Chapter 10
Research Productivity

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10.1 Introduction

Society in the twenty-first century has been identified as a knowledge-based society. To sustain and develop society, the creation, communication and application of new knowledge are important (Technology and Science Council 2005). Specifically, the university, which is primarily concerned with conducting education and research activity, is very important in respect of the formation of students' character, the training of young researchers and for the advanced professions, the progress of national strategy such as the promotion of culture, and increasing global competitiveness. Higher education reforms, such as the advancement of education and research activity, the individualization of higher education institutions, and the activation of higher education management, have been instituted in response to social and national expectations. For example, the education and research activities of those universities that had established high research potentiality was supported by "the 21st Century COE program", which was implemented from 2002.

As a result of such higher education reforms, many fields of academic research in Japan are located at a high level internationally or play a leading role in the Asian region. On the other hand, Japanese academic research does not possess a large stock of researchers and the breadth of academic research is insufficient (Negishi 1999). In the future, creating an environment in which various areas of research with substance and depth are established at the leading edge internationally will be a major task.

Based on an awareness of these issues, and through clarifying the factors leading to promotion of research activity of faculty in the Japanese 4-year universities, in this chapter we try to show the means by which the productivity of research activities in the universities may be improved.

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To achieve this purpose, in Sect. 10.2, we review the average amounts of each research achievement according to the forms they take and their specialized fields, and clarify the forms of research achievement that are most suited to each disciplinary area.

In Sect. 10.2, a range of factors is examined that may contribute to research productivity. To this end, productivity is estimated as indicated by the number of research papers published, a common research measure that is applicable in many disciplinary areas. Analysis by cross-tabulation allows determination of the significance of the contributions to research productivity of the various factors to be assessed.

In Sect. 10.4, by using multiple regression analysis (stepwise procedure) with the variables identified in Sect. 10.2, it is possible to recognize those that contribute significantly to research publication. It is also possible to examine the differences between the determinants according to fields of specialization and over time.

In the concluding section, the analyses allow us to examine ways in which research productivity could be improved.

10.2 Change in Research Achievement According to Specialized Fields and Time

10.2.1 Change in the Amount of Research Achievement

In the Carnegie survey (1992) and in the repeated survey (2007) with the same questionnaire, information was sought from respondents on their scholarly contributions in the previous 3 years. Mean values for the numbers of these are shown in Table 10.1. Between 1992 and 2007, the number of "Articles published in a book or journal," "Research reports or monographs," and "Papers presented at conferences" increased significantly.

10.2.2 Research Achievements According to Specialized Fields

There is a statistically significant difference in the average number of research contributions identified according to academic discipline. For example, in both 1992 and 2007, faculty in the health and medical sciences published more books than those in other specialized fields. Similarly, faculty in natural sciences, engineering, agricultural, and health and medical sciences provided more papers in academic journals and papers at meetings than those in other fields; faculty in agricultural science presented more research reports or monographs than those in other fields; and faculty in art, not unexpectedly, presented more artistic work, and performed and exhibited more than those in other fields.

Table 10.1 Average research outputs by category according to academic discipline in 1992 and 2007

							(1992)	
	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Art	Overall mean value
Scholarly book authored	0.67	1.15	0.72	0.71	1.33	2.64	0.40	1.07
Scholarly book edited	0.33	0.46	0.49	0.33	0.24	0.71	0.24	0.42
Article published in a book or journal	3.92	5.32	8.24	7.34	8.87	15.97	0.80	7.72
Research report or monograph	0.34	0.97	1.33	1.39	1.85	2.29	0.25	1.26
Paper presented at a conference	1.17	2.19	7.72	10.09	9.18	15.79	0.31	7.43
Professional article written for magazine	1.91	3.05	1.21	1.27	2.19	3.15	2.74	2.00
Patent secured	0.00	0.00	0.14	0.34	0.18	0.23	0.65	0.19
Computer program written for public use	0.00	0.05	0.25	0.16	0.01	0.17	0.00	0.12
Artistic work performed or exhibited	0.96	1.72	0.29	0.30	0.41	1.23	12.07	1.41
Video or film produced	0.08	0.10	0.07	0.12	0.05	0.57	0.27	0.17

(continued)

Table 10.1 (continued)

							(2007)	
	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Art	Overall mean value
Scholarly book authored	0.82	1.09	0.76	1.00	1.92	2.21	0.48	1.21
Scholarly book edited	0.44	0.44	0.24	0.25	0.29	0.41	0.30	0.33
Article published in a book or journal	3.15	4.42	10.24	12.58	9.99	13.94	0.91	9.15
Research report or monograph	0.78	0.84	1.45	2.16	3.14	2.14	0.27	1.65
Paper presented at a conference	2.49	2.96	10.78	12.09	10.90	15.00	0.36	9.06
Professional article written for magazine	1.55	2.81	1.89	1.37	0.73	1.92	0.94	1.73
Patent secured	0.01	0.00	0.15	1.73	0.36	0.25	0.06	0.50
Computer program written for public use	0.01	0.01	0.12	0.13	0.00	0.06	0.00	0.06
Artistic work performed or exhibited	0.83	1.39	0.43	0.87	0.49	0.90	11.58	1.26
Video or film produced	0.26	0.10	0.23	0.16	0.03	0.32	0.52	0.20

Notes: For "Article published in a book or journal," individual responses of 101 or more were excluded from the data base. For "Paper presented at a conference," individual responses of 181 or more were excluded from the data base

10.2.3 The Number of Research Articles According to Fields of Specialization and the Change Over Time

The mean number of research articles according to academic discipline in 1992 and 2007 is displayed in Table 10.2.

Over all academic disciplines the mean number of research articles rose from 8.15 in 1992 to 9.49 in 2007 ($p < .01$).

Between the specialized fields there are differences. While there are statistically significant increases in the average mean number of research articles in the natural sciences and engineering, there are decreases in the fields of the humanities and social sciences.

In 2007, in all disciplinary areas, the minimum number of research articles published by individual respondents remained at zero but the maximum number across all disciplines had, with the exception of engineering, fallen by varying factors from 4 in humanities to 0.9 in medical and health sciences. But the purpose of this chapter lies in exploring the causes of the differences that occur in the number of research articles in each specialized field. In particular, there is interest in clarifying those variables that contribute uniquely to disciplinary areas and those which provide common characteristics.

Table 10.2 Changes in the average number of research articles according to academic discipline, 1992 and 2007

Discipline	Research year	Average		Standard deviation	Survey respondents	Minimum	Maximum
Humanities	1992	3.92	n.s.	4.97	264	0	55
	2007	3.15		3.17	106	0	15
	Mean	3.70		4.54	370	0	55
Social sciences	1992	5.32	n.s.	7.53	192	0	80
	2007	4.42		4.28	134	0	30
	Mean	4.95		6.41	326	0	80
Natural sciences	1992	8.24	*	9.59	323	0	72
	2007	10.24		9.53	160	0	45
	Mean	8.90		9.61	483	0	72
Engineering	1992	7.34	***	8.74	393	0	60
	2007	12.58		15.42	191	0	85
	Mean	9.05		11.61	584	0	85
Agriculture	1992	8.87	n.s.	8.70	119	0	41
	2007	9.99		6.27	77	0	28
	Mean	9.31		7.84	196	0	41
Health and medical sciences	1992	15.97	n.s.	17.70	239	0	100
	2007	13.94		13.68	136	0	90
	Mean	15.24		16.36	375	0	100
All disciplines	1992	8.15	**	10.90	1,530	0	100
	2007	9.49		11.36	804	0	90
	Mean	8.61		11.08	2,334	0	100

Notes: ***$p < .001$, **$p < .01$, *$p < .05$

10.3 The Relationship Between Operational Variables and Research Productivity

In this section, the influence of a range of operational factors on research productivity, assessed as the publication of research articles is examined. The selected variables conform to those which have been generally employed in discussions of research productivity (Bellas and Toutkoushian 1999; Bland et al. 2006; Bonzi and Day 1991; Daizen 1996a, b; Kotrlik et al. 2002; Stack 2004) and were available from the surveys conducted in 1992 and 2007. The operational factors are arranged into six arbitrary categories for which the effects of independent variables on productivity can be estimated: social, career, organizational, resource, attitudinal, and professional.

10.3.1 Social Attributes

10.3.1.1 Gender

The average numbers of research articles produced by men and women respondents are shown in Table 10.3.

The average number of research articles is larger for men than women overall and in each specialized field. However, because the number of women academics included in the surveys is relatively small, the results for individual disciplines do not achieve statistical significance.

10.3.1.2 Age

The average number of research articles according to the age of respondents is shown in Table 10.4. Overall and in almost all specialized fields, those aged from 45 to 54 years are the most prolific publishers. Beyond the age of 65 years, retirement causes the rate of publication to fall rapidly. Numerically, only the overall results and those for the humanities carry statistical significance.

Table 10.3 Average number of research articles published by gender

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall Total
	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	**
Male	3.35	4.43	10.42	12.64	10.23	14.82	10.84
Female	2.26	4.38	5.67	0.00	5.50	8.85	6.09
Mean value	3.15	4.42	10.24	12.58	9.99	13.94	10.45

Notes: $^{**}p < .01$

10.3.2 Career

10.3.2.1 Highest Degree Obtained

The average number of research articles according to the highest degree obtained is shown in Table 10.5.

Overall, those respondents with doctorates published significantly more research articles than those with master's or bachelor's degrees; but for individual fields of specialization, the numbers are statistically significant only in the humanities.

10.3.2.2 Academic Rank

An attempt was made to test whether significant differences occurred in the number of academic articles published according to academic rank The results showed no evidence of meaningful differences either overall or for any individual specialization.

Table 10.4 Average number of articles published by age

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall total
	**	n.s.	n.s.	n.s.	n.s.	n.s.	*
Less than 45	3.46	4.62	8.76	13.46	10.44	13.53	9.07
45–54	4.26	4.26	12.93	13.56	10.34	15.03	10.74
55–64	2.05	4.70	10.03	12.25	9.42	12.70	9.30
65 or more	1.50	3.30	6.57	3.22	9.00	13.00	4.98
Mean value	3.04	4.41	10.26	12.56	10.01	13.94	9.49

Notes: $^{**}p<.01$, $^{*}p<.05$

Table 10.5 Average number of articles published by level of degree

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall total
	**	n.s.	n.s.	n.s.	n.s.	n.s.	***
Doctor	4.22	5.56	10.57	13.15	10.07	14.29	11.20
Master	2.62	3.75	3.88	2.17	4.00	7.00	2.92
Bachelor	2.43	3.77	–	7.00	–	3.33	2.38
Mean value	3.15	4.46	10.24	12.61	9.99	13.94	8.77

Notes: $^{***}p<.001$, $^{**}p<.01$

– indicates that there were no respondents in this category

10.3.3 Organizational Climate

10.3.3.1 Type of University

The average number of research articles published according to the type of university is shown in Table 10.6. Respondents in the national universities publish more than those in private universities and those in research universities publish more than those in non-research universities, with those in national research universities publishing the most research articles. This is true both overall and for the individual specialized fields, and statistically significant in all disciplines except the social sciences and agriculture.

10.3.3.2 Evaluation of Research Activities

Explicit institutional measures to encourage research productivity have included assessment of research activities. The average number of research articles according to the presence or absence of research activities evaluation in respondent's institutions is shown in Table 10.7.

Over all disciplines, faculty reporting that their research is regularly assessed published significantly more research articles than those that were not assessed ($p < .01$).

Table 10.6 Average number of articles published by type of university

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health & medical sciences	Overall Total
	***	n.s.	**	***	n.s.	***	***
National Research Univ.	7.50	5.73	13.50	24.59	11.09	21.36	17.58
National non-Research Univ.	3.41	4.70	10.61	12.96	10.16	13.08	10.25
Private Research Univ.	4.40	4.25	9.40	10.94	9.75	3.33	8.61
Private non-Research Univ.	2.24	3.83	6.31	5.56	7.69	8.73	5.91
Mean value	3.15	4.42	10.20	12.62	9.99	14.01	10.46

Notes: ***$p < .001$, **$p < .01$

For individual disciplines, however, the numerical results are not significant in the humanities or agriculture; while for engineering the results actually indicate a reduction in publications from assessed faculty, though this is not significant.

10.3.3.3 Expectations of Research Activity in Faculty Evaluation

Faculty were asked, in responding to the surveys, whether in their institution there was an expectation of a strong research record. The results (Table 10.8) show overall clear evidence that this expectation is reflected in research publication. In those institutions that attach importance to research achievement, a higher than average number of publications is achieved by faculty overall. In terms of the individual disciplines, however, this remains statistically significant only in the high-publishing disciplines of natural sciences and engineering; the humanities, social sciences, agriculture, and health and medical sciences show neither numerical nor significant increases.

Table 10.7 Effect of institutional evaluation of research activity on average number of articles published

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall Total
	n.s.	*	**	n.s.	n.s.	*	**
Presence	3.15	5.02	11.50	11.93	10.34	15.43	10.21
Absence	3.15	3.37	7.29	13.98	9.05	9.81	7.95
Mean value	3.15	4.42	10.24	12.58	9.99	13.94	9.49

Notes: $^{**}p<.01$, $^{*}p<.05$

Table 10.8 Influence of institutional expectations on average number of articles published

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall total
	n.s.	n.s.	*	*	n.s.	n.s.	**
Important	3.14	4.44	12.15	15.60	10.36	14.34	10.76
Fairly important	3.44	4.40	9.73	10.15	10.19	13.47	8.89
Others	2.86	4.56	6.37	9.14	8.42	13.67	7.52
Mean value	3.18	4.45	10.24	12.48	9.99	13.90	9.48

Notes: $^{**}p<.01$, $^{*}p<.05$

10.3.3.4 Intellectual Atmosphere

In the surveys, respondents were asked to indicate how they assessed the intellectual character of their institutions. The relation between the average number of research articles published and the institutional intellectual atmosphere is shown in Table 10.9. Over all disciplines, faculty reporting a good or excellent institutional intellectual atmosphere published significantly more research articles and at a high level of significance. A similar trend is shown also by faculty in natural sciences and engineering. But, elsewhere, the trend is less evident: in the humanities, social sciences, and agriculture the numerical results lack statistical significance; and in health and medical sciences an excellent intellectual atmosphere corresponds to a lower than average rate of publication.

10.3.4 Research Resources

10.3.4.1 Research Funding

Availability of research funding might be expected to be directly related to research output. The question arises, however, about the lag between provision of funding and publication of research articles. To accommodate this, respondents were asked to identify research funding over the 3 years previous to the survey. The results (Table 10.10) over all disciplines show a clear relationship that is replicated in all the individual disciplines except social sciences in terms of statistical significance. The largest effects in terms of increased publications are shown by the natural sciences, engineering, and health and medical sciences, with factors of 4–10 between those receiving no research funding and those receiving $250,000 or more. It is, though, these disciplinary areas that have the greater ability to conduct research through larger research teams and consequently produce larger numbers of multi-authored articles for publication, so further distorting any comparisons between disciplines.

Table 10.9 Influence of institutional intellectual atmosphere on average number of articles published

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall Total
	n.s.	n.s.	*	***	n.s.	*	***
Excellent	5.00	4.36	15.10	27.29	9.00	9.46	13.27
Good	3.06	4.34	11.85	13.00	12.06	19.24	10.86
Fair	3.23	4.18	8.64	9.27	9.15	11.97	7.91
Poor	2.31	5.24	8.20	11.58	10.12	10.58	8.54
Mean value	3.15	4.42	10.28	12.44	9.99	13.94	9.46

Notes: ***$p < .001$, *$p < .05$

Table 10.10 Effect of access to research funding over the previous three years on average number of articles published

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall Total
	**	n.s.	***	***	**	**	***
Zero	2.20	3.44	3.89	2.64	4.67	6.00	3.37
Less than $25,000	3.05	4.41	6.88	6.59	6.88	9.77	5.80
$25,000 to $49,999	4.00	6.07	9.80	9.88	11.90	12.96	9.64
$50,000 to 249,999	5.92	4.29	15.47	18.44	10.85	17.26	14.35
$250,000 or more	–	6.67	15.11	25.81	13.67	23.15	20.82
Mean value	3.13	4.43	10.55	12.97	9.97	14.02	9.76

Notes: ***$p < .001$, **$p < .01$
– indicates that there were no respondents in this category

10.3.4.2 Assessment of Research Equipment and Instruments

The satisfaction expressed by faculty in the facilities for research, as indicated by research equipment and instrumentation over all disciplines, is related to the average number of research articles published (Table 10.11). For individual disciplines, the relation is weak and statistically not significant except for engineering. While this is perhaps not unexpected in the humanities and social sciences, it is perhaps unexpected for disciplines such as the natural sciences and health and medical sciences.

10.3.4.3 Quality of Students

In the surveys, respondents were asked to rate the quality of students enrolled in their department. Over all disciplines those respondents reporting that the quality was good or excellent published significantly more research articles (Table 10.12). For individual disciplines, the numerical results show a similar trend but statistically the results are significant only for the humanities and engineering. In other disciplines the numerical results suggest that the trend is more marked for perceptions of "good" rather than for "excellent" students.

10.3.5 Attitude

10.3.5.1 Preference for Teaching or Research Activity

In the surveys, faculty were asked whether their interests lay primarily in teaching, in research, or in both. The overall average number of research articles published by faculty across all disciplines increases in parallel with an increased interest in research (Table 10.13). This pattern is echoed in all the individual disciplinary areas.

Table 10.11 Influence of satisfaction with research equipment on average number of articles published

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall total
	n.s.	n.s.	n.s.	***	n.s.	n.s.	*
Good	3.58	4.86	11.25	16.06	11.92	12.60	10.97
Fair	3.41	4.22	10.03	15.41	9.68	16.73	10.04
Poor	2.65	4.66	10.46	6.93	9.52	11.37	7.97
Mean value	3.30	4.48	10.53	12.56	9.99	13.93	9.68

Notes: ***$p<.001$, *$p<.05$

Table 10.12 Influence of quality of students on average number of articles published

	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall total
	+	n.s.	n.s.	***	n.s.	n.s.	***
Excellent	8.00	6.71	11.00	39.40	9.00	14.77	14.05
Good	3.28	4.35	12.29	15.15	13.15	16.66	9.96
Fair	3.04	4.63	10.92	12.98	8.81	13.52	8.14
Poor	2.70	3.79	8.92	9.47	10.26	8.35	7.60
Mean value	3.15	4.46	10.37	12.38	9.99	13.91	8.73

Notes: ***$p<.001$, +$p<.10$

10.3.6 Professional Activities

The survey data for the independent variables treated in this section were analyzed by bivariate linear regression with the average number of research articles published.

10.3.6.1 Time Spent on Research

The relationship between time spent on research (in hours per week) and the number of research articles published is indicated by the correlation coefficients listed in Table 10.14. The positive values confirm that expenditure of more time does yield more publications though the correlations are not strong. Numerically similar results are shown for both the correlations over all disciplines and individual disciplines. However, while the values for the overall result and those for the natural sciences, engineering, and health and medical sciences are all statistically significant, this is not so for the remaining disciplinary areas. The result for agriculture suggests that, uniquely, in this discipline publication is essentially not dependent on the time devoted to research.

Table 10.13 Influence of individual preference for research on average number of articles published

Interest in teaching or research	Humanities	Social sciences	Natural sciences	Engineering	Agriculture	Health and medical sciences	Overall total
	+	*	*	***	+	**	***
Primarily in research	4.17	5.31	11.80	19.62	13.86	15.10	12.78
In teaching and research	3.59	5.10	10.98	15.10	10.15	16.67	10.86
Primarily in teaching	1.94	3.16	5.48	3.77	7.60	8.11	4.59
Mean value	3.13	4.42	10.20	12.37	9.99	13.94	9.44

Notes: ***$p<.001$, **$p<.01$, *$p<.05$, +$p<.10$

Table 10.14 Coefficients for linear correlation of time spent on research and number of research articles published

Humanities	0.155	n.s.
Social sciences	0.135	n.s.
Natural sciences	0.220	**
Engineering	0.285	***
Agriculture	0.010	n.s.
Health and medical sciences	0.176	*
Over all disciplines	0.209	***

Notes: ***$p<.001$, **$p<.01$, *$p<.05$

10.3.6.2 Attendance at Disciplinary Conferences

Attendance at conferences is valued by academics as a means of both demonstrating and strengthening research commitment. Accordingly it might be expected that attendance at disciplinary conferences as well as providing the opportunity to present research papers might stimulate the publication of research articles. The results of regression of attendance at conferences with numbers of articles published by faculty support this expectation (Table 10.15). Over all disciplines, the correlation coefficient is positive, confirming that the extent of research publication increases with the number of disciplinary conferences attended. In individual areas of discipline, in the humanities, natural sciences, engineering, and health and medical sciences, a significant correlation is indicated; though this does not extend to social sciences and agriculture, the correlation for agriculture is at least stronger for conference attendance than for research time.

Table 10.15 Coefficients for linear correlation of number of disciplinary conferences attended and number of research articles published

Humanities	0.310	***
Social sciences	0.159	n.s.
Natural sciences	0.294	***
Engineering	0.425	***
Agriculture	0.093	n.s.
Health and medical sciences	0.385	***
Over all disciplines	0.352	***

Note: ***$p < .001$

10.4 Determinants of the Number of Articles Published in Academic Books or Journals

To explore which of the explanatory variables identified in Table 10.16 offer significant contributions for the numbers of research papers published, a multiple regression analysis was performed by a stepwise procedure. The results for data from 2007 are displayed in Table 10.17 and for 1992 in Table 10.18. In both tables, partial regression coefficients and the statistical probability of the significance of the explanatory variables are shown. Only regression coefficients for those variables yielding results of statistical significance are shown in the tables.

10.4.1 Results for Responses Over All Fields, 2007

Across all disciplines, the analysis of the data for 2007 showed that seven of the explanatory variables contributed significantly to the results (Table 10.17). Together, these seven variables account for about 20–30 % of the variations in the reported range of research articles published. Of these seven variables, those showing the highest level of significance were research funding, conference attendance, and the level of degree followed by preference for research.

10.4.2 Results for Individual Specialized Fields

For the individual fields, the results are considerably different from those for the overall responses. Only two variables contribute significantly to more than one specialized area: research funding and attendance at conferences. Three contribute to only one specialized area: age, research preference, and research time. No other variables yield results of statistical significance.

For two of the specialized areas, three variables make significant contributions: for humanities these are age, research funding, and attendance at conferences;

Table 10.16 The explanatory variables used in this paper

Variables	Category
Gender	Male = 1, Female = 0
Age	The actual number
Highest degree obtained	Doctor = 1, Others = 0
Academic rank	Professor = 1, Others = 0
Type of university	National research university = 1, Others = 0
Faculty reporting that their research is regularly assessed	Yes = 1, No = 0
Intellectual atmosphere	Good = 1, Others = 0
Importance or a strong record or successful research activity in faculty evaluation	Important = 1, Others = 0
Research funding in the previous 3 years	0 = 1, Less than $25,000 = 2, $25,000 to $49,999 = 3, $50,000 to $249,999 = 4, $25,000 or more = 5
Assessment of research equipment and instruments	Excellent = 1, Others = 0
Quality of students	Good = 1, Others = 0
Preference for teaching or research	Primarily in research = 1, Learning toward research = 1, Learning toward teaching = 0, Primarily in teaching = 0
Research hours per week	The actual number
Number of times of attending disciplinary conferences	The actual number

and for engineering they are research funding, time for research, and attendance at conferences. For natural sciences and for health and medical sciences, the two variables of research funding and attendance at conferences prove to be significant. For agriculture only research funding appears to have significance. In the social sciences, uniquely, none of funding, time, nor attendance at conferences appears significant; the sole significant variable is preference for research. Yet with the exception of the social sciences, the significant variables for the other areas of specialization do contribute about 20 % of the reported variation in the number of published research articles.

10.4.3 Variation Over Time

Applying the same multivariate analysis to the data for 1992 permits comparison with the results for 2007 to indicate what changes have occurred over the period of 15 years. In general, the analytical results suggest that the variables made wider and more significant contributions to assessment of research productivity in 1992 than they did in 2007 and account for 30–40 % of the variations in numbers of research articles published (Table 10.18).

Table 10.17 Determinants of research productivity (2007)

Explanatory variables	Humanities		Social sciences		Natural sciences		Engineering		Agriculture		Health and medical sciences		Overall total	
Gender														
Age	–0.265	*												
Highest degree obtained													0.141	***
Academic rank														
Type of university														
Research regularly assessed													0.071	*
Intellectual atmosphere													0.078	*
Importance of a strong record of successful research activity														
Research funding over the previous three years	0.301	**			0.350	***	0.389	***	0.446	***	0.285	***	0.306	***
Assessment of research equipment and instrumentation														
Quality of students														
Preference for teaching or research			0.260	*									0.098	**
Research hours per week							0.188	**					0.078	*
Number of times of attendance at disciplinary conferences	0.246	*			0.173	*	0.219	**			0.322	***	0.203	***
R^2	0.238		0.058		0.173		0.320		0.186		0.204		0.295	

Notes: ***$p<.001$, **$p<.01$, *$p<.05$

Table 10.18 Determinants of research productivity (1992)

Explanatory variables	Humanities		Social sciences		Natural sciences		Engineering		Agriculture		Health and medical sciences		Overall total	
Gender														
Age														
Highest degree obtained					0.160	**			0.211	*	0.159	*	0.106	***
Academic rank							0.132	**			0.164	*	0.053	*
Type of university	0.191	*			0.154	*	0.325	***	0.286	**			0.114	***
Research regularly assessed														
Intellectual atmosphere							0.128	**						
Importance of a strong record of successful research activity														
Research funding over the previous three years	0.199	**			0.210	**			0.269	*	0.153	*	0.173	***
Assessment of research equipment and instrumentation														
Quality of students														
Preference for teaching or research							0.172	***						
Research hours per week	0.200	**							0.348	***			0.061	*
Attendance at disciplinary conferences	0.252	***	0.277	**	0.290	***	0.292	***			0.436	***	0.398	***
R^2	0.163		0.069		0.306		0.409		0.324		0.319		0.352	

Notes: ***$p < .001$, **$p < .01$, *$p < .05$

For the responses across all disciplines, six variables made significant contributions. Four were identical with those doing so in 2007: level of degree, research funding, research time, and attendance at conferences. The value of the coefficient for research funding in 1992 was about half that for 2007, perhaps reflecting the generally greater availability of research funding in 1992; and conversely the coefficient for conference attendance had doubled by 2007, perhaps reflecting the increased importance attached to networking. No significance was attached to the effects of research assessment or intellectual atmosphere in 1992 but significance did attach to academic rank and type of university.

As in 2007, the pattern of variables contributing significantly to the multivariate analysis differed markedly from those contributing to the overall response. Attendance at conferences contributed to five of the specialized areas (all except agriculture), research funding and type of university contributed to four areas, and level of degree to three. Time spent on research was significant for only two disciplinary areas and a preference for research, academic rank, and an intellectual atmosphere were significant in only one area, that of engineering. With respect to the individual disciplinary areas, all with the exception of the social sciences showed an increased number of variables that contributed significantly to research productivity. While attendance at conferences was widely shared as a significant variable, the coefficients for research funding—also a widely significant variable—were notably smaller in 1992. Conversely, the significance of type of university and of level of degree had vanished in 2007. Contrary to the expectation that selective research funding has widened the differences between types of university in research output, the results suggest that differences in 2007 were less widespread than they were in 1992.

10.5 Conclusion

The building of a knowledge-based society, which presupposes that knowledge will become an important factor, is demanded mainly in the economically advanced nations. Because research contributes substantially to the generation of new knowledge, improving the effectiveness of research activities is important in a knowledge-based society. Based on such recognition, the Law for Orientation of Science and Technology was enacted in Japan in 1995 and the government implemented a science and technology policy deemed to be systemic and consistent with this long-term objective.

In this chapter, an analysis has sought to clarify the determinants of factors contributing to research output as indicated by the number of research articles published. The results show that research funding over the previous 3 years and attendance at disciplinary conferences were two common determinants of the number of research articles published in many academic fields in both 1992 and 2007.

To promote science and technology effectively under financial retrenchment, the proportion of research funds allocated competitively, such as the 21st Century COE funding, has been expanding in recent years. As a result, it seems that the differences in the amount of research funds among researchers have expanded. While leading to

expansion of research output, this policy has also altered relative levels of funding between the specialized fields. To promote science and technology fully, it becomes an important aspect of policy to clarify the relation between the method employed in allocating research funding and research productivity.

In this study, some of the determinants of the quantitative expansion of research results have been clarified. In the future, it will be necessary to examine in more detail other factors that contribute both to research and to a knowledge-based society.

References

Bellas, M. L., & Toutkoushian, R. K. (1999). Faculty time allocations and research productivity: Gender, race, and family effects. *Review of Higher Education, 22*(4), 367–390.

Bland, C. J., Center, B. A., Finstad, D. A., Risbey, K. R., & Staples, J. (2006). The impact of appointment type on the productivity and commitment of full-time faculty in research and doctoral institutions. *Journal of Higher Education, 77*(1), 89–123.

Bonzi, S., & Day, D. (1991). Faculty productivity as a function of cohort group, discipline, and academic age. *Proceedings of the ASIS Annual Meeting, 28*, 267–275.

Daizen, T. (1996a). Nippon to America no butsurigaku bunya no gakumonteki gyouseki no ketteiyoin ni kannsuru hikaku kennkyu [A comparative study on the determinants of academic achievements between USA and Japan – On the field of physics]. *Human Sciences, 2*, 207–237.

Daizen, T. (1996b). Kenkyu seisansei no kokusaihikaku [The international comparison of research productivity]. In A. Arimoto & T. Ehara (Eds.), *Daigaku kyojushoku no kokusai hikaku* [The international comparison of the academic profession] (pp. 166–183). Tokyo: Tamagawa University Press.

Kotrlik, J. W., Bartlett, J. E., II, Higgins, C. C., & Williams, H. A. (2002). Factors associated with research productivity of agricultural education faculty. *Journal of Agricultural Education, 43*(3), 1–10.

Negishi, M. (1999). International comparison of the number of scientific papers: Summary of results and viewpoints for further analysis. *Jyoho Kanri, 39*(4), 245–257.

Stack, S. (2004). Gender, children and research productivity. *Research in Higher Education, 45*(8), 891–920.

Technology and Science Council. (2005). *Science policy to support the variety of research – About the building of academic research promotion strategy in the university and the support by the country*. http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu4/toushin/1213892.htm