(Some numbers still preliminary)

Inventions and the innovation process in Japan and the US: Highlights from the US-Japan Inventor Survey

Sadao Nagaoka* and John P. Walsh**

March 2008

•Professor, Institute of Innovation Research, Hitotsubashi University
Research Counselor, Research Institute of Economy, Trade and Industry
** Associate Professor, Georgia Institute of Technology
We would like to thank the research assistance by Naotoshi Tsukada, Wang Tingting Connie Huang, Taehyun Jung and Yeonji No.

I. Design of Inventor Surveys

- Pioneered by PATVAL, followed by RIETI, GT/RIETI
- Survey inventors (rather than R&D managers) for specific R&D projects
- Large sample, broad technology/industry coverage
- Comparative (JP-US, also Europe)
- Measures
  - Inventor Career, Mobility, Background and Motivations
  - Invention Process, Collaboration
  - Business objective of R&D, R&D strategy and performance
  - Uses of the Patent, Commercialization

Primary Sampling Frame – OECD Triadic Patent Families

- Triadic Patent Families
  - Compiled by OECD
  - Sharing, either directly or indirectly, at least one priority patent applications in three patent offices
  - Filed in EPO and JPO and granted in USPTO
- Advantage of using the TPF
  - Reduce home country bias
  - Focus on economically important patents (Random sampling would result in targeting most questionnaires to economically unimportant patents. Filing in multiple jurisdictions works as a threshold)
- Disadvantage of using the TPF
  - **Select subset of inventions, and even of patented inventions. Likely to be biased toward commercialized inventions**
  - Perhaps, bias against nonprofit, small, and/or independent inventors?

Triadic patents in the total picture

- Japan
  - 8% in terms of the share of granted patents by Japanese applicants
- US
  - 23% of US patent grants (any country of origin) are triadic [Jensen, et al., 2005]
- Level of commercialization of triadic and non-triadic patents in Japan according to the RIETI Survey

	Triadic	non-triadic
The share of the patents used internally by a firm (%)	56%	41%
The share of the patents licensed by a firm (%)	23%	14%

Data

- Japan: 5,300 responses
  - 20.6% response rate (27.1% adjusted for undelivered, ineligible, etc.)
  - triadic patents: approximately 70% (about 3600 responses)
  - non-triadic patents: approximately 30%
  - very important patents (selected from the JPO reports and the essential patents of standards): roughly 120 patents
- US: 1,900 (all triadic)
  - 24.1% response rate (31.8% adjusted)
- Comparisons based on triadic patent samples
- Created country-technology weights to adjust for different composition across technology in each country
  - Effects of the weighting quite small.

Table 1. Composition of the sample

Category Name	No.	Sub-Category Name	内容	JP	US
Chemical	11	Agriculture, Food, Textiles	農業、食品、繊維	1.6%	0.4%
	12	Coating	コーティング材料、処理方法、製品	2.2%	1.8%
	13	Gas	ガス	1.2%	0.6%
	14	Organic Compounds	有機化合物	3.3%	3.2%
	15	Resins	ゴム、樹脂、プラスチック加工	3.4%	4.4%
Computer & Communications	19	Miscellaneous-chemical	その他の化学	5.7%	12.1%
	21	Communications	通信機器、システム（光通信を含む）	4.4%	7.8%
	22	Computer Hardware	符号化、暗号化、画像処理	1.6%	2.1%
	77	Computer Software	各種情報処理技術、アプリケーション、ビジネス特許、カーナビ、マルチメディア、音声処理、データ圧縮、人工知能、データーベース、情報セキュリティ	3.4%	4.9%
	23	Computer Peripherals	コンピューター周辺機器	2.1%	1.7%
	24	Information Storage	情報記憶装置、メモリ	3.3%	2.1%
Drug &Medicals	31	Drugs	医薬	3.5%	5.2%
	32	Surgery & Medical Instruments	手術、医療機器	2.3%	6.3%
	33	Biotechnology	バイオ	2.4%	2.1%
	39	Miscellaneous-Drug&Med	その他の医薬・医療	1.2%	1.5%
Electrical &Electronic	41	Electrical Devices	チューナー、コンデンサー、増幅器等電子デバイス	2.5%	2.4%
	42	Electrical Lighting	電気照明デバイス、装置、イルミネーション	2.6%	1.7%
	43	Measuring & Testing	電気、光学、温度を用いた計量、実験装置	3.0%	3.2%
	44	Nuclears & X-rays	原子力工学、X線、その他の放射線技術	2.0%	2.1%
	45	Power Systems	電力供給、バッテリー、電動式モーター	4.7%	4.7%
	46	Semiconductor Devices	半導体デバイス、製造プロセス、電子ロジック回路、超伝導	3.5%	2.9%
	49	Miscellaneous-Elec.	その他の電気分野	3.3%	1.7%
Mechanical	51	Materials Processing & Handling	ガラス、石材、木材のカッティングなど各種加工技術	2.8%	2.9%
	52	Metal Working	金属カッティング、接着などの加工技術、金具	3.7%	2.6%
	53	Motors, Engines & Parts	モーター、エンジン、ブレーキ、バルブなどの部品	4.0%	2.9%
	54	Optics	カメラ、プロジェクトなどの光学機器、デバイス	2.7%	2.2%
	55	Transportation	鉄道、船、タイヤ、エレベータ、リフト、宇宙飛行など	2.0%	1.7%
	59	Miscellaneous Mechanical	その他の機械分野	3.4%	2.1%
Others	61	Agriculture, Husbandry, Food	肥料、飼料、タバコ、食品加工	2.4%	0.7%
	63	Apparel & Textile	衣服繊維	2.1%	0.5%
	64	Earth Working & Wells	削孔・採鉱	0.5%	0.3%
	65	Furniture, House Fixtures	家具、据え付け品	1.4%	0.5%
	66	Heating	加熱	2.3%	0.4%
	67	Pipes & Joints	パイプ・継ぎ目	1.8%	0.7%
	68	Receptacles	包装、容器	1.5%	1.0%
	69	Miscellaneous-Others	その他(おもちゃを含む)	6.2%	6.4%
				3,658	1912

II. Inventor

Table 2 Basic profile of the surveyed inventors and their organizational affiliations

		Trilateral patents		Europe
		Japan	US	
	Sample size	3,658	1,912	9,017
Academic background	University graduate (%)	86.0	93.7	76.9
	Doctorate (%)	12.4	44.9	26
	Female (%)	1.5	5.4	2.8
	Age (years old)	39.5	52.7	45.4
Organizational affiliation	Employed at large corporation (251 or more employees) (%)	87.8	81.1	70.6
	Employed at small or medium-sized corporation(%)	8.7	14.0	22.5
	Institutions of higher education(%)	2.3	2.2	3.2
	National research institutes or other government organs (%)	0.7	0.1	2.2
	Foundations and other organizations (%)	0.5	2.1	

Source: RIETI Inventor Survey (2007) for Japan, Europe's PatVal for EU (covering six countries: Germany, France, England, Italy, Spain, and the Netherlands).
Note: The inventors who have no organizational affiliations are extremely rare.

Figure 1 Inventor mobility- Within 5 prior year, have you worked for another employer? (%)

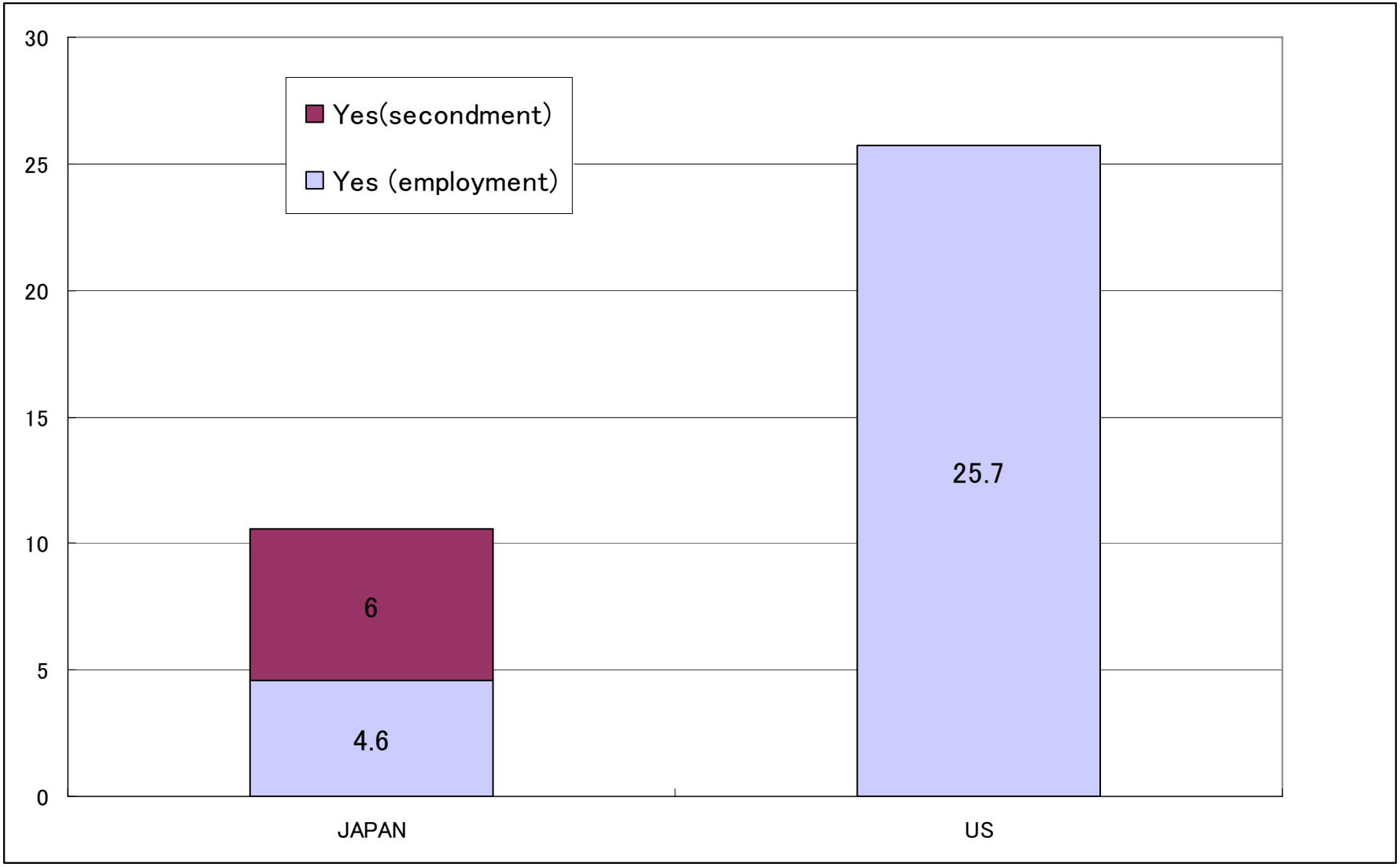


Figure 2. Share of the inventors who moved in last 5 years before the invention
(%, bar: Japan line: US)

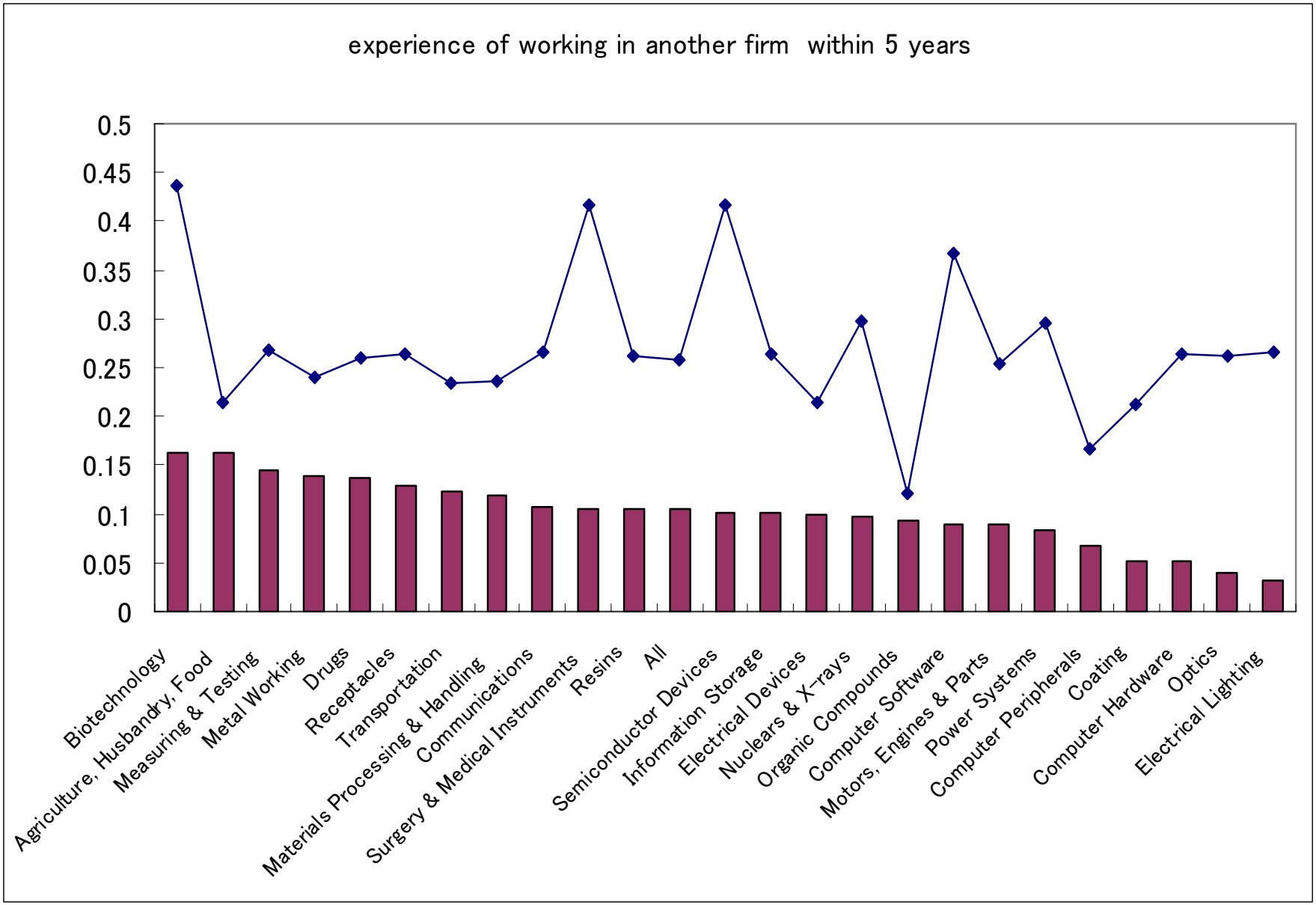


Figure 3. Inventors' Mobility, From-To [in Biotech, US]

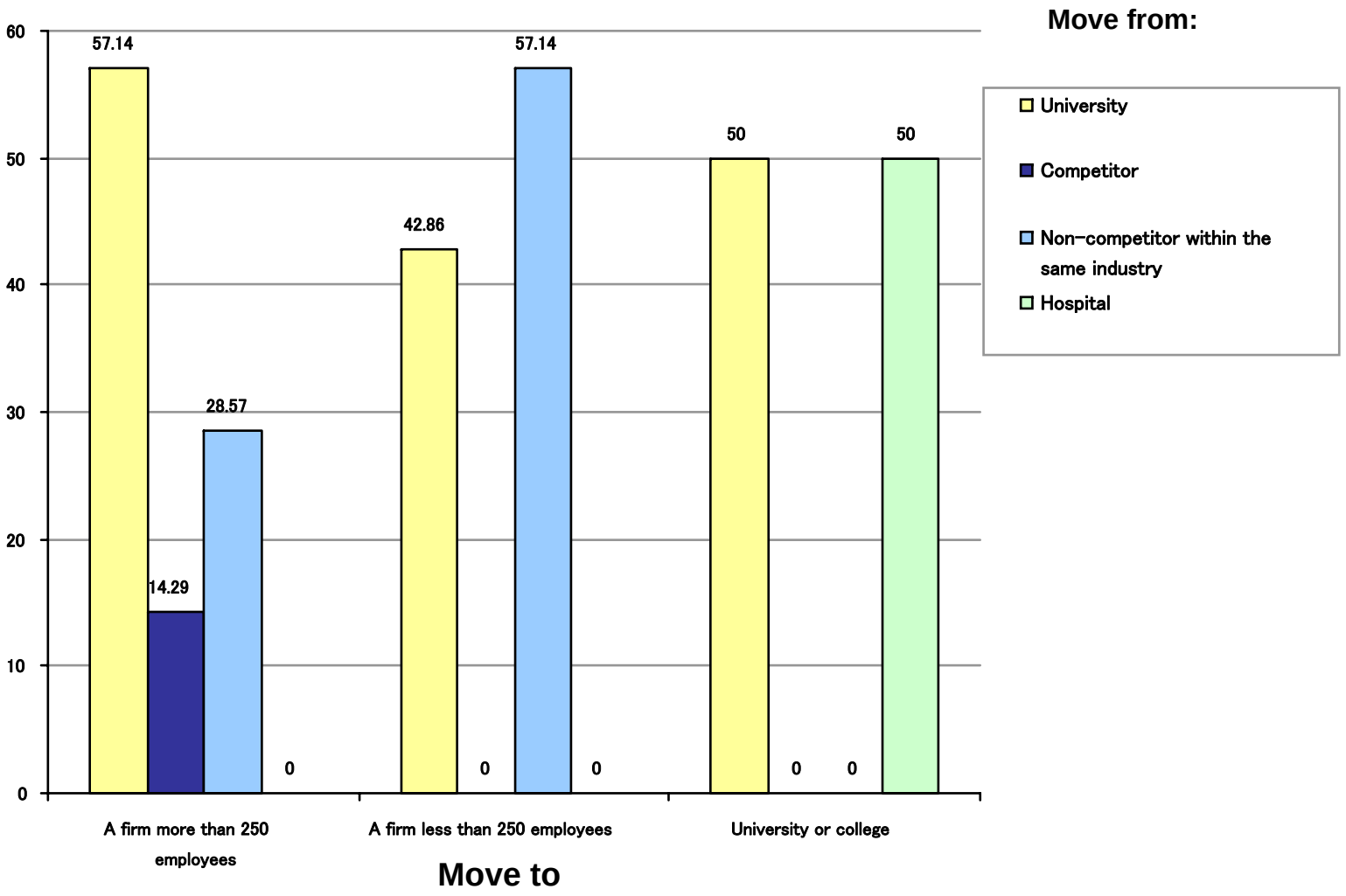


Figure 4. Source of mobility in Japan (% of the moved inventors)

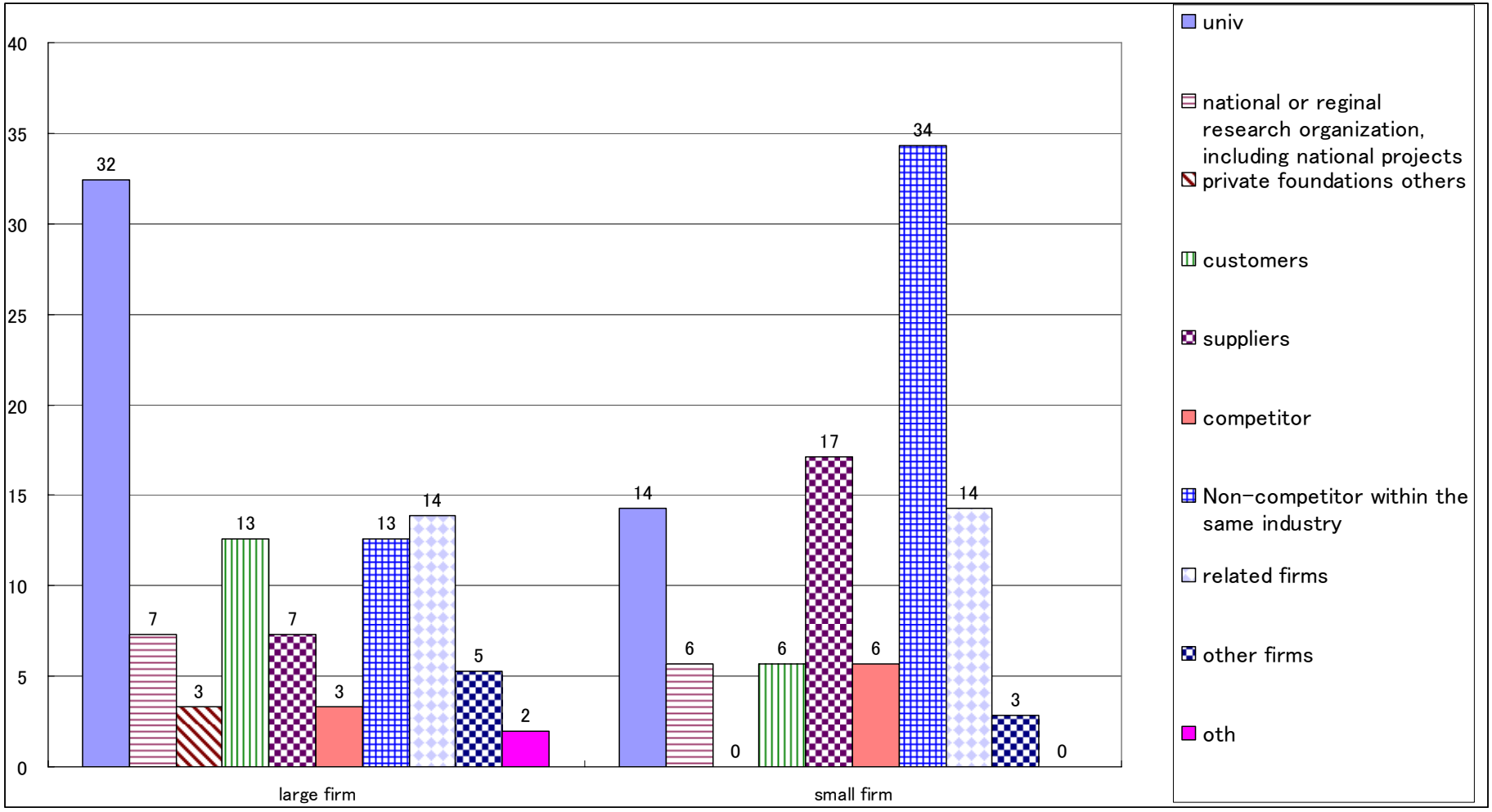
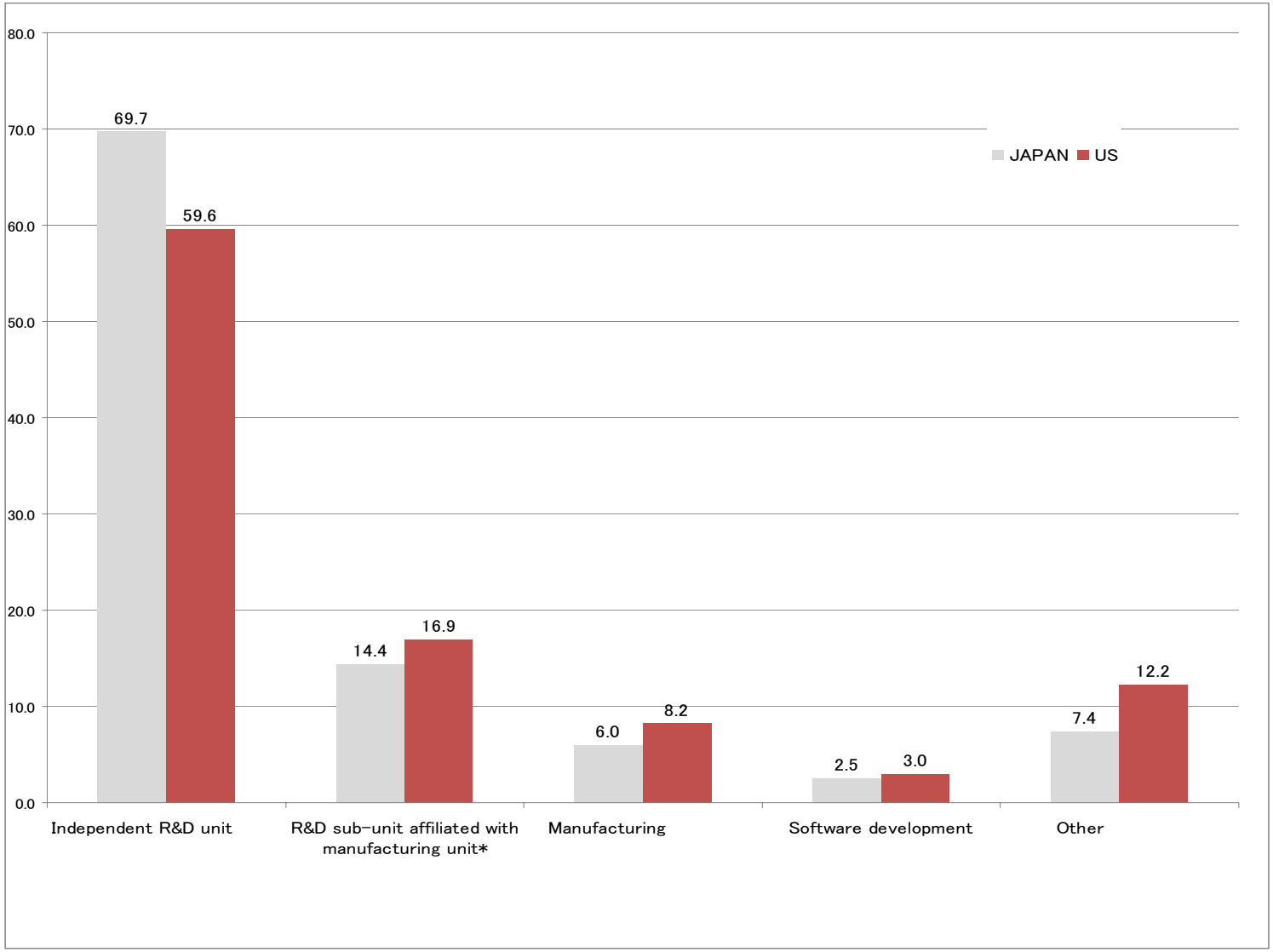


Figure 5. Inventor Functional Affiliation

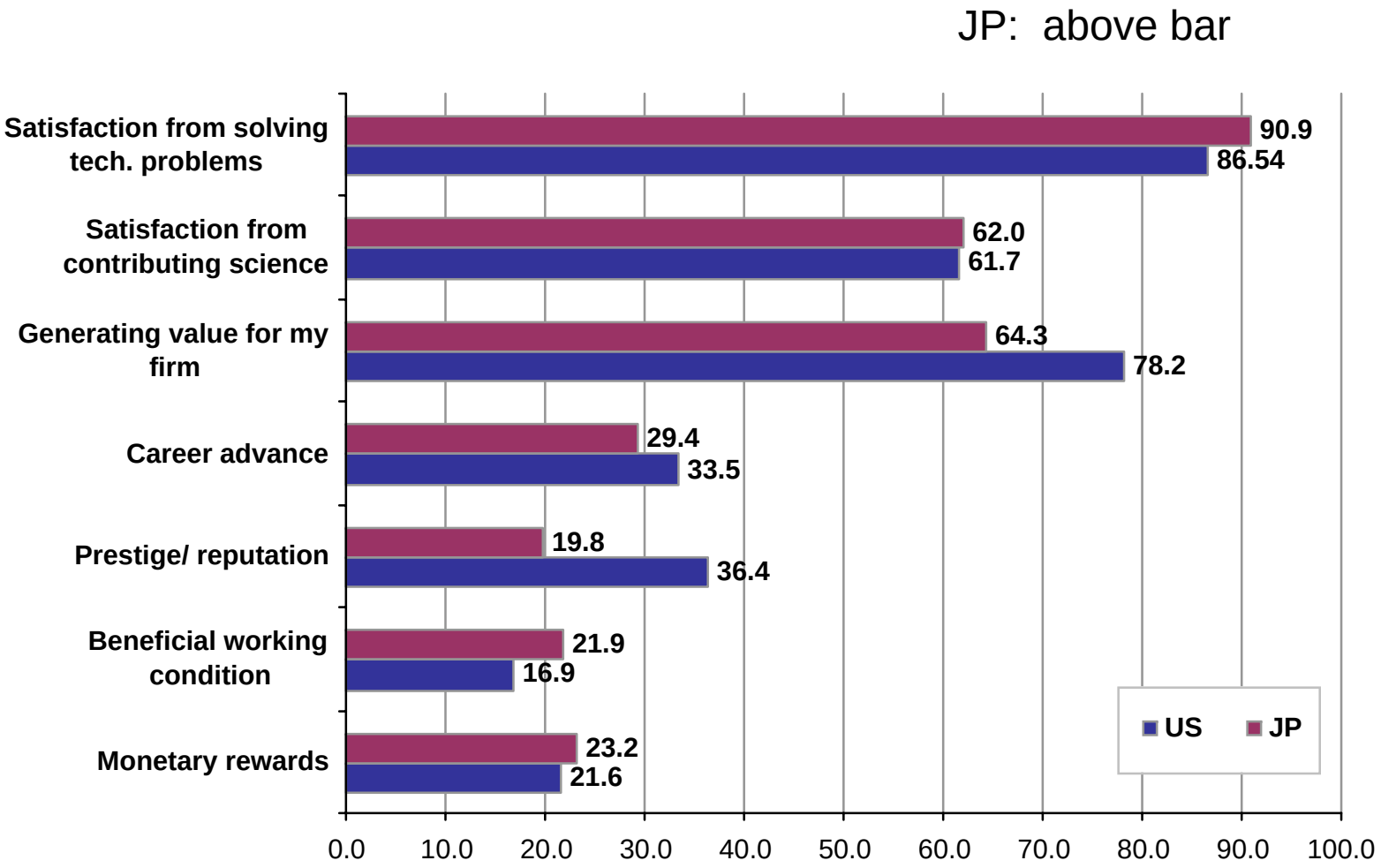


Note: The “Other” category includes design and engineering sectors.

Inventor motivations

- What motivates inventors?
- How important are financial rewards directly tied to the commercial success of the invention work?
- Asked for Likert-scale scores on a variety of motivations:
  - Satisfaction from solving technical problems; Satisfaction from contributing to progress of science; Society good
  - Generating value for firm; It is my job
  - Prestige/reputation; Recognition from co-workers; Recognition in my profession; Career opportunities
  - Monetary rewards; Beneficial working conditions
- Note: be careful about potential Socially Desirable Response [SDR] bias

Figure 6. Inventor Motivations



%High (4 or 5), weighted

III. Characterizing the Invention Process

- **Nature of Project**
  - Product vs. process
  - Invention process (targeted vs. serendipity)
- **Time**
  - How long the research lasted until the patent application
  - How many man-months the research required
- **Outcome**
  - Product vs. Process

Figure 7. Technological Goal of Research Project

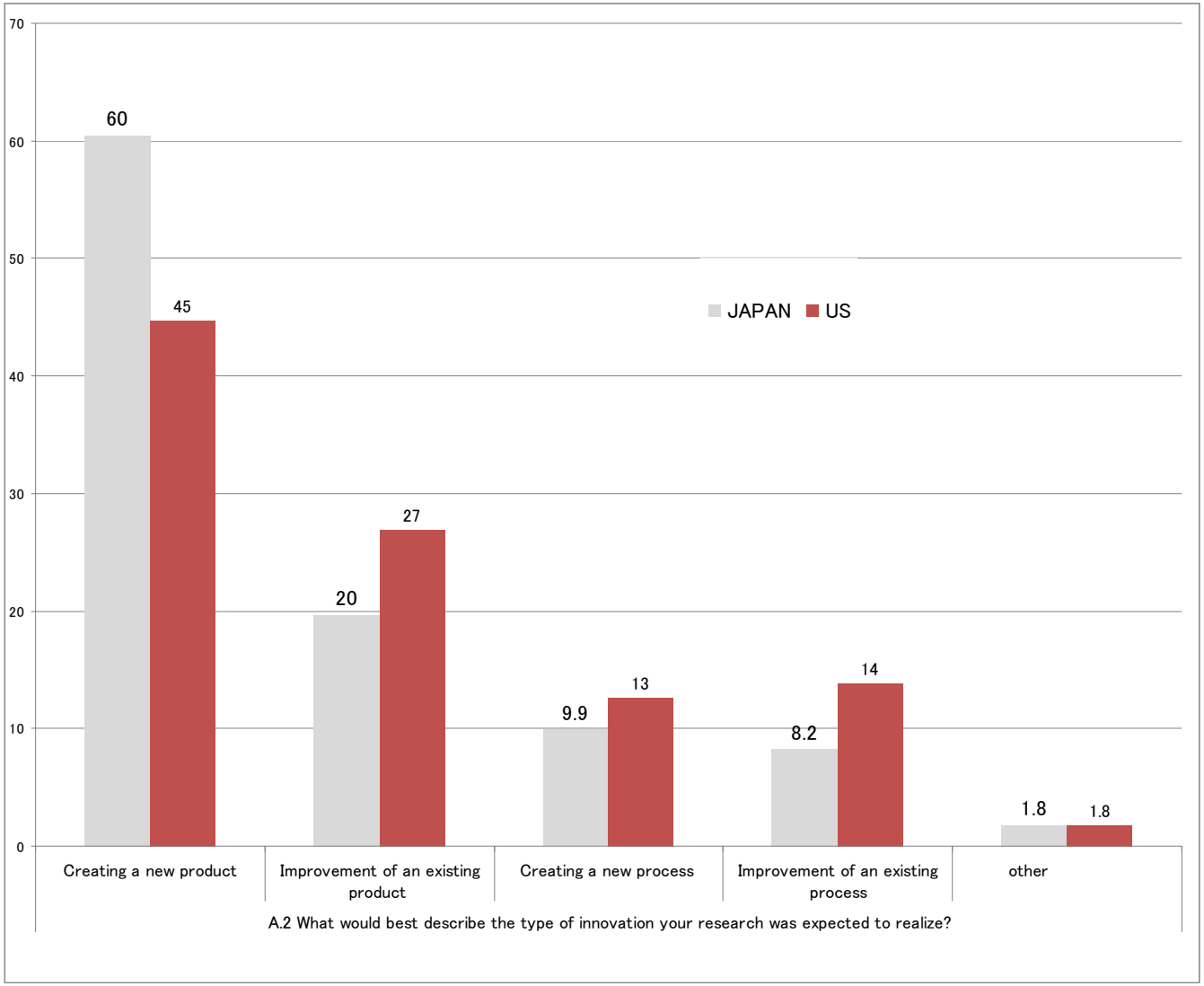


Figure 8. Product vs. process patents

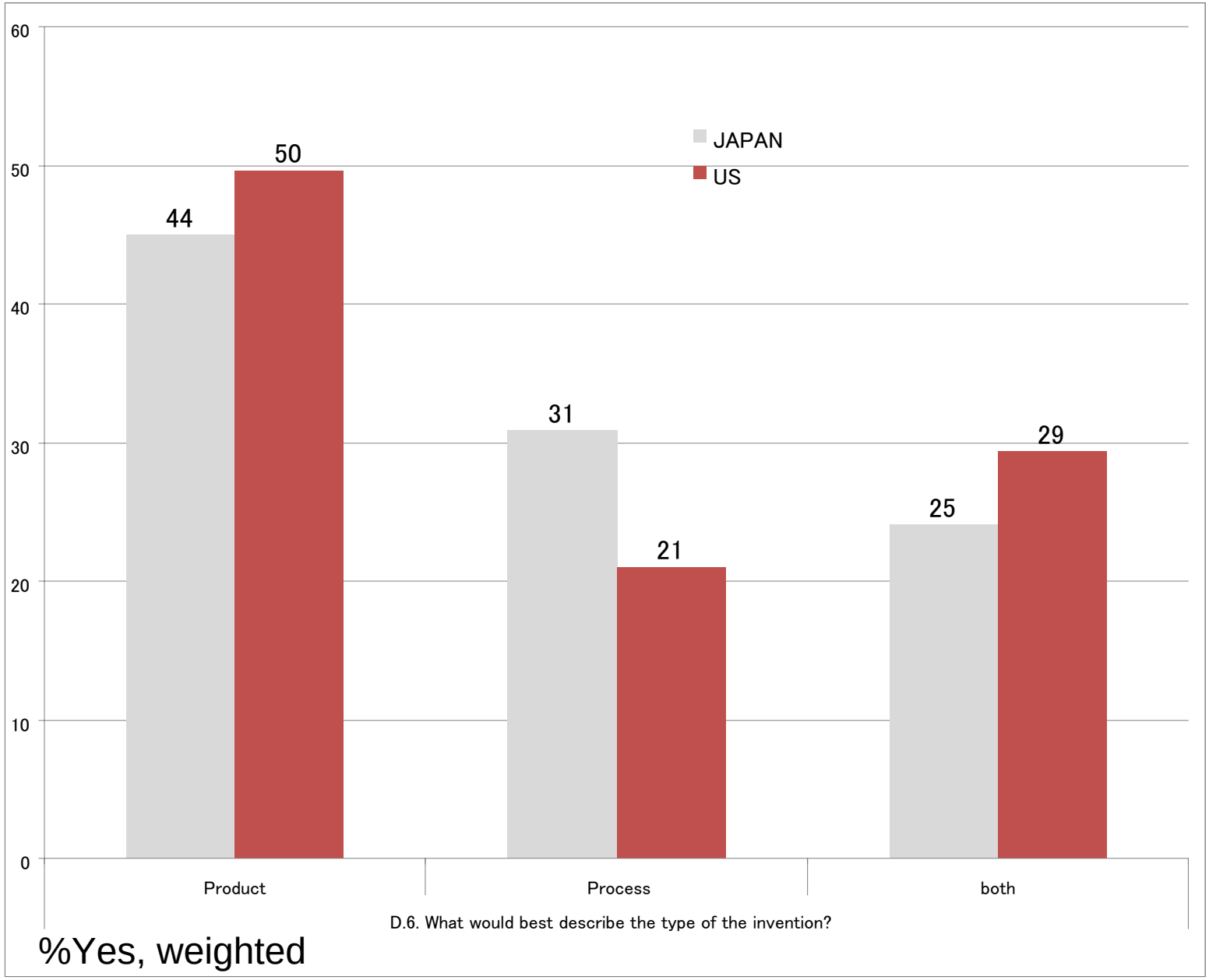


Figure 9. Invention Process (Targeted v. Serendipity)

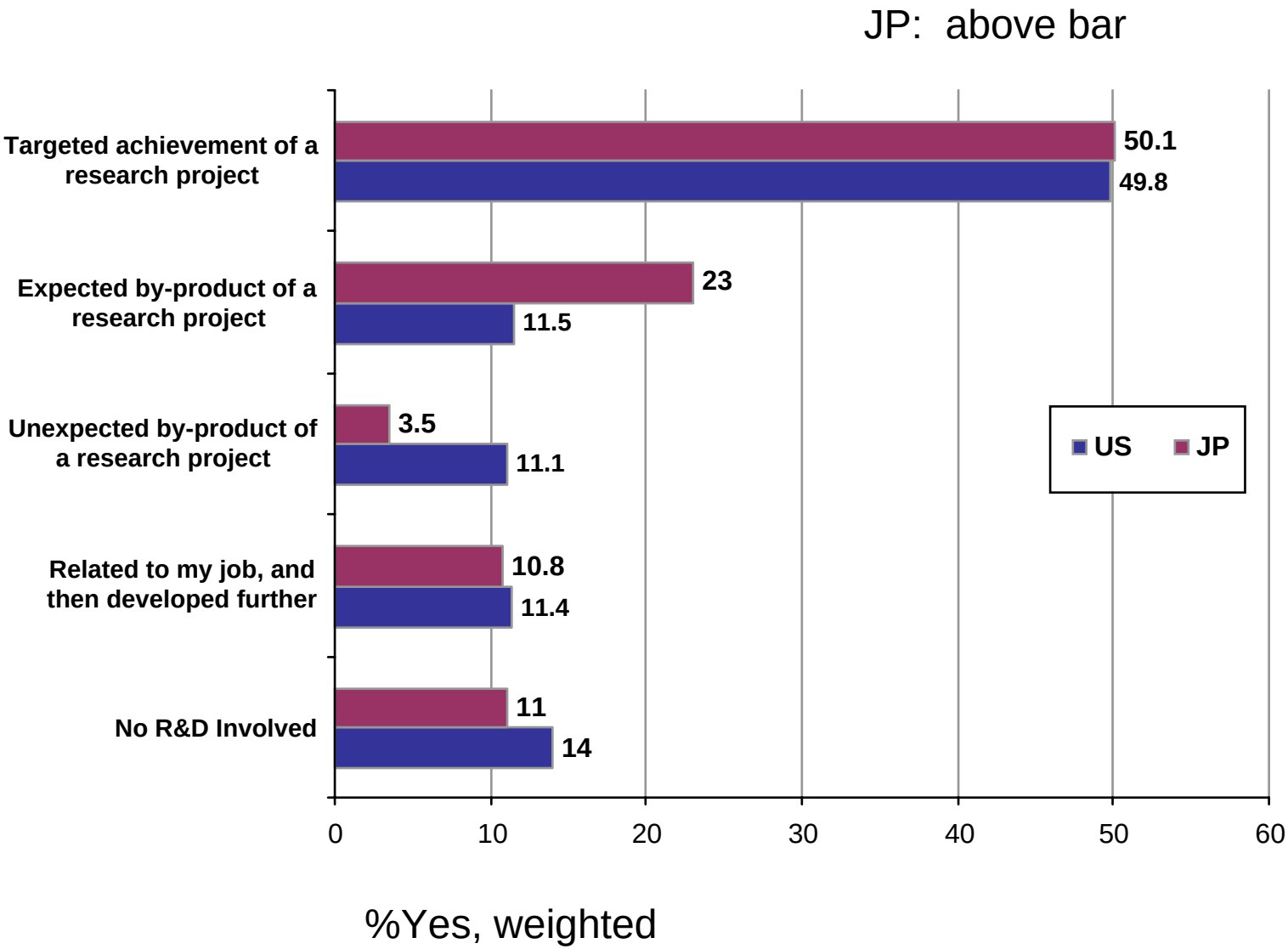


Figure 10. Man months for an Invention

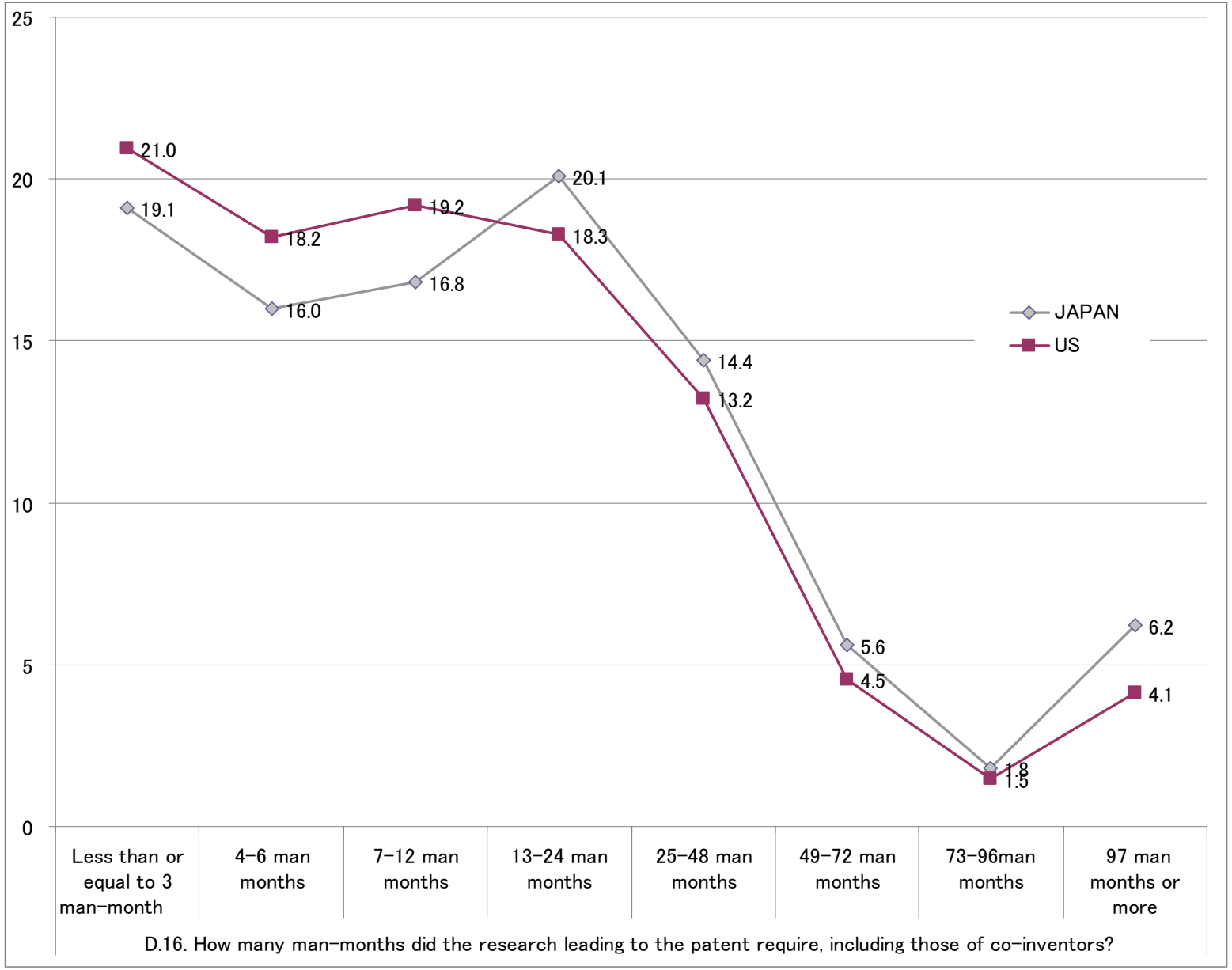


Figure 11. Calendar year for an invention

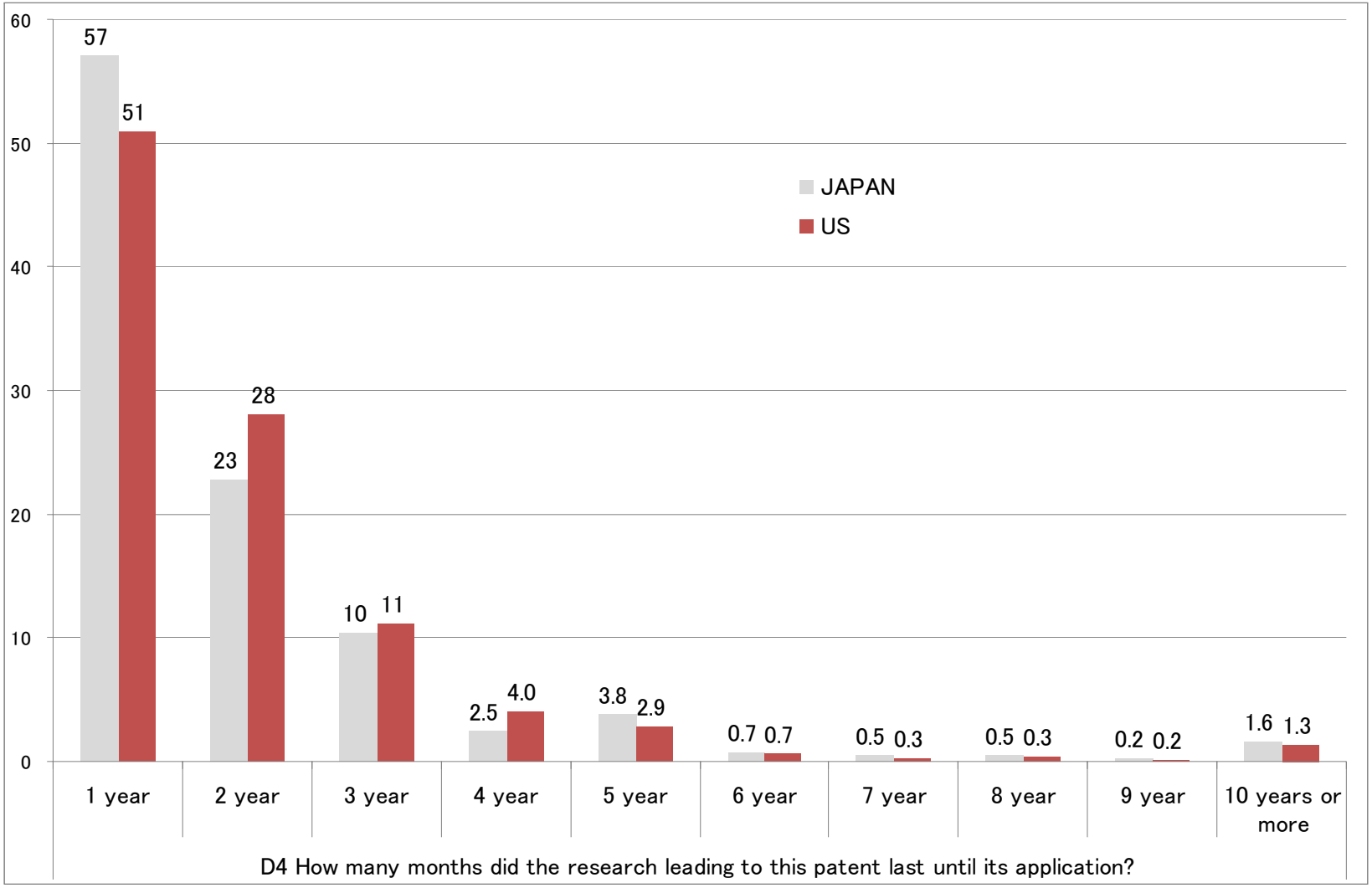
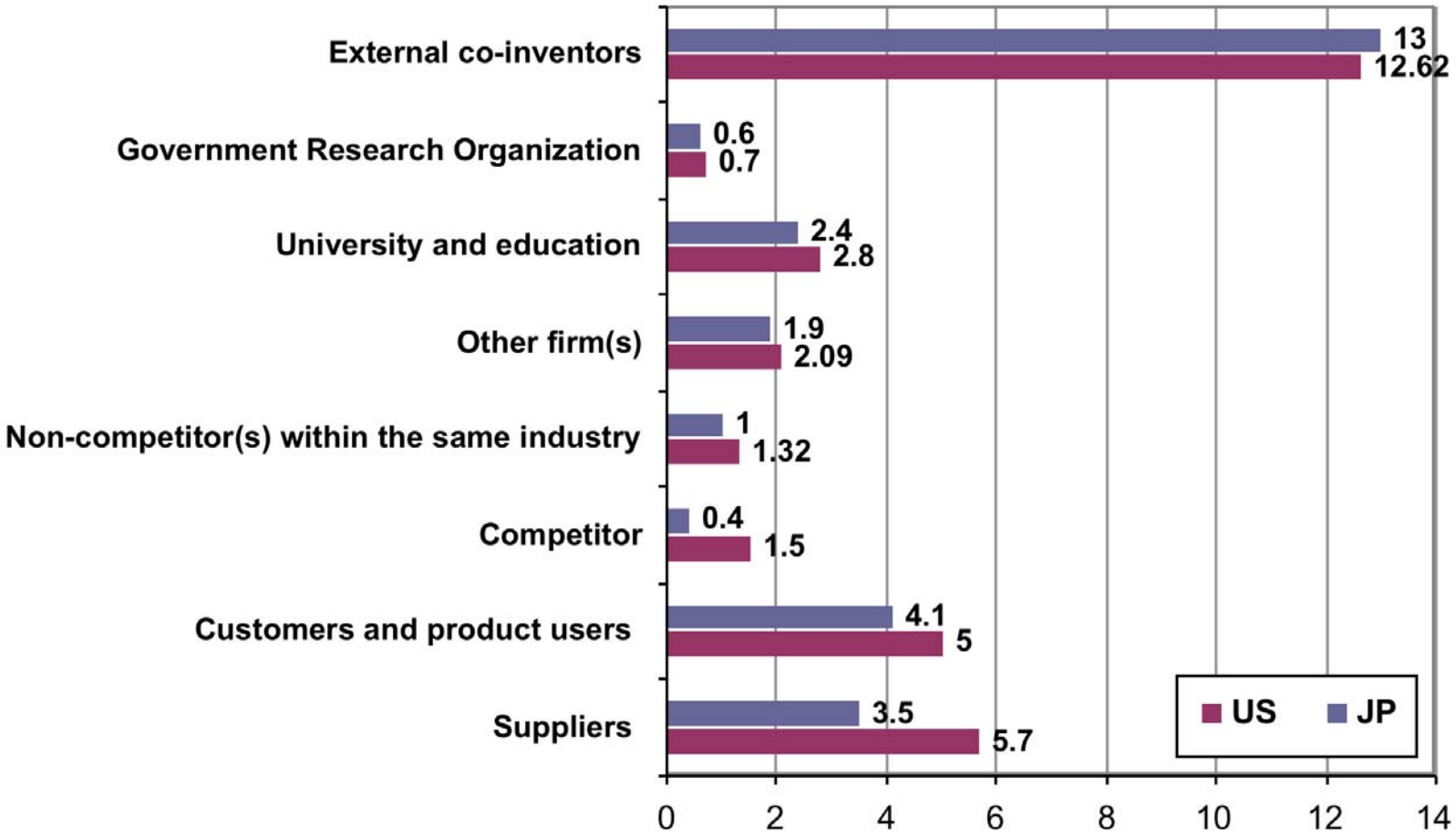
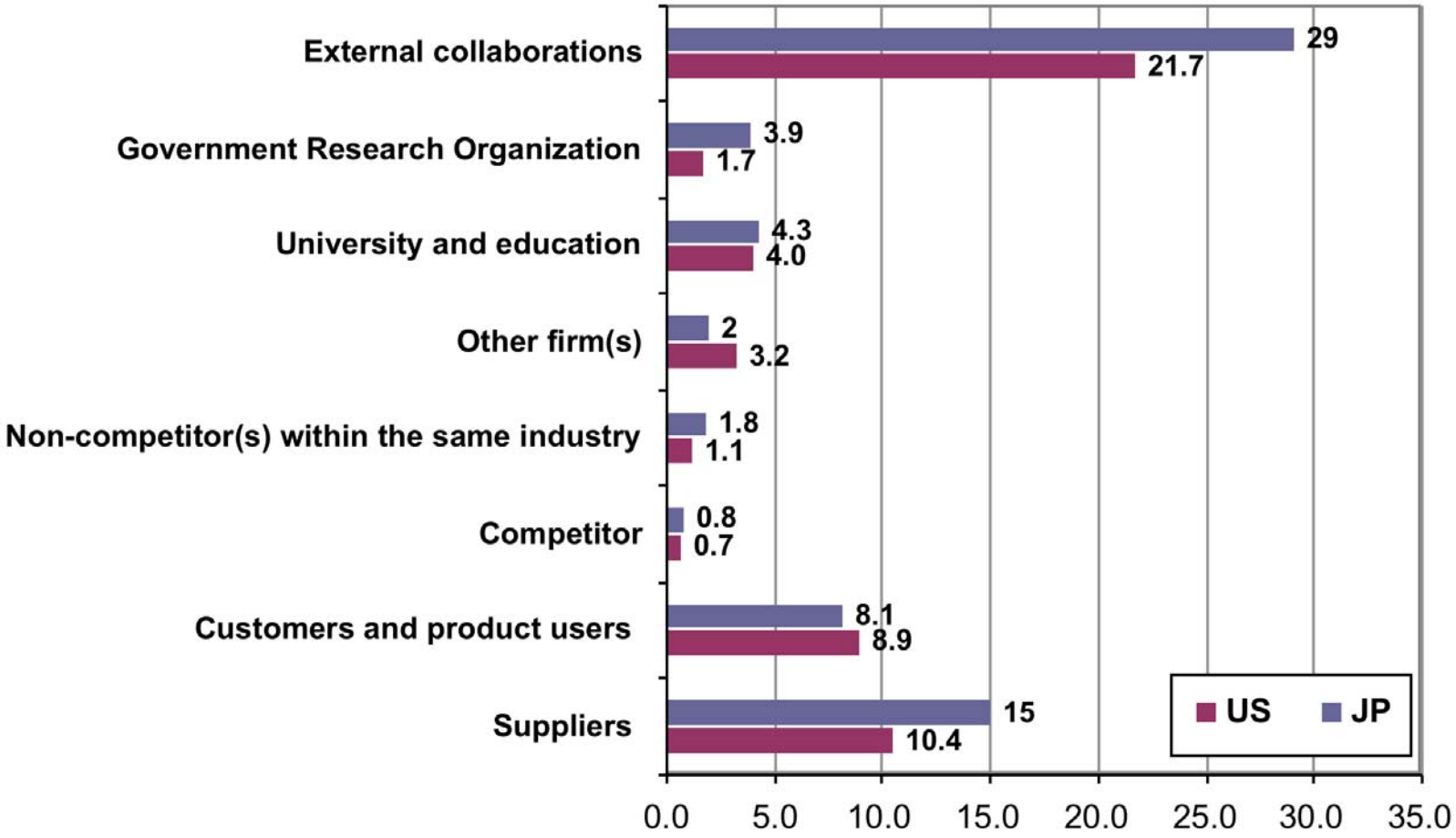


Figure 12. External Co-inventors, by organization type



%Yes, unweighted

Figure 13. Formal/Informal Collaborations (excluding co-inventors), by organization type



%Yes, unweighted

Figure 14A: Sources of Information-Suggesting New Project

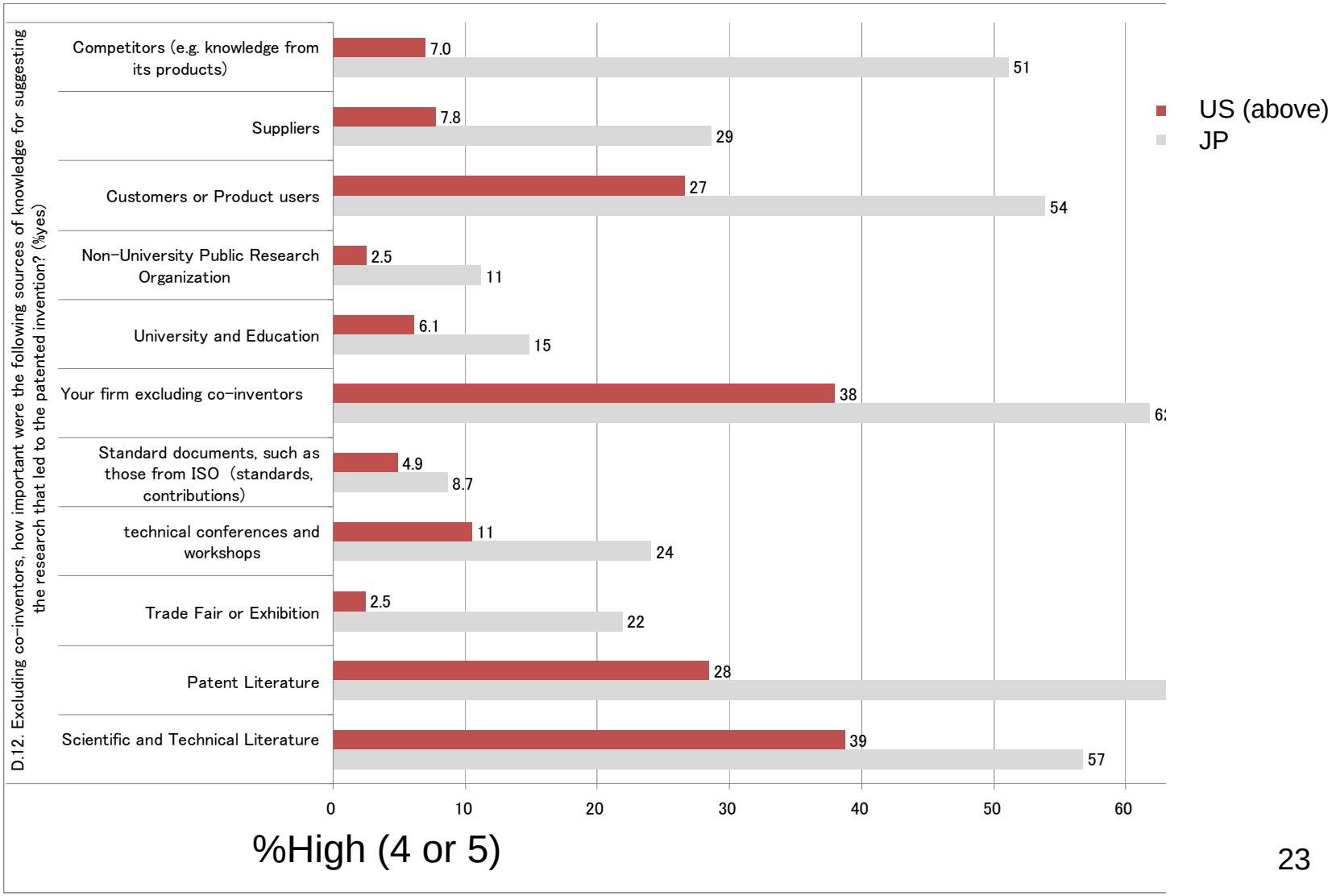
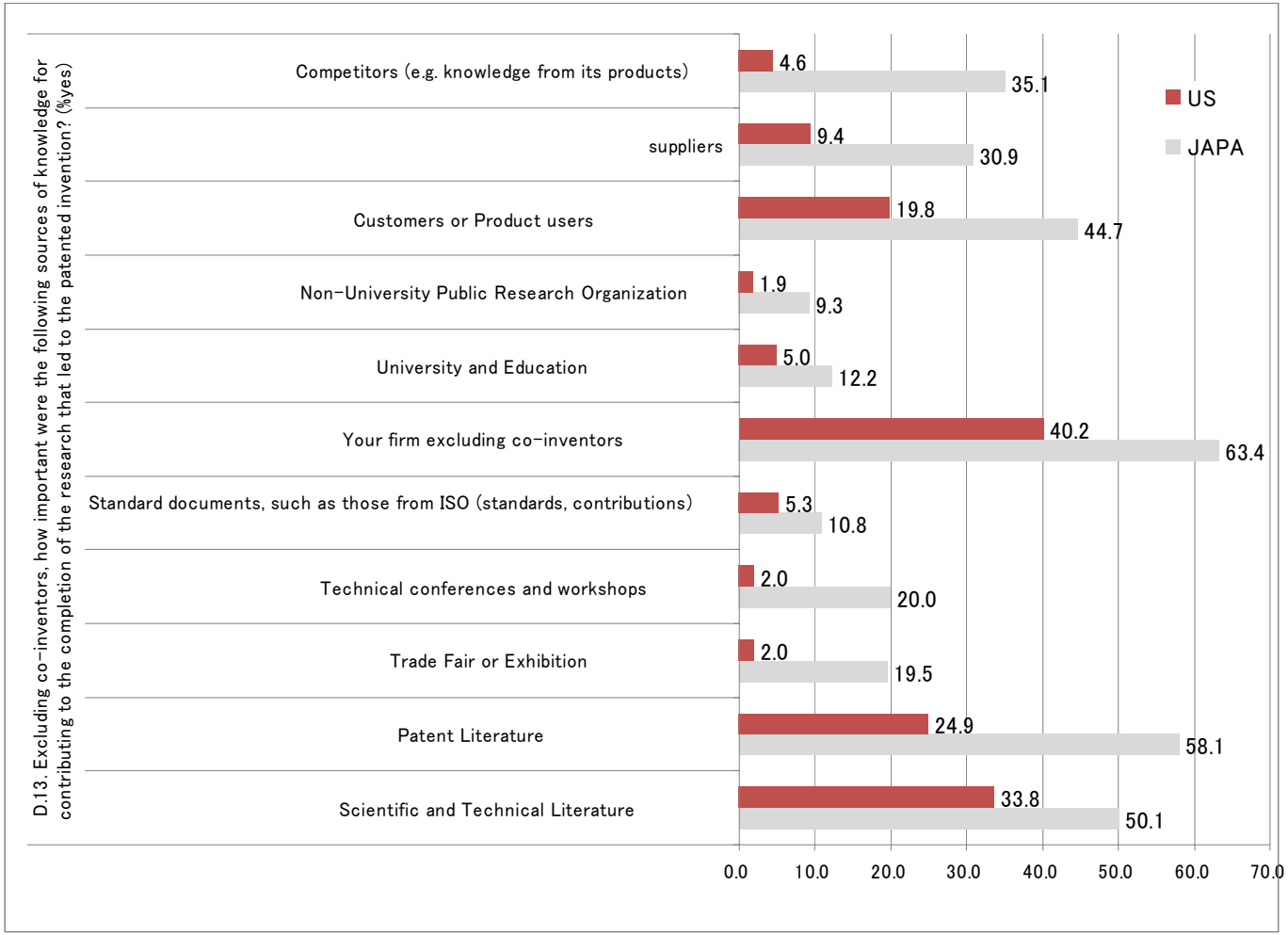


Figure 14B: Sources of Information-Contributing to Project Completion



%High (4 or 5)

Figure 15. Business objectives of the research (%Yes)

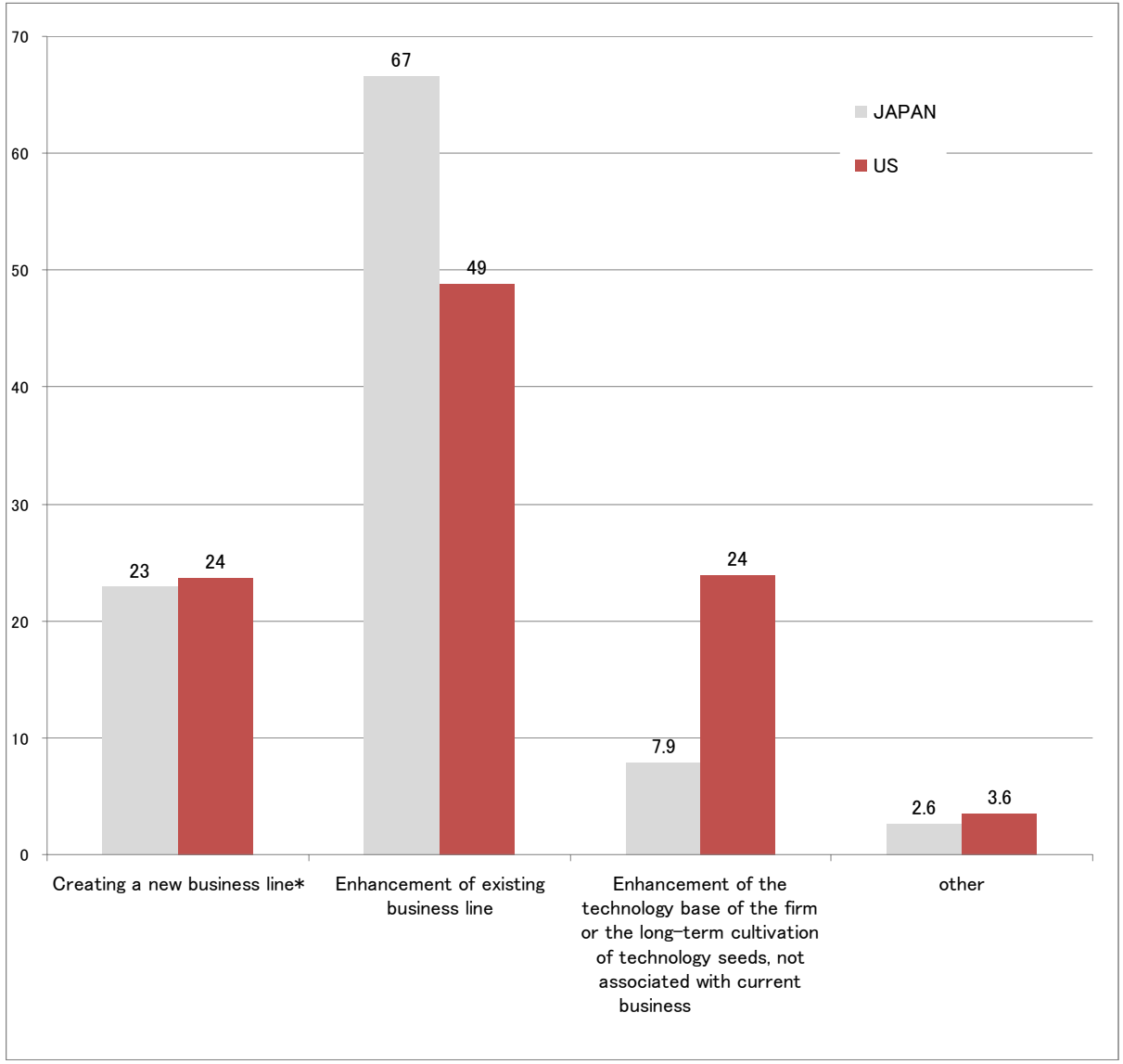
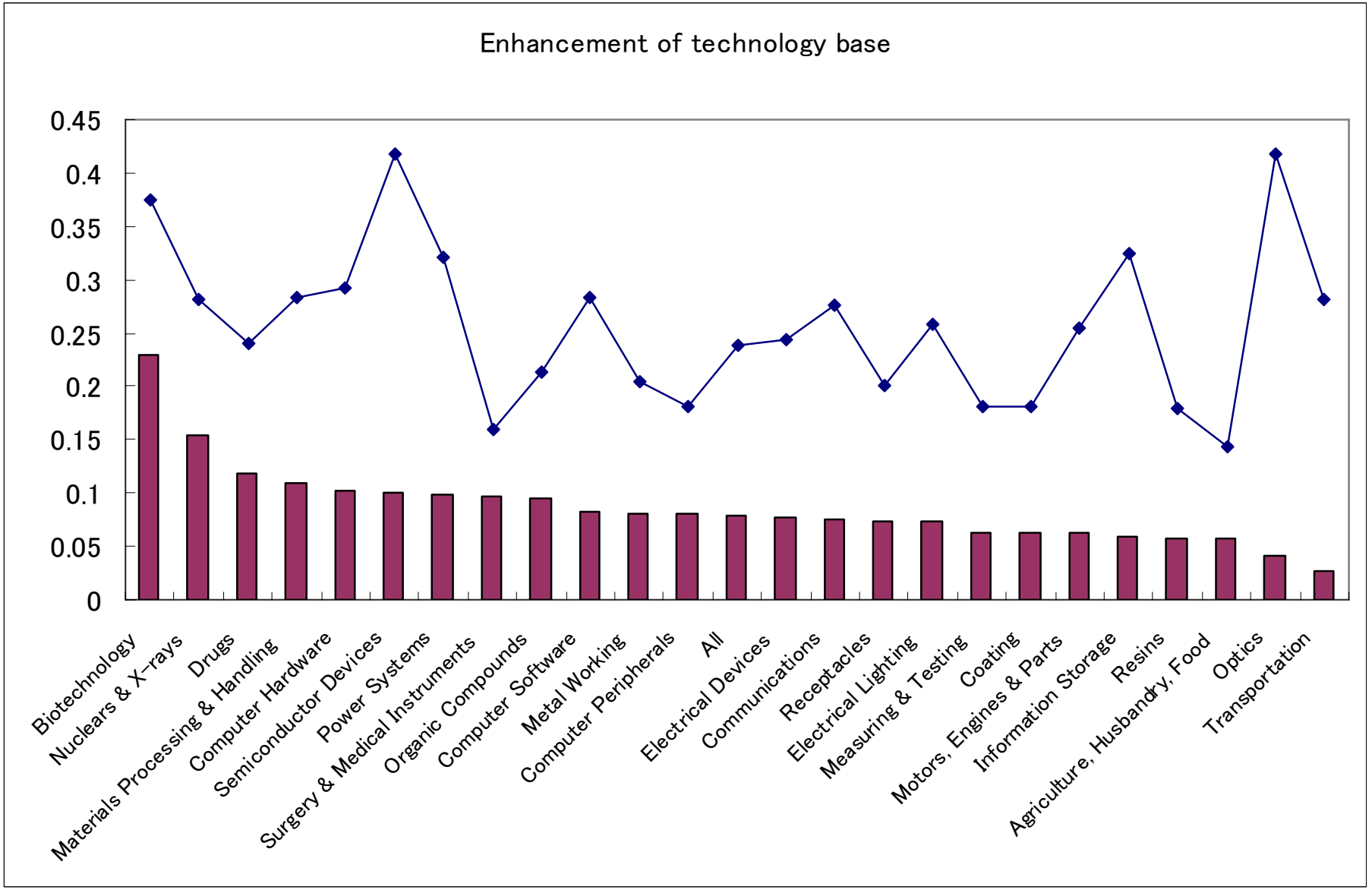


Figure 16. Share of projects for enhancing technology base, bar: Japan line: US

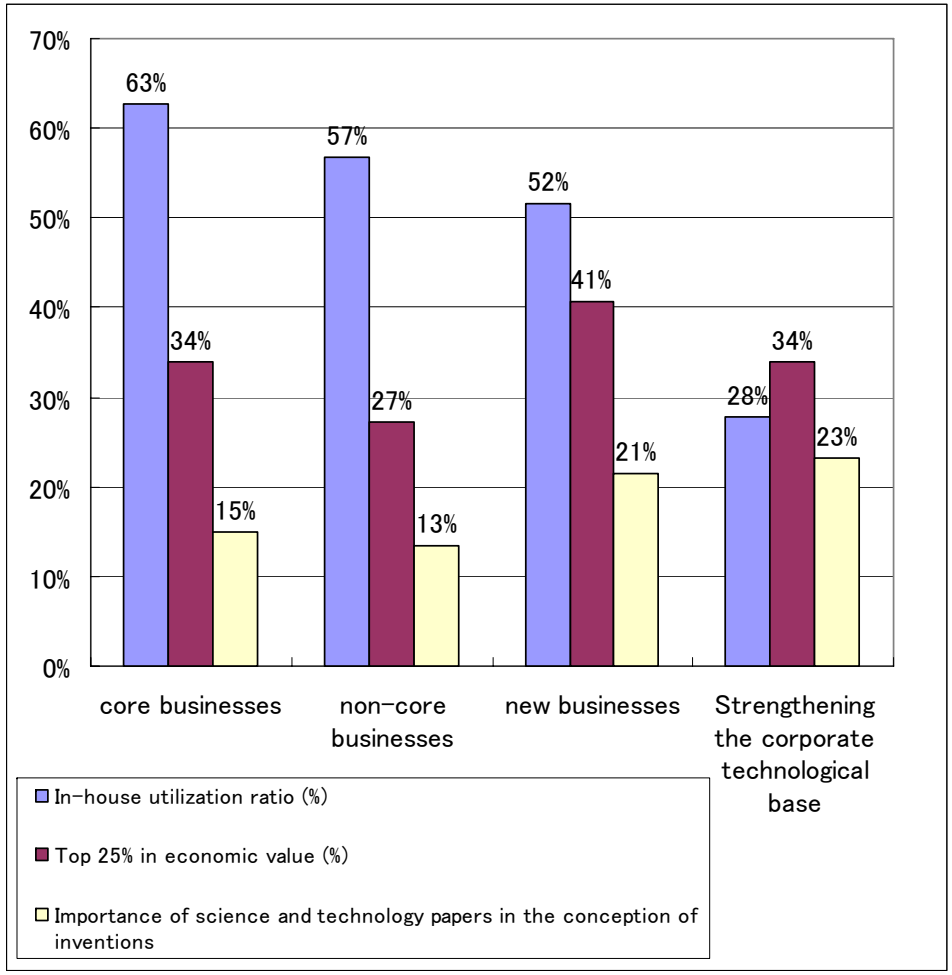


IV. Business objectives of R&D and commercialization process

- R&D for enhancing the existing business of a firm is more common in Japan
- R&D for enhancing the technology base or for cultivating seeds is much more common in US
  - Especially in semiconductors, information storage, computer software, optics

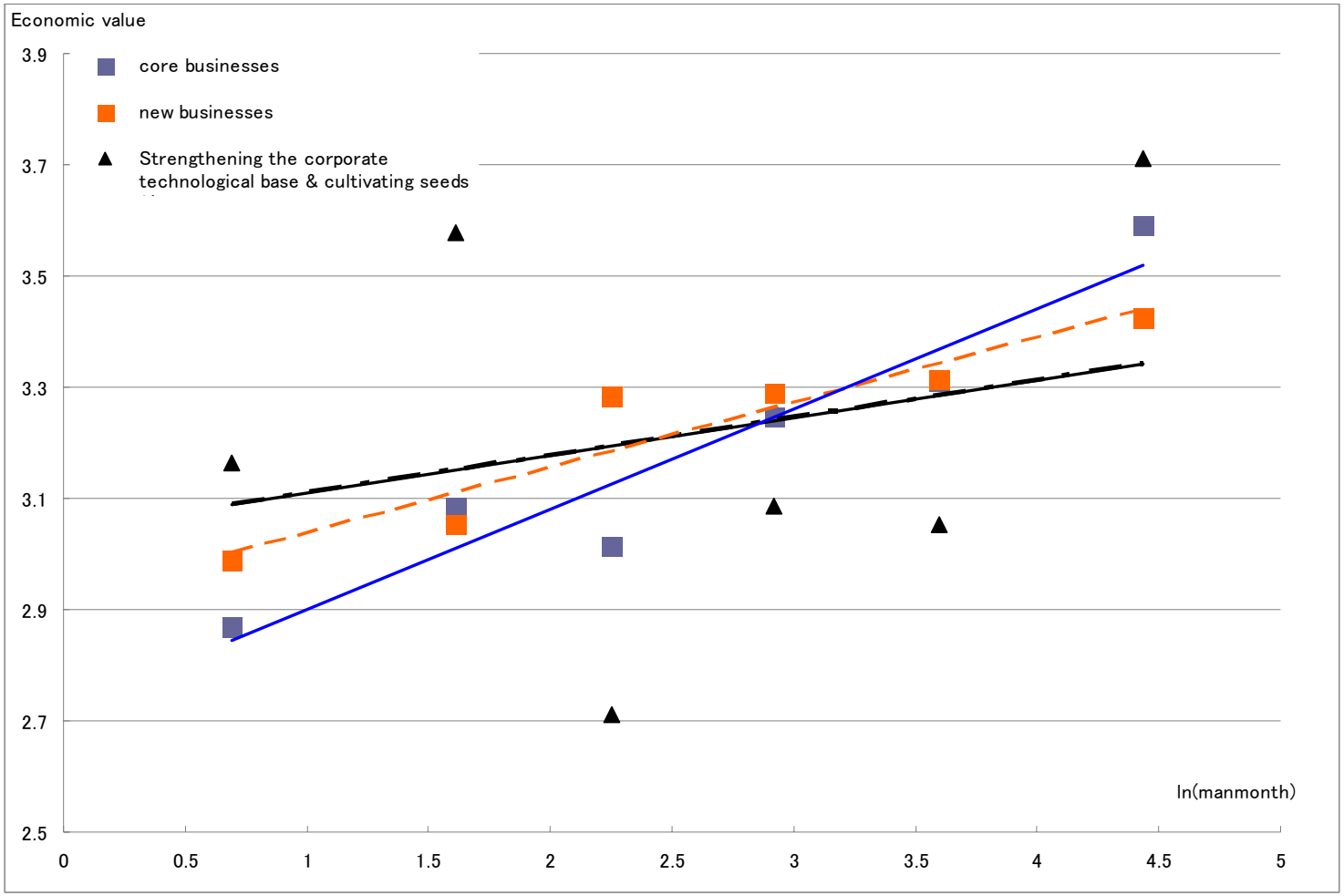
→US more focused on exploiting technological opportunities and/or building absorptive capacity?

Figure 17. Characteristics of R&D by business objectives (Japan)



Note: “In-house utilization" indicates the ratio of inventions used in the products or production processes of the firm in question. “Top 25% in economic value” refers to the ratio judged by the inventors to fall in the nation’s economic top quarter of the technology accomplishments. “Importance of science and technology papers in the conception of invention” refers to the responses stating that such papers are very important in inspiring the invention.

Figure 18. The relationship between the man month and the value of the patent by business purpose



Based on the survey in Japan

Figure 19. Use of the inventions

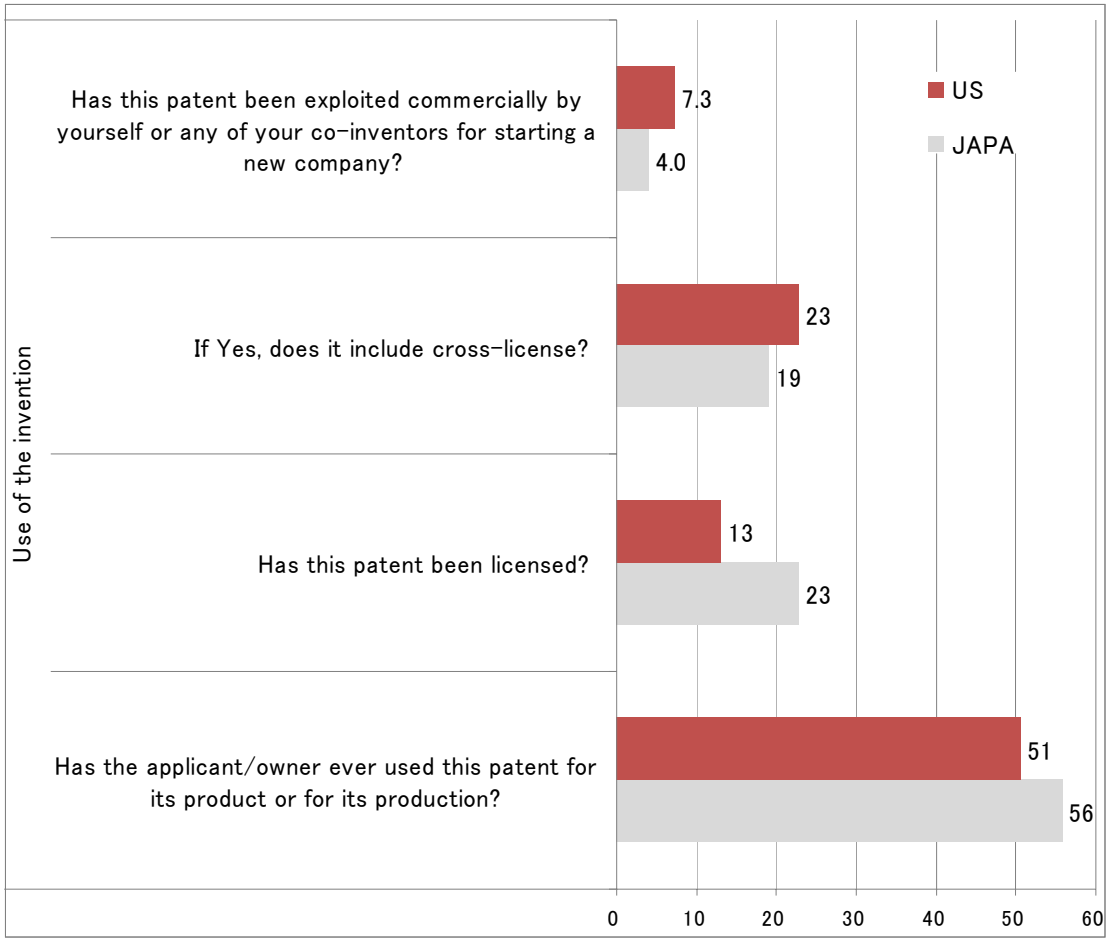


Figure 20. Share of patents used for startups, bar: Japan line: US

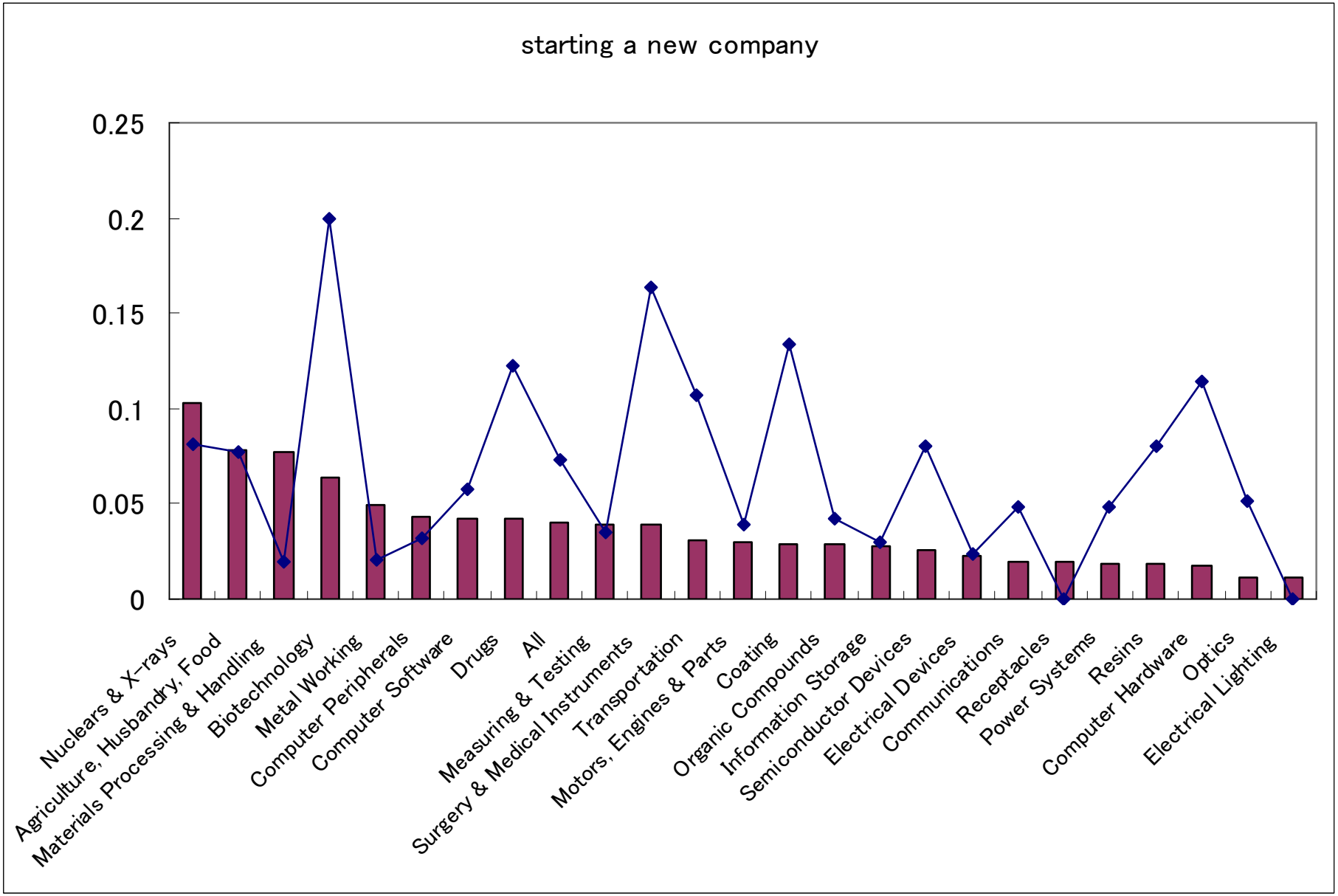


Figure 21A. Estimated Number of Patents Use in Commercializing the Invention (own and others)

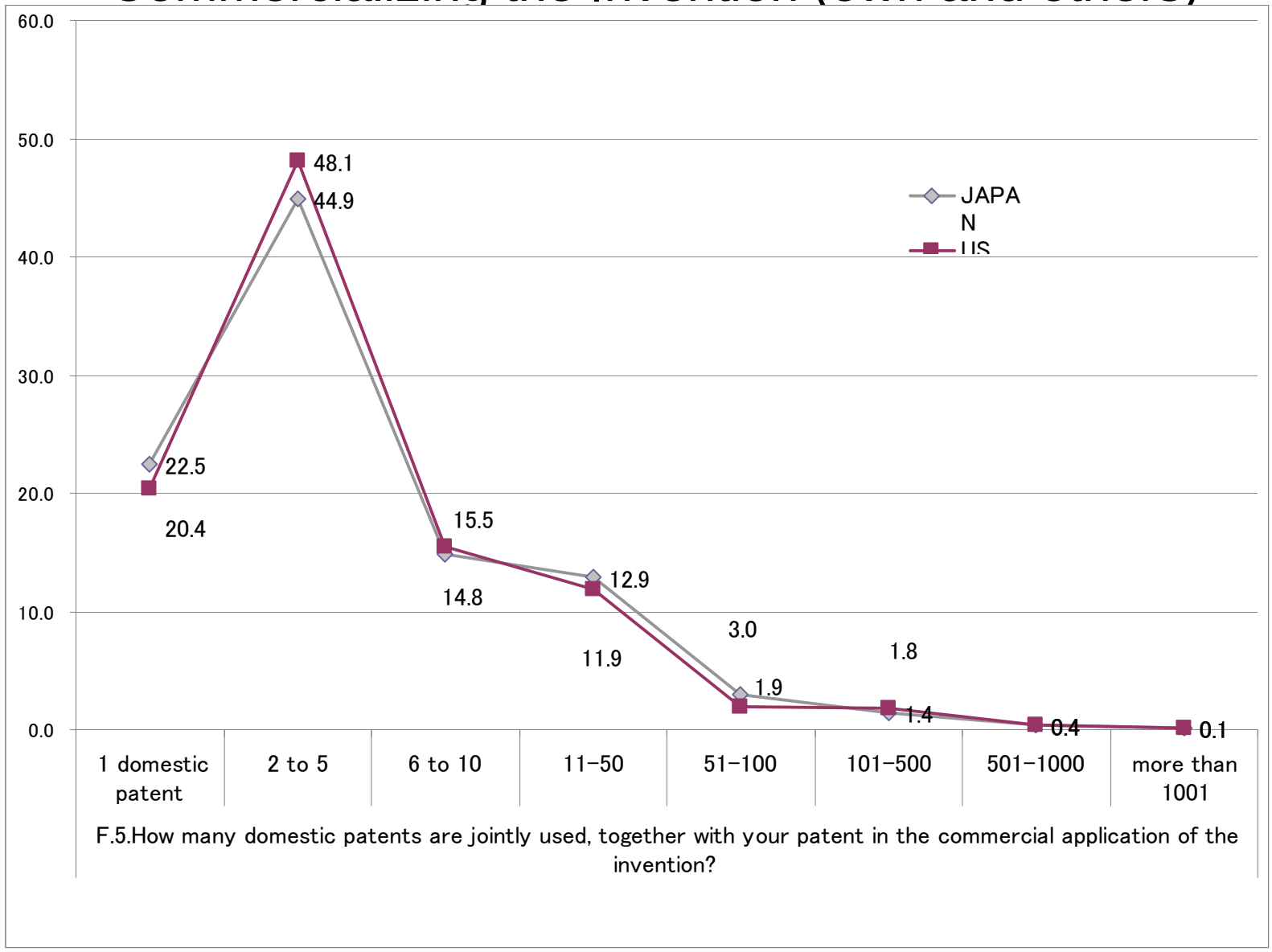


Figure 21B: % of the Sectors where Commercialization Requiring more than 10 Patents, by Sector

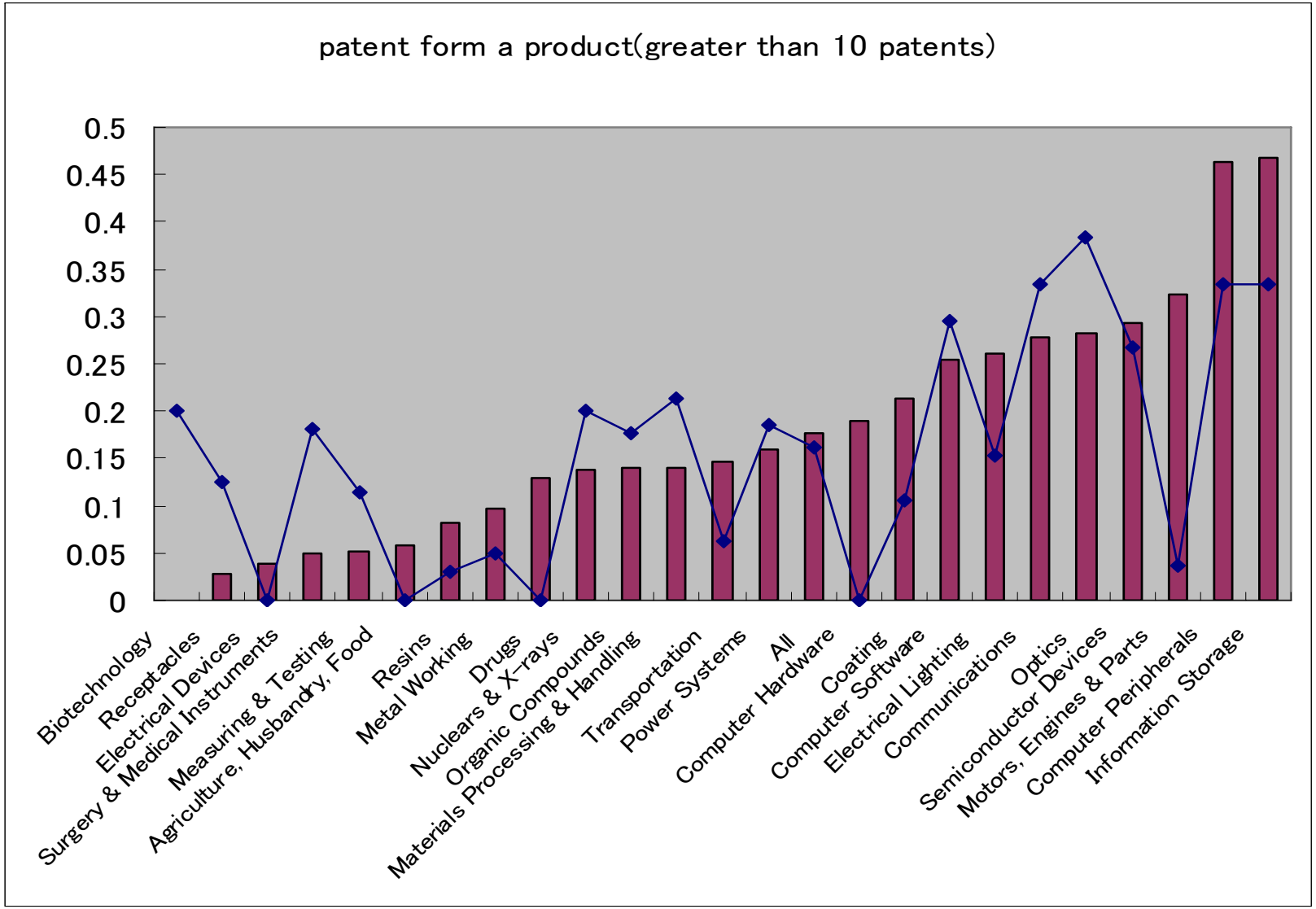


Figure22. Reasons for patenting (very important share,%)

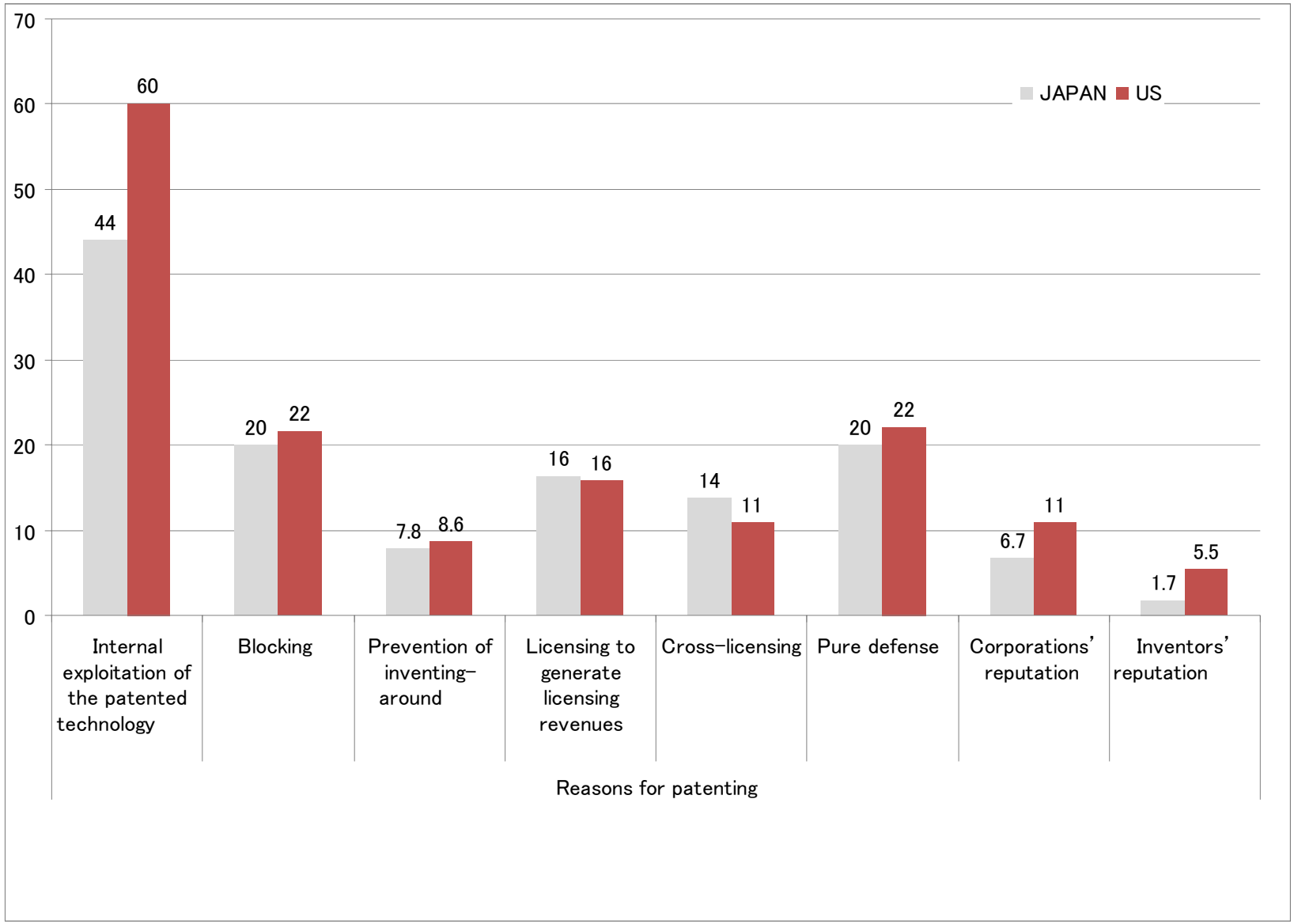


Figure 23. Appropriation Strategies (%, very high)

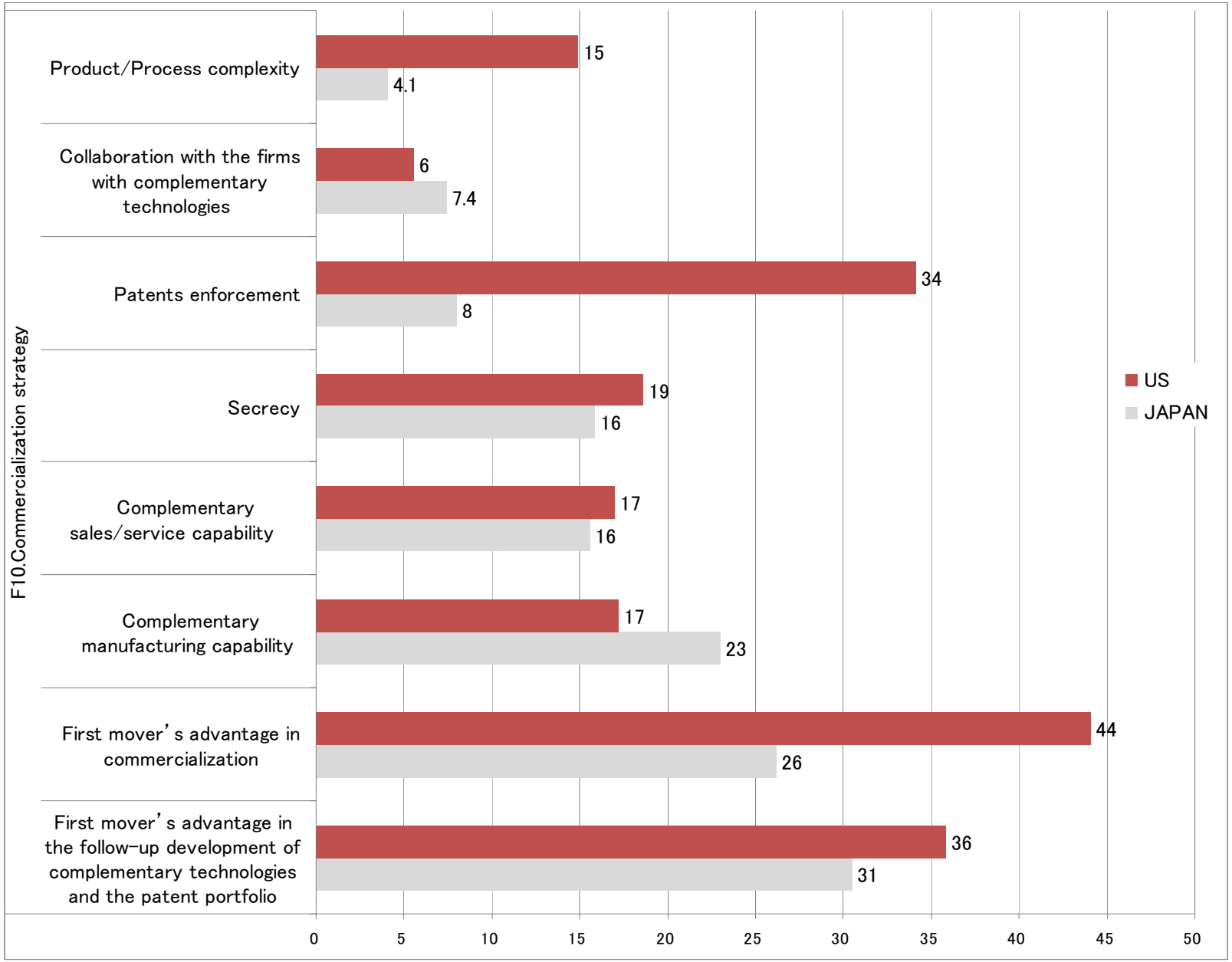
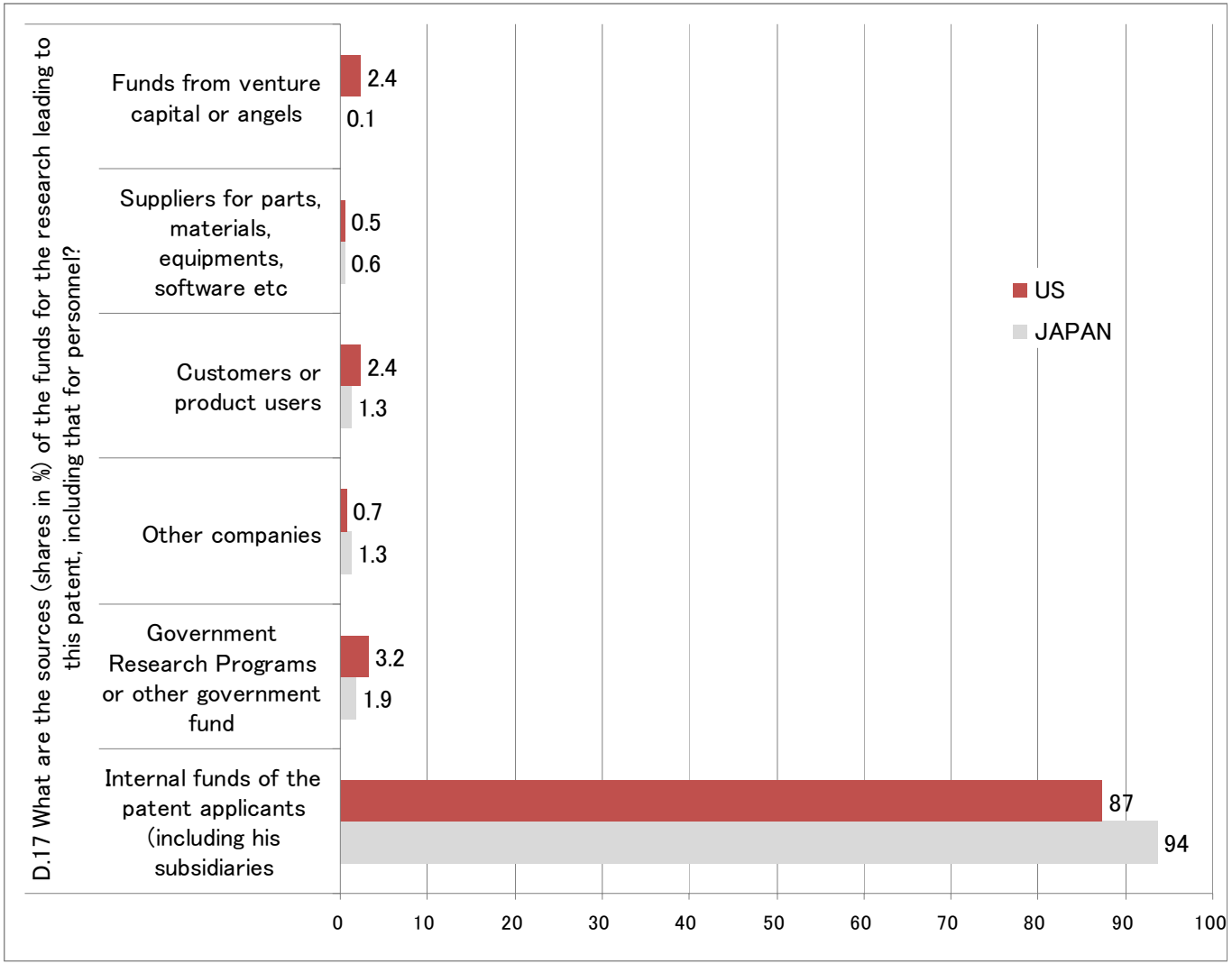


Figure 24. Finance Shares of R&D Projects



Note: Averages not adjusted for project size. Internal funds includes debt or equity funding

Figure 25. The share of venture capital finance of R&D bar: Japan line: US

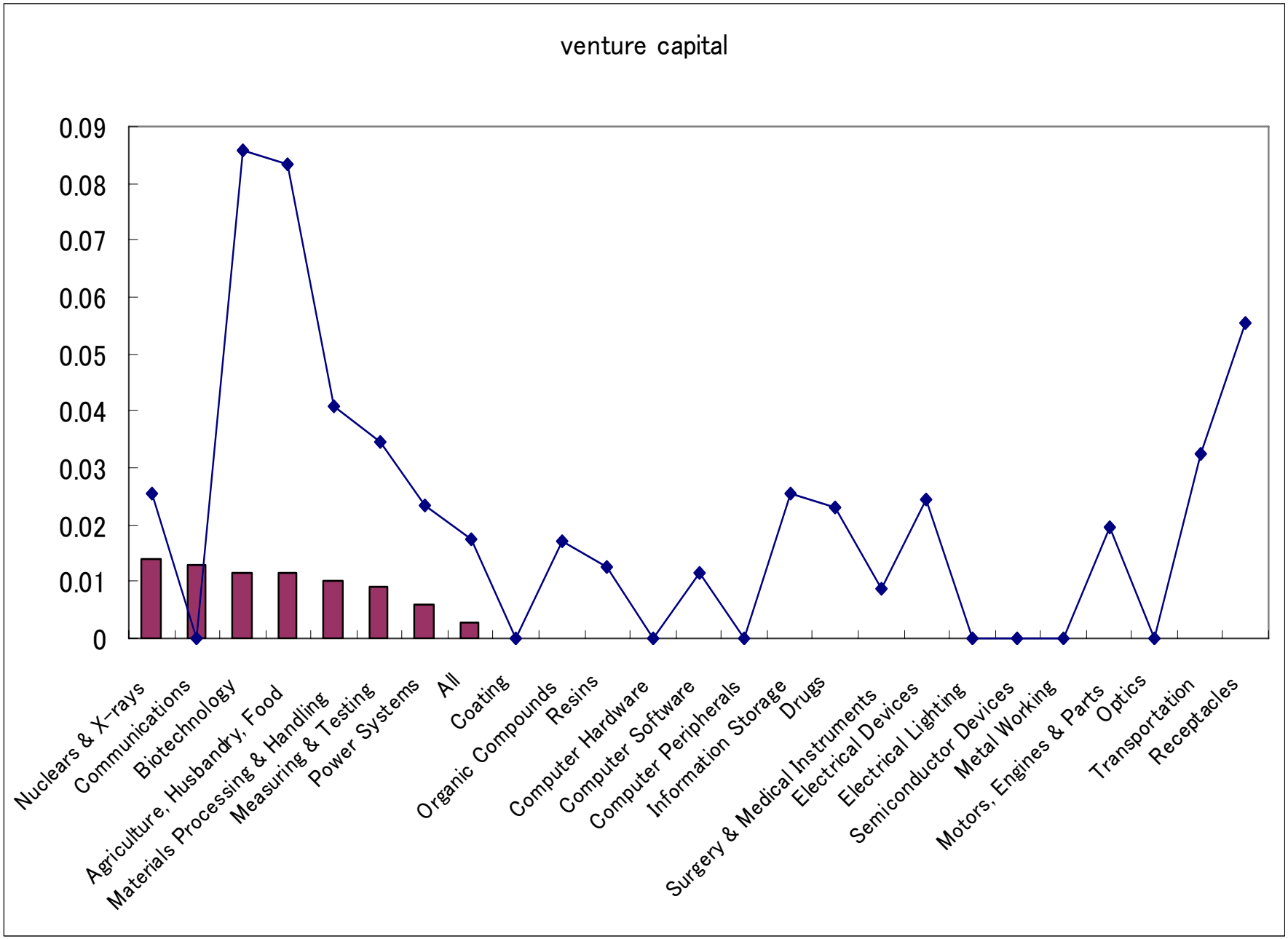
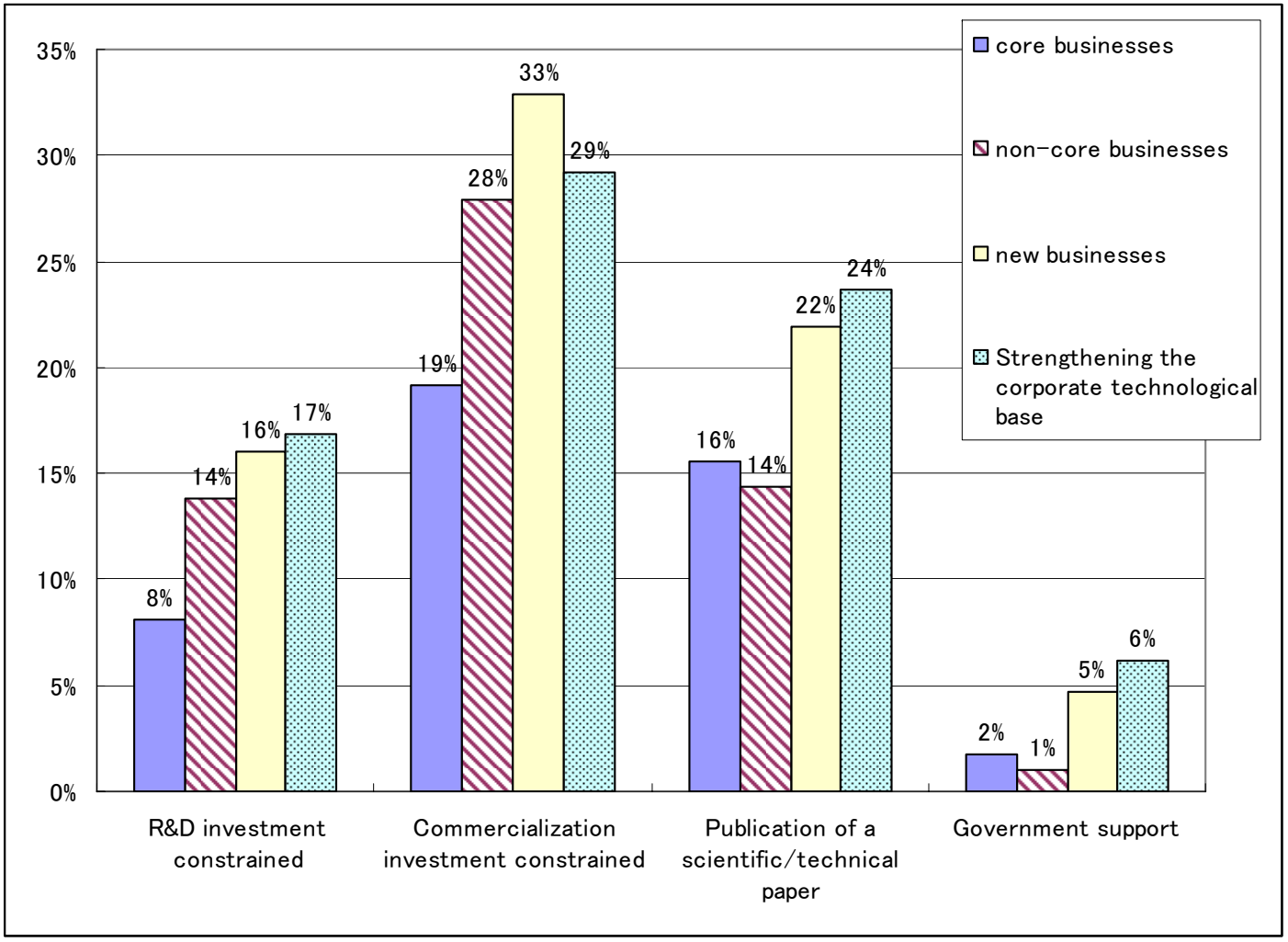


Figure 26. Financial Constraints on Business R&D, Spillover and Government R&D support in Japan



V. Tentative conclusions

Key findings in terms of similarity and difference of US and Japanese invention and innovation process

High similarity between US and Japan despite large institutional differences:

- Relatively small contribution from universities as inventors and collaborators
- Inventor motivations
- Proportions of product vs. process patents
- Time input for inventions
- Level of use of patents
- High proportion of inventions the idea for which do not originate from R&D etc.

Key differences

- High inventor mobility in US
- More use of patents for startups in US
- More exploratory R&D with more serendipities by US firms
- More license in Japan
- More emphasis by US firms on FMAs and patent enforcement relative to complementary manufacturing and sales capability