

Fast Facts on Japan’s R&D Investment in the *Tankan*: Uncovering Data Trends and Patterns

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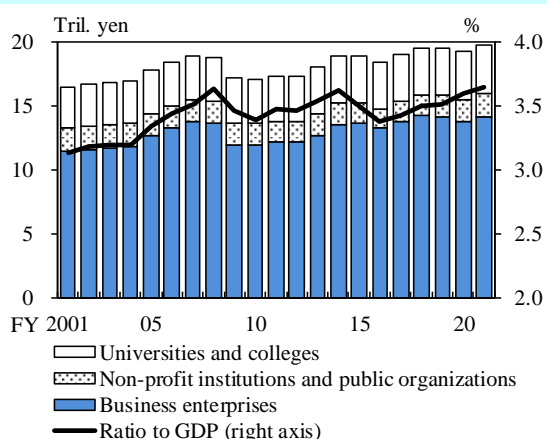
The Bank of Japan has recorded R&D investment in its *Tankan* since the March 2017 survey. As the R&D data have been collected for several years now, this report aims to provide a snapshot of data trends and patterns for users. Compared to other well-known R&D statistics, the *Tankan* asks annual projections and makes it possible to conduct a comparison across items and cross tabulation with the same sample. In fact, data analysis suggests that (1) large manufacturing firms stand out in their R&D share and R&D implementation rate, and (2) revisions for annual projections of R&D investment are smaller than those of fixed investment, which cannot be necessarily quantified with the existing statistics. Going forward, more in-depth analysis would be expected to be made possible as the data set grows.

Introduction

The Bank of Japan has recorded research and development (R&D) investment since the March 2017 survey in its *Tankan* (Short-Term Economic Survey of Enterprises in Japan)¹, on the back of the rising importance of R&D in economic activity. In recent years, firms have focused on the development of new technology as a source of medium- to long-term competitiveness amidst the rapid progress of technological innovation in decarbonization and digital domains etc., while they have regarded royalty revenue in exchange of new technology as an increasingly important source of income. For instance, “Survey of

Research and Development” by Ministry of Internal Affairs and Communications shows an increasing trend of R&D expenditure² in Japan (Chart 1). The benchmark revisions of Japan’s SNA conducted in the end of 2016 have reclassified R&D investment as investment (gross fixed capital formation) from services consumed as inputs into production (intermediate consumption) (Chart 2), given that R&D can be recognized as a source of added value in corporate activity. Accordingly, capturing R&D investment has become an essential element for understanding the economic and business activity.

[Chart 1] R&D Expenditure



Source: Ministry of Internal Affairs and Communication “Survey of Research and Development”; Cabinet Office “National Accounts of Japan”

[Chart 2] Treatment of R&D

Inclusion to GDP	CY2009	The 2008 SNA was approved at UN to treat R&D as capital formation
	Dec-16	R&D investment has been incorporated into capital formation since FY2015 GDP
Use of <i>Tankan</i>	Mar-17	“R&D investment” was added to the <i>Tankan</i>
	Dec-21	<i>Tankan</i> has been used as base data for R&D since 3Q2021 GDP estimate

Compared to other well-known R&D statistics, the *Tankan* asks not only the actual results but also annual projections of R&D investment on a quarterly basis, which makes it possible to gauge revisions in a timely manner (Chart 3). It can also conduct a comparison across items and cross tabulation with the same sample.

[Chart 3] Comparison between the *Tankan* and Other Statistics

	<i>Tankan</i>	Survey of Research and Development	Survey on Planned Capital Spending
Conducted by	Bank of Japan	Ministry of Internal Affairs and Communication	Development Bank of Japan
Coverage	Private enterprises with a capital of 20 million yen or more: 8,660 as of the June 2022 survey	Business enterprises, non-profit institutions and public organizations, universities and colleges for a total of approximately 18,400 as of 2021	Large enterprises with a capital of a billion yen or more: 592 as of FY 2021
Statistical unit	Unconsolidated basis	Enterprises and groups	Consolidated basis
Frequency and release schedule	Mar, Jun, Sep, and Dec (the beginning or middle of next month)	Once a year (Dec of next year)	Once a year (June)
Projections	Available	Not available	Available
Survey items other than R&D	Available Sales, business conditions and so forth	Available Sales etc.	Available Fixed investment, sales DI

Note: The coverage of the *Tankan* and the Survey on Planned Capital Spending corresponds to the number of respondents on R&D.

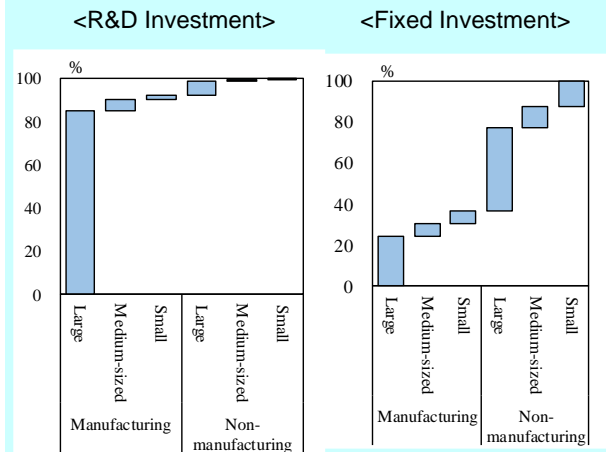
Due in part to the timeliness of the *Tankan*, the R&D data have been used in the quarterly estimates of GDP for the R&D output since the 3rd quarter of 2021, which underscores the importance of the *Tankan* regarding R&D data development (Chart 2). Nonetheless, there have been virtually no studies that examine the trends and characteristics of R&D investment in the *Tankan*, as far as the authors know.³ Therefore, this report aims to provide a snapshot of data trends and patterns in order to increase and broaden the use of the data for a wider segment of users.

This report is structured as follows: the next section presents the features of R&D investment by firm size and industry, and then outlines revision patterns of the past surveys observed from a chart on revisions of annual projections of R&D investment toward the actual results. Lastly, it reviews some caveats to be kept in mind when using the R&D data in the *Tankan*.

Data Trends of R&D Investment

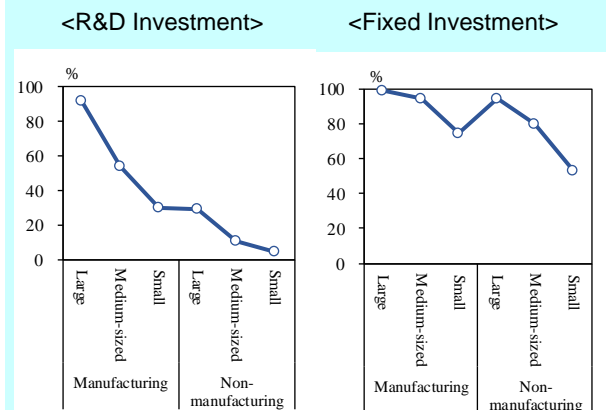
Looking at the comparison between “R&D investment” and “fixed investment (tangible fixed asset investment)”⁴ by firm category, the data suggest that large manufacturing firms have led R&D investment in Japan, unlike fixed investment. For six main categories—two industries (manufacturing and nonmanufacturing) times three capital sizes (large, medium-sized, and small enterprises)—, large manufacturing firms account for more than 80 percent of R&D investment, while the share of nonmanufacturing is less than 10 percent (Chart 4). This is in contrast to nonmanufacturing having a sizable presence in the share of fixed investment. The implementation rate also shows that about 90 percent of large manufacturing firms make some sort of R&D

[Chart 4] Share by Six Categories (FY2021)



Note: Fixed investment includes land purchasing expenses, but excludes software investment and R&D investment (hereafter the same).
Source: Bank of Japan

[Chart 5] Implementation Rate by Six Categories (FY2021)

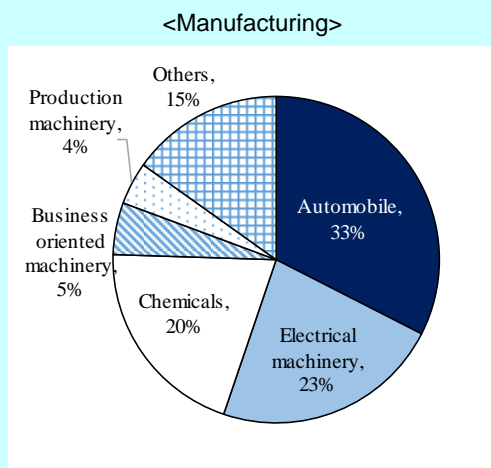


Note: Estimates based on firm-level data.
Source: Bank of Japan

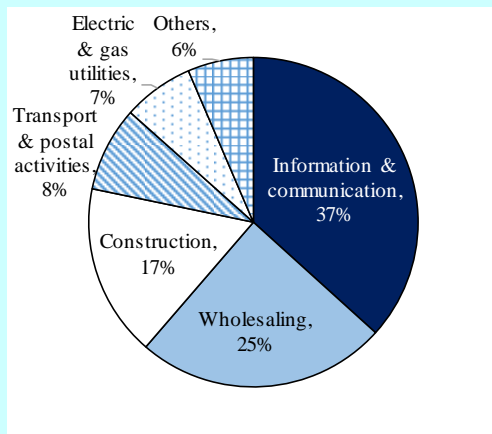
investment, while only around 30 percent of large firms have spent on R&D in nonmanufacturing (Chart 5). In terms of the R&D share of large firms by industry, “automobile” has the largest share in manufacturing, followed by “electrical machinery” and “chemicals”, while “information communication” has the largest share in nonmanufacturing, followed by “wholesaling” and “construction” (Chart 6). Comparing the investment size in large manufacturing firms by industry, the level of R&D investment outweighs that of fixed investment in several industries (such as business oriented industry and automobile) on a non-consolidated basis (Chart 7).⁵

While large manufacturing firms have actively engaged in R&D in domestic sites coupled with an optimization of global supply chains, the export of new products as a result of new technology and license provision toward overseas base have expanded. For instance, the relationship between R&D investment

[Chart 6] R&D Investment Share by Industries (Large Firms, FY2021)

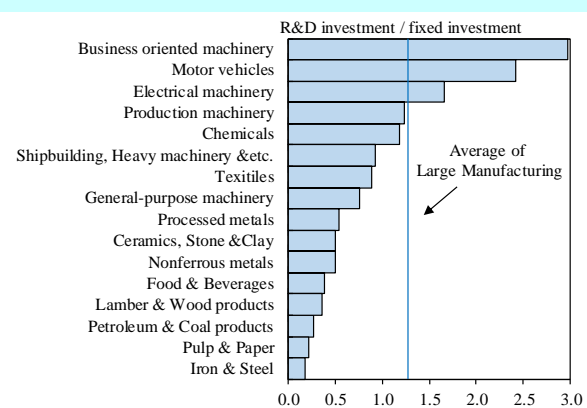


<Non-manufacturing>



Source: Bank of Japan

[Chart 7] Comparison of Investment (Large Manufacturing Firms, FY2021)

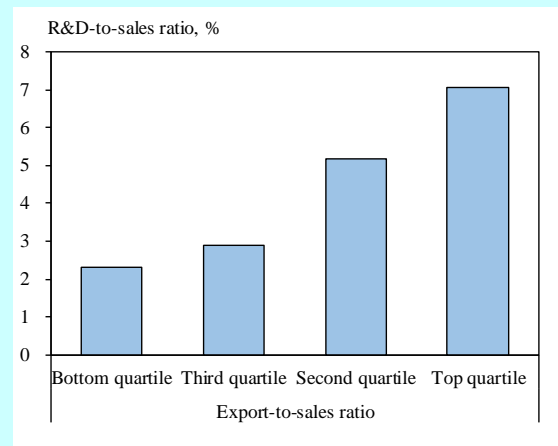


Source: Bank of Japan

and exports implies the tendency that the higher the export-to-sales ratio is, the higher R&D-to-sales ratio would be (Chart 8). Earlier literature also pointed out that a number of firms have expanded their products worldwide through rising competitiveness by R&D.⁶ In addition, “Survey of Research and Development” by Ministry of Internal Affairs and Communications

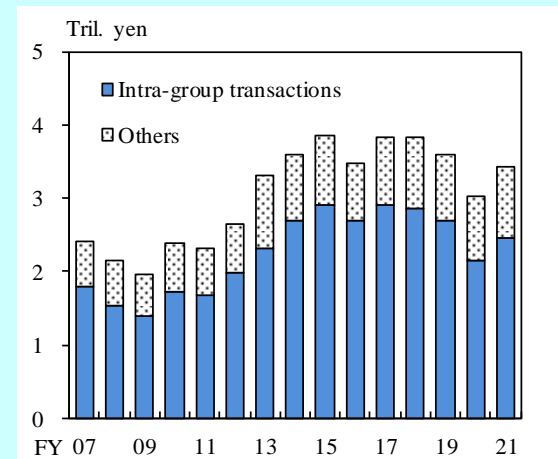
shows that intra-group transactions account for the majority of technology exports by manufacturing (Chart 9), thus implying that new technology developed by domestic R&D activity is often used in the form of license fee for the production of overseas subsidiaries.

[Chart 8] Relationship between Export and R&D Investment (Large Manufacturing Firms, FY2021)



Note: Estimates based on firm-level data.
Source: Bank of Japan

[Chart 9] Technology Exports



Note: Technology exports are the receipts for providing license, know-how and technical assistance etc.
Source: Ministry of Internal Affairs and Communication “Survey of Research and Development”

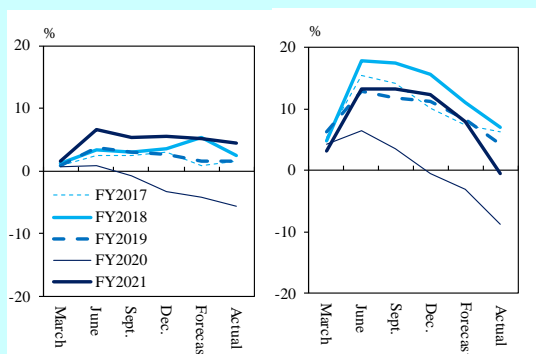
Data Patterns

Revision Patterns

Next, let us take a look at revision patterns of annual R&D projections (year-on-year terms) of large manufacturing firms from the first March survey—which asks annual projections for the next year for the first time—to the sixth actual result survey (the July survey of the next year). The extent of revisions of R&D investment is smaller relative to fixed investment, and there do not appear significant downward revisions toward the actual results (Chart 10).⁷ During FY2020 when the spread of COVID-19 started to materialize, R&D investment saw continuous downward revisions over the year similar to fixed investment, albeit to a modest extent. A similar trend can be confirmed with the firm-level revision patterns for selected industries

[Chart 10] Revision Patterns (Large Manufacturing Firms)

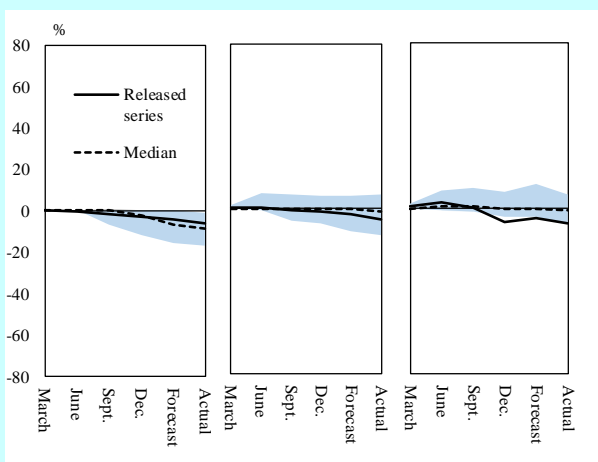
<R&D Investment> <Fixed Investment>



Source: Bank of Japan

[Chart 11] Revision Patterns of R&D Investment (Large Firms, FY2020)

<Automobile> <Electrical Machinery> <Chemicals>

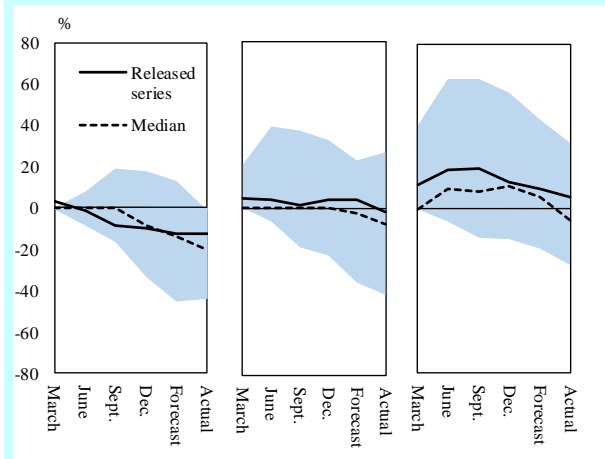


Note: Median is based on firm-level data. Shaded area represents upper and lower 25 percentile (hereafter the same).

Source: Bank of Japan

[Chart 12] Revision Patterns of Fixed Investment (Large Firms, FY2020)

<Automobile> <Electrical Machinery> <Chemicals>



Source: Bank of Japan

(Chart 11 and 12).⁸ Reasons for this include that R&D investment is less adjusted to short-term business cycle and tends to be implemented based on the medium-to long-term plan including labor costs for researchers.⁹

Relationships with Short-term Business Cycle

Here we briefly review the relationship between R&D investment, short-term business cycle, and financial conditions.¹⁰ This section examines their relationship over a relatively long period, and then explores the relationship between DI for business conditions and financial position, and R&D investment in the *Tankan* before and after the COVID-19 pandemic, using the firm-level data.

The scatter plot of R&D investment and machinery & equipment investment against DI for business conditions (all industries) reveals that there is a positive correlation between them, but the variations in R&D investment are smaller relative to fixed investment (Chart 13, left panel). The same association can be observed for the relationship with DI for financial position. For instance, fixed investment recorded a sizable negative growth in the wake of devastating deterioration in financial position during the Leman's collapse. On the other hand, the decline in R&D investment was relatively limited (Chart 13, right panel).

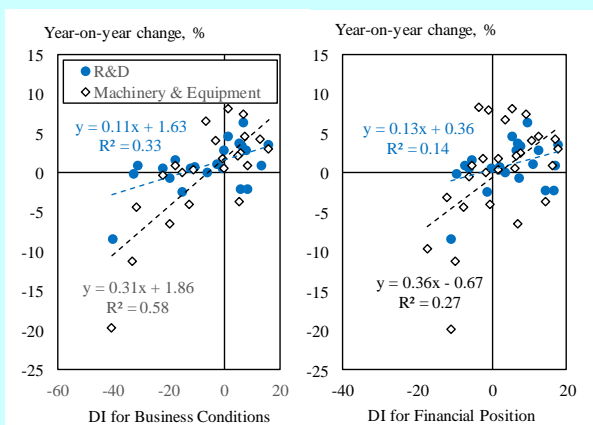
Further, let us compare the year-on-year change in R&D investment and fixed investment using the firm-level data with the sample (large manufacturing) which chose tighter options for DI for business conditions and financial position before and after the COVID-19 pandemic. The results show that the year-on-year changes of fixed investment declined to a large extent as either of business conditions or financial position deteriorated, while the decline in R&D investment remained relatively limited (Chart 14). Although care should be taken in interpreting the results given the limited data period, the results indicate that, at least through the lens of the *Tankan*, the impact of short-term

business cycle and deteriorating financial position on R&D investment would be smaller relative to fixed investment.

Caveats to Be Kept in Mind

Lastly, let us review some caveats to be kept in mind when using the R&D data in the *Tankan*. While the *Tankan* covers more than 90 percent of R&D investment by private enterprises¹¹, it excludes some specific industries and firms with small levels of capital. For instance, “scientific research, professional and technical services” accounts for about 40 percent of R&D investment in nonmanufacturing according to “Survey of Research and Development” by Ministry of Internal Affairs and Communications (Chart 15). On the other hand, some industries which may have a weak link with economic conditions such as “education, learning support” are excluded from the target

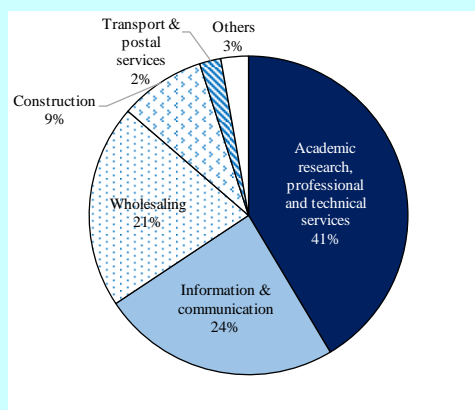
[Chart 13] DI for Business Condition and Financial Position, and Fixed Capital Formation by Type



Note: The sample period ranges from CY2000 to 2021. DI is the annual average for each year (all industries).

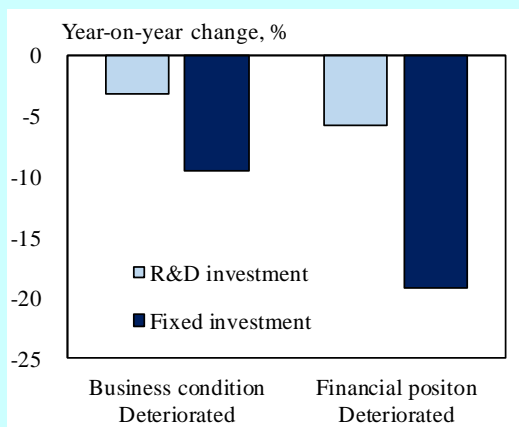
Source: Cabinet Office “National Accounts of Japan”, Bank of Japan

[Chart 15] Share of R&D Expenditure in Non-manufacturing by Industries (Survey of Research and Development, FY2021)



Source: Ministry of Internal Affairs and Communication “Survey of Research and Development”

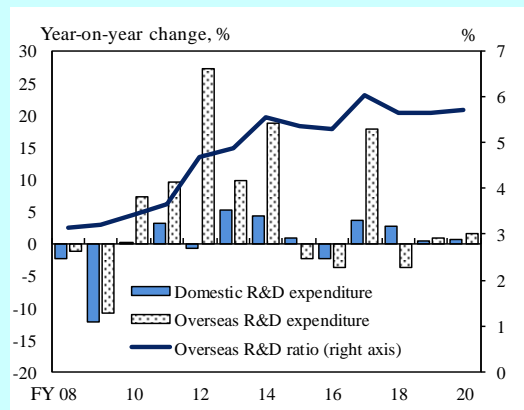
[Chart 14] Changes in Fixed Investment and R&D Investment in the Wake of Deteriorating Business Condition and Financial Position (FY2020)



Note: Estimates based on firm-level data. The sample are those whose responses for business conditions and financial position worsened from December 2019 to June 2020 (large manufacturing firms).

Source: Bank of Japan

[Chart 16] Overseas R&D Ratio



Source: Ministry of Internal Affairs and Communication “Survey of Research and Development”; Ministry of Economy, Trade and Industry “Basic Survey on Overseas Business Activities”

population in the *Tankan* (Chart 6). Also, firms with capital of less than 20 million yen which include startups are out of the target population of the *Tankan*.¹²

According to “Basic Survey on Overseas Business Activities” by the Ministry of Economy, Trade and Industry etc., the share of overseas R&D in total R&D has been on an increasing trend (Chart 16). Thus it should be noted that the size of overseas R&D activity is non-negligible, which is not captured by the *Tankan*.

Concluding Remarks

As the data on R&D investment have been collected for several years (since the March 2017 survey), this report provides an overview of trends and patterns on R&D investment. Unlike fixed investment, R&D investment has been led by large manufacturing firms and, for these firms, R&D investment outweighs fixed investment on a non-consolidated basis. In the wake of sizable economic shocks etc., the revisions of annual projections of R&D investment toward actual results appear smaller relative to fixed investment given that R&D investment is implemented based on medium-to long-term investment plan.

Nonetheless, more data are needed to conduct detailed analysis on, for instance, identifying the causal relationship between R&D investment and overseas business activities. From this perspective, it is crucial to provide data conducive to various research by collecting accurate figures and enhancing the data quality on R&D investment in the *Tankan*.

BOX: Global Landscape of R&D Investment

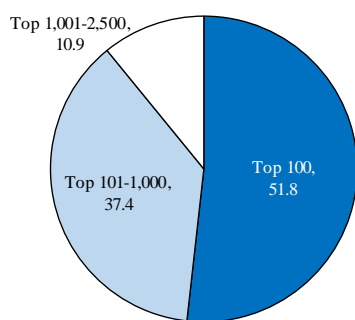
This report confirms that Japan’s R&D investment is characterized by a remarkable concentration in large manufacturing firms, while the share of nonmanufacturing is less than 10 percent. This box examines whether these characteristics are also observed in other major countries, using “Industrial R&D Investment Scoreboard” (2020) by the EU, which surveys the top 2,500 companies accounting for approximately 90 percent of the world’s business-funded R&D investment. The results suggest that large manufacturing companies have led R&D investment in all major countries, albeit with some variations in the industry composition across countries.

First, the composition of the 2,500 companies’ R&D investment shows that the top 100 companies account for more than half of the total R&D investment (Box Chart 1). In other words, R&D investment tends to be concentrated in a handful of large companies, not only in Japan but also worldwide.

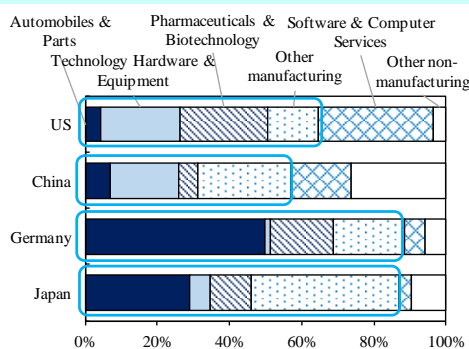
Second, the industry composition of R&D investment for the four major countries (the U.S., China, Japan, and Germany) indicates that manufacturing sector account for more than half of R&D investment in all countries (Box Chart 2). Notably, the manufacturing sector—especially automobile manufacturing—has a high share in Germany, similar to Japan. On the other hand, the share of nonmanufacturing sector—led by information communication, which has invested in R&D related to information technology—is relatively high in the U.S. and China.

Country breakdowns of R&D investment for the world’s top 100 companies show that the U.S. and China has increased their presence in recent years (Box Chart 3), which suggests that both countries have focused on R&D investment in digital domain including not only technology hardware but also information communication.

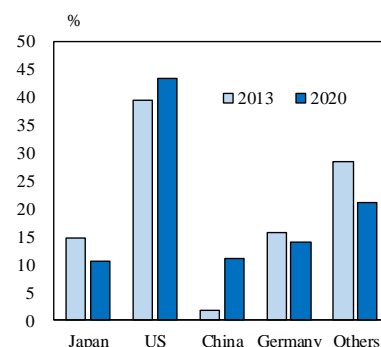
[BOX Chart1]



[BOX Chart2]



[BOX Chart3]



Note: BOX Charts 1 and 2 are based on the data as at 2020. The blue thick lines in BOX Chart 2 represent the share of manufacturing. BOX Chart 3 shows the share of the top 100 companies by country.

Source: EU “Industrial R&D Investment Scoreboard”

¹ The *Tankan* consists of the *Tankan* (main survey) and three supplemental surveys, that is, the Survey of Financial Institutions; the Survey of Business Consultants & Pure Holding Companies; and the Survey on Overseas Business Activities. In this report, the *Tankan* refers to the main survey.

² R&D expenditure consists of labor costs, material, tangible fixed assets, intangible fixed assets, lease fees and other expenses.

³ For the characteristics of major items in the *Tankan*, see the following:

Masahiko Kataoka, “A Primer on the *Tankan*—Characteristics and Peculiarities of Major Items,” (Bank of Japan Review Series, 2010-E-8, 2010).

⁴ In this report, fixed investment includes land purchasing expenses, but excludes software investment and R&D investment.

⁵ It has been pointed out that the level of fixed investment outweighs that of R&D investment in almost all industries on a consolidated basis. For all industries, R&D investment amounts to about a third of fixed investment in the *Tankan* as well.

⁶ Though a panel Granger test was conducted to examine the statistical relationship between exports and R&D investment with the sample period from FY2017 to FY2021, the results were not significant partly due to the relatively short sample period.

Among previous studies, the following indicates that R&D can enhance firms' productivity, which has a larger impact on export market relative to domestic market.

Maican, F.G., M. Orth, M.J. Roberts, and V.A. Vuong, "The Dynamic Impact of Exporting on Firm R&D Investment," NBER Working Paper No. 27986 (2020)

⁷ Fixed investment of large firms tends to be revised upward from the first March survey to the June survey, with investment plans crystallized and those from the previous fiscal year delayed to the fiscal current year. From the December survey to the actual result survey (the June survey of the next year), fixed investment of large firms tends to be revised downward due to delay in construction and the deferment of plans to the following fiscal year.

⁸ It should be noted that the released series are based on a population estimate, which are different from the mean of individual (firm-level) data.

⁹ For instance, the breakdown of R&D expenditure in "Survey of Research and Development" shows that labor costs account for about 40 percent of R&D investment. During the Lehman's collapse, labor costs declined by only around 5 percent in year-on-year term, while the total R&D spending decreased by about 12 percent.

¹⁰ Previous studies suggest that the deterioration in firms' financial position is expected to reduce the amount of R&D investment. For instance, see the following. But it should be

noted that the results would be subject to what explanatory variables are used as a proxy for financial conditions.

Aghion, P., N. Berman, L. Eymard, P. Askenazy, and G. Cette, "Credit Constraints and the Cyclicity of R&D Investment: Evidence from France," *Journal of the European Economic Association*, Vol. 10, No. 5 (October 2012), pp. 1001-1024.

¹¹ As mentioned above, the share of nonmanufacturing in R&D investment amounts to only around 10 percent. Given that large firms account for a majority of R&D investment, the share of those with capital of less than 20 million yen is estimated to be very limited.

¹² This depends on the definition of startups (e.g., the size and age of firms). The target population of the *Tankan* basically includes firms with capital of 20 million yen or more including startups.

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