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Innovation, Economic Growth, and Policy Implications

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— Joint-work with Sohei Kaihatsu (Bank of Japan)
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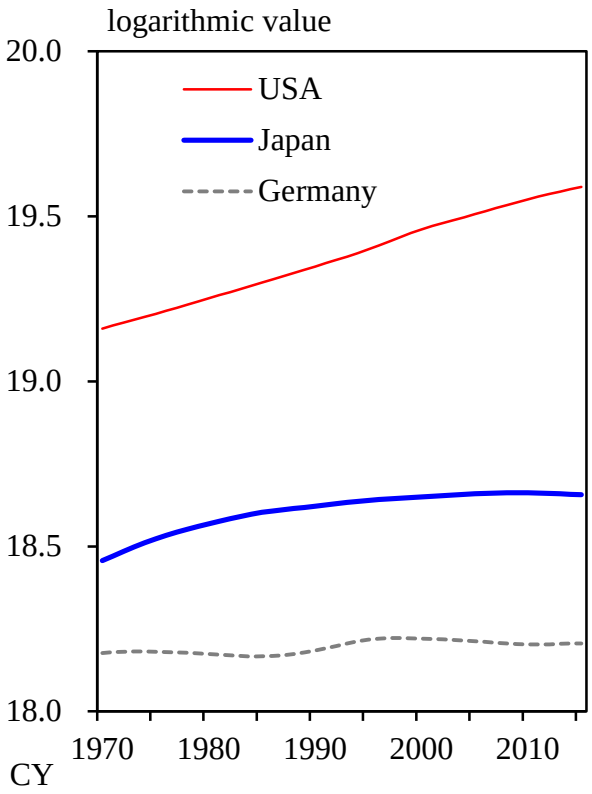
Today's topic

1. Innovation and economic growth
2. Are we creating new innovation?
3. Are we utilizing new innovation?
4. Policy implications

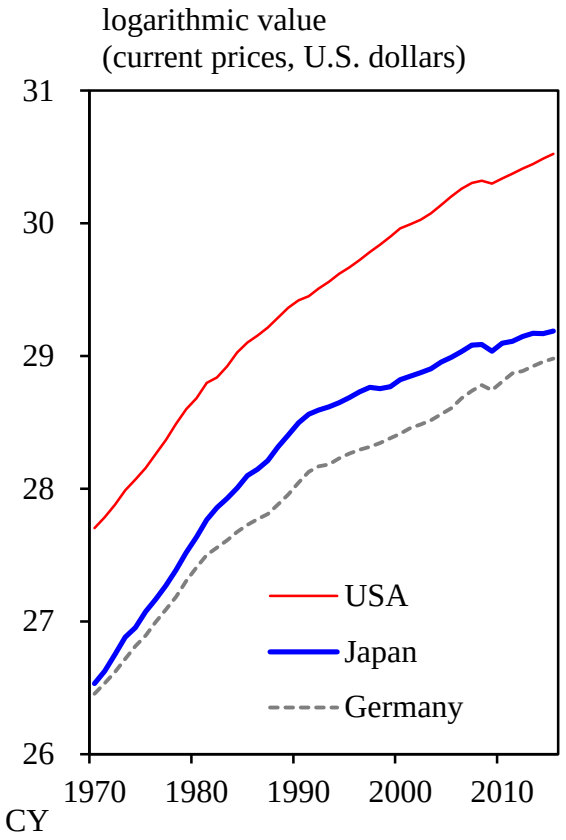
1. INNOVATION AND ECONOMIC GROWTH

Stylized fact

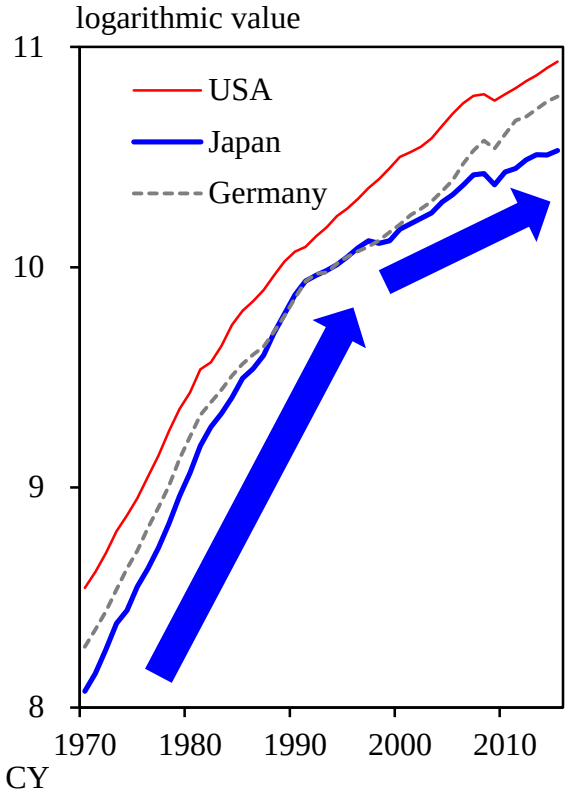
(1) Population



(2) GDP



(3) Per capita GDP



Sources: OECD, "OECD. Stat"; United Nations, "World Population Prospects".

What theory says…

Malthus: Per capita economic growth is limited by productivity of land, that is, food production capacity.

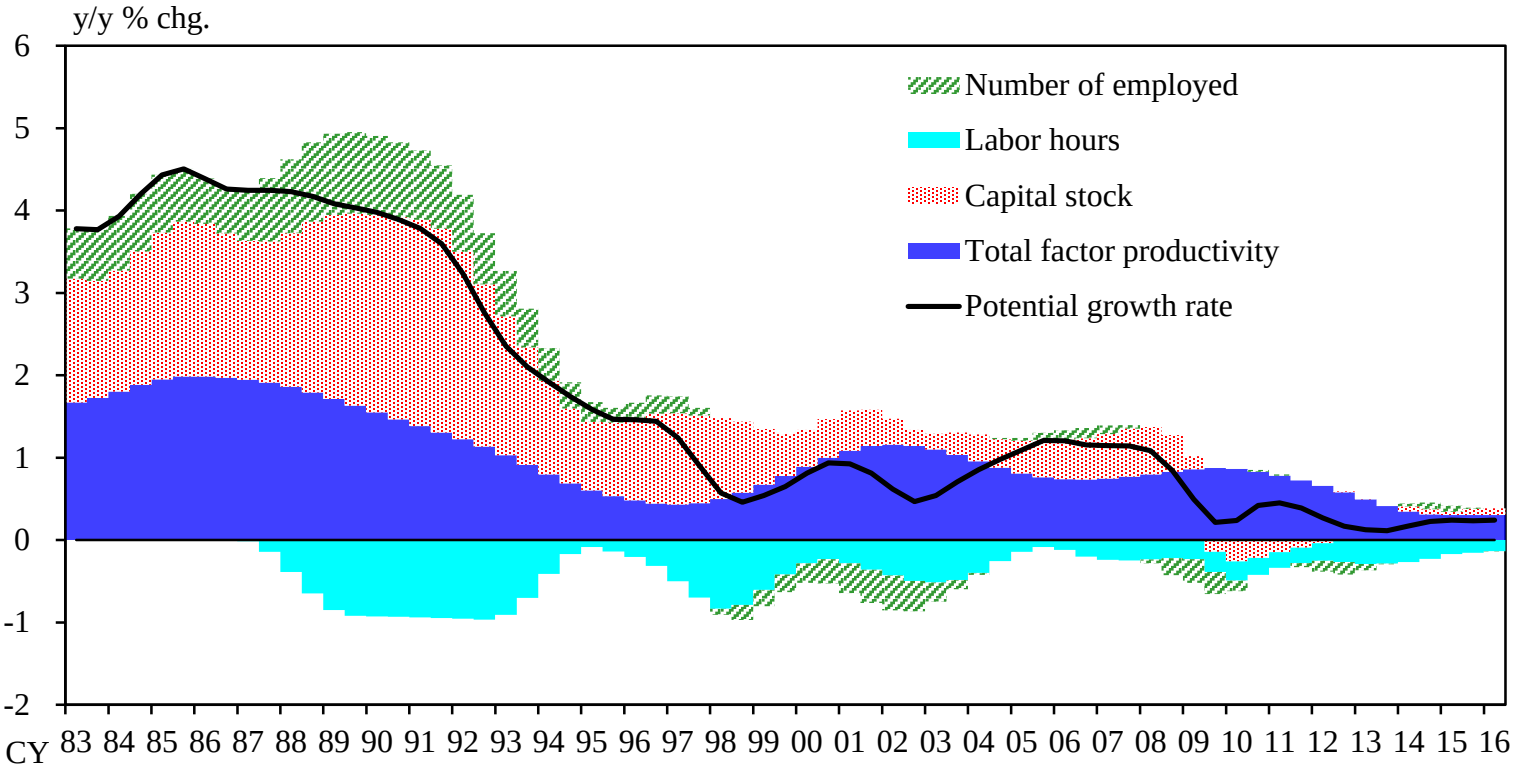
Solow model: Per capita economic growth is exogenously determined by technological progress.

Endogenous growth theory: R&D, human capital, and education --with market mechanism-- induce per capita economic growth.

Growth-accounting approach

- Slowdown in TFP and capital stock accumulation are the two main causes of Japan's long-term economic stagnation.

Potential growth rate (Japan)

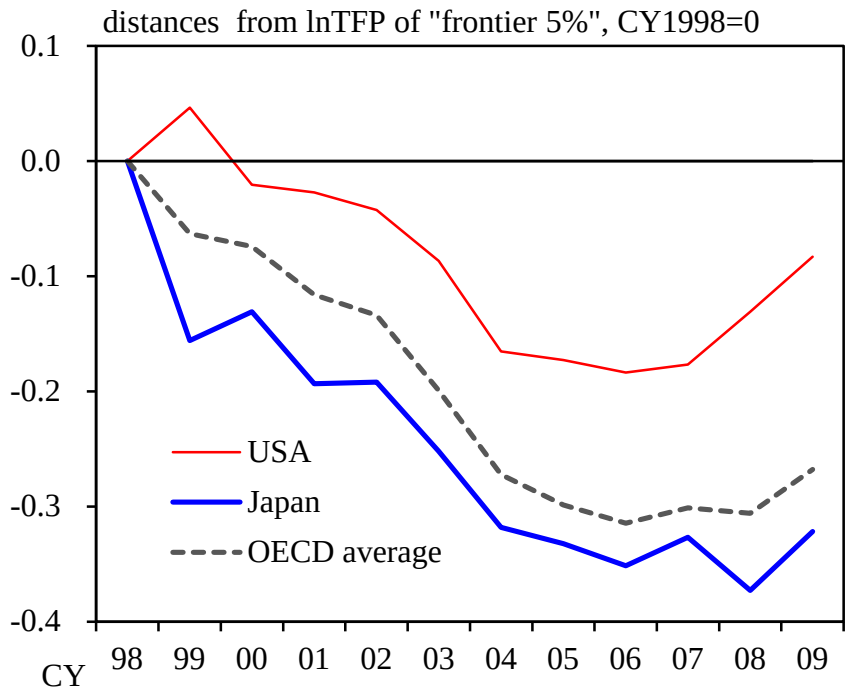


Note: The potential growth rate is estimated by the Research and Statistics Department, Bank of Japan.
Sources: Cabinet Office; Bank of Japan; Ministry of Internal Affairs and Communications; Ministry of Health, Labour and Welfare; Ministry of Economy, Trade and Industry; Research Institute of Economy, Trade and Industry.

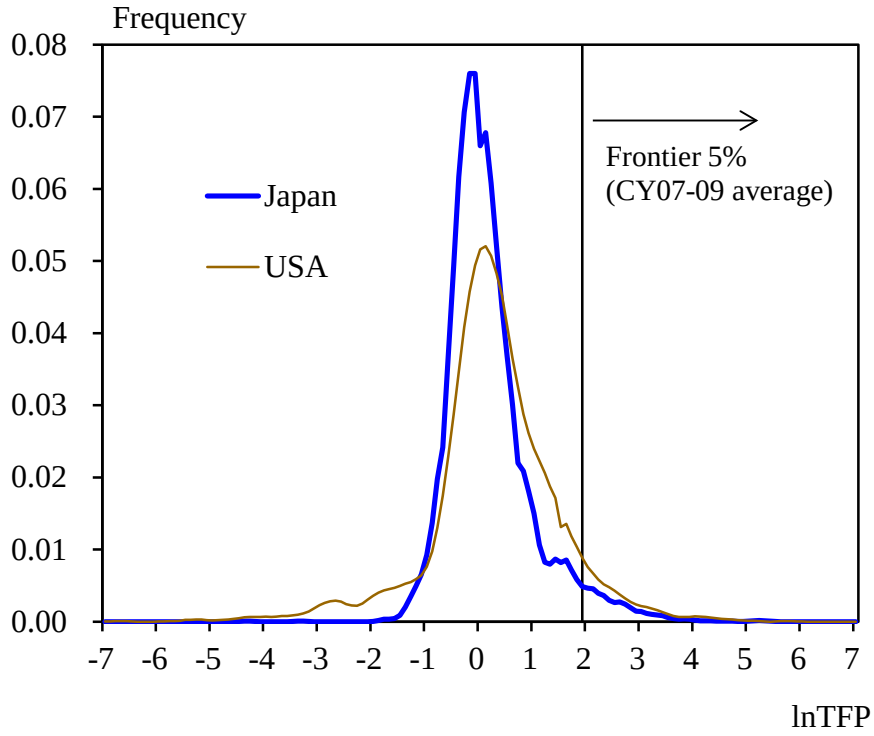
Firm-level approach

- Top-notch firms lead economic growth.
- Japanese firms tend to stay at the average level of TFP and thereby lag behind U.S. and OECD average.

(1) Distance from "frontier"



(2) Distribution of firm-level TFP



Notes: 1. Calculated results of "firm-level TFP" in manufacturing sector. See Appendix 1-2 for details on calculation.
2. The TFP levels of Japan, the US, and the OECD average indicate value of weighted average by sales volume.
3. Estimated results of kernel density with pooled data of "firm-level TFP" in manufacturing sector in 2007-2009. Figure 2 is drawn to so that the distribution of Japan/US adds up to one.

Sources: Thomson Reuters, "Data Stream"; OECD, "STAN database"; Cabinet Office, Government of Japan, "National Accounts of Japan"; IMF, "World Economic Outlook".

2. ARE WE CREATING NEW INNOVATION?

Innovation stagnation

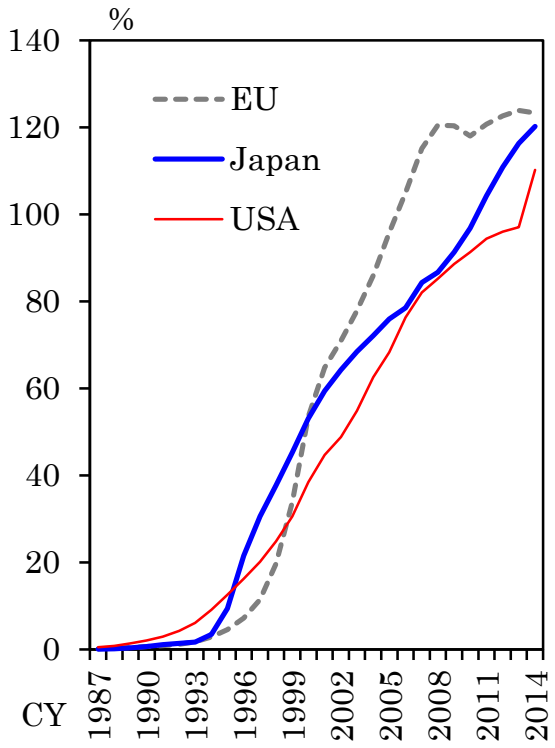
- Gordon claims that low productivity growth is caused by slowdown of innovation.
- We do not have any significant innovation to revolutionize our lives these day, such as electricity, internal-combustion engine etc.

Modern innovation

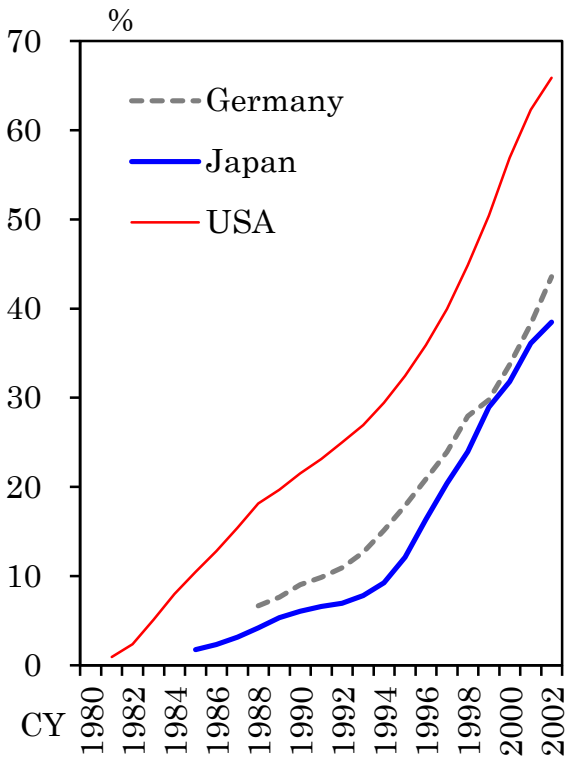
- ICT innovation has changed our way of lives.
- Thanks to new medical innovation, cancer has become curable.

ICT penetration rate (per 100 people)

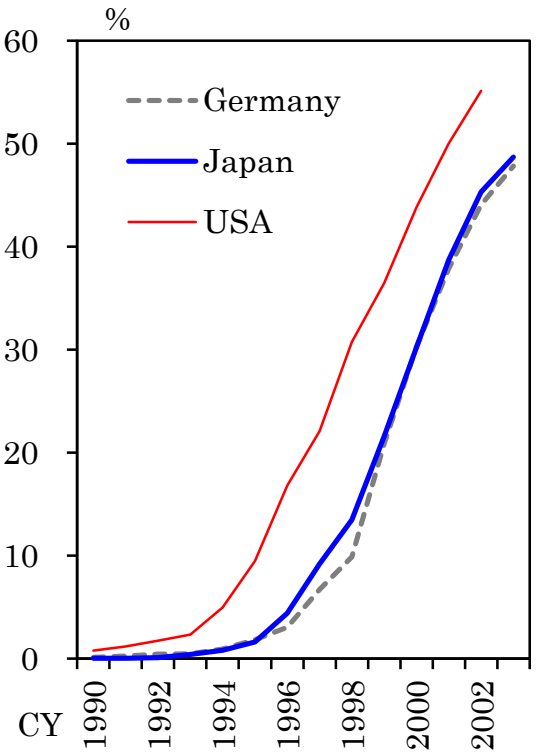
(1) Mobile phone



(2) Computer



(3) Internet

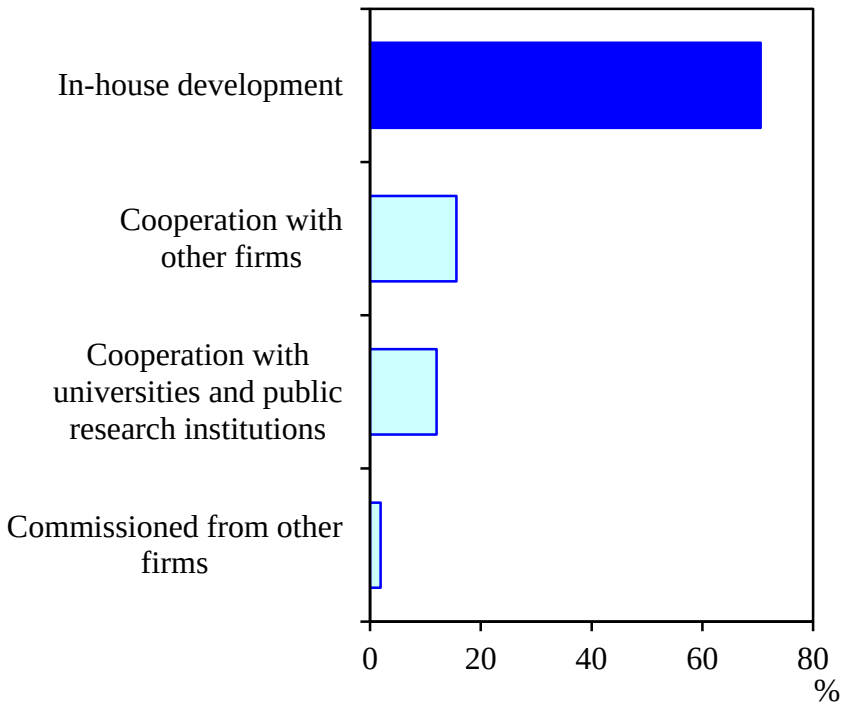


Sources: World Bank, "World Development Indicators"; Comin and Hobijn (2009); United Nations, "World Population Prospects".

Open source innovation

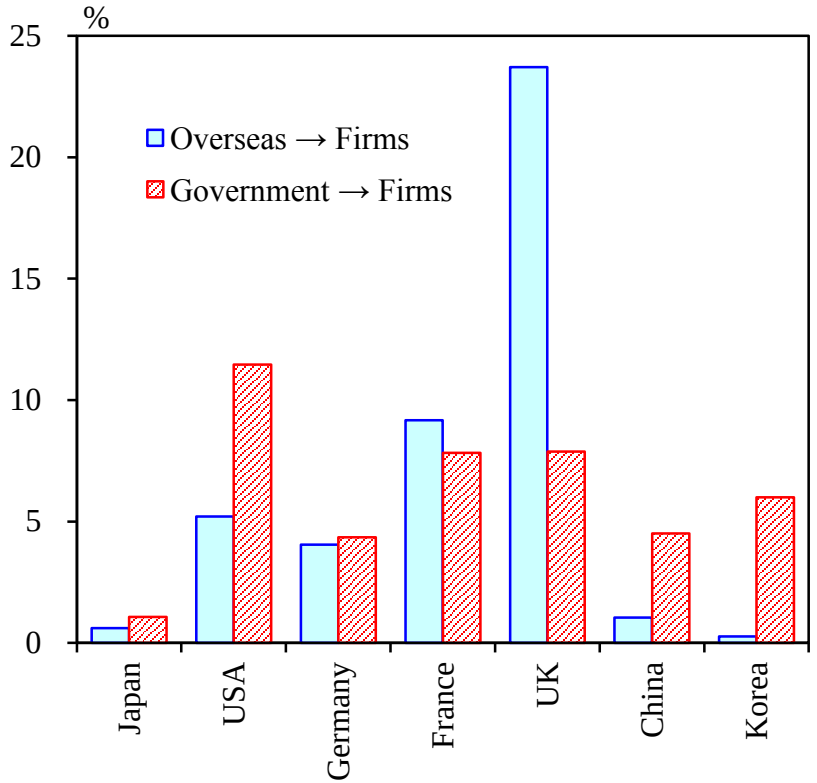
- Japanese firms stick to their own R&D, and collaborate less with other organizations.

(1) Characteristic of Japan's R&D



Note: Survey results for Japanese firms.
Source: New Energy and Industrial Technology Development Organization, Japan and Japan Open Innovation Council, "Open Innovation White Paper (2016)".

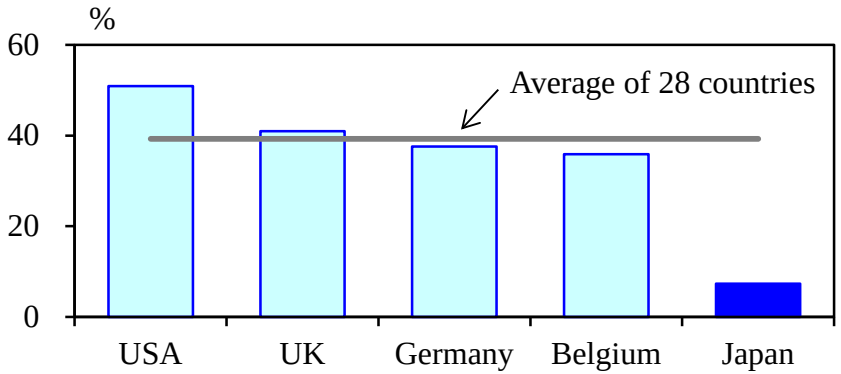
(2) R&D fund providers



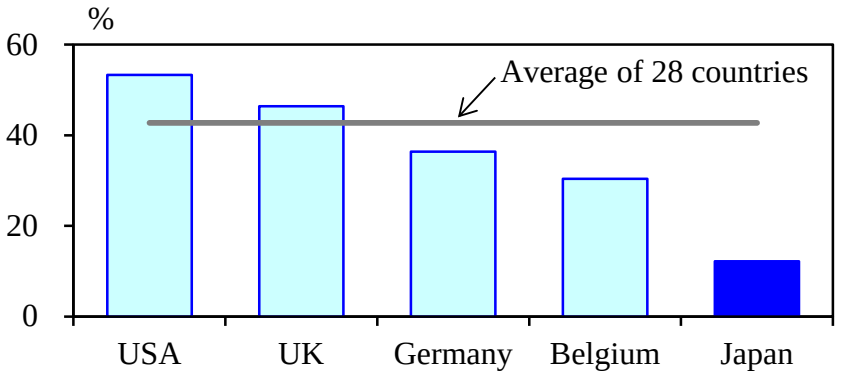
Note: Ratios of funding from overseas/government for corporate sector.
Source: Ministry of Education, Culture, Sports, Science and Technology, Japan, "Japanese science and technology indicators (2015)".

Entrepreneurship: Less animal spirits?

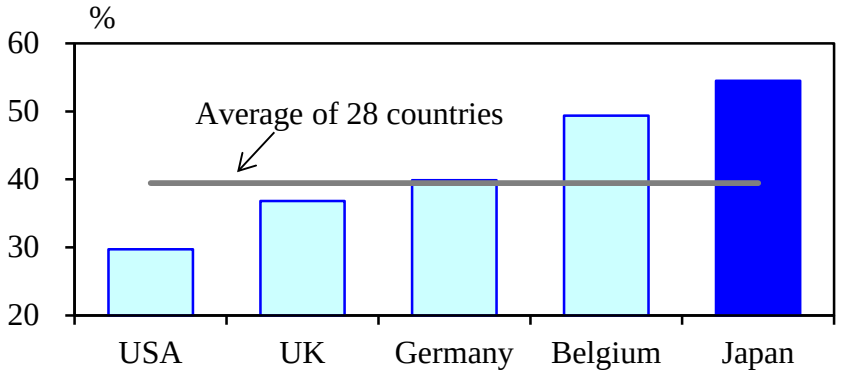
(1) Perceived opportunities



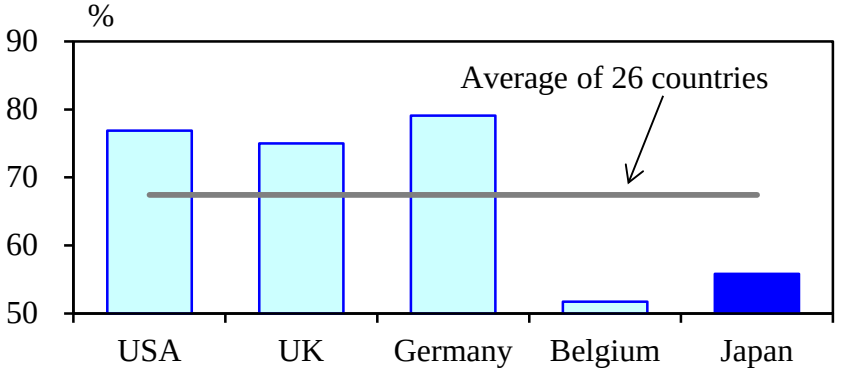
(2) Perceived capabilities



(3) Fear of failure



(4) Respect for successful entrepreneurs

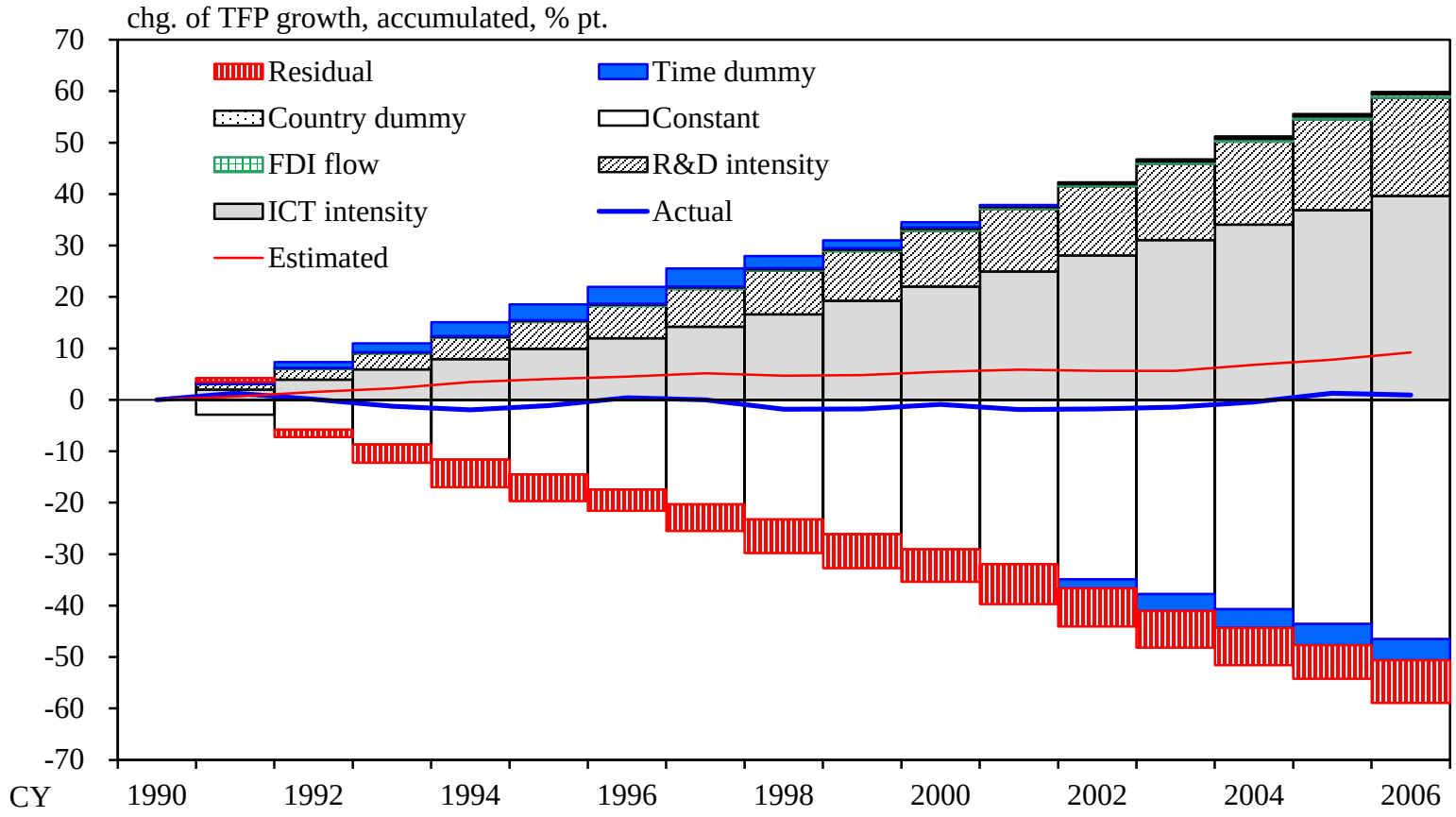


Notes:
1. Survey for individual attributes of potential entrepreneurs in 73 economies in 2014.
2. Perceived opportunities reflect the percentage of individuals who believe there is occasion to start a venture in the next six months in their immediate environment. Perceived capabilities reflect the percentage of individuals who believe they have the required skills, knowledge and experience to start a new venture. The measure of fear of failure (when it comes to starting own venture) only applies to those who perceive opportunities.
Source: Global Entrepreneurship Monitor, "2014 Global Report".

3. ARE WE UTILIZING NEW INNOVATION?

Decomposition of Japan's TFP

- Japanese companies do invest in ICT and R&D, but something is weighing down on TFP growth.



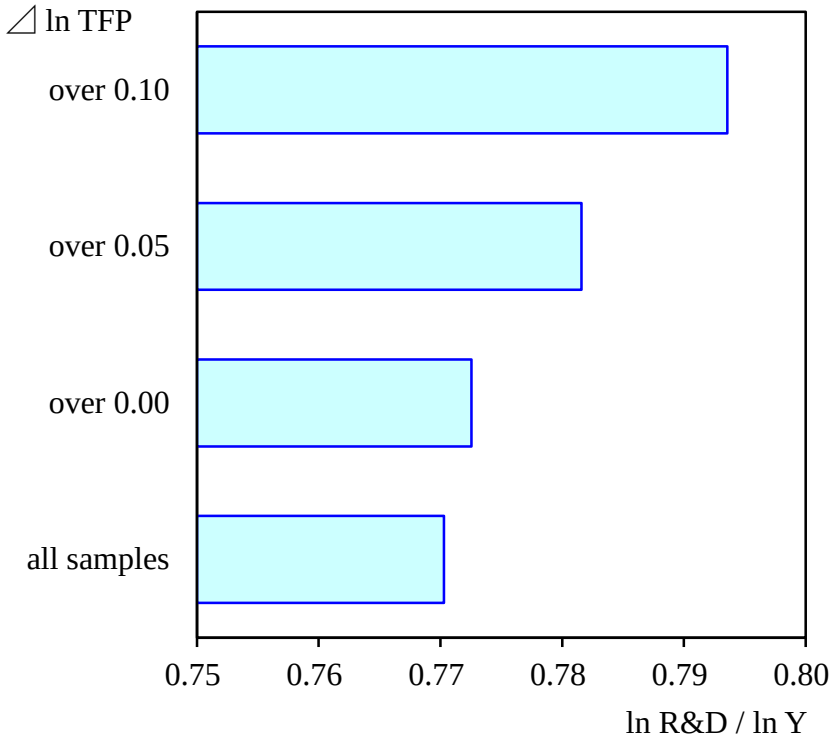
Note: The figure shows cumulative contributions for TFP from CY1990, which are calculated based on Eq.1, Appendix 4.
Sources: OECD, "OECD. Stat"; EU KLEMS.

Problems of Japanese firms

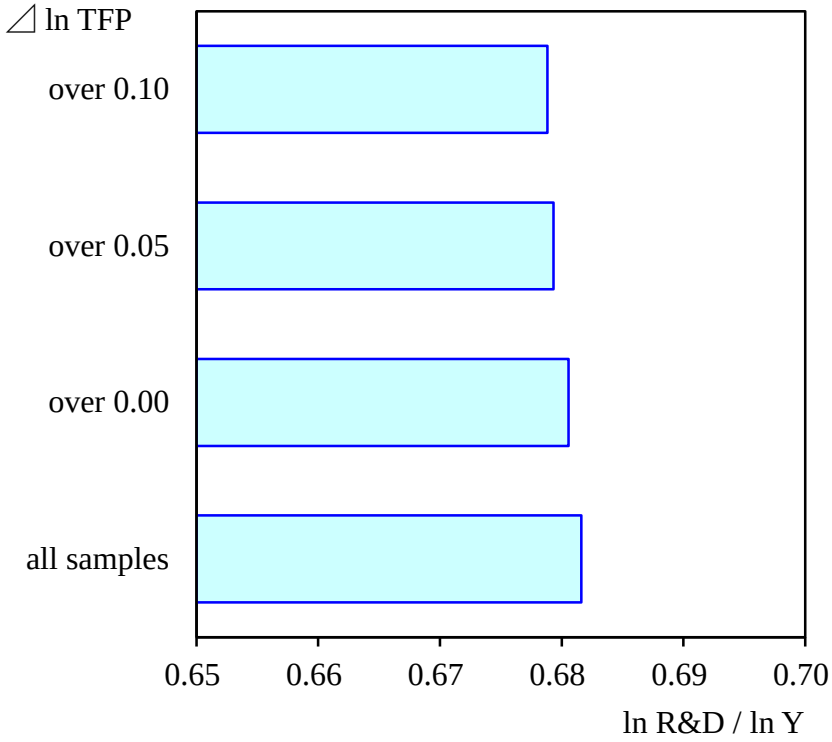
- More R&D leads to higher TFP growth for US firms, but not for Japanese firms.

R&D and TFP growth

(1) USA



(2) Japan

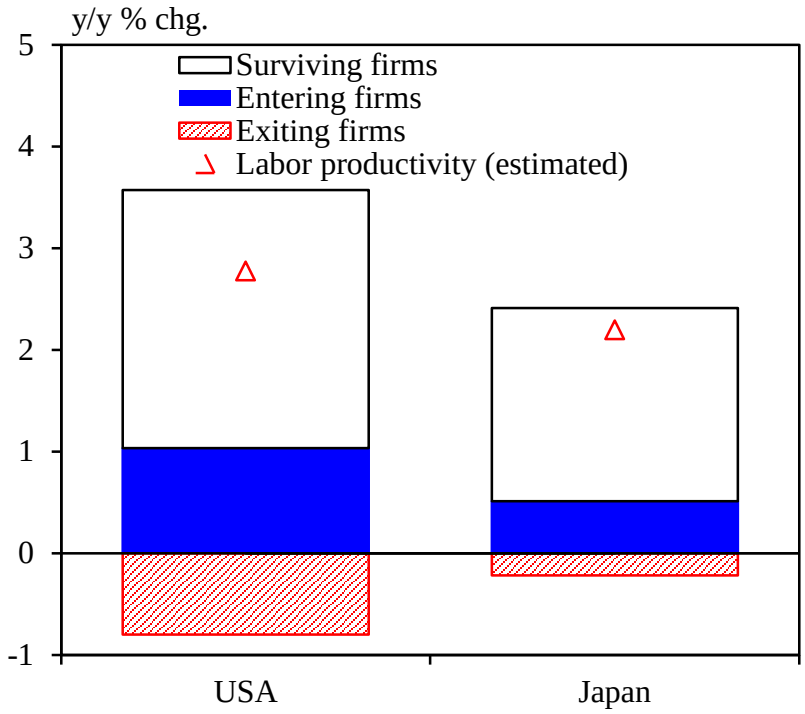


Note: Calculated results of "firm-level TFP" in manufacturing sector in 1998-2009. The data of "ln R&D / ln Y" are averaged from t-3 to t-5.
Sources: Thomson Reuters, "Data Stream"; OECD, "STAN database"; Cabinet Office, Government of Japan, "National Accounts of Japan"; IMF, "World Economic Outlook".

Entry and exit

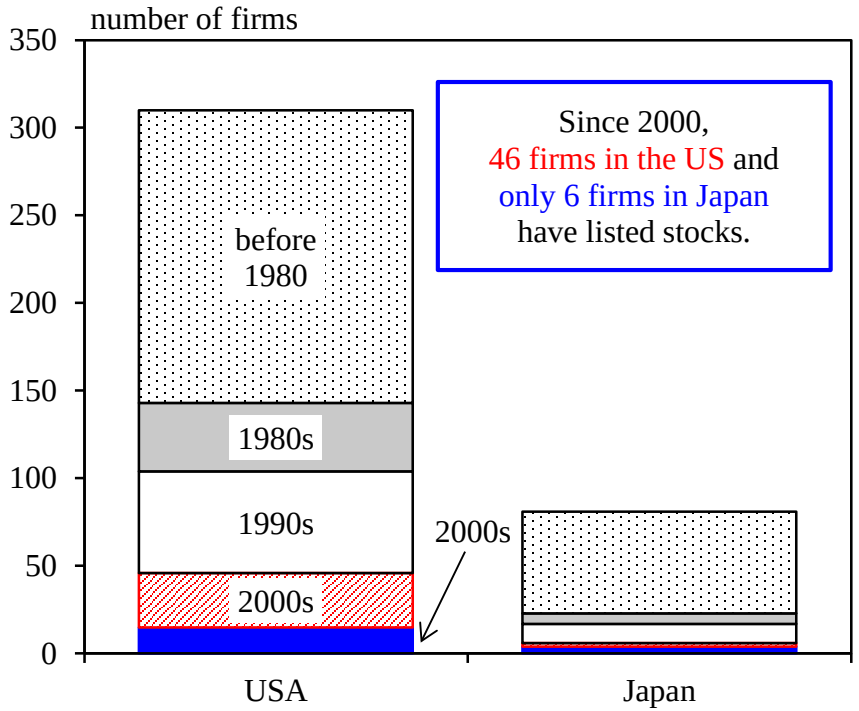
- Entry of innovative entrepreneurs and exit of unproductive firms promote macroeconomic growth.

(1) Entry/exit and productivity



Note: Averaged data in 1985-2014.
Source: Hogen et al. (forthcoming).

(2) Listed year of large firms

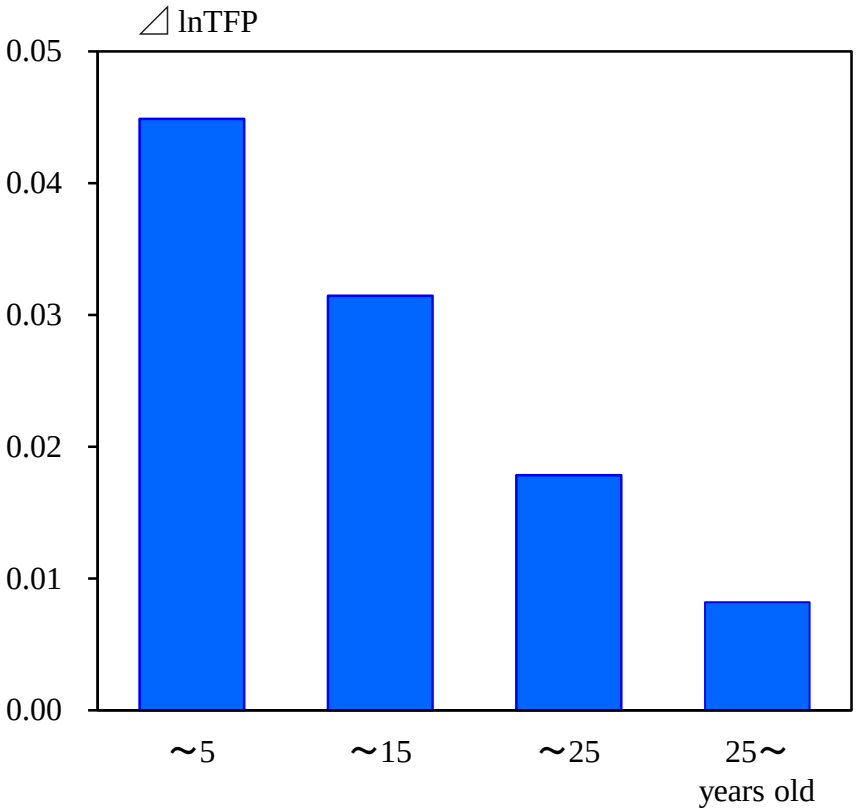


Notes:
1. Over 10-billion-USD firms are selected (market capitalization, as of Feb. 2016, finance sector excluded).
2. Nationalities of firms are selected based on locations of headquarters.
Source: Bloomberg.

Aging companies

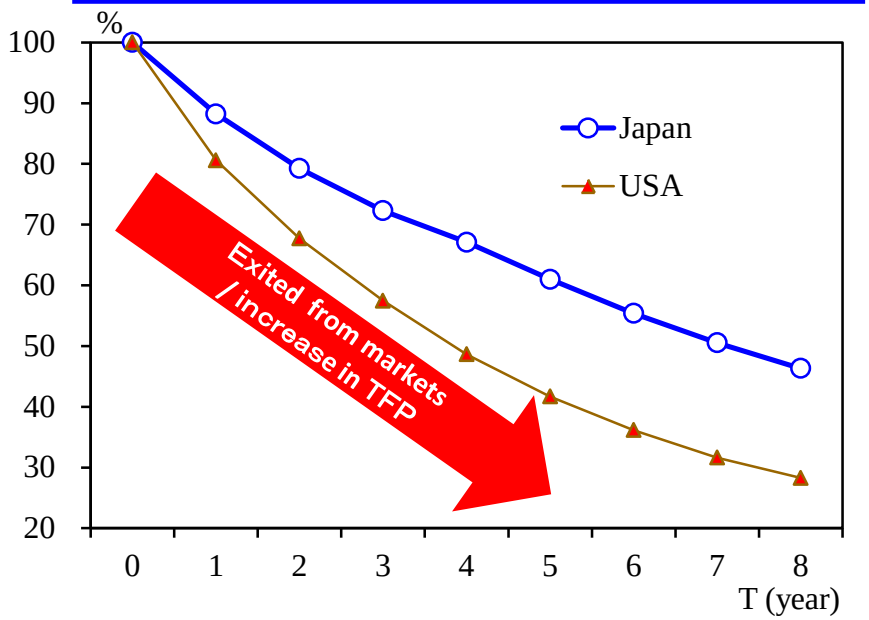
- Firms as well as people get older and less active.

(1) "Firm age" and TFP



(2) Survival probability of lower TFP firms

$$\text{Survival probability of lower TFP firms} = \frac{\#\ of\ continuing\ lower\ TPF\ firms\ from\ T=0\ to\ T=t}{\#\ of\ lower\ TFP\ (\ln TFP<0)\ firms\ at\ T=0}\cdot 100$$



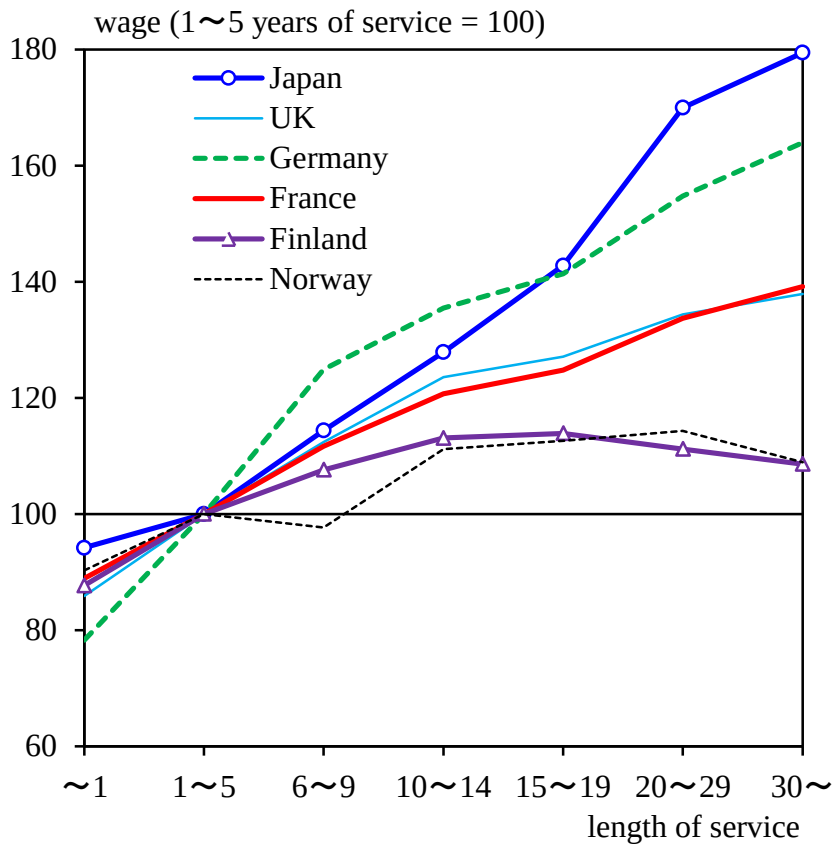
Note: Calculated results of "firm-level TFP" in manufacturing sector (pooled data of Japan and the US in 1998-2009).
Sources: Thomson Reuters, "Data Stream"; OECD, "STAN database"; Cabinet Office, Government of Japan, "National Accounts of Japan"; IMF, "World Economic Outlook".

Flexible labor market (1)

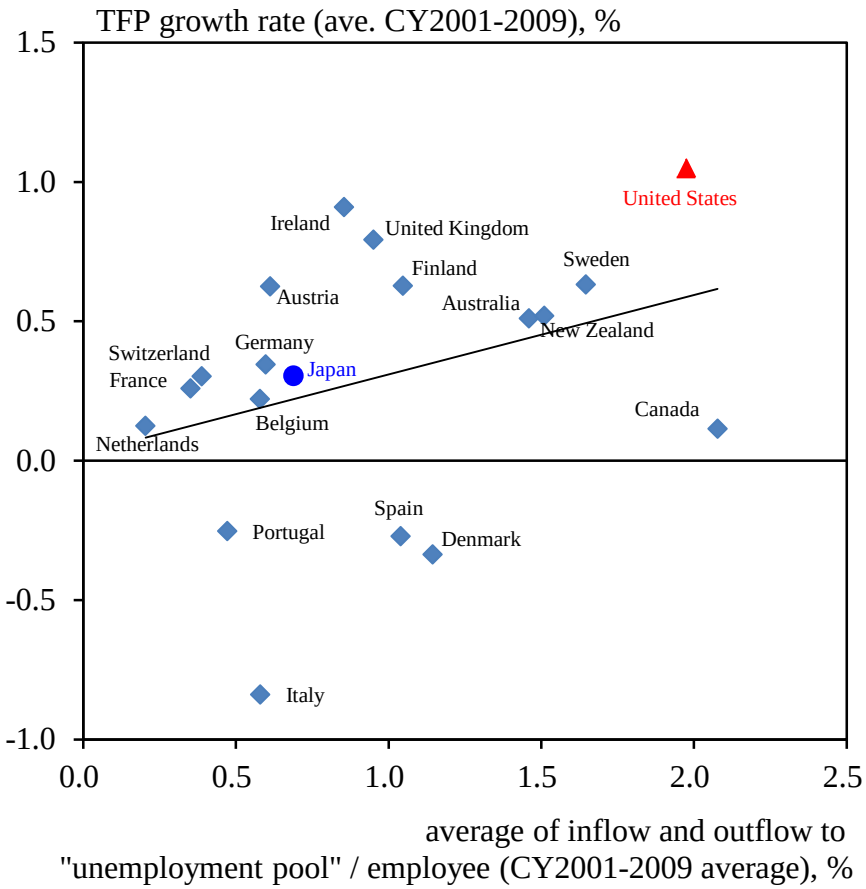
- Traditional life-time employment and seniority-wage system contributed to lift productivity growth in Japan. They worked well in the “catch-up phase” of economic growth after WWII.
- But now we are facing uncharted territory. The traditional Japanese labor system is now an impediment to new innovation.

Flexible labor market (2)

(1) Length of service and wage



(2) Labor market mobility



Note: As of 2014 (Japan) and 2010 (others).
Source: Japan institute for labour policy and training, “Databook of international labour statistics 2016”.

Source: OECD, “OECD. Stat”.

4. POLICY IMPLICATIONS

Education

- High level of education is a source of innovation.
- Due to rapid changes in business environment, mid-carrier training programs need to be enhanced.
- We may need to instill animal spirits and provide more grounds for entrepreneurship.

Labor market policy

- Easier firing and hiring are key factors for reallocating human resources so as to adapt to new innovation.
- Firing of regular workers is almost impossible in Japan. Financial settlements of firing is a key step. Clear regulatory rules for that are imperative.

Income policy

- Flexible labor market may need proactive income policy that allow fired workers to get financial assistance and re-training opportunities.
- Innovative society may increase inequality--- “Winner-takes-all” “Bipolar society.” Inequality may lead to social unrest and unstable society.
- More proactive income policy may provide innovative and stable society.

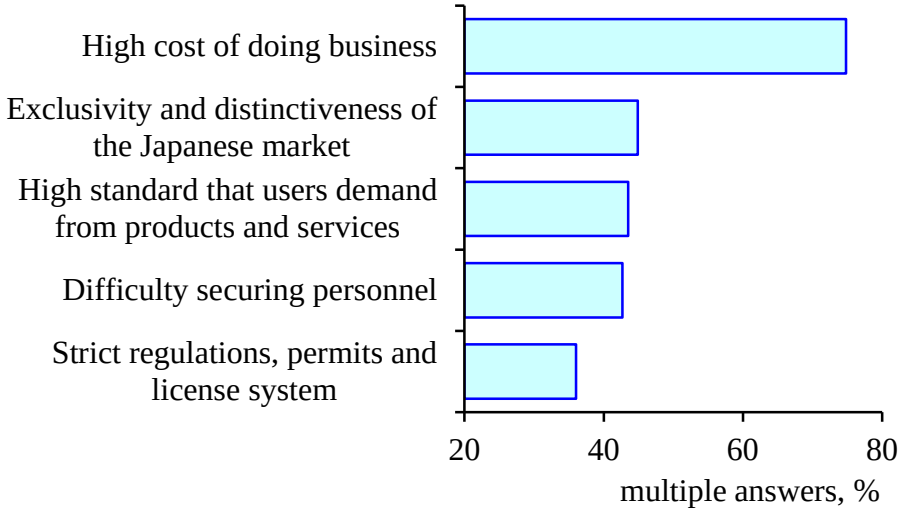
Government expenditure

- Government could provide more expenditure for R&D. Publicly-funded innovation could be used for private businesses.
- Public assistance to unproductive companies may ensure job security of workers, but may keep human and capital resources unproductive.

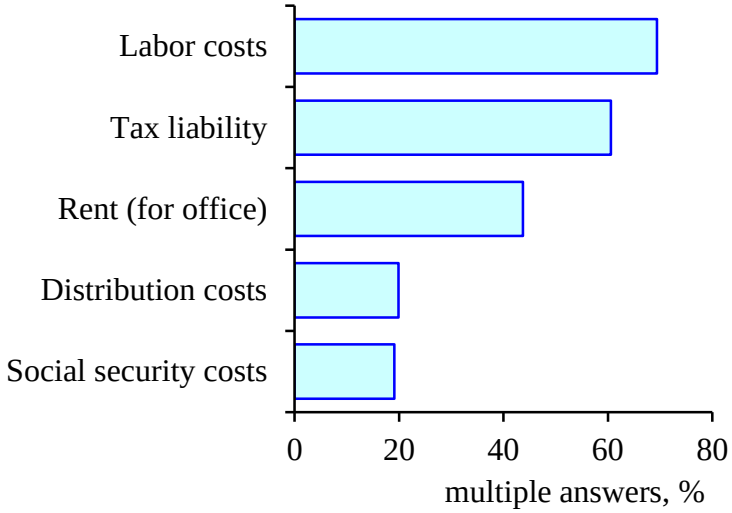
Trade/immigration policy

- Increase in trade barrier could hinder diffusion of technological progress and optimal allocation of human and other resources.
- Social consensus on immigration is crucial.

(1) Factors inhibiting business expansion in Japan



(2) Inhibiting factors with regard to the cost of doing business in Japan

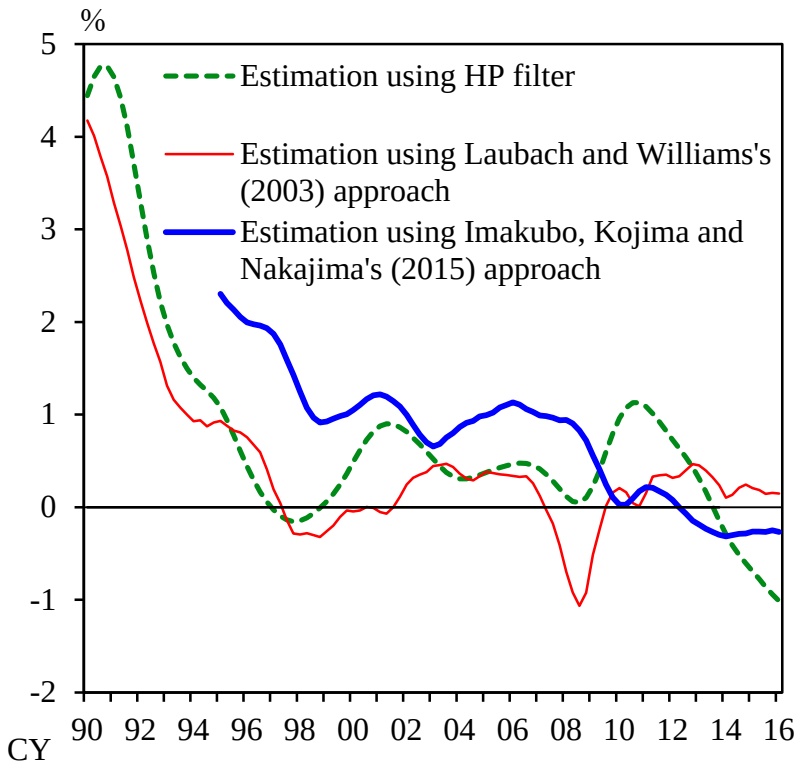


Note: Survey results in 2015.
Source: Ministry of Economy, Trade and Industry, Japan, "Survey of Trends in Business Activities of Foreign Affiliates 2015".

Monetary policy

- Low innovation and growth correspond to low natural rate. Monetary policy could be constrained by effective lower bound under low-growth environment. Unconventional monetary policy is no longer "unconventional?"

Japan's natural rate of interest



Note: For details on the estimation procedures, see Imakubo et al. (2015) etc.
Source: Bank of Japan.

Macroprudential policy

- Low growth prospects discourage investments and induce saving gluts. This could exert downward pressure on profitability of financial sector and induce speculative activity.
- A more careful assessment of flow of funds is needed both domestically and internationally.

Appendix 1
Calculation method of firm-level TFP

- Related studies: Andrews et al. (2015) and Fukao et al. (2006).
- Period: 1998 - 2009.
- Samples: listed manufacturing companies of 10 OECD member states.
  - Belgium, Germany, Denmark, Estonia, Finland, France, Greece, Italy, Japan, and the United States.
  - about 2,900 firms per annum (Japan: about 1,500; USA: about 1,000).
- Index number method:

$$ln\ TFP_{i,t} = \left(\ln Y_{i,t} - \overline{\ln Y_t}\right) - \frac{1}{2}\left(SL_{j,t} + \overline{SL_t}\right)\left(\ln L_{i,t} - \overline{\ln L_t}\right) - \frac{1}{2}\left(SK_{j,t} + \overline{SK_t}\right)\left(\ln K_{i,t} - \overline{\ln K_t}\right)$$

$$+ \left(\overline{\ln Y_t} - \overline{\ln Y_T}\right) - \frac{1}{2}\left(\overline{SL_t} + \overline{SL_T}\right)\left(\overline{\ln L_t} - \overline{\ln L_T}\right) - \frac{1}{2}\left(\overline{SK_t} + \overline{SK_T}\right)\left(\overline{\ln K_t} - \overline{\ln K_T}\right)$$

  - *Y* (net sales): deflated by industrial GDP deflator
  - *K* (tangible fixed assets): deflated by industrial investment deflator
  - *L* (man-hour): number of employees × hours worked by Industry
  - *SL* (labor cost share): industrial compensation of employees / GDP
  - *SK* (capital cost share): 1-SL
  - *T*: Base year (CY2000), *j*: industry, *i*: firm
  - Upper bar: averaged data of all samples in each year
  - PPP-based values
  - Industrial classification : Industry classification benchmark (icb)

Appendix 2
Calculation method of firm-level TFP (cont.)

- Sources: [Nominal data] Thomson Reuters, “Data Stream”
  [Deflator] OECD, “STAN database”; Cabinet Office, Government of Japan, “National Accounts of Japan”
  [PPP] IMF, “World Economic Outlook”
- Statistics of firm level TFP (ln TFP):

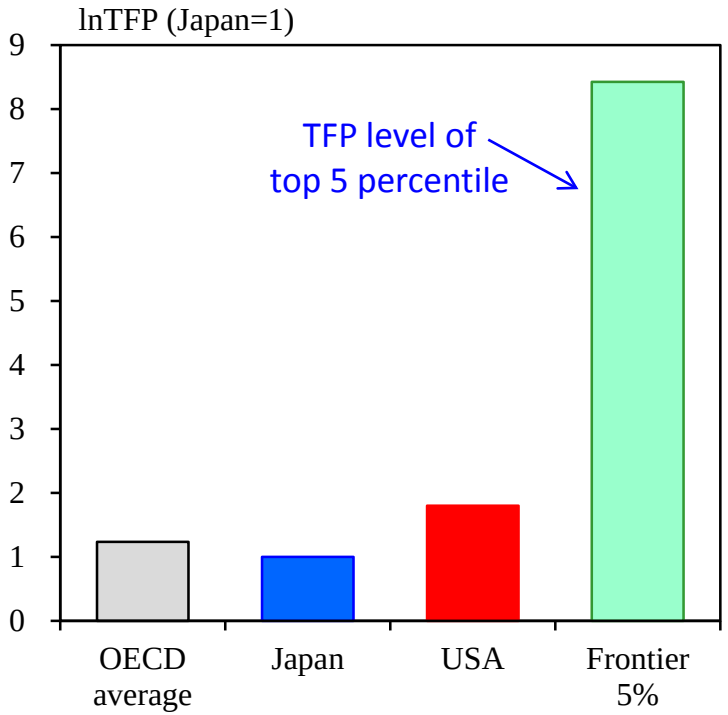
	All samples (pooled from 1998 to 2007)			
		Frontier 5%	Others	Difference in means
Mean	0.13	2.51	0.01	2.50 ***
Std dev.	0.94	0.57	0.75	——

Note: *** denotes significance at 1%.

- “Frontier 5%” is defined for firms which are located in the 5 percentile in terms of the TFP level of each year.

Appendix 3
Firm-level approach

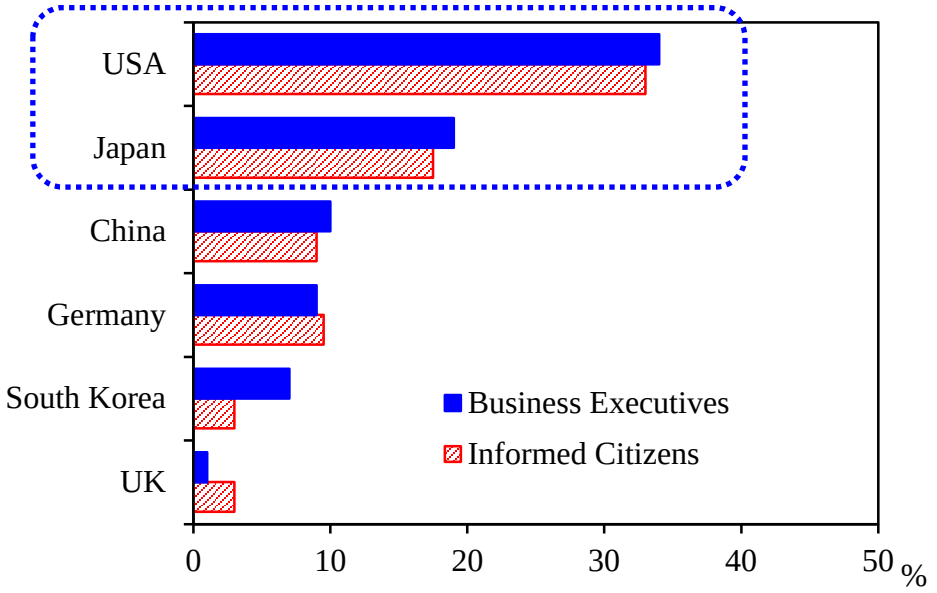
(1) Level of TFP



Note: Calculated results of "firm-level TFP" in manufacturing sector. TFP levels of Japan, the US, and the OECD average indicate value of weighted average by sales volume. The figure shows data in 2007-2009.
Sources: Thomson Reuters, "Data Stream"; OECD, "STAN database"; Cabinet Office, Government of Japan, "National Accounts of Japan"; IMF, "World Economic Outlook".

(2) Survey

Q: What is the country that you consider to be the leading innovation champion?



Note: Survey for business executives engaged in the management of their firm's innovation strategy in 23 countries, and informed citizens in 13 countries in 2015.
Source: GE, "2016 GE Global Innovation Barometer".

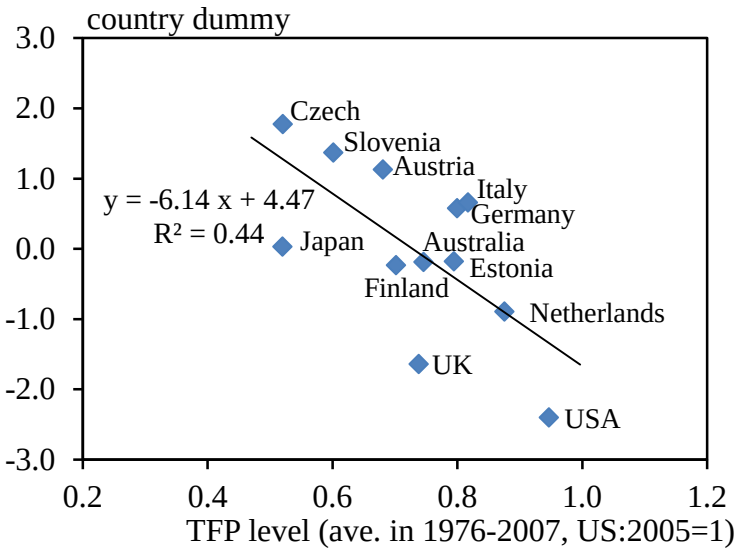
Appendix 4
Panel estimation of TFP growth

- Sample period: 1976 - 2007.
- Countries: 12 OECD member states (unbalanced).
  - — Australia, Austria, Czech Republic, Estonia, Finland, Germany, Italy, Japan, Netherlands, Slovenia, the United Kingdom, and the United States.
- Fixed effect.

Dependent variable: ⊿TFP

Variables	Coeff.	1 Total	2 Manufacturing
ICT intensity (ICT and software investment / total investment)	a	0.172 *** (0.045)	0.230 *** (0.078)
R&D intensity (R&D investment / total investment)	b	0.155 *** (0.060)	0.134 *** (0.034)
FDI flow (FDI inflow and outflow / nominal GDP)	c	0.050 * (0.028)	0.114 * (0.061)
Constant		-2.909 *** (0.716)	-4.531 *** (1.542)
Adjusted R-squared		0.206	0.256
AIC		3.436	5.111
Time dummy		Yes	Yes

TFP level and country dummy (Eq. 1)



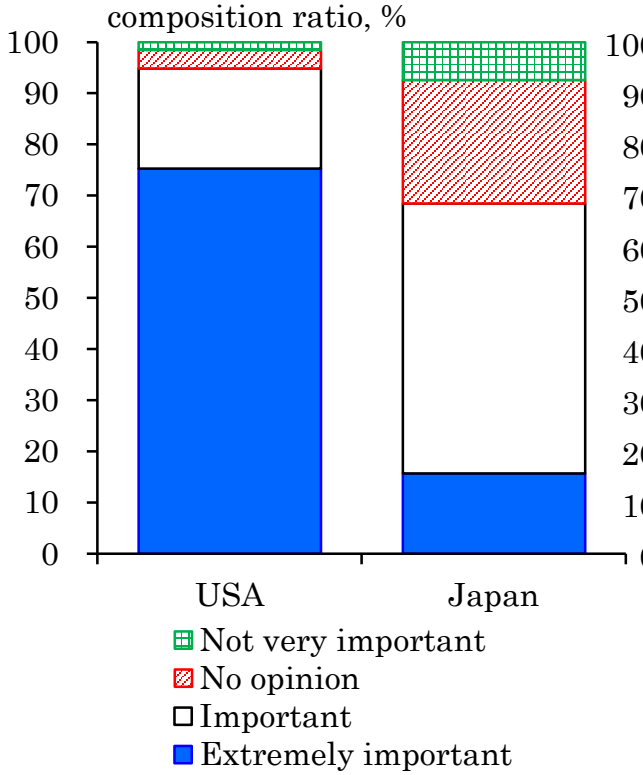
Notes:
1. Due to constraints in data availability, sample periods are shorter than others, and/or some values are used to fill in data of unavailable periods for some countries.
2. Total investment includes fixed assets investment and R&D investment.
3. Standard errors are given in parentheses. * denotes significance at 10%, *** at 1%.
4. Independent variables are averaged using data of the previous three years, and FDI intensity has almon lags (three years).
5. In order to correct for biases due to heteroscedasticity and contemporaneous correlation, we use panel-corrected standard errors.
6. Values of TFP levels in the figure are calculated by using the database of Inklaar and Timmer (2014).

Sources: OECD, "OECD. Stat"; EU KLEMS; Inklaar and Timmer (2014).

Appendix 5
ICT utilization

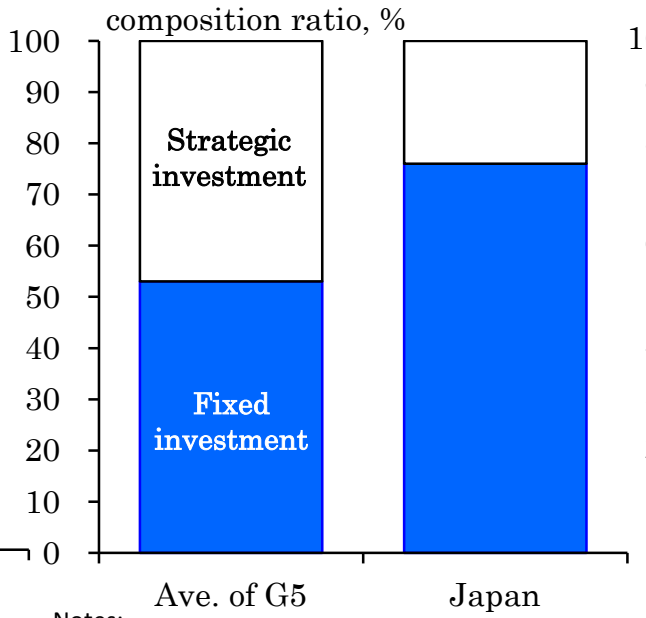
- The usage of ICT technology is much more important than just introducing it.

(1) Stance on IT investment



Note: Survey results in 2013.
Source: JEITA.

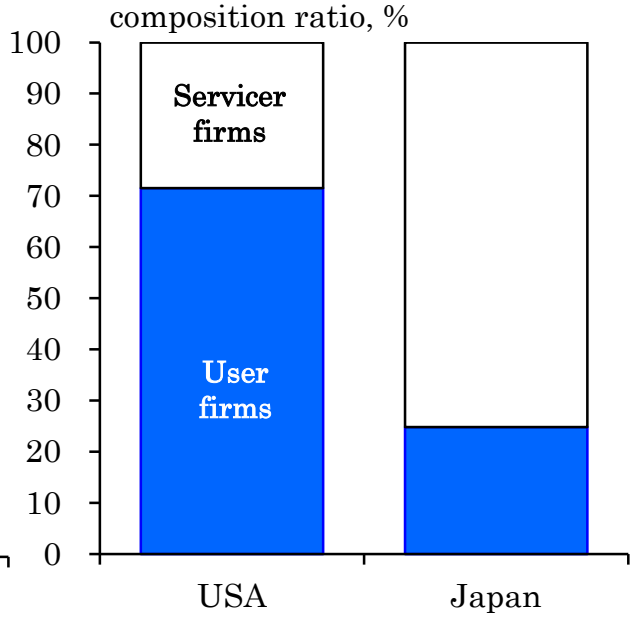
(2) Details on IT investment



Notes:
1. G5 includes the US, the UK, France, Germany, and Italy.
2. Survey results in 2000.
3. Fixed investment means maintenance costs (e.g. for maintaining system and software). Strategic investment means development cost (e.g. for developing new system and software).

Source: Accenture, "Accenture High Performance IT Program (2005)".

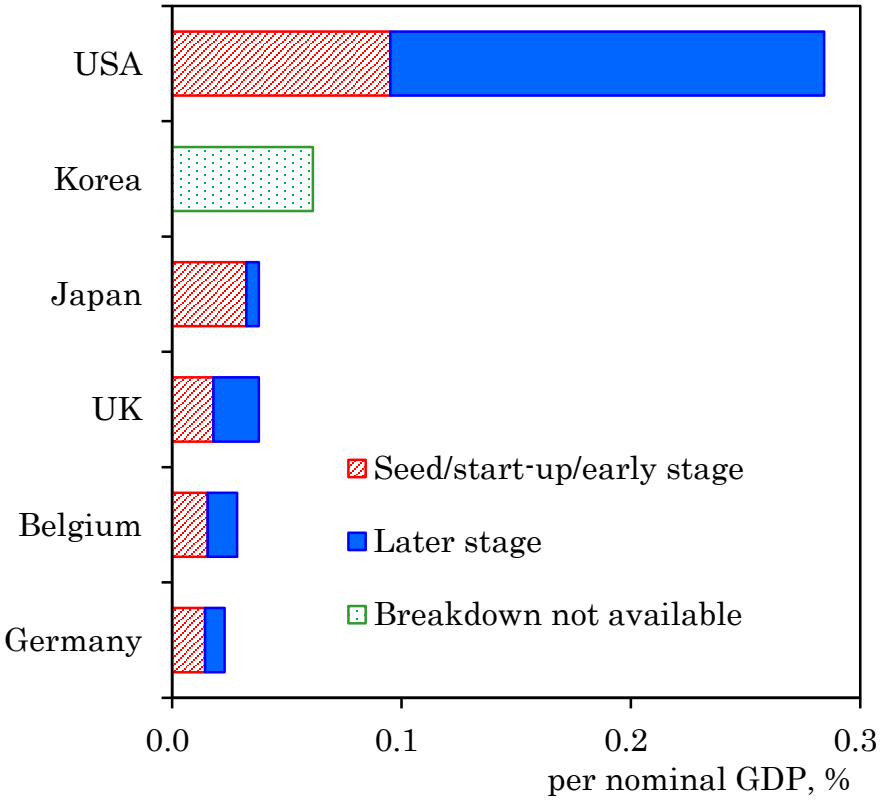
(3) Place for work (IT engineers)



Note: Calculated by IPA in 2009.
Source: Information-technology promotion agency (IPA), Japan.

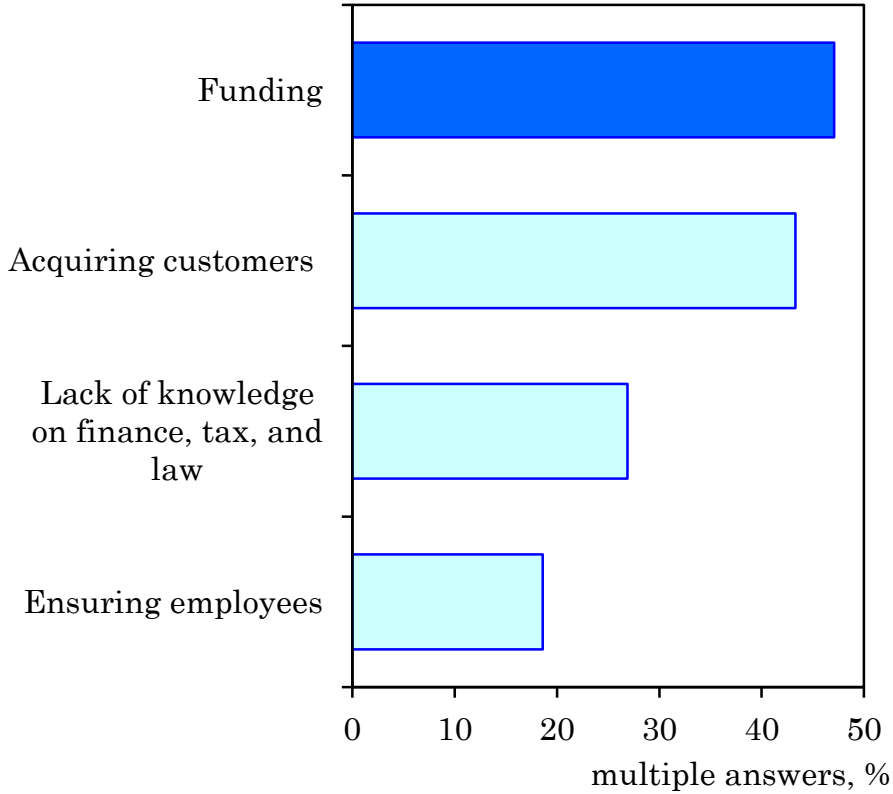
Appendix 6
Funding for entrepreneurs

(1) Investment value of venture capital



Note: As of 2014.
Source: OECD, "OECD Science, Technology and Industry Scoreboard 2015".

(2) Hardships for entrepreneurs in Japan



Note: Survey results in 2015.
Source: Japan Finance Corporation, "Survey on State of New Business Start-ups 2015".

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