

Greater Female Presence Means Better Corporate Performance

How Patents Reveal the Contribution of Diversity to Economic Value

1. Verifying the Relationship between Women's Participation and the Economic Value of Patents

- The Law on Promotion of Women's Participation and Advancement in the Workplace came into force in April 2016. The law obliges companies with more than three hundred employees to formulate and announce action plans, including numerical targets, for the appointment of women. Firms have responded with intensified efforts to create a workplace environment where women can participate and thrive.
- Women will be among the major topics of discussion at next month's G7 Summit in Ise-Shima. While its goal is to promote female participation in all sorts of fields, the Summit will specifically consider women's participation in the natural sciences, technology and engineering in the context of its main theme of female empowerment.
- A previous issue of Topics (*Women's Involvement in Research and Development: Meeting Female Consumption and Improving Innovation*; May 22, 2015) focused on research and development as one area in which women were achieving little advancement. The article pointed out that women were expected to account for a growing share of consumption in the coming years; that a greater role for women researchers would be essential in order to meet this demand; and that companies would need to create environments which were more conducive to diversity and innovation (Figure 1-1).
- In this paper, we verify whether women's participation improves actual corporate performance – specifically, whether greater gender diversity translates into greater innovation in the world of research and development. (By innovation, we mean that which results in high knowledge-based value: the economic value of patents.)
- Our calculations are based on patent data obtained from the Mitsubishi Research Institute's intellectual property analysis support service, MRIP. Approximately one million domestic patents* granted to 400 manufacturing firms were divided into those issued to male inventors only and those in which both male and female inventors were involved. By comparing the average economic value of the patents of each group, we calculated the extent to which the economic value of the latter exceeded that of the former (Figure 1-2).

*Limited to those with valid rights as of March 2016.

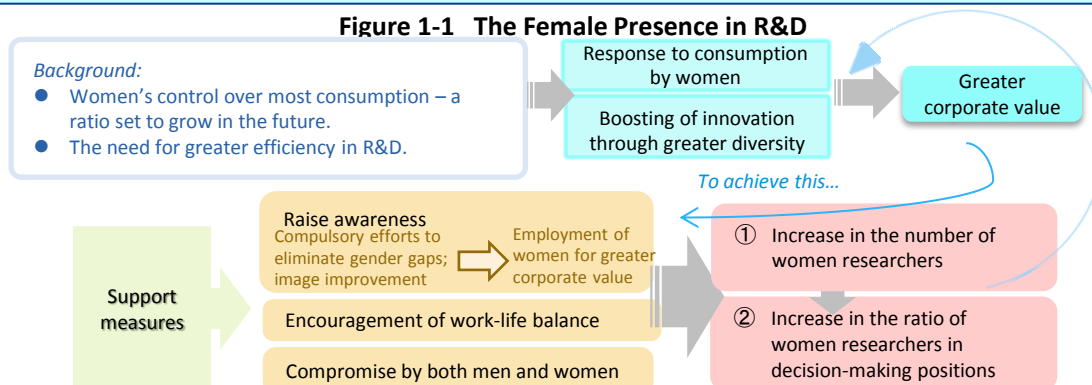
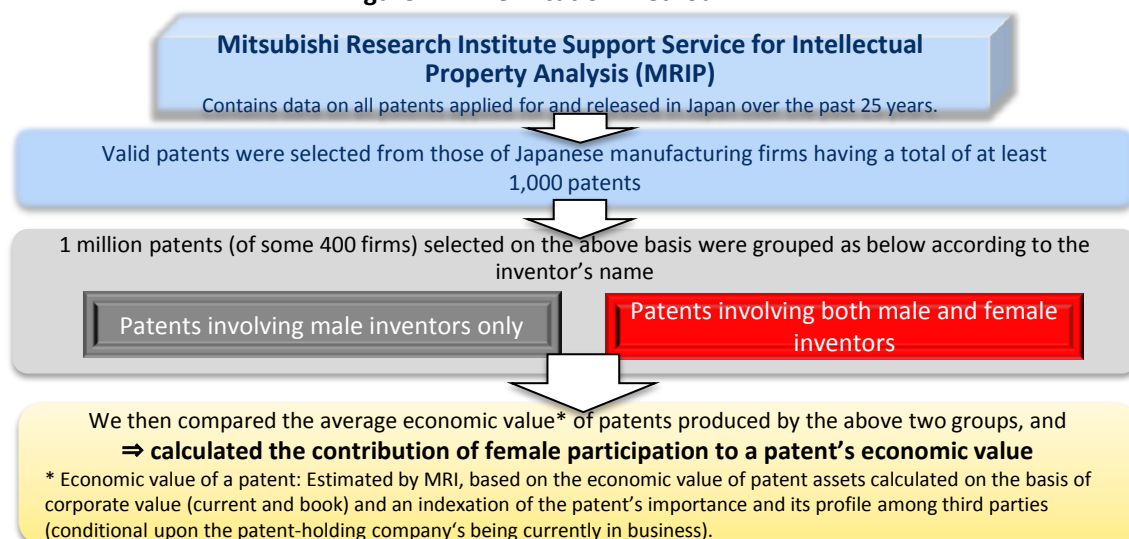


Figure 1-2 Verification Method



Note: Figures 1-1 and 1-2 prepared by DBJ.

2. Patents Invented by Mixed-gender Teams Show Greater Economic Value

- Out of the approximately one million patents we examined, the majority were for processing and assembly items. Almost half were for electrical equipment, followed by transportation machinery, chemicals, machinery and others (Figure 2-1). Application numbers were examined in 5-year increments, volume being greatest for the period from 2005 through 2009 (Figure 2-2).
- One indicator of women's participation is the percentage of patents involving a female inventor. High percentages were found in foods, pharmaceuticals, pulp and paper, and certain other materials industries. By contrast, levels were low, at 10 percent or less, across all processing and assembly industries (Figure 2-3).
- We classified the patents into two groups: those with male inventors only, and those in which both male and female inventors were involved, and calculated how many times the economic value of the former was produced by the latter. We found that more value was produced across virtually every field of industry when both men and women were involved. In eleven of fifteen industries, more than 1.2 times as much value was produced (Figure 2-4).
- The "male-only" group included solo inventions, created by one man only, and joint inventions created by all-male teams. Across every field of industry, certain materials fields excepted, most domestic patents were issued to inventions created by men only. Inventions created by mixed-gender teams accounted for more than 20 percent of domestic patents in fields such as foods and pharmaceuticals, but less than 10 percent in the processing and assembly industries and most others (Figure 2-3).

Figure 2-1 Numbers of Domestic Patents^{1, 2}

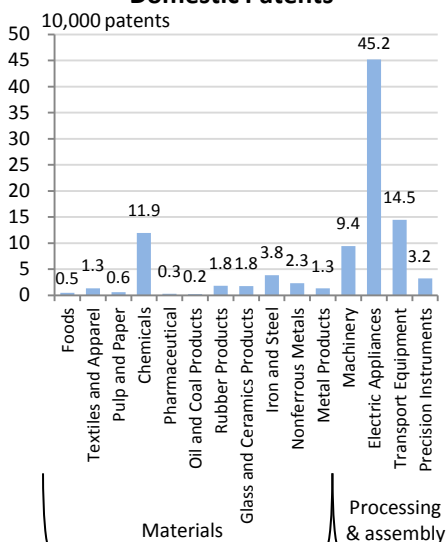


Figure 2-2 Domestic Patent Applications, by Year

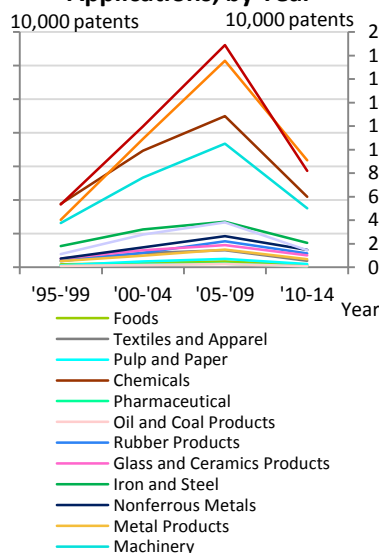


Figure 2-3 Patent Categories

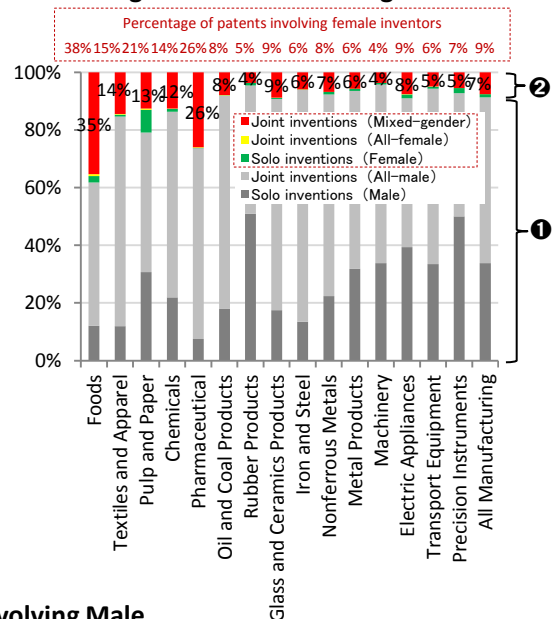
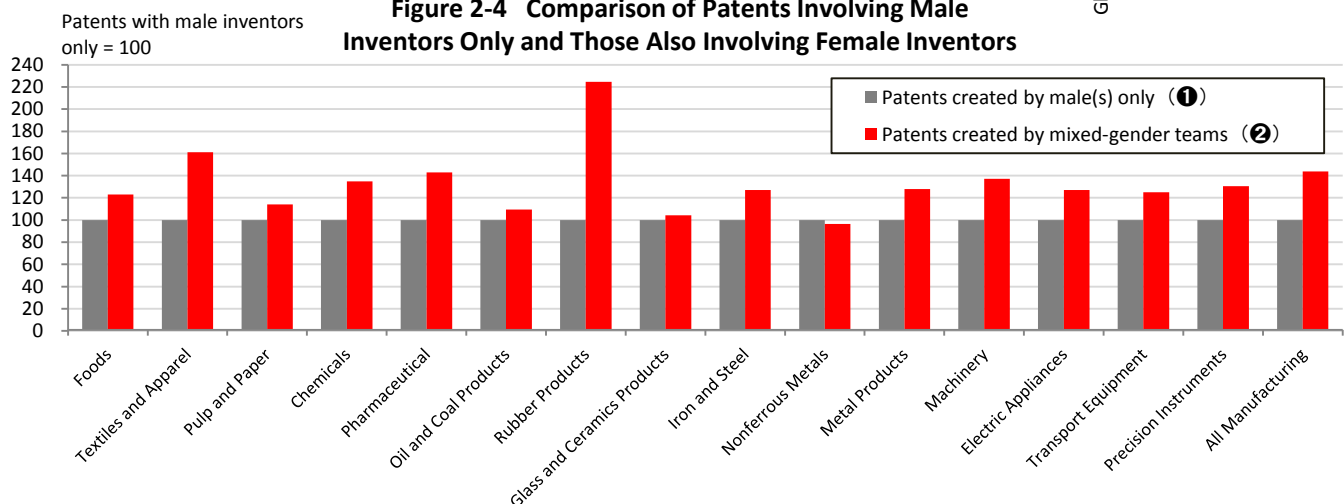


Figure 2-4 Comparison of Patents Involving Male Inventors Only and Those Also Involving Female Inventors



Note for Figures 2-1, 2-2, 2-3 and 2-4: Prepared by DBJ using data obtained from MRIP.

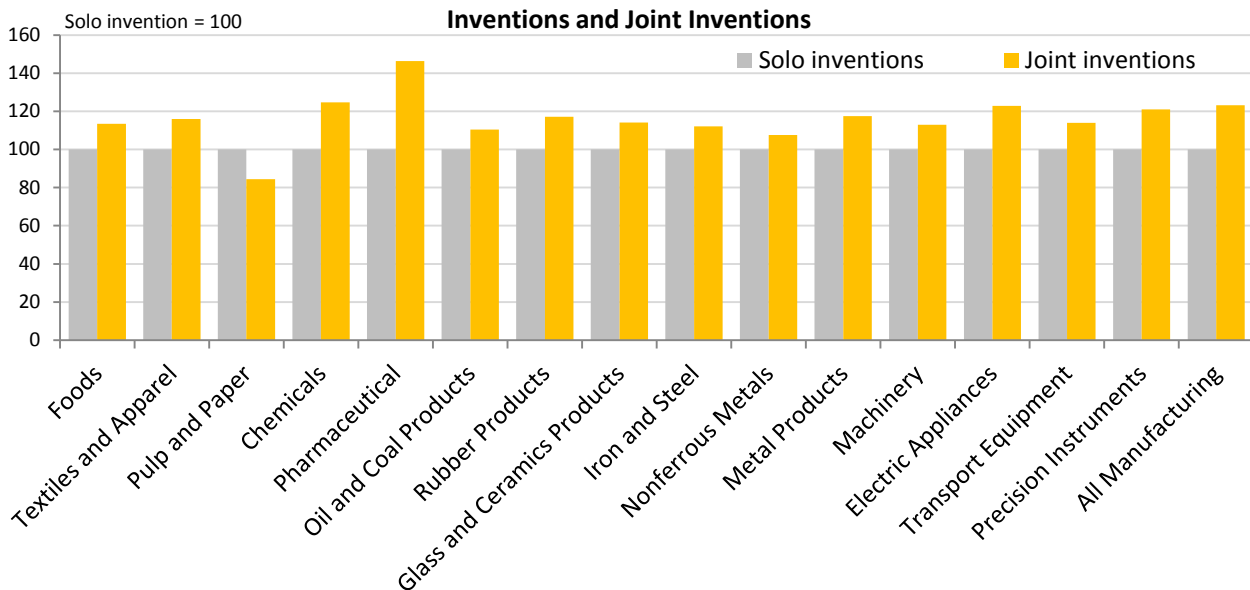
1. Patents considered were those which were valid as of March 2016 and belonged to firms having made 1,000 or more patent applications in Japan over the past 25.

2. Patents involving non-Japanese inventors were excluded from consideration because ① it was difficult to determine whether a foreign inventor was male or female from their name, and ② our aim was to examine solely the difference in economic value of patents produced by men only and those in which female inventors were involved, without being influenced by the inclusion of one or more foreign nationals in a team of inventors.

3. Teams are Better than Individuals. Gender-diverse Teams are Even Better.

- Classifying patents into solo inventions and joint inventions proved a useful means of examining economic value. We found greater economic value among the latter (Figure 3-1). Our calculation, while a simple comparison of averages, made it clear that team inventions resulted in patents with greater economic value than those resulting from solo inventions.
- We further analyzed joint inventions by grouping them into those produced by single-sex teams and teams which included both men and women. (As the number of all-female teams was exceedingly small, we limited our comparison to teams which were all-male or mixed-gender.) In almost every field, average economic value was greater for patents produced by mixed-gender teams.
- Here we have evidence that economically valuable patents tend to result from team rather than solo inventions, and that economic value is greater still when the teams involved are gender-diverse.

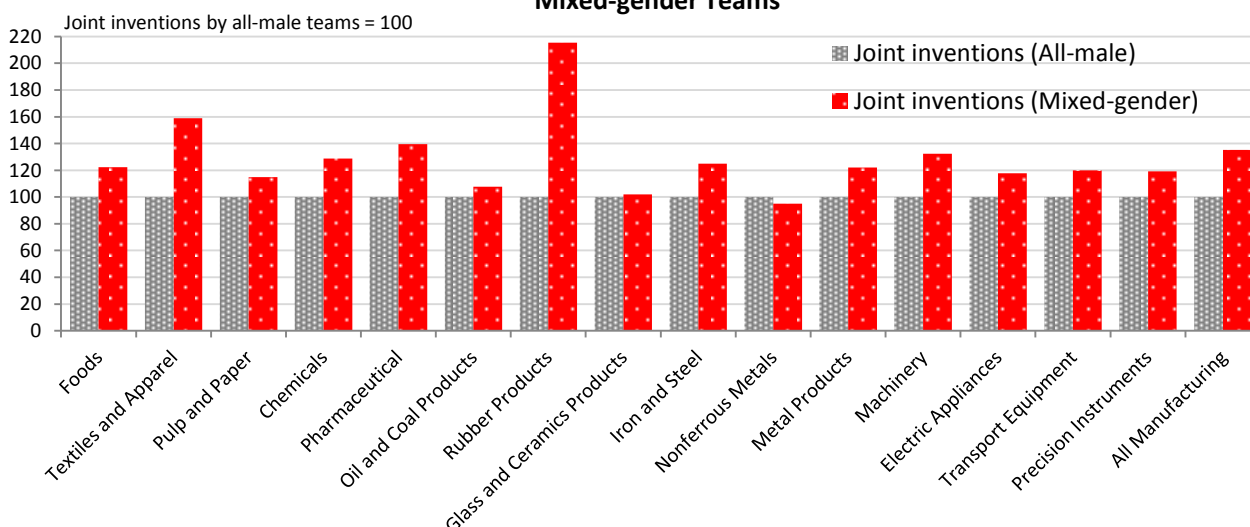
Figure 3-1 Economic Value Comparison of Patents Issued for Solo Inventions and Joint Inventions



Notes: 1. "Solo inventions" include those made by men and by women.

2. "Joint inventions" include those by all-male teams, all-female teams, and teams including both men and women.

Figure 3-2 Economic Value Comparison of Patents Issued for Inventions by All-male Teams and Mixed-gender Teams



Note: Figures 3-1 and 3-2 prepared by DBJ using data obtained from MRIP.

4. The Greater the Female Presence, the Greater the Benefits of Gender Diversity ①

- On the previous page we showed how higher economic value resulted from patents produced by gender-diverse teams. We now break this down on an individual-firm basis.
- Figures 4-1 through 4-3 show the relationship between the ratio of patents to which female inventors have contributed ($\hat{=}$ the rate of female participation) and the economic value of patents produced by teams including both men and women, supposing the economic value of patents produced by male-only teams to be 100 ($\hat{=}$ the contribution of gender diversity to a patent's economic value).
- Throughout the manufacturing sector, companies where gender diversity made only a small contribution to patents' economic value were overwhelmingly the ones with low rates of female participation. The higher the rate of female participation in a firm, the greater the contribution of gender diversity to its patents' economic value (Figure 4-1). For Figure 4-4 we divided companies in the materials and processing/assembly sectors into two groups: one where female participation was higher, and another where it was lower (higher: companies with a high ratio of patents in which female inventors were involved; lower: companies with a low ratio of the same). The aim was to examine the contribution to economic value of patents produced through gender diversity. We found that gender diversity brought clear benefits to the group showing high levels of female participation.

Figure 4-1 Contribution of Female Participation and Gender Diversity to the Economic Value of Patents (All Manufacturing)

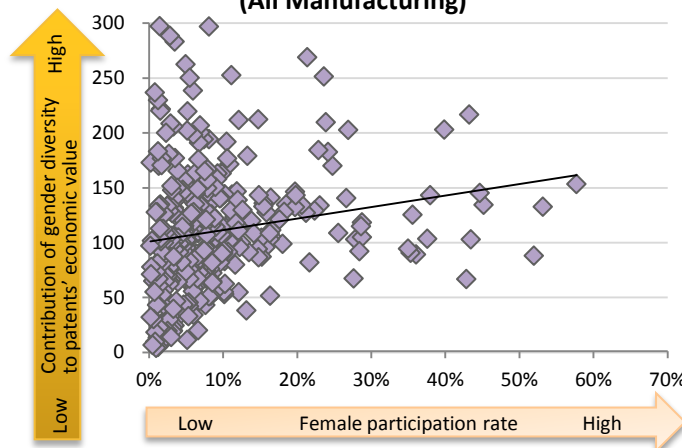


Figure 4-2 Contribution of Female Participation and Gender Diversity to Patents' Economic Value (Materials)

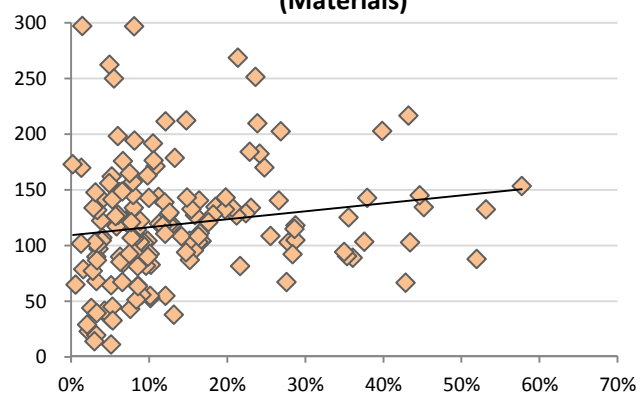


Figure 4-3 Contribution of Female Participation and Gender Diversity to Patents' Economic Value (Processing and Assembly)

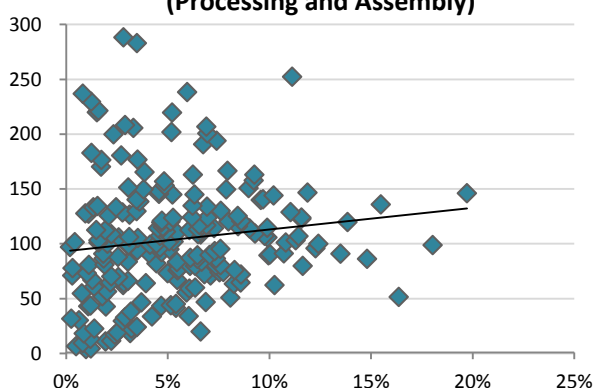
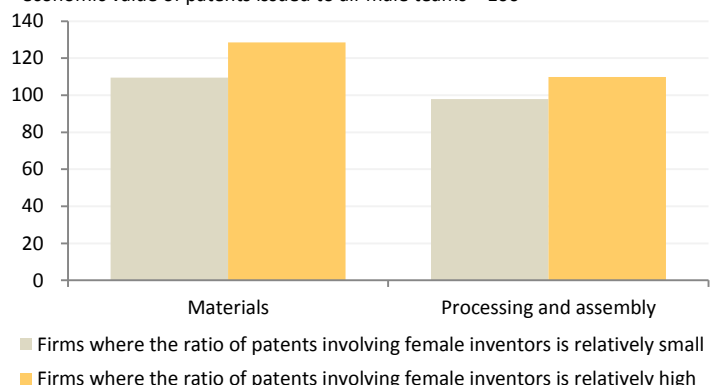


Figure 4-4 Contribution of Female Participation and Gender Diversity to Patents' Economic Value (Classified by Firms with High and Low Female Participation)

Economic value of patents issued to teams including both men and women, when economic value of patents issued to all-male teams = 100



Notes to Figures 4-1, 4-2, 4-3 and 4-4

- Prepared by DBJ using data obtained from MRIP.
- Figures 4-1 through 4-3 plot the contribution of gender diversity to patents' economic value, and the female participation rate, at 361 individual firms.
- "Contribution of gender diversity to patents' economic value" refers to the economic value of patents issued to teams of mixed gender, when the economic value of patents issued to all-male teams = 100. A contribution rate of 300, for example, means that mixed-gender teams produce three times more economic value than teams of men only.
- "Female participation rate" is calculated as the ratio of patents involving female inventors in relation to the total number of patents.
- These figures are limited to firms scoring 300 or less on the contribution of gender diversity to the economic value of patents (firms with rates above 300 include many where only a very small number of patents were issued to mixed-gender teams).

4. The Greater the Female Presence, the Greater the Benefits of Gender Diversity ②

- These findings suggest that if we wish gender diversity to have a positive effect on the economic value of patents, a greater female presence in research and development – a larger number of female inventors and a larger percentage of women inventors involved in patents – will be necessary to some extent.
- Another feature which came to light was that the lower the rate of female participation, the greater the disparities in the contribution rate of gender diversity to the economic value of patents (Figures 4-1, 4-2, 4-3). In environments where women are scarce, the benefits of gender diversity will depend to a great extent on the capacity of the individuals involved. Some firms enjoyed the benefits of gender diversity because their female employees were strong and imaginative, even if small in number. But this did not hold true for other firms with few women, possibly because their female employees lacked the presence to bring the benefits of diversity to their R&D teams. As female participation continues to grow and companies become better equipped to manage their women employees, disparities of this sort are likely to decrease.
- We found another correlation as well: the higher the rate of female participation, the greater the economic value of patents by solo male inventors and all-male inventor teams (Figures 4-5, 4-6). A high rate of female participation means that diverse viewpoints and ideas can percolate throughout a firm, even to male inventors working alone or as part of a team. This, we believe, is why groups of male inventors can enjoy the benefits of gender diversity to the same extent as teams which are gender-diverse.
- Future research should shed more light on patents' economic value and corporate performance. Through corporate interviews and other methods, we will examine which kinds of environment are conducive to producing the effects of gender diversity and how the rate of female participation affects the performance of men.

Figure 4-5 Female Participation Rates and the Economic Value of Patents Issued to Solo Male Inventors

Economic value of patents by solo male inventors, at firms where the ratio of patents involving female inventors in relation to all patents is less than 5%, = 100

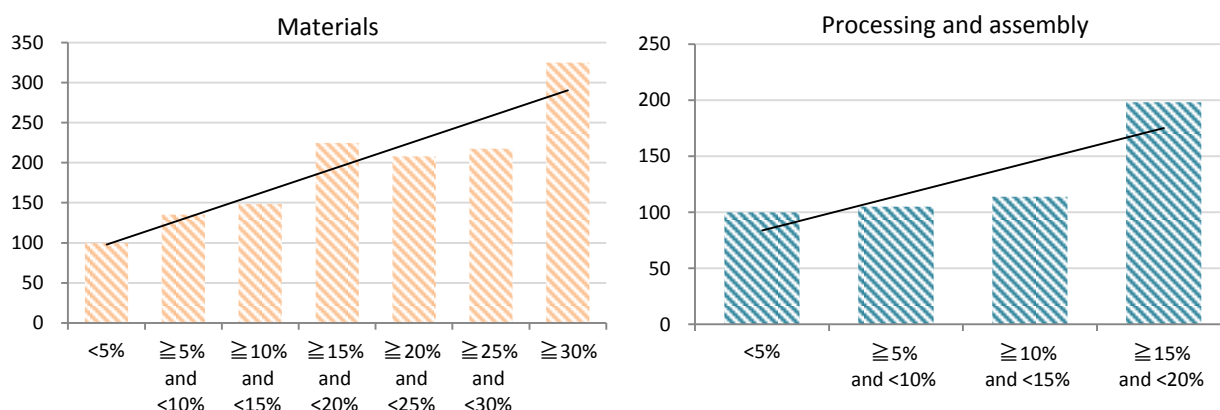
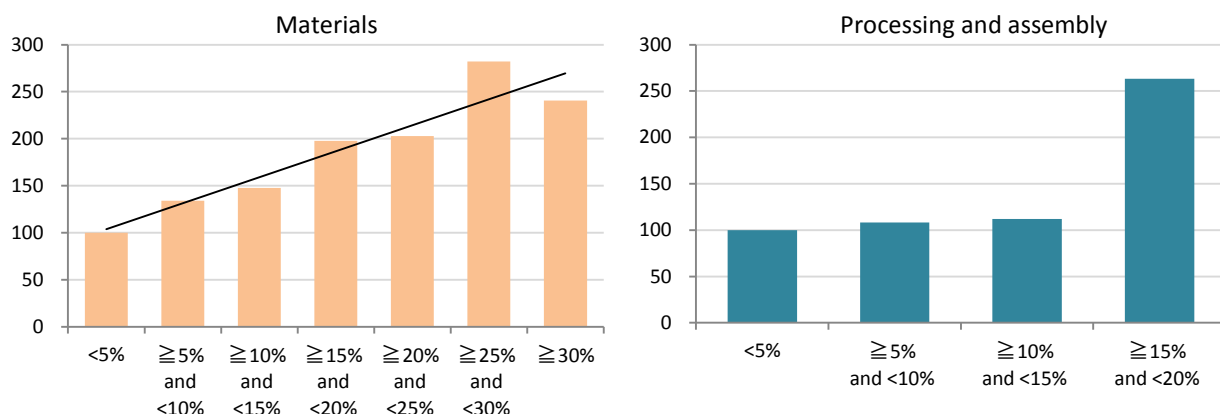


Figure 4-6 Female Participation Rates and the Economic Value of Patents Issued to All-male Teams

Economic value of patents by all-male teams, at firms where the ratio of patents involving female inventors in relation to all patents is less than 5%, = 100



Notes

1. Prepared by DBJ using data obtained from MRIT.

2. Average economic value of patents issued to solo male inventors or all-male teams of inventors in groups of firms in the materials and processing/assembly sectors, classified according to the ratio of each firm's patents involving women inventors in relation to the total number of its patents (horizontal axis).

5. Toward A Future of Greater Female Participation and Diversity as a Whole

- Looking at the percentage of patents in which female inventors were involved ($\hat{=}$ the rate of female participation) in terms of a time series, we observe a rising trend. The share remains quite low, however, in the processing and assembly industries in particular (Figure 5-1). We have verified in this paper that by increasing gender diversity through female participation, firms enhance the value of their patents; furthermore, the greater the degree of female participation, the greater the beneficial effects of gender diversity. This finding leads to the conclusion that there is real value in companies' actively utilizing their female employees.
- With the enforcement of the Law on Promotion of Women's Participation and Advancement in the Workplace and the hosting of the upcoming G7 Summit, the advancement of female participation has been gaining momentum. We must now ensure that this will not be a transitory phenomenon, and that inclusive work environments where all people feel welcome, irrespective of gender, prove the rule and not the exception over the long term.
- Within Japan, the most immediate factor in raising diversity, and the most realistic, may well be to increase the hiring and utilization of women as human resources. Many companies, government agencies and other entities are focusing first on their female employees. But gender is not the only element of diversity: age, nationality, and physical ability are among the many others to be considered (Figure 5-2).
- One factor in increasing non-gender diversity, which could be seen from the patent data, was the contribution of foreign nationals to the economic value of patents. We attempted to verify this contribution in this study (Figure 5-3). We found that patents produced by teams including both Japanese and non-Japanese resulted in greater economic value than those produced by Japanese nationals only. At present, however, there seems to be little advancement in participation by foreign nationals (Figure 5-4). Companies that promote multifaceted diversity, over and above the sphere of gender, and accept and manage diversity as a natural part of corporate life, will reap the benefits in the form of better performance.
- It may take some time to create an environment in which different work practices, values, and culture are respected and accepted. The benefits of diversity, moreover, may not be visible in the short term. We have found, however, that a diverse workforce can play an important role in improving corporate performance. For this reason, we hope that firms will adapt their management frameworks to a diverse range of employees, and take active steps to hire and make the most of women and the many other elements of our diverse society.

Figure 5-1 Ratio of Patents Involving Female Inventors to Total Number of Patents

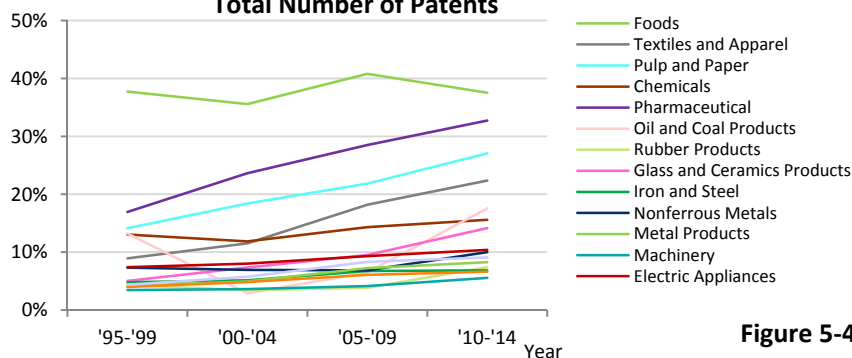
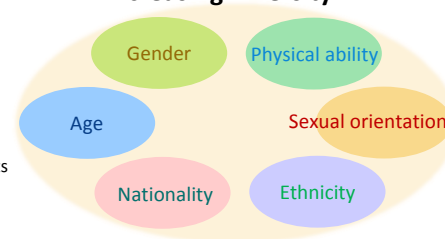


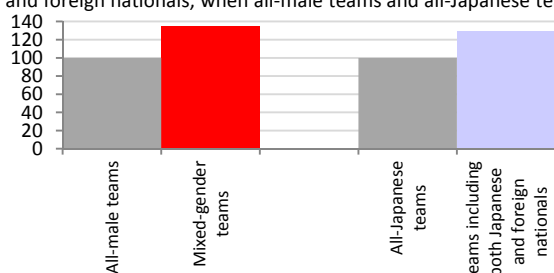
Figure 5-2 Some Human Factors in Increasing Diversity



Note: Prepared by DBJ.

Figure 5-3 Effects Obtained from the Inclusion of Women Inventors (All Manufacturing)

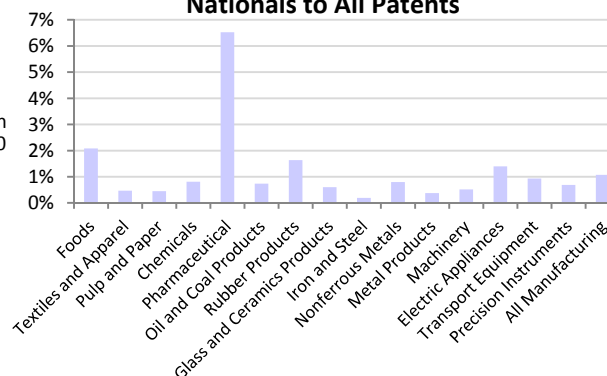
Economic value of patents issued to mixed-gender teams and teams including both Japanese and foreign nationals, when all-male teams and all-Japanese teams = 100



Notes

- As the economic value of patents issued to joint inventions tends to be greater than that for solo inventions, to eliminate this factor we used joint inventions as the basis for all comparisons.
- For all-Japanese teams and teams including both Japanese and foreign nationals, we grouped on the basis of single applications (applications for one firm only) in order to eliminate the influence of foreigners outside a firm on its patents' economic value.

Figure 5-4 Ratio of Patents Involving Foreign Nationals to All Patents



Note: Ratio of patents involving foreign nationals to all single applications (applications for one firm only). Includes solo inventions by foreign nationals.

Note for Figures 5-1, 5-2 and 5-3:

Prepared by DBJ using data obtained from MRIP.

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