mil. US$); $SP$: Smartphone share in the US telephone market (%).
$D$: Dummy variables; $D_1$: Feb. 2014 = 1, others = 0; $D_2$: Sep. 2014 - Nov. 2014 = 1, others = 0
The figures in parentheses indicate the t-statistics: all are significant at the 1% level.

#### (iv) 未活用資源

**表 3-4 Correlation between Internet Dependence, Gender Balance Improvement and Male-dominated Society in 44 Countries** (2013)

$$\ln Y = 0.99 + 0.30 D_1 \ln ID + 0.40 D_2 \ln ID + 0.36 D_3 \ln ID$$
(1.46)* (1.63)* (2.63) (2.16)
$$- 0.31 D_2 \ln W - 2.93 D_3 \ln W - 0.98 D_a + 0.72 D_b \quad adj.\ R^2\ 0.801$$
(-2.60) (-5.58) (-7.57) (3.12)

$Y$: Gender balance index; $ID$: Internet dependence; $W$: Intensity of male dominated society.
$D_1$, $D_2$ and $D_3$: Coefficient dummy variables corresponding to $EMC$ (13 emerging countries), $INC$ (27 industrialized countries) and $CSC$ (4 countries with specific culture), respectively.
$D$: Dummy variable: $D_a$: BEL, CHL, HUN, TWN, RUS, PRT, BRA, GRC, EGY = 1, others = 0; $D_b$: NOR, SAU = 1, others = 0.
The figures in parentheses indicate the t-statistics: all are significant at the 1% level except * 10%.

#### 2) 自己増殖機能評価

**表 3-5 Correlation between Internet Dependence and Self-propagating Function** (1995-2017)

$$\ln N_L(R) = 2.973 + 0.362\, D_1 \ln ID + 0.424\, D_2 \ln ID + 0.536\, D_3 \ln ID \quad adj.\ R^2\ 0.985$$
(109.79) (11.30) (21.51) (32.91) $DW$ 1.20

$N_L(R)$: Self-propagating function; $ID$: Internet dependence; $D$: Dummy variables
$D_1$: 1995 – 2002 = 1, others = 0 ; $D_2$: 2003 – 2007 = 1, others = 0 ,$D_3$: 2008 – 2017 = 1, others = 0
The figures in parentheses indicate the t-statistics: all are significant at the 1% level.

#### 3) インターネット誘発

**表 3-6 Correlation between People's preferences Shift and the Advancement of the Internet in Japan** (1994-2012)

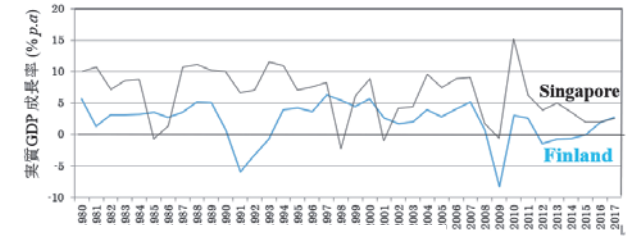
$$\ln ID = -34.77 + 8.81\, D_1 \ln Q + 9.34\, D_2 \ln Q + 9.50\, D_3 \ln Q - 1.11\, D$$
(-2.97) (3.05) (3.24) (3.33) (-2.56) $DW$ 1.75 $adj.\ R^2$ 0.937

$ID$: Internet dependence; $Q$: Preference ratio of supra-functionality beyond economic value;
$D$: Dummy variables ($D_1$: 1994-1996 = 1, others = 0; $D_2$: 1997-2003 = 1, others = 0;
$D_3$: 2004-2012 = 1, others = 0; $D$: 1994 = 1, others = 0).
The figures in parentheses indicate the t-statistics: all are significant at the 1% level.

## 4. ソフトイノベーション資源のハイブリッド機能

### 4.1 IT リーダーの成長軌道の逆転

#### (1) GDP 成長率の逆転傾向



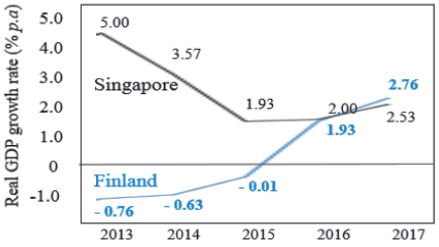




図 4.1. ﾌｨﾝﾗﾝﾄﾞ・ｼﾝｶﾞﾎﾟｰﾙの実質 GDP

世界の IT ﾘｰﾀﾞｰの低成長・高福祉、高成長低福祉の構造も変容。ﾌｨﾝﾗﾝﾄﾞは、福祉は成長のｴﾝｼﾞﾝたるﾊｲﾌﾞﾘｯﾄﾞ効果を内包することを実証。

資料： IMF (Oct. 2017).

#### (2) 逆転要素

表 4-1 ﾌｨﾝﾗﾝﾄﾞ・ｼﾝｶﾞﾎﾟｰﾙの GDP 成長率への貢献 (2013-2017)

| Finland | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Private consumption | -2.09 | 0.11 | 1.50 | 0.83 | 0.96 |
| Government consumption | 2.28 | 0.00 | 0.10 | 0.37 | 0.32 |
| Gross fixed capital | -9.50 | -0.11 | 0.20 | 1.19 | 1.49 |
| Net exports of goods and services | 8.45 | -0.63 | -1.98 | -0.18 | 0.53 |
| Others (inventories and net acquisitions of variables) | 0.10 | 0.00 | 0.17 | -0.28 | -0.54 |
| **Total** | **-0.76** | **-0.63** | **-0.01** | **1.93** | **2.76** |

Original source: National Accounts of Finland (Statistics Finland, 2018).

| Singapore | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| Private consumption | 1.27 | 1.37 | 1.40 | 0.33 | 0.98 |
| Government consumption | 0.98 | ]0.00 | 0.61 | 0.17 | 0.35 |
| Gross fixed capital | 1.67 | 1.74 | 0.44 | -0.08 | -0.42 |
| Net exports of goods and services | 1.27 | 1.56 | 1.58 | 0.92 | -0.56 |
| Others (inventories and net acquisitions of variables) | -0.19 | -1.10 | -2.10 | 0.66 | 2.18 |
| **Total** | **5.00** | **3.57** | **1.93** | **2.00** | **2.53** |

Original source: National Accounts of Singapore (Department of Statistics Singapore, 2018).
Adjusted to IMF statistics using the share of respective contribution by respective statistics.

| GTC contribution to GDP (% p.a) | | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Finland | **GDP** | **-0.76** | **-0.63** | **-0.01** | **1.93** | **2.76** |
| | GC contribution to GDP | -9.50 | -0.11 | 0.20 | 1.19 | 1.49 |
| | GSC contribution to GC | -1.80 | 0.40 | -1.20 | -1.81 | -1.51 |
| | GTC contribution to GC | -7.70 | -0.51 | 1.40 | 3.00 | 3.00 |
| Singapore | **GDP** | **5.00** | **3.57** | **1.93** | **2.00** | **2.53** |
| | GC contribution to GDP | 1.67 | 1.74 | 0.44 | -0.08 | -0.42 |
| | GSC contribution to GC | 4.57 | 4.54 | -0.16 | -1.18 | 1.28 |
| | GTC contribution to GC | -2.90 | -2.80 | 0.60 | 1.10 | -1.70 |

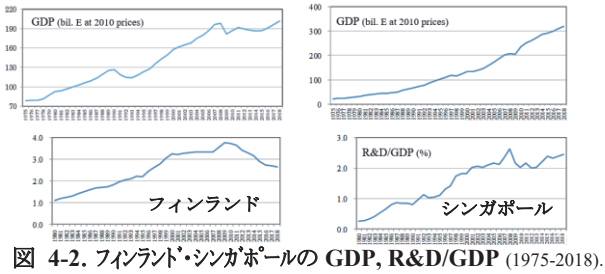



図 4-2. ﾌｨﾝﾗﾝﾄﾞ・ｼﾝｶﾞﾎﾟｰﾙの GDP, R&D/GDP (1975-2018).

## 4.2 フィンランド復調のダイナミズム

### (1) ダイナミズム

ソフトイノベーション資源が R&D に代替しつつ有形固定資本にスピルオーバーして、その成長制約を打破。

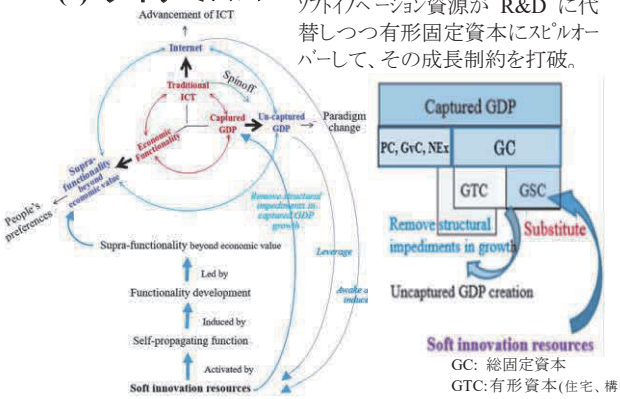



図 4-3. フィンランド復調のダイナミズム.

GC: 総固定資本
GTC: 有形資本(住宅、構築物、機械・設備)
GSC:無形資本(R&D, ソフトウエアー)
PC: 民間消費 GvC: 政府消費
NEx:ネット輸出

### (2) 検 証

#### 1) GDP への MFP の貢献

**表 4-2. Correlation between MFP and GDP growth rate in Finland** (1994-2016).

$GGR = 0.85 + 1.22\ MFPGR$ adj. $R^2$ 0.917 DW 1.66
(4.05) (15.60)

$GGR = 1.09 + 1.24\ MFP^*GR$ adj. $R^2$ 0.889 DW 1.36
(4.61) (13.29)

where *GGR*: Real GDP growth rate, *MFPGR*: MFP growth rate including contribution of R&D, and *MFP*GR*: MFP growth rate not including contribution of R&D.
The figures in parentheses indicate the t-statistics: all are significant at the 1% level.

#### 2) MFP 貢献要素

$MFP = F(T, I, C, \lambda) = A' e^{\lambda t} T^{\alpha} C^{\beta} I^{\gamma} = A e^{\lambda t} R^{\alpha} C^{\beta} I^{\gamma}$
$A = A'(\rho + g)^{\alpha}$
where $A$, $A'$: scale factor, $\lambda$: learning coefficient, $T$: technology knowledge stock, $R$: R&D expenditure $C$: final consumption expenditure, $I$: Internet dependence, $\alpha$, $\beta$, $\gamma$: elasticity, $\rho$: rate of obsolescence of technology, and $g$: R&D growth rate at the initial period.
$\ln MFP = \ln A + \lambda t + \alpha \ln R + \beta \ln C + \gamma \ln I$

**表4-3 Governing factors of MFP in Finland** (1994-2018)

$\ln MFP = -43.23 - 0.04\ t + 0.03\ D_1 \ln R - 0.25\ (D_2+D_3) \ln R + 1.80 \ln C$
(–6.01) (–6.71) (2.75) (–2.56) (7.23)
$+ 0.04\ D_1 \ln I + 0.84\ D_2 \ln I + 8.96\ D_3 \ln I + 38.89\ D_1 + 36.87\ D_2 + 0.02D$
(1.75)*1 (1.87)*1 (6.27) (6.22) (5.78) (2.91)
adj. $R^2$ 0.983 DW 2.27

*D*: dummy variables identifying R&D-driven economic features of respective periods as follows:

| *D*: Dummy variables | | 1994 - 2009 | 2010 - 2015 | 2016 - 2018 | Features of the period |
|---|---|---|---|---|---|
| $D_1$ | 1994-2009 = 1, others = 0 | 1 | 0 | 0 | Sustainable increase in R&D intensity that supported economic growth |
| $D_2$ | 2010-2015 = 1, others = 0 | 0 | 1 | 0 | R&D intensity decline in the economic stagnation |
| $D_3$ | 2016-2018 = 1, others = 0 | 0 | 0 | 1 | Economic resurgence after the Competitiveness Pact despite R&D intensity decline |

*D*: 2000, 2001, 2007, 2010, 2011 = 1, others = 0.
The figures in parentheses indicate the t-statistics: all are significant at the 1% level except *1 10%.

#### 3) 代替

**表 4-4** Correlation between I/R ratio and relative price in Finland (1995-2018).

$\ln \frac{I}{R} = -2.01 + 0.63 D_1 \ln \frac{P_I}{P_C} + 2.17 (D_2+D_3) \ln \frac{P_I}{P_C} + 3.34 D_1 - 0.13 D$ adj. $R^2$ 0.966 DW 1.25
(–2.30) (18.12) (5.44) (3.82) (–2.39)

*D*: dummy variables. $D_1$-$D_3$: see Table 6; *D*: 1999, 2000 = 1, others = 0..
The figures in parentheses indicate the t-statistics: all are significant at the 1% level.

#### 4) スピルオーバー

**表 4-5 Governing factors of MFP in Finland** (1994-2018)

$\ln MFP = -43.23 - 0.04\ t + 0.03\ D_1 \ln R - 0.25\ (D_2+D_3) \ln R + 1.80 \ln C$
(–6.01) (–6.71) (2.75) (–2.56) (7.23)
$+ 0.04\ D_1 \ln I + 0.84\ D_2 \ln I + 8.96\ D_3 \ln I + 38.89\ D_1 + 36.87\ D_2 + 0.02D$
(1.75)*1 (1.87)*1 (6.27) (6.22) (5.78) (2.91)
adj. $R^2$ 0.983 DW 2.27

*D*: dummy variables identifying R&D-driven economic features of respective periods as follows:

*D*: 2000, 2001, 2007, 2010, 2011 = 1, others = 0,
The figures in parentheses indicate the t-statistics: all are significant at the 1% level except *1 10%.

## 4.3 Uncaptured GDP の誘導効果

Uncaptured GDP が代替・スピルオーバーを誘導。

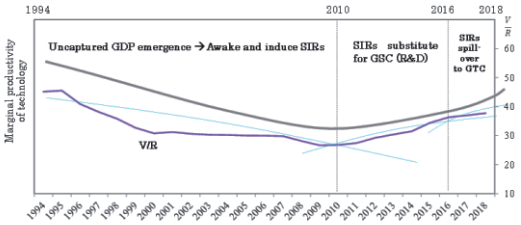



図 4-4. Uncaptured GDP の代替・スピルオーバー誘導 軌道 (1994-2018),

$$\frac{\partial V}{\partial T} = \left[\frac{b(\alpha+\gamma q)}{1+b(\gamma q-\beta b^*)}\right](\rho + g)\frac{V}{R}$$

| | | | 1994 - 2009 | 2010 - 2015 | 2016 - 2018 |
|---|---|---|---|---|---|
| $b$ | $\partial \ln V / \partial \ln MEP$ | MFP elasticity to GDP | 1.22 | 1.22 | 1.22 |
| $b^*$ | $\partial \ln C / \partial \ln V$ | GDP elasticity to consumption | 0.46 | 0.46 | 0.46* |
| $\alpha$ | $\partial \ln MFP / \partial \ln R$ | R&D elasticity to MFP | 0.03 | -0.25 | -0.25 |
| $\beta$ | $\partial \ln MFP / \partial \ln C$ | Consumption elasticity to MFP | 1.80 | 1.80 | 1.80 |
| $\gamma$ | $\partial \ln MFP / \partial \ln I$ | SIRs elasticity to MFP | 0.04 | 0.84 | 8.96 |
| $q$ | $\partial \ln I / \partial \ln (R/V)$ | R&D intensity elasticity to SIRs | 4.17# | -0.21 | -0.21 |
| $\varepsilon$ | $\partial \ln (I/R) / \partial \ln (p_I/p_C)$ | Elasticity of SIRs substitution for R&D | 0.63# | 2.17 | 2.17 |

*Estimate by 2016-2017 and #estimate by 1995-2009.

## 4.4 ソフトイノベーション資源の復調への貢献

### (1) 貢献ダイナミズム

ソフトイノベーション資源が、復調のトリガー。労使協調の Competitiveness Pact (2016) が核。

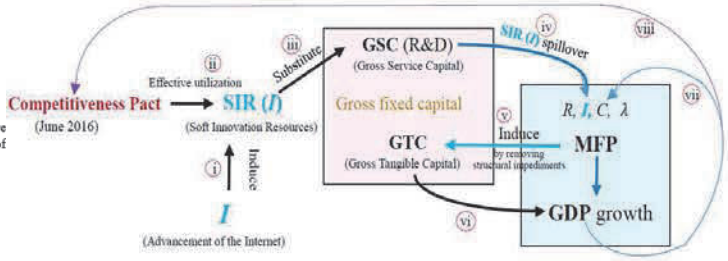



図 4-5. ソフトイノベーション資源の成長制約克服メカニズム.

### (2) ソフトイノベーション資源の成長制約打破

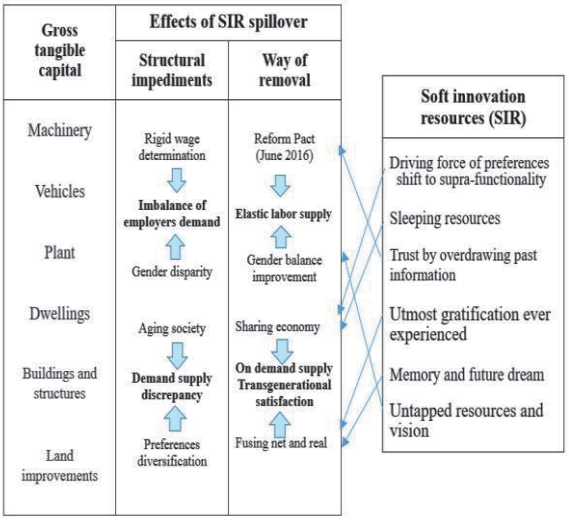



図 4-6. ソフトイノベーション資源の成長制約打破.

## 5. 結　論

従来の常識を覆し、在来の枠組みを越えて、想像を絶するｽﾋﾟｰﾄﾞで進み続けているﾃﾞｼﾞﾀﾙ経済は、GDP の枠を、概念を越えて 世界を飛びまわり、次々に新たな非常識な常識を創り出していく。

ｲﾉﾍﾞｰｼｮﾝや成長の概念も顕著に変容している。年々覚醒して新たなｿｼｱﾙｴｺｼｽﾃﾑを創り出し、ICT はもとより、すべての生産要素を自己増殖的に席巻するｲﾝﾀｰﾈｯﾄは、従来にないｻｰﾋﾞｽ・ﾋﾞｼﾞﾈｽ・社会・文化を生み出す。だが、その多くは GDP には反映されない。

しかるに、GDP 万能神話からの脱却は遅々として進まない。

ｲﾉﾍﾞｰｼｮﾝのｲﾝﾌﾟｯﾄにおいてもしかりである。Amazon は 2017 年には、2 年間に R&D 投資を倍増させ、一挙に Google, Samsung, MS, Intel, Apple を抜いて一躍 R&D ﾄｯﾌﾟに躍出した。だが、その“R&D” の中身は、従来の常識を破るものである。

昨年は、ﾃﾞｼﾞﾀﾙ経済下での GDP の計測を狙いに、その根幹をなす Uncaptured GDP の構造解析と計測を試みた。

本稿は、さらに限界生産性ｾﾞﾛ社会に直面して、R&D 投資と生産性低下のｼﾞﾚﾝﾏに直面するｸﾞﾛｰﾊﾞﾙ ICT ﾘｰﾀﾞｰの生存戦略にﾒｽをいれ、ﾃﾞｼﾞﾀﾙ経済下におけるネオ・オープンｲﾉﾍﾞｰｼｮﾝ戦略ともいうべき、ｿﾌﾄｲﾉﾍﾞｰｼｮﾝ資源の活用の実相を明らかにし、その検証・計測を試みた。

さらに、Uncaptured GDP ｼﾌﾄをﾘｰﾄﾞした IT 大国ﾌｨﾝﾗﾝﾄﾞの GDP 面での顕著な復調に注目して、R&D 投資に代替したｿﾌﾄｲﾉﾍﾞｰｼｮﾝ資源が、他の生産要素にｽﾋﾟﾙｵｰﾊﾞｰして、成長制約を打破したことを実証し、ｿﾌﾄｲﾉﾍﾞｰｼｮﾝ資源のﾊｲﾌﾞﾘｯﾄﾞ効果を示した。

いずれも、ﾃﾞｼﾞﾀﾙ経済下における「成長・ｲﾉﾍﾞｰｼｮﾝ指標」の再考を促すものである。

## 参考文献


[1] Ahmad, N., Schreyer, P., 2016. Are GDP and Productivity Measures up to the Challenges of the Digital Economy? International Productivity Monitor 30, Spring, 4-27.

[2] Aladeojebi, T.K., 2013. Planned Obsolescence, International Journal of Scientific & Engineering Research 4(6), 1504-1508.

[3] Balcerzak, A.P. and Pietrzak, M.B., 2016. Quality of Institutions and Total Factor Productivity in the European Union. Statistics in Transition 17 (3), 497-514.

[4] Bharadwaj, A., Sawy, O.A.E., Pavloyu, P.A. and Venkatraman, N. 2013. Digital Business Strategy: Toward a Next Generation of Insights. MIS Quarterly 37 (2) 471–482.

[5] Brynjolfsson, E., 1993. Productivity Paradox of Information Technology, Communications of the Association for Computing Machinery 36 (12), 66–77.

[6] Brynjolfsson, E., McAfee, A., 2011. Race against the Machine. Digital Frontier, Lexington, MA.

[7] Brynjolfsson, E., McAfee, A., 2014. The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. W.W. Norton & Company, New York.

[8] Bulow, J., 1986. An Economic Theory of Planned Obsolescence, Quarterly Journal of Economics 101, 729-749.

[9] Byrne, D., Corrado, C., 2016. ICT Prices and ICT Services: What do They Tell about Productivity and Technology? Economic Program Working Paper Series, EPWP #16-05, The Conference Board, New York.

[10] Chew, M., Watanabe, C. & Tou, Y., 2010. Technology Leapfrogging: Findings from Singapore's Water Industry. Journal of Technology Management for Growing Economies 1 (2), 29-47.

[11] Cowen, T., 2011. The Great Stagnation: How America Ate All the Low-Hanging Fruit of Modern History, Got Sick, and Will (Eventually) Feel Better. A Penguin eSpecial from Dutton, Penguin, New York.

[12] Department of Broadband, Communications and the Digital Economy (DBCDE), 2009. Digital Economy Future Directions. DBCDE, Camberra.

[13] Department of Statistics Singapore, 2018*a*. National Accounts of Singapore, Department of Statistics Singapore, Singapore.

[14] Department of Statistics Singapore, 2018*b*. Detailed Statistical Time Series, R&D Expenditure. Department of Statistics Singapore, Singapore.

[15] Dervis, K. and Qureshi, Z., 2016. The Productivity Slump - Fact or Fiction: The Measurement Debate, Global Economy and Development at Brookings, Washington, D.C.

[16] Devezas, T. C., Linstone, H. A., Santos, H. J.S., 2005. The Growth Dynamics of the Internet and the Long Wave Theory. Technological Forecasting and Social Change 72, 913-935.

[17] European Commission, Joint Research Center, 2004-2016. The EU Industrial R&D Investment Scoreboard. European Commission, Brussels.

[18] EU, 2017. *The Internet of Things: Digital Single Market*. EU, Brussels.

[19] Feldstein, M., 2017. Understanding the Real Growth of GDP, Personal Income, and Productivity. Journal of Economic Perspectives 31 (2), 145-164.

[20] Groshen, E.L., Moyer, B.C., Aizcorbe, A.M., Bradley, R., Friedman, D.M., 2017. How Government Statistics Adjust for Potential Biases from Quality Change and New Goods in an Age of Digital Technologies: A View from the Trenches. Journal of Economic Perspectives 31 (2) 187-210.

[21] Hautamaki, A., 2017. Finland's Research and Innovation Policy Needs to be Revised with a Broad Brush, Business & Finance, Politics, Tech & Science.

[22] Hutchenreiter, G., Zuniga, P. & Weber J., 2017. OECD Review of Innovation Policy: Finland Assessment and Recommendations, Launch Seminar, Helsinki.

[23] Innovation Policy Research Center (IPRC), 2013. Academic Landscape System. Retrieved April 09, 2017, from http://academic-landscape.com/.

[24] International Monetary Fund (IMF), 2017*a*. World Economic Outlook Database, IMF, Washington, D.C.

[25] International Monetary Fund (IMF), 2017*b*. Measuring the Digital Economy: IMF Statistical Forum. IMF, Washington D.C.

[26] Internet Society, Global Internet Report 2016, https://www.internetsociety.org/globalinternetreport/2016/wp-content/uploads/2016/11/ISOC_GIR_2016-v1.pdf, 2016 (retrieved 05.08.2017).

[27] Internet Society, *The Internet of Things: An Overview*. Internet Society, https://www.internetsociety.org/doc/iot-overview, 2015 (accessed 05.08.2017).

[28] International Telecommunication Union (ITU), 2018. World telecommunication/ICT indicators database, ITU, Geneva.

[29] Japan Cabinet Office (JCO), 2012. National Survey of Lifestyle Preferences. JCO, Tokyo.

[30] Kajikawa, Y., Ohno, J., Takeda, Y., Matsushima, K., Komiyama, H., 2007. Creating an Academic Landscape of Sustainability Science: An Analysis of the Citation Network. Sustainability Science 2 (2) 221-231.

[31] Lowrey, A., 2011. Freaks, Geeks, and GDP. Slate. http://www.slate.com/articles/business/moneybox/2011/03/freaks_geeks_and_gdp.html (accessed 20.06.17).

[32] McDonagh, D., 2008. Satisfying Needs beyond the Functional: The Changing Needs of the Silver Market Consumer. Presented at the International Symposium on the Silver Market Phenomenon – Business Opportunities and Responsibilities in the Aging Society, Tokyo, Japan.

[33] McKinsey Global Institute, 2015. The Internet of Things: Mapping the Value beyond the Hype. McKinsey & Company, San Francisco.

[34] Ministry of Employment and the Economy (MEE), 2008. Finland's National Innovation Strategy, MEE, Helsinki.

[35] Milne, L., 2017. Finland Nurses Its Economy Back to Health, EU Economy. https://www.ft.com/content/73d66498-e19d-11e7-a8a4-0a1e63a52f9c

[36] Ministry of Economic Affairs and Employment of Finland (MEAE), 2017. Finland's Preliminary Views on the EU's 9th Framework Programme (2021-) for Research and Innovation. MEAE, Helsinki.

[37] Ministry of Economic Affairs and Employment of Finland (MEAE), 2018. Innovation Policy Provides an Incentive for Continuous Renewal. MEAE, Helsinki. http://tem.fi/en/innovation-policy Retrieved 6 April 2018.

[38] Ministry of Finance Singapore, 2018. Singapore Budget 2018. Ministry of Finance Singapore, Singapore.

[39] Ministry of Finance Singapore, 2018. Singapore budget 2018), Ministry of Singapore, Singapore.

[40] Moriya, K., 2017. On the OECD/WPNA: Challenges to the Digital Economy in Official Statistics and Countries' Reports on 2008SNA Issues. Quarterly Journal of National Accounts 162, 61-78.

[41] Nadiri, M.I. and Schankerman, M.A., 1981. The Structure of Production, Technological Change, and the Rate of Growth of Total Factor Productivity in the U.S. Bell System. In T.G. Cowing and R.E. Stevenson (eds.) Productivity Measurement in Regulated Industries (Economic Theory, Econometrics, and Mathematical Economics) 219-247. Academic Press, New York.

[42] Naveed, K., Watanabe, C. & Neittaanmäki, P., 2018. The Transformative Direction of Innovation toward an IoT-based Society: Increasing Dependency on Uncaptured GDP in Global ICT Firms. Technology in Society 53, 23-46.

[43] Naveed, K., Watanabe, C., Neittaanmäki, P., 2017. The Transformative Direction of Innovation toward an IoT-based Society: Increasing Dependency on Uncaptured GDP in Global ICT Firms. Technology in Society 53 (in print).

[44] Newman, M.E.J., 2004. Fast Algorithm for Detecting Community Structure in Networks. Physical Review E. 69 (66133).

[45] OECD, 2016. OECD Observer: The Digital Economy. OECD, Paris..

[46] OECD, 2017. OECD Review of Innovation Policy: Finland Assessment and Recommendation, OECD, Paris.

[47] OECD, 2018. OECD Database, OECD, Paris.

[48] Rifkin, J., 2011. The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World, Macmillan, New York.

[49] Solow. R., 1987. We'd Better Watch Out. Review of S.S. Cohen and J. Zysman, Manufacturing Matters: The Myth of the Post-industrial Economy. New York Times Book Review 36.

[50] Statistics Finland, 2018*a*. National accounts of Finland, Statistics Finland, Helsinki.

[51] Statistics Finland, 2018*b*. Government Budget Allocation for R&D in 2018. Statistics Finland, Helsinki.

[52] Statistics Finland, 2018*c*. The Labor Market in Finland, Statistics Finland, Helsinki.

[53] Statistics Finland, 2018*d*. Statistics Finland's PX-Web databases, Statistics Finland, Helsinki.

[54] Syverson, C., 2017. Challenges to Mismeasurement Explanations for the US Productivity Slowdown. Journal of Economic Perspectives 31(2), 165-186.

[55] Tapscott, D., 1994. The Digital Economy: Promise and Peril in the Age of Networked Intelligence. McGraw-Hill, New York.

[56] The World Bank, Digital Dividends, 2016. The World Bank, Washington D.C.

[57] Tou, Y., Moriya, K., Watanabe, C., Ilmola, L. & Neittaanmäki, P., 2018. Soft Innovation Resources: Enabler for Reversal in GDP Growth in the Digital Economy. International Journal of Managing Information Technology 10 (3), 9-28.

[58] Tou, Y., Watanabe, C., Ilmola, L. Moriya, K., & Neittaanmäki, P., 2018. Hybrid Role of Soft Innovation Resources: Finland's Notable Resurgence in the Digital Economy International Journal of Managing Information Technology 10 (4), in print.

[59] US Council on Competitiveness., 2016. No Recovery: An Analysis on Long-term U.S. Productivity Decline. Washington, D.C.

[60] Watanabe, C., Kondo, R., Ouchi, N., Wei, H. and Griffy-Brown, C., 2004. Institutional Elasticity as a Significant Driver of IT Functionality Development. Technological Forecasting and Social Change 71 (7), 723-750.

[61] Watanabe, C., 2013. Innovation-consumption Co-emergence Leads a Resilience Business. Innovation and Supply Chain Management 7 (3), 92-104.

[62] Watanabe, C., Naveed, K., Zhao, W., 2015*a*. New Paradigm of ICT Productivity: Increasing Role of Un-captured GDP and Growing Anger of Consumers. Technology in Society 41, 21–44.

[63] Watanabe, C., Naveed, K., Neittaanmäki, P., 2015*b*. Dependency on Un-captured GDP as a Source of Resilience beyond Economic Value in Countries with Advanced ICT Infrastructure: Similarities and Disparities between Finland and Singapore. Technology in Society 42, 104–122.

[64] Watanabe, C., Naveed, K., Neittaanmäki, P., Tou, Y., 2016*a*. Operationalization of Un-captured GDP: The Innovation Stream under New Global Mega-trends. Technology in Society 45, 58–77.

[65] Watanabe, C., Naveed, K., Neittaanmäki, P. & Tou, Y., 2016*b*. Co-evolution of Three Mega Trends Nature Uncaptured GDP: Uber's Ride-sharing Revolution. Technology in Society 46, 164–185.

[66] Watanabe, C., Naveed, K. & Neittaanmäki, P., 2016*c*. Co-evolution between Trust in Teachers and Higher Education toward Digitally-rich Learning Environments. Technology in Society 48, 70–96.

[67] Watanabe, C., Naveed, K., Neittaanmäki, P., Fox, B., 2017*a*. Consolidated Challenge to Social Demand for Resilient Platforms: Lessons from Uber's Global Expansion. Technology in Society 48, 33–53.

[68] Watanabe, C., Naveed, K. & Neittaanmäki,P., 2017. ICT-driven Disruptive Innovation Nurtures Uncaptured GDP: Harnessing Women's Potential as Untapped Resources. Technology in Society 51, 81–101.

[69] Watanabe, C., Moriya, K., Tou, Y., Neittaanmäki, P., 2018*a*. Structural Sources of a Productivity Decline in the Digital Economy. International Journal of Managing Information Technology 10 (1), 1-20.

[70] Watanabe, C., Moriya, K., Tou, Y. & Neittaanmäki, P., 2018*b*. Consequences of the Digital Economy: Transformation of the Growth Concept. International Journal of Managing Information Technology10 (2), 21-39.

[71] Watanabe, C., Tou, Y. & Neittaanmäki, P., 2018*c*. A New Paradox of the Digital Economy: Structural Sources of the Limitation of GDP Statistics, Technology in Society, in print.

[72] World Economic Forum (WEF), 2013. The Global Information Technology Report, 2013. WEF, Geneva.

[73] Ylhainen, I., (2017) Challenges of Measuring the Digital Economy. https://www.sitra.fi/en/articles/challenges-measuring-digital-economy/

[74] Zubascu. F., 2017. Finland Remodels Its Innovation Strategy, Science & Business.