The quantitative and qualitative scientific production: A bibliometric study of the five main Asian economies in R&D

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ABSTRACT
The five economies in Asia that invest the most in research and development, as a percentage of Gross Domestic Product (GDP), are Israel, South Korea, Japan, Singapore and China. Nevertheless, the results in the number of scientific output in terms of research publications, and the citations received by them, reveal a whole different reality among those countries. Furthermore, the intellectual production based on quantitative research methods used to be much more popular and defended than that on qualitative methods. However, three of these five countries mentioned trust more in the qualitative paradigm, represented by grounded theory, than in the quantitative one, represented by structural equation modeling. The current study investigates 25 years of scientific production available in the Web of Science and shows that, even though China is undoubtedly Asia's leader in intellectual production, measured by publication productivity and scientific impact, the scientific community trusts the least on China's papers regarding grounded theory, placing China in fifth place among the studied countries for qualitative studies, and third place for quantitative studies. The paper also deepens on the concept of trust as a replacement of impact, and projects the near future for the five studied countries regarding quantitative and qualitative intellectual production.

Keywords: Bibliometrics; Citation analysis; Grounded theory; Structural equation modeling; Research performance; Trust in science.

INTRODUCTION

Research and development (R&D) has been recognized as two direct factors that lead a country to growth and wealth (Greenstone 2011; Solow 1956). A specific example is the additional budget destined to R&D in Montenegro to catch up with the rest of the European Union (EU) countries in the framework of its incorporation to the EU (Tomljanović and Grubišić 2016). The Organization for Economic Cooperation and Development (OECD) defined R&D expenditure as "the money spent on creative work undertaken on a systematic basis to increase the stock of knowledge and the use of this knowledge to devise new applications" (OECD 2019). Therefore, it relates tightly with innovation, which was defined by Baregheh, Rowley and Sambrook (2009) as "the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their market place" (p. 1334).

Based on the previous definitions, incurring in R&D should be desired, not only at a country level, but also at an organizational level. For example, there is evidence from the United Kingdom (UK) that states three main reasons why an organization incurs in R&D: (a) manager aspirations, (b) proximity of bankruptcy, and (c) additional resources available (Guedes et al. 2016). Nevertheless, the most relevant European countries that invest in R&D show lower amounts as percentages of their Gross Domestic Product (GDP), although money invested increases every year, and Bilas et al. (2016) detected, studying those European countries, a strong relation between the R&D expenditure and two particular factors: the R&D/GDP and the GDP per capita's growth rate. Their findings involved that R&D tends to grow compared to the previous year, although shows also a negative relation with the behavior of the GDP per capita. In a study of American, European and Asian countries, innovation through R&D was proposed as "a determinant of competitiveness for sustainable development" (Akcali and Sismanoglu 2015, p. 774). Whether it behaves incrementally or not as a percentage of a country's GDP, or if it has a negative relation with its GDP per capita (Bilas et al. 2016), or even if it is proactive or reactive (Guedes et al. 2016) it is strongly sustained that incurring in R&D offers important know how (OECD 2019), potential competitive advantages (Frankort 2016), and has the potential to promote the growth of small and medium enterprises (SMEs) (Rodríguez and Nieto 2016).

Consequently, if a country targets to grow and be wealthy (Greenstone 2011; Solow 1956), and have a strong competitive advantage (Frankort 2016) for a sustainable future (Akcali and Sismanoglu 2015), then R&D should be prioritized. In Asia, undoubtedly China is the country that spends the most in R&D with US$ 371 billion per year. Worldwide China is only behind the United States which spends US$ 476 billion, and followed by Japan (US$ 170 billion), Germany (US$ 110 billion) and South Korea (US$ 73 billion) (UNESCO 2019). Nevertheless, if Asian countries are ranked for the R&D expenditure as a percentage of its GDP, the top five would be South Korea (4.3%), Israel (4.2%), Japan (3.4%), Singapore (2.2%) and China (2.0%) (UNESCO 2019). Even though China does not share the same position in R&D seen as the absolute annual expenditure or the percentage of R&D versus its GDP, it is important to assess whether the knowledge generated by the five main countries investing in R&D in Asia is actually productive or trusted. Furthermore, North America and Western Europe as a whole region invest US$ 844 billion, and represent 39.7 percent of the World's researchers, while Asia as a region invests US$ 750 billion, less than North America and Western Europe, but represents 44.9 percent of the World's researchers (UNESCO 2019). Is it a matter of funding or how relevant their research findings are?

Nicolson (2013) considered that something is true for the backup that the fact receives from the community who believes that that fact is true, while Giffin (1967) defined trust as the "reliance upon the characteristics of an object, or the occurrence of an event, or the behavior of a person in order to achieve a desired but uncertain objective in a risky situation" (p. 105). Some authors consider the citations per paper ratio as scientific impact (Asubiaro, 2019; Merigó et al. 2015; Mulet-Forteza et al. 2019). Nonetheless, the intellectual production must also receive the scientific community's trust, as per Giffin's (1967) definition, relying on the findings of that research, and therefore that knowledge should be cited to create more knowledge based on it. That is how Arana (2020), combining Nicolson's (2013) and Giffin's (1967) definitions proposed a different interpretation of the citations per paper: it should be a trust measure, instead of an impact one.

Thornley et al. (2015) indicated that the amount of citations that a paper receives could be influenced by the prestige of the authors or the journals, or co-authorship (Sadatmoosavi

et al. 2018), while Cintra, Furnival and Milanez (2018) and Erfanmanesh (2019) proposed that the free access to journals also contributes to the citation of their papers. On the other hand, Simkin and Roychowdhury (2003) affirmed that only 20 percent of the research cited by authors is actually read by them.

R&D is supposed to generate knowledge, and that knowledge should lead to wealth. The fact that there is an absence of statistics of Asian quantitative and qualitative scientific production in the past years against other Asian economies; and added to the fact that the important gap between the R&D investments and percentages of the World's researchers between Asia and North America and Western Europe should be understood, it becomes very important to study China's intellectual production and its performance regarding how much does the scientific community trusts its findings, together with the other four more relevant countries in Asia in terms of R&D as a percentage of their GDPs. Theoretically speaking, the economical effort verted in R&D should be accompanied by a strong trust from the scientific community if the knowledge is relevant (Arana 2020). Regarding qualitative research, the grounded theory is the methodological reference for the study because since it was proposed by Glaser and Strauss (1967) and later modified by Strauss and Corbin (1990), it (a) has been proven to be rigorous (Gioia, Corley and Hamilton 2013), (b) considered as a strong tool to develop science (Jones 2009), (c) qualified as one of the five best qualitative methods (Creswell 2007), and (d) is still being developed nowadays (Charmaz 2006). Regarding quantitative research, the structural equation modeling is the methodological reference because it was officially proposed in 1970 by K. Jöreskog (Mateos-Aparicio 2011), almost at the same time as grounded theory (Glaser and Strauss 1967), and is the most relevant one proposed by Chión and Charles (2016) among the multivariate techniques mentioned in their book.

The objective of the study is therefore to determine how reliable Asian research is. To address this research objective, three research questions are posed:

a) How much does the scientific community trusts the quantitative and qualitative scientific production of the five main countries investing in R&D as a percentage of their GDPs?
b) Does China lead the trust received from the scientific community in the same way it leads the funds invested in R&D?
c) How does the trust measured in research question 1 will behave in the next 25 years?

Particular attention is paid to findings on China, not only for being the country that invests the most in terms of funds in Asia, but also because it is the second main R&D investor in the World, only surpassed by the United States. This is clearly reflected in research question 2.

MATERIALS AND METHOD

A bibliometric study was conducted, specifically regarding the evolution throughout 25 years (1994-2018) of average citations per paper for the two methodological reference in this study i.e. grounded theory representing the qualitative methods, and structural equation modeling representing the quantitative methods. This information can be classified as the number of papers produced per country, and the number of citations received per paper per year. The countries considered for the study are the five most important regarding R&D expenditure as a perentage of their GDP (UNESCO 2019): (a) South Korea, (b) Israel, (c) Japan, (d) Singapore, and (e) China.

The data were discovered and extracted on June 18th, 2019, through the Web of Science Basic Search, specifically the Topic Option, which includes Title, Abstract, Author Keywords and Keywords Plus. The search terms were "grounded theory" and "structural equation modeling", filtering afterwards by type of document (article) and geographically for each of the five countries studied. None of the articles are articles "in press". The information obtained was processed considering the net citations per year, but regarding the amount of papers, it was processed as the accumulated number of papers produced to date, since past papers keep generating citations (Arana 2020).

The information are interpreted first as descriptive statistics, both illustrated through tables and graphs. Statistical regressions are conducted using time as the independent variable, and the citations per paper as the dependent variable. The coefficients for the regressions are statistically validated, and finally an estimation of the future is offered based on the regressions obtained.

RESULTS

The information extracted from the Web of Science for the five countries on the number of papers published per year, per country, per methodology, is shown in Table 1, and the citations per paper published per year, per country, per methodology for the 25-year period is shown in Table 2. In both tables, grounded theory has been abbreviated as GT, while structural equation modeling as SEM.

During the 25-year period, South Korea produced 898 grounded theory papers and 2,015 structural equation modeling papers in total. Israel published 768 and 579 respectively. In the same order, Japan generated 3,067 and 1,218. Singapore offered 361 grounded theory papers and 513 structural equation modeling papers, and finally China published 7,125 and 5,736 respectively. China is nowadays, without any doubt, the main scientific paper publisher in Asia. In the case of grounded theory, China led the intellectual production in 2018 followed by Japan, while for structural equation modeling China is followed by South Korea. Table 1 details these findings.

Nevertheless, Table 2 shows a whole different situation regarding the citations per paper. In 2018, China was the least cited country for grounded theory, with only 1.65 citations per paper, against the leader, Israel, with 2.52. In the case of structural equation modeling, China occupied the third place with 2.82 citations per paper, surpassed by Singapore (3.79) and South Korea (3.15). The citations per paper indicator is important since it denotes impact factor (Cobo et al. 2015). Nevertheless, under Arana (2020)'s concept of trust per paper, the volume of intellectual production offered by China among the years would not be offering the same impact in trust among the scientific community. Furthermore, China never led the citations per paper ratio for grounded theory among the 25-year timeframe studied, and regarding structural equation modeling, China only led that corresponding ratio during years 2006 and 2007.

Table 1: Number of Papers Published Per Year, Per Country, Per Methodology (1994-2018)

GT papers	**1994**	**1995**	**1996**	**1997**	**1998**	**SEM papers**	**1994**	**1995**	**1996**	**1997**	**1998**
South Korea	4	4	9	10	17	South Korea	2	4	3	4	6
Israel	20	8	14	18	15	Israel	6	7	7	10	7
Japan	84	64	86	94	101	Japan	13	13	18	15	15
Singapore	0	3	3	1	1	Singapore	1	1	1	5	4
China	29	24	45	46	50	China	5	4	9	11	13
GT papers	**1999**	**2000**	**2001**	**2002**	**2003**	**SEM papers**	**1999**	**2000**	**2001**	**2002**	**2003**
South Korea	18	21	20	21	25	South Korea	9	6	14	21	25
Israel	29	16	22	21	26	Israel	11	12	9	12	10
Japan	85	96	119	101	106	Japan	19	19	32	23	28
Singapore	6	5	5	4	5	Singapore	1	5	9	5	8
China	60	91	92	126	127	China	17	32	42	41	59
GT papers	**2004**	**2005**	**2006**	**2007**	**2008**	**SEM papers**	**2004**	**2005**	**2006**	**2007**	**2008**
South Korea	18	30	35	32	39	South Korea	21	32	33	32	56
Israel	19	29	11	27	39	Israel	18	11	16	21	23
Japan	96	137	144	130	130	Japan	26	38	44	58	51
Singapore	6	11	10	15	8	Singapore	4	14	14	17	21
China	178	208	238	290	329	China	57	68	75	119	131
GT papers	**2009**	**2010**	**2011**	**2012**	**2013**	**SEM papers**	**2009**	**2010**	**2011**	**2012**	**2013**
South Korea	33	37	53	52	50	South Korea	95	71	99	116	144
Israel	25	38	33	40	39	Israel	34	18	24	36	28
Japan	136	135	124	149	147	Japan	56	55	55	69	66
Singapore	18	21	11	24	24	Singapore	27	31	21	30	35
China	385	403	417	478	489	China	174	204	234	291	358
GT papers	**2014**	**2015**	**2016**	**2017**	**2018**	**SEM papers**	**2014**	**2015**	**2016**	**2017**	**2018**
South Korea	42	78	80	76	94	South Korea	174	225	256	267	300
Israel	43	56	66	54	60	Israel	38	41	67	50	63
Japan	137	143	159	186	178	Japan	56	105	109	110	125
Singapore	28	32	47	35	38	Singapore	34	55	59	57	54
China	486	567	597	644	726	China	407	551	776	829	1,229

Graphically, it can be appreciated how contundent China's intellectual production is. Figure 1 shows its intellectual production for grounded theory, while Figure 2 shows the corresponding scientific production for structural equation modeling. The difference is not only overwhelming against the other four countries studied, but the behavior in Figure 2 of the scientific production related to structural equation modeling is exponential.

The exact same situation that Table 2 showed can be apprehended in Figures 3 and 4. Figure 3 shows graphically the behavior of the citations per paper for each country among time for the intellectual production related to grounded theory, while Figure 4 shows the same for structural equation modeling. The trends show an absolute different reality than the one shown in Figures 1 and 2.

Table 2: Citations Per Paper (Cpp) Published Per Year, Per Country, Per Methodology (1994-2018)

GT CPP	1994	1995	1996	1997	1998	SEM CPP	1994	1995	1996	1997	1998
South Korea	1.31	1.25	1.72	1.08	1.57	South Korea	0.00	0.33	0.75	0.56	0.50
Israel	1.70	2.56	2.29	2.07	2.33	Israel	1.53	0.46	0.77	0.61	1.02
Japan	1.44	1.60	1.48	1.45	1.46	Japan	0.45	0.91	0.98	0.63	0.88
Singapore	0.75	0.57	0.30	1.00	1.75	Singapore	0.00	0.00	0.40	0.30	0.21
China	0.64	0.77	0.74	0.77	0.94	China	0.46	0.59	0.58	0.62	0.72
GT CPP	**1999**	**2000**	**2001**	**2002**	**2003**	**SEM CPP**	**1999**	**2000**	**2001**	**2002**	**2003**
South Korea	0.99	0.99	1.19	1.13	1.20	South Korea	0.65	0.65	0.88	0.71	0.64
Israel	2.30	2.18	2.20	1.81	1.69	Israel	1.05	1.21	1.43	1.15	1.32
Japan	1.54	1.57	1.52	1.43	1.54	Japan	0.78	1.03	0.87	0.74	1.04
Singapore	1.44	1.61	1.29	1.16	1.46	Singapore	0.27	0.95	0.79	0.79	1.62
China	0.89	0.98	0.99	0.91	0.95	China	0.54	0.64	0.69	0.88	1.18
GT CPP	**2004**	**2005**	**2006**	**2007**	**2008**	**SEM CPP**	**2004**	**2005**	**2006**	**2007**	**2008**
South Korea	1.35	1.57	1.48	1.37	1.45	South Korea	0.81	0.87	1.11	1.51	1.55
Israel	1.79	1.87	1.95	1.92	2.07	Israel	1.13	1.58	1.58	1.61	1.70
Japan	1.50	1.66	1.53	1.49	1.51	Japan	0.84	0.90	0.95	1.12	1.16
Singapore	1.26	1.19	1.27	1.68	1.54	Singapore	1.48	1.62	1.59	1.59	2.08
China	0.90	1.01	1.02	1.04	1.24	China	0.98	1.33	1.65	1.65	2.06
GT CPP	**2009**	**2010**	**2011**	**2012**	**2013**	**SEM CPP**	**2009**	**2010**	**2011**	**2012**	**2013**
South Korea	1.41	1.44	1.42	1.59	1.63	South Korea	1.75	1.89	2.16	2.19	2.41
Israel	2.12	2.09	2.34	2.31	2.41	Israel	2.01	1.82	2.24	2.00	2.24
Japan	1.59	1.60	1.63	1.68	1.71	Japan	1.50	1.43	1.45	1.52	1.53
Singapore	1.54	1.76	1.91	2.24	2.36	Singapore	2.39	2.46	2.74	3.43	3.30
China	1.30	1.26	1.34	1.36	1.39	China	1.93	1.95	2.00	2.26	2.35
GT CPP	**2014**	**2015**	**2016**	**2017**	**2018**	**SEM CPP**	**2014**	**2015**	**2016**	**2017**	**2018**
South Korea	1.69	1.68	1.76	1.74	1.76	South Korea	2.78	2.88	2.98	3.01	3.15
Israel	2.54	2.50	2.75	2.61	2.52	Israel	2.25	2.45	2.54	2.80	2.59
Japan	1.62	1.65	1.65	1.69	1.75	Japan	1.61	1.56	1.48	1.57	1.63
Singapore	2.69	2.78	2.51	2.38	2.41	Singapore	3.88	4.08	4.10	3.96	3.79
China	1.41	1.41	1.48	1.50	1.65	China	2.53	2.58	2.62	2.69	2.82

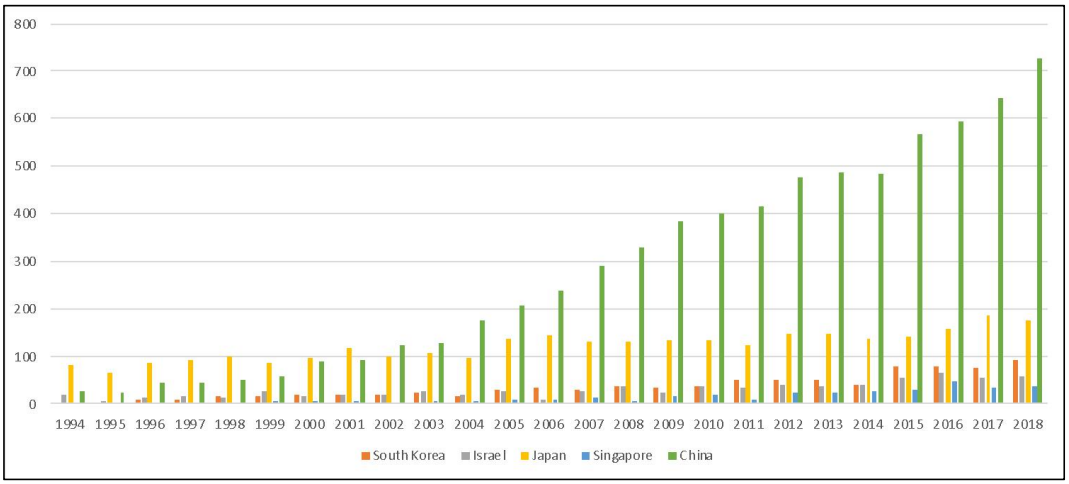

Figure 1: Number of Papers Published Per Year, Per Country, for Grounded Theory

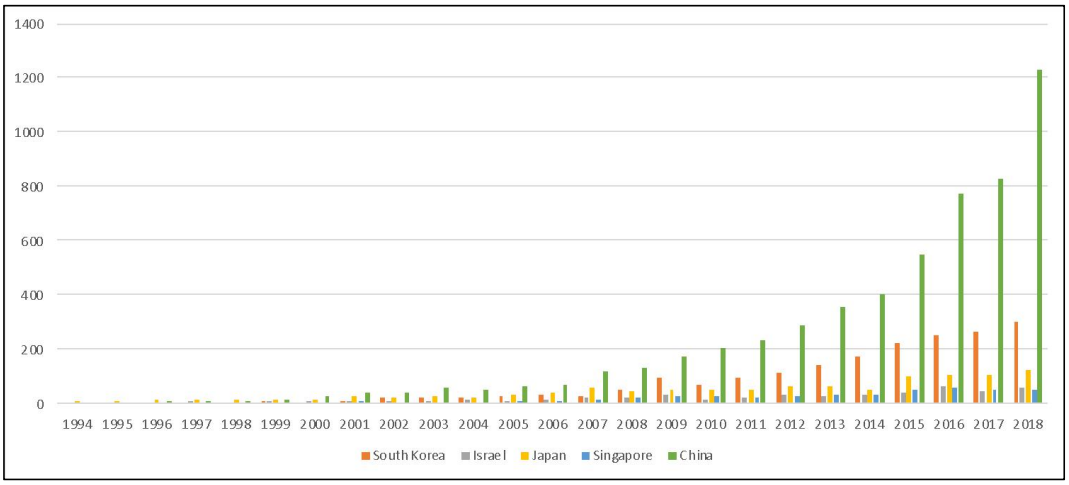

Figure 2. Number of Papers Published Per Year, Per Country, for Structural Equation Modeling

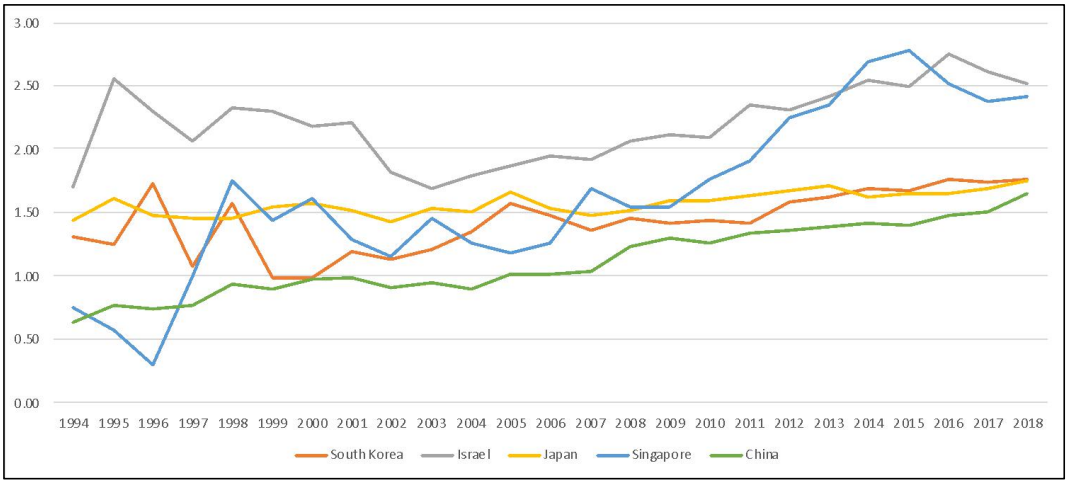

Figure 3: Citations Per Paper Published Per Year, Per Country, for Grounded Theory.

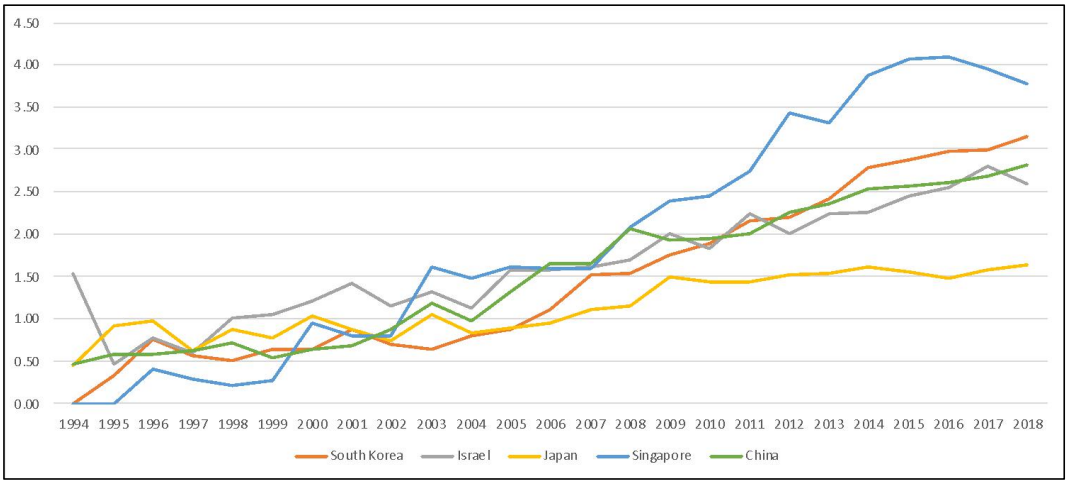

Figure 4: Citations Per Paper Published Per Year, Per Country, for Structural Equation Modeling

Answering the Research Questions

The first and the second research questions can now be answered. Regarding how much the scientific community trusts the quantitative and qualitative scientific production of the five Asian countries investing in R&D as a percentage of their GDPs, trust has been increasing among time. In 1994, the average citations per paper per country were considerably lower for the five countries studied, for both methodologies, as per shown in Figures 3 and 4. Nonetheless, the curves shown in Figure 3 for grounded theory show lower slopes than in Figure 4. In spite of this latter finding, citations per paper evidence a high level of trustworthiness on Asian scientific production and upon which the quality and cedibility of the works are determined.

The second research question has an even more contundent answer. China, the country that not only invests the most in terms of funds in Asia, but also is the second main R&D investor in the World, does not lead any of the citations per paper analyzed. China was ranked third for grounded theory and fifth for structural equation modeling, in spite of its economic efforts to lead the expenditure in R&D worldwide.

In order to understand the future situation of the citations per paper per country, linear regressions were run for each country, for each methodological reference. Table 3 shows the information that was originally shown in Table 2, but in the corresponding format that was entered to the statistical software used. The years were replaced by numbers from 1 to 25 to represent the number of periods studied.

Table 3: Citations Per Paper, Per Country, Per Methodology, Per Period

Year	Grounded Theory					Structural Equation Modeling				
	South Korea	Israel	Japan	Singapore	China	South Korea	Israel	Japan	Singapore	China
1994	1.31	1.70	1.44	0.75	0.64	0.00	1.53	0.45	0.00	0.46
1995	1.25	2.56	1.60	0.57	0.77	0.33	0.46	0.91	0.00	0.59
1996	1.72	2.29	1.48	0.30	0.74	0.75	0.77	0.98	0.40	0.58
1997	1.08	2.07	1.45	1.00	0.77	0.56	0.61	0.63	0.30	0.62
1998	1.57	2.33	1.46	1.75	0.94	0.50	1.02	0.88	0.21	0.72
1999	0.99	2.30	1.54	1.44	0.89	0.65	1.05	0.78	0.27	0.54
2000	0.99	2.18	1.57	1.61	0.98	0.65	1.21	1.03	0.95	0.64
2001	1.19	2.20	1.52	1.29	0.99	0.88	1.43	0.87	0.79	0.69
2002	1.13	1.81	1.43	1.16	0.91	0.71	1.15	0.74	0.79	0.88
2003	1.20	1.69	1.54	1.46	0.95	0.64	1.32	1.04	1.62	1.18
2004	1.35	1.79	1.50	1.26	0.90	0.81	1.13	0.84	1.48	0.98
2005	1.57	1.87	1.66	1.19	1.01	0.87	1.58	0.90	1.62	1.33
2006	1.48	1.95	1.53	1.27	1.02	1.11	1.58	0.95	1.59	1.65
2007	1.37	1.92	1.49	1.68	1.04	1.51	1.61	1.12	1.59	1.65
2008	1.45	2.07	1.51	1.54	1.24	1.55	1.70	1.16	2.08	2.06
2009	1.41	2.12	1.59	1.54	1.30	1.75	2.01	1.50	2.39	1.93
2010	1.44	2.09	1.60	1.76	1.26	1.89	1.82	1.43	2.46	1.95
2011	1.42	2.34	1.63	1.91	1.34	2.16	2.24	1.45	2.74	2.00
2012	1.59	2.31	1.68	2.24	1.36	2.19	2.00	1.52	3.43	2.26
2013	1.63	2.41	1.71	2.36	1.39	2.41	2.24	1.53	3.30	2.35
2014	1.69	2.54	1.62	2.69	1.41	2.78	2.25	1.61	3.88	2.53
2015	1.68	2.50	1.65	2.78	1.41	2.88	2.45	1.56	4.08	2.58
2016	1.76	2.75	1.65	2.51	1.48	2.98	2.54	1.48	4.10	2.62
2017	1.74	2.61	1.69	2.38	1.50	3.01	2.80	1.57	3.96	2.69
2018	1.76	2.52	1.75	2.41	1.65	3.15	2.59	1.63	3.79	2.82

The results for the linear regressions run for each country are shown in Table 4. The adjusted R^2s highlighted in bold are those that were statistically relevant over 0.70 (Véliz 2011). The p-values highlighted in bold for the corresponding constants and coefficients are the ones statistically significant at a 95% confidence interval (Hair et al. 2010). The first three R^2s that correspond to the regressions of grounded theory citations per paper for South Korea, Israel and Japan were the ones that did not reach at least 0.70. Regarding the p-values for the constants, only those for the structural equation modeling regressions for South Korea and China were not relevant at a 95% confidence interval, which are coherent with the lower and upper limits for the corresponding confidence intervals shown. All of the coefficients for the linear regressions, though, were statistically significant at a 95% level. Their confidence intervals are as well coherent with this. The fact that the coefficients are relevant is important for the projection of the future behavior of citations per paper, since the slopes will mainly determine the speed of the future growth.

For both, grounded theory and structural equation modeling, Singapore evidences the highest slopes for the linear regressions. China, for both regressions, has the third highest slope. These facts are evidenced in Figures 5 and 6, which correspond to the linear projections based on the regressions obtained and shown in Table 4, but applied from 2019 to 2043. The citations per paper for grounded theory should be in the future led by Singapore, followed by Israel and China. Regarding structural equation modeling, the citations per paper should be led in the future by Singapore, South Korea and China. Even though the future is definitely not linear, projections were made to evidence the graphical average behavior of the regressions. As previously proclaimed, the statistically relevant coefficients (slopes) are contundent enough to redefine the picture of grounded theory, while in the case of structural equation modeling, they strengthen the countries' positions.

Table 4: Regression Analysis Results

Method	Country	R	R^2	Adj. R^2	Const.	P-value	Lower limit	Upper limit	Coeff.	P-value	Lower limit	Upper limit
Grounded Theory	South Korea	0.668	0.446	0.422	1.146	**0.000**	0.989	1.303	0.022	**0.000**	0.011	0.033
	Israel	0.487	0.237	0.204	1.938	**0.000**	1.710	2.167	0.020	**0.014**	0.005	0.035
	Japan	0.780	0.609	0.592	1.445	**0.000**	1.395	1.495	0.010	**0.000**	0.006	0.013
	Singapore	0.883	0.780	**0.770**	0.608	**0.000**	0.340	0.877	0.079	**0.000**	0.061	0.097
	China	0.971	0.944	**0.941**	0.637	**0.000**	0.579	0.694	0.037	**0.000**	0.033	0.041
Structural Equation Modeling	South Korea	0.966	0.933	**0.930**	-0.199	0.075	-0.421	0.022	0.128	**0.000**	0.113	0.143
	Israel	0.931	0.866	**0.861**	0.587	**0.000**	0.383	0.792	0.081	**0.000**	0.067	0.095
	Japan	0.911	0.830	**0.822**	0.573	**0.000**	0.445	0.700	0.044	**0.000**	0.035	0.052
	Singapore	0.979	0.958	**0.957**	-0.540	**0.000**	-0.792	-0.288	0.189	**0.000**	0.172	0.206
	China	0.979	0.958	**0.957**	0.112	0.125	-0.034	0.258	0.109	**0.000**	0.099	0.119

Regarding the third research question, it can be evidenced in Figures 5 and 6, through the graphic behavior of the linear regressions run for both methodologies, that the trust in the quantitative and qualitative scientific production of the five main countries will keep increasing. Nevertheless, China will not be able to lead the trust received from the scientific community, in spite of its considerably higher investment in R&D. The projections for structural equation modeling are even more optimistic than those for grounded theory, although both of them increase among time.

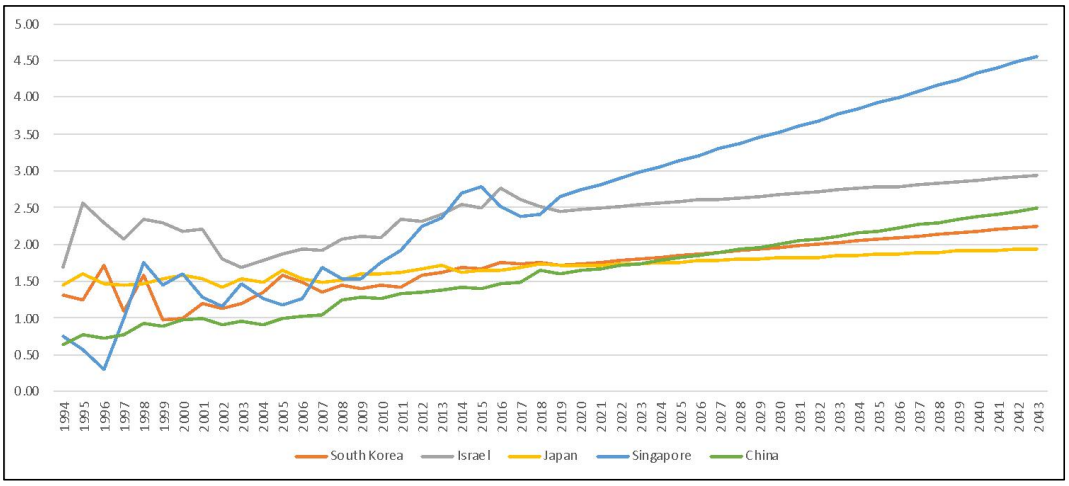

Figure 5: Projection of Citations Per Paper, Per Year, Per Country, for Grounded Theory (historic information from 1994 to 2018 and projection from 2019 to 2043) based on the Regression Analysis Results.

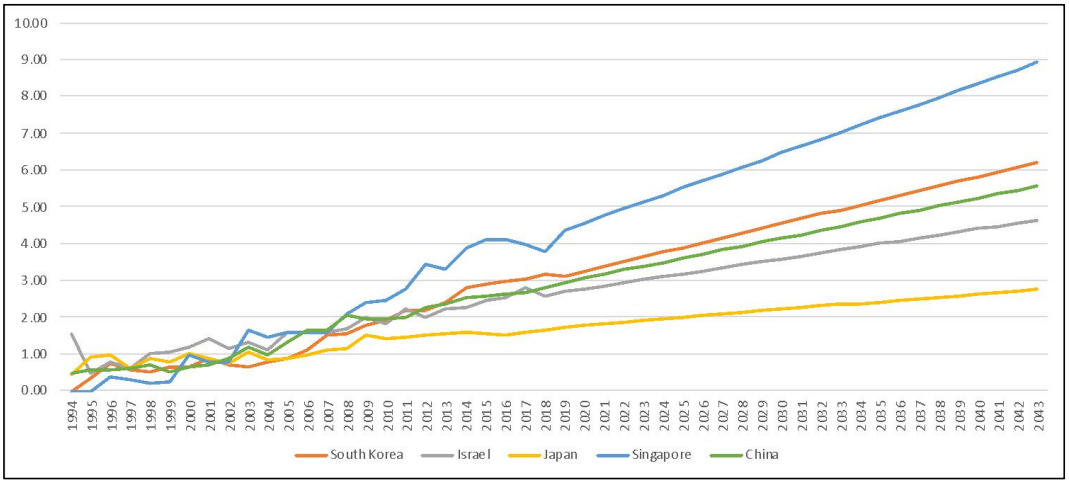

Figure 6: Projection of Citations Per Paper, Per Year, Per Country, for Structural Equation Modeling (historic information from 1994 to 2018 and projection from 2019 to 2043) based on the Regression Analysis Results.

DISCUSSIONS

Based on the fact that R&D are considered critical factors for growth and wealth not only for countries (Greenstone 2011; Solow 1956), but also for small and medium enterprises (Rodríguez and Nieto 2016), definitely it cannot be said that China is underperforming in these fields, since its robust intellectual production of 726 grounded theory papers and 1,229 structural equation modeling papers demonstrate that China leads, in absolute numbers the intellectual production among the five studied countries. This is also backed through the budget of US$ 371 billion per year in R&D, which is worldwide only behind the United States with US$ 476 billion (UNESCO 2019).

Nevertheless, the literature also states that R&D are sources of important procedural knowledge or "know-how" (OECD 2019) and competitive advantages (Frankort 2016). Therefore, if China's intellectual production was innovative enough, or at least more innovative than the other four Asian economies studied (Baregheh, Rowley and Sambrook

2009), it would be considered as a generator of valuable know-how and important competitive advantages, and consequently be more trusted through a stronger citation per paper ratio (Arana 2020). As a whole though, the five economies have increased their intellectual production's trustworthiness. This points to competitiveness and sustainable development (Akcali and Sismanoglu 2015), which is coherent with the projections obtained through the linear regressions run until year 2043, and that show that their trustworthiness will keep increasing.

From an efficiency perspective of the investment in R&D, although China invests much more money than South Korea, Japan, Israel and Singapore, the country does not achieve to lead the citations per paper indicators, not even in the projections, which would denote that the higher level of investment is not returning not only financially, but in what the OECD mentions in the definition of R&D as "creative work for new applications" (OECD 2019). It seems to be about not only the quantity of papers produced, but also their quality, scientific rigor and applicability regarding the new applications mentioned by the OECD, among other factors such as prestige of the scholarly journals or authors (Thornley et al. 2015), the open access of those journals (Cintra, Furnival and Milanez 2018; Erfanmanesh 2019) or co-authorship (Sadatmoosavi et al. 2018).

Regarding the trust on Chinese research, better results are shown for structural equation modeling in 2018, placing China third behind Singapore and South Korea, while for grounded theory China is placed fifth. It needs to be noticed too that the amount of intellectual production for grounded theory is much lower than for structural equation modeling (1,096 against 1,771 respectively). This can be attributed to the fact that generation of knowledge through grounded theory is much more complex in method, since the measurement instrument is the researcher itself, and the constructivist epistemology behind grounded theory could get in the way between the gathered information and its eventual objective coding and interpretation (Charmaz 2006; Creswell 2007; Strauss and Corbin 1990). Hence, China is not only fifth in the most challenging method of the two studied ones, but in 25 years it is projected to have 2.49 citations per paper, while Israel would reach 2.94 and Singapore 4.56. Something very similar occurs with structural equation modeling, but with much more aggressive citations per paper, theoretically based on the fact that multivariate models only rely on statistical validation, and Singapore would lead those citations (8.91), followed by South Korea (6.20) and China (5.56). For both methods in 25 years, China would be in third place, and Singapore would lead in both cases. This definitely represents an opportunity for China in the framework of the transnational knowledge transfer initiative already undertaken between China and Singapore (Liu and Wang 2018).

It is important to notice that, even though grounded theory seems more challenging than structural equation modeling, in 2018 Israel published almost the same number of papers for each methodology (60 for grounded theory and 63 for structural equation modeling) and Japan generated more grounded theory papers (178) than structural equation modeling (125). Unfortunately, for both projections of citations per paper until year 2043, Japan ends fifth, which represents an interesting finding because it seems that even if grounded theory was really more challenging than structural equation modeling, the country would not receive an additional premium over its citations per paper ratio for conducting the most challenging methodology, but for creative (OECD 2019), innovative (Akcali and Sismanoglu 2015; Baregheh, Rowley and Sambrook 2019) or competitive advantage (Frankort 2016) related findings.

CONCLUSIONS

R&D are an important edge to reach wealth through creativity, know-how (OECD, 2019) and innovation (Akcali and Sismanoglu 2015; Baregheh, Rowley and Sambrook 2009). Indeed, in spite of the different strategies among the five countries studied, their citations per paper ratios for both methodologies (grounded theory and structural equation modeling) have increased, which denotes a higher level of trust received from the scientific community among the timeframe studied (1994 – 2018). This keeps increasing through the linear regression conducted and would mean an even better trustworthiness in the future, enhancing the Asian intellectual production position among scientists.

Grounded theory seems, according to its constructivist epistemology (Charmaz 2006; Creswell 2007; Strauss and Corbin 1990) more challenging than the statistically-based structural equation modeling. It appears that Japan decided to embrace this as an interesting strategy to focus on grounded theory, but the country ended up fifth among the projections to year 2043 for the five economies. This can be interpreted as that the method by itself will not improve the citations per paper ratio, but the quality of the research findings should.

The intellectual production measured in amount of papers indexed in the Web of Science is China's strength, but the results obtained regarding citations per paper do not reflect a relevant level of trust from the scientific community, and countries that invest less in R&D obtain better citation per paper ratios than China. It is therefore relevant to work on the efficiency of that investment measured in how trustworthy are the findings presented in the Chinese intellectual production, particularly for grounded theory. The fact that the 25-year projection of citations per paper places China in third place for both methodologies does not mean at all that that will happen. If the current growth trend is changed, then China could lead the citation ratios in 25 years. Nonetheless, China has already identified an important opportunity regarding transnational knowledge transfer in the framework of the Singapore model (Liu and Wang 2018), which is the country that leads both quantitative and qualitative levels of trust.

It is recommended that China reconfigures its R&D effort to focus on the quality of its findings, and not on the quantity of papers. This will place the country in a better know-how and competitive advantage. Also, a special focus on qualitative methods, particularly grounded theory, should be placed, as long as findings are relevant. Japan should redirect its efforts as well, since grounded theory seems not to be working, at least as long as the findings are not relevant enough. South Korea and Israel neither lead nor last in the citations per paper ratios, but they should consider, if they have not done it yet, the kind of findings that the scientific community find valuable among intellectual production. Finally, future papers should focus on comparing the intellectual production in Asia with North America and Western Europe, since Asian countries invest US$ 750 billion with 44.9 percent of the World's researchers, while North America and Western Europe invest US$ 844 billion with 39.7 percent of the World's researchers, so that not only citations per paper ratios are compared, but also the efficiency in terms of investments in R&D and number of scientists.

ACKNOWLEDGEMENT

No grant from any public, commercial, or non-profit funding agency was offered for the conduct of this research. We thank the reviewers for their enriching comments to improve the article.

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