

RESEARCH PERFORMANCE OF THE LIFE SCIENCES PROGRAMS FUNDED BY MINISTRY OF SCIENCE AND TECHNOLOGY IN TAIWAN- A BIBLIOMETRIC STUDY

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ABSTRACT

In order to enhance the life science research capacity in Taiwan, the Ministry of Science and Technology has been promoting several research programs, such as “Frontier Science Research Program”, “Team of Excellence Research Program”, and “Academic Summit Program”. This study is the first comprehensive evaluation of academic performance of the aforementioned programs and focuses on the quality of the research outputs. Papers are regarded as one of the most important media for disseminating scientific research results. In this study, bibliometric methods were used to examine whether and to what extent that the goals of these programs were reached. The data used throughout this study was acquired from the on-line edition of SCI-Expanded, SSCI and JCR (Journal Citation Report) databases. These databases were used for evaluating research performance from international perspectives. In this study, we used the publication information provided by the principal investigators and compared to information indexed in the aforementioned databases. Moreover, the overall research performance of Israel, Netherlands, South Korea, and Taiwan in related fields from 2012 to 2016 were also analysed by using bibliometric methods as international benchmarks. The studied documents are limited to articles, reviews and notes. No other limitations on languages or attributes have been applied. Based on the data acquired, bibliometric indicators for counting the number of articles, the percentage of journal impact factor percentile, relative impact to the world, and the percentage of top 10% papers of each program were calculated. As a result, 355, 46 and 116 papers were identified as research outputs of “Frontier Science Research Program”, “Academic Summit Program”, and “Team of Excellence Research Program”, respectively. The analysis shows that these three programs all have research papers of higher quality than Taiwan and South Korea, especially “Academic Summit Program”. However, the findings can only show the academic influence that the research papers of these three programs have. Further analyses are needed to answer the questions that how the research collaboration networks were formed and what and how the outputs influenced the related industry.

Key words: Program Evaluation; Research Performance; Bibliometric Analysis; Life Science

INTRODUCTION

In order to enhance the life science research capacity in Taiwan, in the last two decades, the Ministry of Science and Technology (MOST) has been promoting several research programs to provide longer

and more adequate research funding support to encourage outstanding scholars to conduct systematic and in-depth scientific research and excellence research results to be published in the international top academic journals and to build up internationally well-known research teams. These are “Frontier Science Research Program” (since 1998), “Team of Excellence Research Program” (since 2006), and “Academic Summit Program” (since 2009).

Since 1998, “Frontier Science Research Program” has been launched to encourage outstanding scholars to conduct systematic and in-depth scientific research and pursue of research excellence. The applicants of “Frontier Science Research Program” are asked to provide innovative proposals, and the research results must be of great academic or application value. The applicants must have outstanding research ability and established and world-class research achievements. By providing long-term (five-year) and adequate research grant, outstanding scholars are able to conduct more systematic studies in the longer term. Their research achievements are expected to be published in top international academic journals and have a breakthrough and far-reaching impact on relevant academic fields, and therefore improve the academic excellence of medical science research in Taiwan. “Team of Excellence Research Program” was launched in 2006 to help build up outstanding research teams in the field of life sciences in Taiwan. It also provides long-term and more adequate funding for research to help researchers do breakthrough research or innovative discovery and build up internationally renowned research team. The research results are also expected to be published in the top international academic journals and be of significant application value. In order to support the world's leading groups and cultivate outstanding scholars with high research potential, “Academic Summit Program” was launched in 2009.

The aforementioned three funding programs are still on-going. This study is the first comprehensive evaluation of academic performance of the aforementioned programs and focuses on the quality of the research outputs. Performance evaluation and monitoring of science and technology research projects is the one of the most important part of project management. The results of assessment can be used as a reference for proposal review process in the future. General performance evaluation methods include literature review, case studies, in-depth interviews, expert evaluation, goal management and bibliometric analysis. In this study, bibliometric methods were used to examine whether and to what extent that the goals of these programs were reached.

METODOLOGY

In this study, research performance of the three life sciences programs funded by MOST in Taiwan are analyzed by using bibliometric methods. The journal publication lists are provided by the principal investigators (PIs) of “Academic Summit Program”, “Team of Excellence Research Program”, and “Frontier Science Research Program” and then are identified in the on-line edition of SCI-Expanded and SSCI database by using the bibliographic information. The data used throughout this study is acquired from the on-line edition of SCI-Expanded and SSCI database. The study is limited to scientific publications published before 2017. Besides, the studied documents are limited to articles, notes, and reviews. Based on the data acquired, bibliometric indicators for counting the number of articles, relative impact to the world, the journal impact factor percentile distribution, and the share of papers in top 10% were calculated. For better understanding the performance of these projects, four countries are selected for benchmarking, which are Taiwan, South Korea, Israel, and Netherlands. Taiwan is chose for domestic benchmarking. For international benchmarking, South

Korea, Israel, and Netherlands are chosen because of the similarities of their area and population density with those of Taiwan.

Relative impact to the world (RI) is an indicator of impact of scientific publications. It is based on number of citations that scientific publications were received. RI is computed as follows:

$$RI = \frac{\sum_{i=1}^n \frac{Citations}{No. Papers} / CPP \text{ in field } i}{n}$$

Where:

N is the number of fields that the observed scientific publications were in;

i between 1 and n;

CPP is citations per paper in a specific field

RI between 0.8 and 1.2 indicates that the impact of the observed scientific publications meets the world average (RI=1.0). RI higher than 1.2 means that the impact of the observed scientific publications is higher than the world average, whereas RI lower than 0.8 means the opposite.

The journal impact factor percentile transforms the rank in a specific field by journal impact factor into a percentile value, allowing more meaningful cross-category comparison. It is calculated by using the following formula:

Where:
$$\text{Journal impact factor percentile} = \frac{N-R}{N}$$

N is the number of journals in a specific field

R is the ascending Rank

The journal impact factor percentile is divided into ten groups, i.e. 0-10%, 10-20%, 20-30%, 30-40%, 40-50%, 50-60%, 60-70%, 70-80%, 80-90%, and 90-100%. If the journal impact factor percentile of a journal is between 0 and 0.01, it will be categorized into 0-10% group and be considered as one of the top 10% journals in a specific field.

The share of papers in top 10% indicator is the top ten percent most cited papers in a specific field, year and publication type divided by the total number of papers in a given set of documents, displayed as a percentage. A lower value is considered to be higher performance. A value of "10" for a set of documents represents that ten percent of the publications in that set are in the top 10% of the world regardless of subject, year and document type and would therefore be considered to be performing at the same level as world average. A value above "10" represents that more than ten percent of papers in the set are in the top 10% of the world and a value of less than "10" would represent that less than ten percent of the papers in the set are in the top 10% of the world. The share of papers in top 10% indicator is considered to be an indicator of research excellence as only the most highly cited papers would make the top 10% in their respective field, year and document type. The indicator can be used in conjunction with other indicators to provide a more complete picture of performance. The share of papers in top 10% indicator can be applied to any level of aggregation (author, institution, projects, national/international, or field).

RESULTS

In this study, the journal publication information provided by the PIs of the three life sciences programs are identified in the on-line edition of SCI-Expanded and SSCI database by using the bibliographic information. The original list includes 610 articles. After removing the articles with wrong information, and those are duplicated, accepted but not published yet, or published after 2016, 517 articles are matched in the database. These articles constitute the scope of this study. There are 355 articles from “Frontier Science Research Program”, 116 articles from “Team of Excellence Research Program”, and 46 articles from “Academic Summit Program”, respectively. The articles of “Team of Excellence Research Program” mainly belong to “clinical medicine” field of Essential Science Indicator research areas (49%) and those of “Frontier Science Research Program” and “Academic Summit Program” mainly belong to “molecular biology & genetics” field (28%). Therefore, “clinical medicine” and “molecular biology & genetics” are chose for comparison analysis between the articles of these three programs and the articles of Taiwan, South Korea, Israel, and Netherlands in respective fields.

Journal impact factor percentile

Due to the differences of characteristics in each field, it may cause great differences in journal impact factor. In some fields, such as life sciences related fields, journals usually have respectively high journal impact factor. On the other hand, journals in engineering fields are tend to have low journal impact factor. Thus, we use journal impact factor percentile indicator to observe the journal impact factor distribution of the published articles from “Team of Excellence Research Program”, “Academic Summit Program”, and “Frontier Science Research Program”. Journal impact factor percentile transforms the rank in a specific field by journal impact factor into a percentile value, allowing more meaningful cross-disciplinary comparison.

Figure 1 shows the journal impact factor percentile distribution of articles in life sciences in Israel, Netherlands, South Korea, and Taiwan during recent five years (2012-2016). The results show that the share of articles in life sciences in Netherlands are published in the top 10% journals is the highest, followed by Israel, South Korea, and Taiwan. More than 30% of the articles in life sciences in Netherlands are published in the top 10% journals. As for Taiwan, there are about 13.46% of the articles in life sciences are published in the top 10% journals.

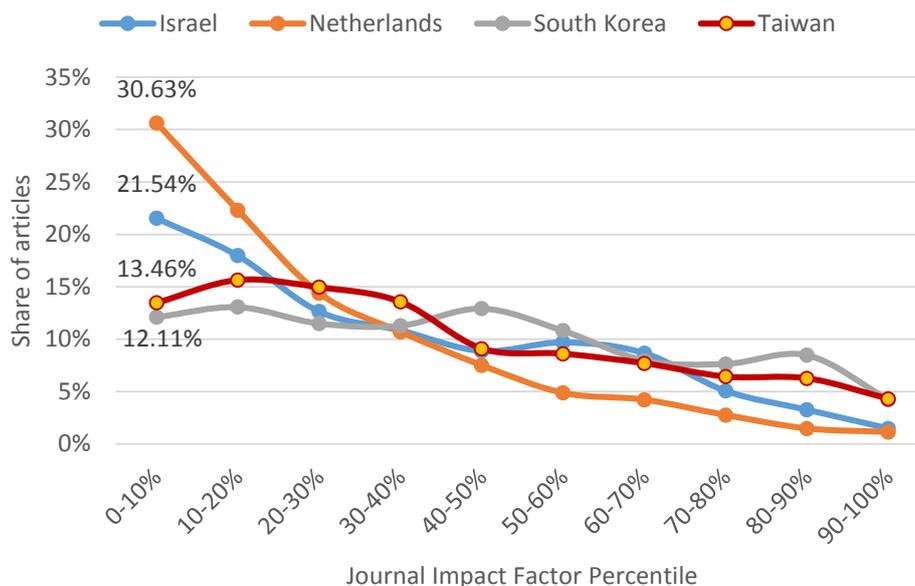


Figure 1: Journal Impact Factor Percentile Distribution of Articles in Life Sciences in Israel, Netherlands, South Korea, and Taiwan (2012-2016)

On the other hand, the journal impact factor percentile distribution analysis of the articles from “Team of Excellence Research Program”, “Academic Summit Program”, and “Frontier Science Research Program”, which are funded by MOST in Taiwan, show different results (Figure 2). The ratio of articles from the above three programs which are published in the top 10% journals are relatively high when compared with that in life sciences in Taiwan. There are more than 50% of the articles from “Academic Summit Program” and “Frontier Science Research Program” and 28.45% of the articles from “Team of Excellence Research Program” are published in the top 10% journals respectively while there are only about 13.46% of the articles in life sciences are published in the top 10% journals. These findings indicate that the research output of these three life sciences programs are more tend to be accepted for publication in the journals with higher impact factors in related fields.

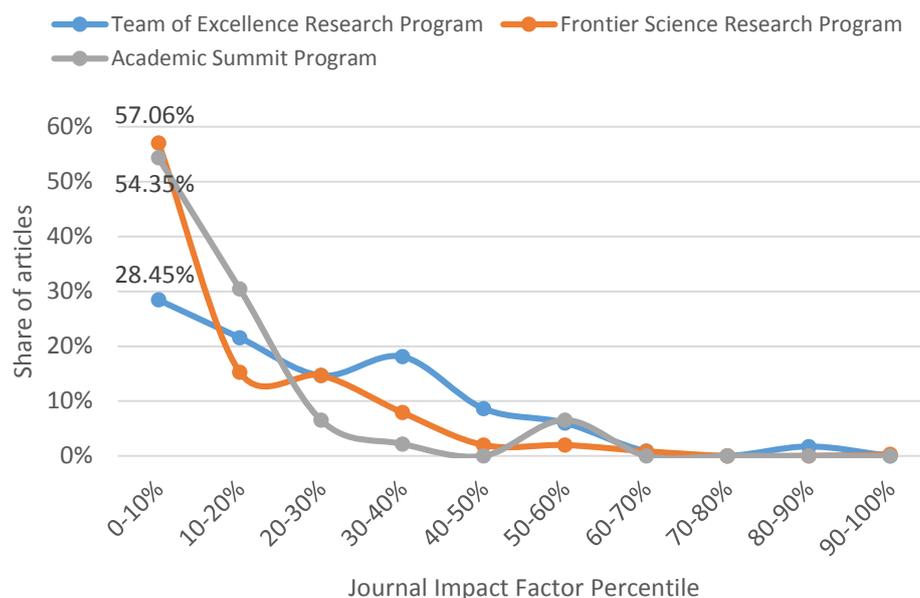


Figure 2: Journal Impact Factor Percentile Distribution of Articles from “Team of Excellence Research Program”, “Academic Summit Program”, and “Frontier Science Research Program”

Relative impact to the world

It is found that the ratio of articles from “Team of Excellence Research Program”, “Academic Summit Program”, and “Frontier Science Research Program” which are published in the top 10% journals is higher than that of articles in life sciences in Taiwan by journal impact factor percentile analysis. However, articles that are published in the top 10% journals does not necessarily have more impact. Therefore, relative impact to the world (RI) and share of papers in top 10%, which are both citation-based indicators, are used to evaluate the impact of these articles. RI can be used to evaluate average impact at any level of aggregation (author, institution, projects, national/international, or field). RI between 0.8 and 1.2 indicates that the impact of the observed scientific publications meets the world average. RI higher than 1.2 indicates that the impact of the observed scientific publications is higher than the world average, whereas RI lower than 0.8 indicates the opposite. The RI analysis results are show in Figure 3. Among the four countries, life sciences related articles in Netherlands have the highest RI (1.74), followed by Israel (1.40), Taiwan (0.92), and South Korea (0.91). RIs of the life sciences related articles in Netherlands and Israel are both higher than the world average. However, those of Taiwan and South Korea are both slightly below the world average. Therefore, it is good to find RIs of articles from “Team of Excellence Research Program”, “Academic Summit Program”, and “Frontier Science Research Program” are all above the world average, which are higher than that of Taiwan and similar with that of Israel.

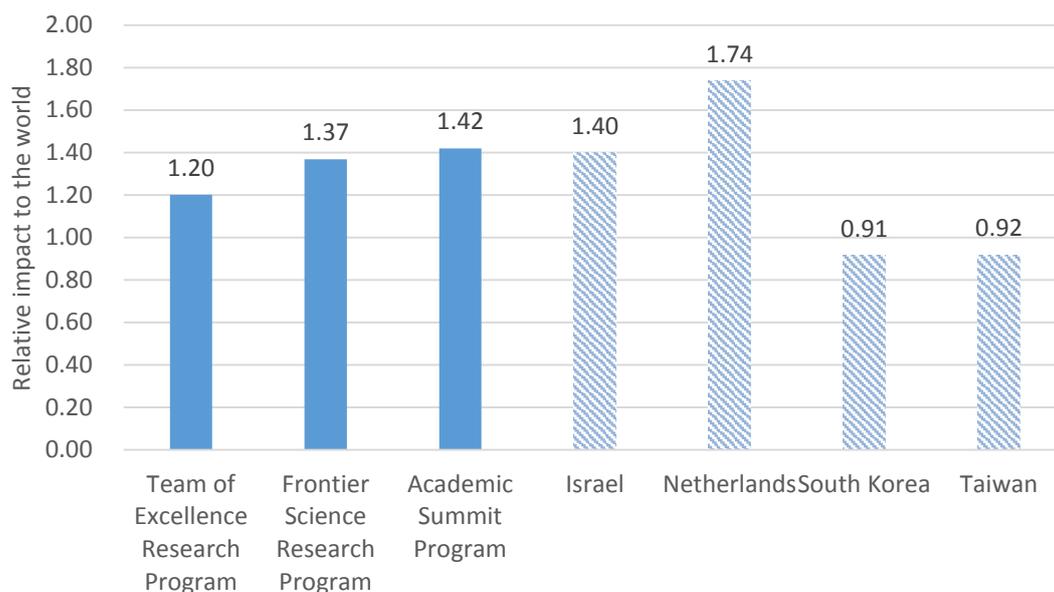


Figure 3: Relative impact to the world of Articles from “Team of Excellence Research Program”, “Academic Summit Program”, and “Frontier Science Research Program” and Articles in Israel, Netherlands, South Korea, and Taiwan in related fields.

Share of papers in top 10% indicator

On the other hand, the share of papers in top 10% indicator is applied to calculate the top ten percent most cited papers in a specific field, year and publication type divided by the total number of papers in a given set of documents, displayed as a percentage. The top ten percent most cited papers are considered as highly cited papers and also papers with high impact. A value above “10” represents that more than ten percent of papers in the set are in the top 10% of the world and a value of less than “10” would represent that less than ten percent of the papers in the set are in the top 10% of the world. The share of papers in top 10% indicator is considered to be an indicator of research excellence as only the most highly cited papers would make the top 10% in their respective field, year and document type. Figure 4 shows the share of papers in top 10% of articles from “Team of Excellence Research Program”, “Academic Summit Program”, and “Frontier Science Research Program” and Articles in Israel, Netherlands, South Korea, and Taiwan in related fields. Similar with the results of RI analysis, the share of papers in top 10% of life sciences related articles in Netherlands is the highest (19.88%) among the four countries, followed by Israel (14.04%), Taiwan (8.42%), and South Korea (8.23%). the share of papers in top 10% of the life sciences related articles in Netherlands and Israel are both higher than the world average while those of Taiwan and South Korea are both below the world average. The share of papers in top 10% of articles from “Team of Excellence Research Program”, “Academic Summit Program”, and “Frontier Science Research Program” are all above the world average, which are higher than that of Taiwan. Among these three programs, the share of papers in top 10% of articles from “Academic Summit Program” is the highest (17.39%), which is also higher than that of Israel, followed by that of “Frontier Science Research Program” (13.80%) and “Team of Excellence Research Program” (11.21%).

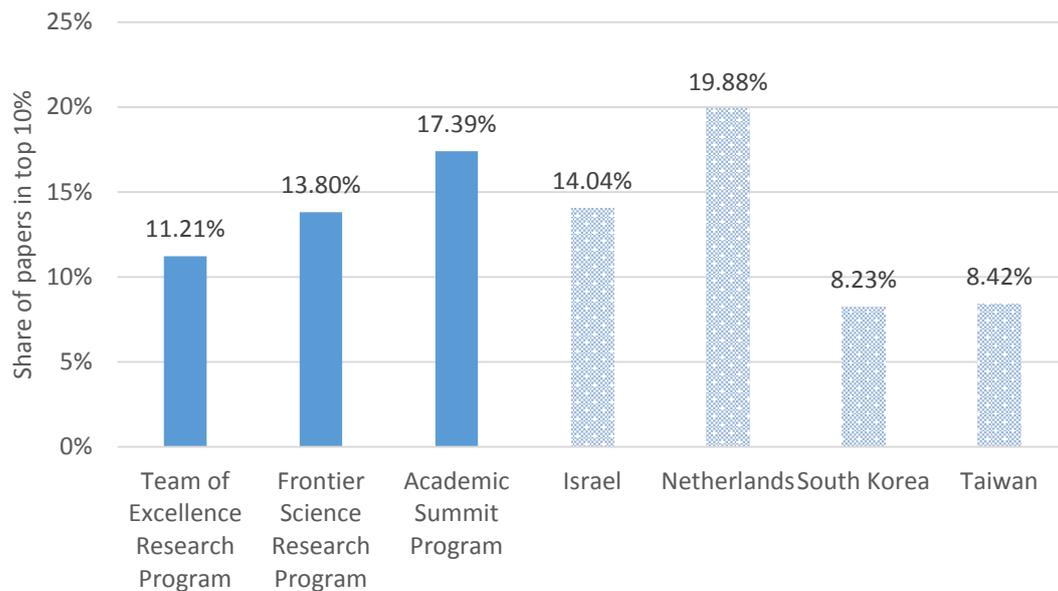


Figure 4: The share of papers in top 10% of Articles from “Team of Excellence Research Program”, “Academic Summit Program”, and “Frontier Science Research Program” and Articles in Israel, Netherlands, South Korea, and Taiwan in related fields.

CONCLUSION

In order to enhance the life science research capacity in Taiwan, the MOST has been promoting several research programs, such as “Frontier Science Research Program”, “Team of Excellence Research Program”, and “Academic Summit Program”. The goals of these three programs are to help researchers conduct more systematic studies to gain high quality research achievements, which are published in top international academic journals. Therefore, bibliometric methods are chosen in this study to evaluate the research performance of these three programs. The results show that more than 50% of papers of Frontier Science Research Program and Academic Summit Program are published in the top 10% journals, which is higher than the research performance of Israel, Netherlands, South Korea, and Taiwan in related fields. On the other hand, about 28% of papers of “Team of Excellence Research Program” are published in the top 10% journals, which is only lower than that of Netherlands. Other analyses also showed similar results. These three programs all have research papers of higher quality than Taiwan and South Korea, especially “Academic Summit Program”. However, the findings can only show the academic influence that the research papers of these three programs have. Further analyses are needed to answer the questions that how the research collaboration networks were formed and what and how the outputs influenced the related industry.

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