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Academic Linkages and Research Productivity

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Abstract: A university that is transitioning from a primarily teaching university to its vision of being a research university, research productivity at some academic departments of De La Salle University (DLSU) have seen notable increases in recent years. To get a clearer picture of the status of research in the University, this study surveys the research productivity of each academic department as measured by the number of DLSU-affiliated research output that are indexed by Scopus. These output include journal publications, conference papers, books and monographs. With the aim of understanding what drives research productivity particularly in the leading departments, academic diversity and the patterns of authorship are appraised, and from these stems an anlysis of the connection between academic linkages, research collaboration and research productivity.

Key Words: research productivity; Scopus; research collaboration; academic diversity

1. INTRODUCTION

De La Salle University (DLSU) is an institution that has a long tradition of excellence in teaching. In the past two decades however, the academic community in general became more mindful of doing research, and in its new vision-mission, the University positions itself as a research university. Strategic targets set to achieve its goals are based on certain assumptions or beliefs that a particular input would lead to a desired outcome. For example, improving faculty profile by having more doctorates is believed to contribute to better research productivity. While these beliefs may seem self-evident, it is still worthwhile to explore if these suppositions have empirical basis.

Studies on research productivity has been conducted in many settings, relating these to researcher attributes like age, gender, doctorates, academic inbreeding and others. (Levin and Stephan 1991, Xie and Shauman 1998, Sax et al 2002, Clemente 1973, Ramsden 1994, Dundar and Lewis 1998, Horta et al 2010, Inanc and Tuncer 2011, McGee 1960, Eells and Cleveland 1999). These studies, however, focus on individual researchers. While the research output of a unit ultimately rests on the accomplishment of its individual members, it is also useful to look at aggregated data, as dynamics within a unit may also affect the performance of individuals.

This study surveys the research productivity of academic units at DLSU as measured by the number of Scopus-indexed research output. Correlations between various department profile metrics and research productivity are determined. Correlations between Scopus-listed output and co-authorship network metrics are evaluated as well.

2. RESEARCH PRODUCTIVITY

Research productivity is measured in this paper through the number of Scopus-listed output. Data was retrieved from Scopus on November 22, 2013, and the 2013 figures were updated on January 13, 2014. Only output with DLSU affiliation are considered in the study.

Research output at DLSU began to rise above the occasional-paper level in 1996, and production rapidly increased between 2003 and 2008, before settling down to a slower pace that continues until today. In 2013, Scopus output with DLSU as affiliation numbered 128. Total citations as of November 22, 2013 is 6672, and the University's h-index (Hirsch 2005) is 38. Only 30 of its faculty members have been cited at least 30 times. In 2013, the S&T (science and technology) sector accounts for 62% of the production, while the BHESS (business, humanities, education and social sciences) accounts for 38% of the total.

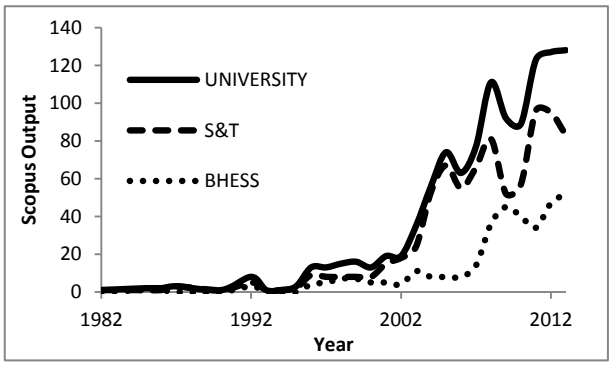

Fig. 1. Scopus output of De La Salle University from 1982-2013

3. DEPARTMENT PROFILES

Department profiles are based on the attributes of individual faculty members, and the following metrics are considered in this study: (1) Gender index computed as the proportion of males among the faculty members; (2) doctorate index measures the proportion of faculty members with doctorates; (3) foreign doctorate index which is similarly computed; (4) average age of the faculty members of the department; (5) average longevity; (6) average doctorate age; (7) Academic Inbreeding index calculated from:

Inbreeding Index = (IB*0+NB*1)/Total Faculty

where:

IB = Number of academically inbred faculty

NB = Number of non-academically inbred faculty

Table 1. Scopus Output of Academic Departments of DLSU from 1982 to 2013.

Department	Scopus Output	Citations
1. Chemical Engineering	163	1881
2. Physics	150	835
3. Software Technology	101	104
4. Chemistry	100	681
5. Biology	98	821
6. Counseling	49	377
7. Economics	41	73
8. Mechanical Engineering	40	289
9. International Studies	38	77
10. Mathematics	37	116
11. Electronics	35	42
12. Industrial Engineering	34	298
13. Manufacturing	32	32
14. Science Education	29	929
15. Accountancy	28	5
16. Computer Technology	26	53
17. Behavioral Science	26	222
18. English	25	29
19. Political Science	21	53
20. Philosophy	15	5
21. Theology	15	4
22. Management	14	40
23. Psychology	12	98
24. Literature	9	5
25. Civil Engineering	8	42
26. Commercial Law	6	
27. Decision Science	5	3
28. Information Technology	4	8
29. Filipino	4	
30. Marketing	3	
31. History	2	
32. Communication	1	35
33. Finance	1	
34. Educational Leadership	1	

(8) Faculty Rank index calculated from

FRI = (FP*3+AP*2+AS*1+IN*0)/TF

where:

FRI = Faculty Rank Index
FP = Number of full professors
AP = Number of associate professors
AS = Number of assistant professors
IN = Number of instructors
TF = Total number of faculty members

(9) Academic mobility index which is based on a classification scheme modifying that of Horta (2013) shown in Table 2, and calculated from:

AMI = (ΣMX*X)/Total number of faculty

where:

AMI = Academic Mobility Index
MX = Academic Mobility Category number X

Four other metrics are used to classify diversity in the departments: (10) academic diversity index is the total number of distinct universities that faculty members of the department graduated from; (11) age spread is the standard deviation of age among members of the department; (12) doctorate age spread is similarly defined; and (13) faculty inflow index is the longevity standard deviation.

Table 2. Academic Mobility Classification Scheme

Mobility Scale MX	Educational Mobility	Academic Employment
M0	All academic degrees from DLSU	Worked only at DLSU
M1	Highest degree from DLSU but has degree from another institution	Worked only at DLSU
M2	All academic degrees from DLSU	Worked or had post-doctoral stint in another institution
M3	Highest degree from DLSU but has degree from another institution	Worked or had post-doctoral stint in another institution
M4	All academic degrees from one institution other than DLSU	Worked only at DLSU or DLSU and the alma mater
M5	All academic degrees from one institution other than DLSU	Worked or had post-doctoral stint in an institution other than DLSU or the alma mater
M6	Academic degrees from different institutions, and highest degree is not from DLSU	Worked only at DLSU or DLSU and the alma mater
M7	Academic degrees from different institutions, and highest degree is not from DLSU	Worked or had post-doctoral stint in an institution other than DLSU or the alma mater

Table 3. Correlations of Department Profile Metrics with Scopus Output.

Faculty Network Metrics	Pearson-R	P-value (2-tailed)
Gender	-.074	.677
Age	.048	.787
Longevity	.272	.120
Doctorate	.390*	.023
Doctorate Age	-.290	.096
Foreign Doctorate	.361*	.036
Faculty Rank	.586**	.000
Academic Inbreeding	.194	.271
Academic Mobility	.244	.165
Academic Diversity	.412*	.016
Age Spread	.316	.069
Doctorate Age Spread	.021	.905
Faculty Inflow	.514**	.002

* significant at 0.05 level ** Significant at 0.01 level

It is found that faculty rank, faculty inflow, doctorate, foreign doctorate, and academic diversity indices correlate significantly with Scopus output. Partial correlation calculations however indicate that only faculty rank index and faculty inflow index are true correlates of Scopus output.

The correlation between faculty rank and research productivity is only to be expected as research output is a requirement for faculty promotion. That faculty inflow is a predictor of Scopus output indicate that when flow of fresh blood is more spread out, the department is likely to have more Scopus-listed output.

4. Co-Authorship Networks

About 75% of the University's Scopus-listed output are co-authored. This indicates that a comprehensive study of research productivity should at least cover co-authorship network analysis.

Studies of co-authorship networks (Liu et al 2005, Barabasi et al 2002, Borner et al 2005, Wagner and Leydesdorff 2005, Leydesdorff and Wagner 2008, Chompalov et al 2002, Ynalvez and Shrum 2011, Chan et al 2006, Newman 2001a, 2001b, 2001c, 2004a, 2004b) is an outgrowth of social network analysis first used by sociologists in studying social relations and structures. Such studies has been aided by the introduction of network metrics from graph theory (Prell 2012), and development of softwares such as NodeXL (Smith et al 2009), a free Excel add-in that is used in this study.

Network metrics that are considered in this study are: (1) vertices or the number of players in the co-authorship network (CAN) of the department; (2) edges or the number of CAN ties; (3) connected components (CC) or part of the CAN graph with vertices that are connected; (4) isolates, or the number of CAN vertices that are not connected to others; (5) VCC or the maximum number of vertices in a CC; (6) ECC, or the maximum number of edges in a CC; (7) diameter, or the maximum number of vertices on a given path between two vertices; (8) distance, or the average number of vertices on a given path between two vertices; (9) density, which is calculated from the actual number of edges in the CAN divided by the total number of possible edges, thus measuring the extent to which vertices in the CAN are connected to each other; (10) external linkage index which measures the number of external linkages per faculty member; (11) big gaph clustering (BGC) which is ECC divided VCC, in effect measuring the tendency of the biggest CC to form a complete graph; (12) seclusion index, or the number of isolates over the total number of faculty members; (13) gelling index which is the number of members of the department in the biggest CC over the total number of faculty in the department, in effect measuring how well members of the department gel with each other; and (14) partition index which is the number of CC that include at least two members of the department.

Correlation computations between the above-mentioned metrics and Scopus output show that the following significantly correlate with research productivity: (1) the number of vertices; (2) the number of edges; (3) the maximum number of vertices in a connected component; (4) the maximum number of edges in a connected component; (5) big graph clustering; (6) seclusion index; (7) gelling index. Partial correlation computations however indicate that only the number of edges is a true correlate of Scopus output.

It has to be noted though that if the academic departments are ranked according to the number of Scopus output, the network graph becomes more intricate as one goes up the ranks. With Pearson-R of .867 compared to .514, the number of co-authorship network ties of a department is a much stronger predictor of research productivity than the best department profile predictor (i.e., faculty inflow). This indicates that to drive research productivity, helping faculty members develop ties with other researchers has greater impact than improving department profile. This is of course not to say that the latter should be ignored.

Table 4. Correlations of Department Network Metrics with Scopus Output.

Department Network Metrics	Pearson-R	P-value (2-tailed)
vertex	.630*	.012
edges	.867**	.000
CC	-.007	.981
isolates	-.354	.195
VCC	.597*	.019
ECC	.717**	.000
diameter	.503	.056
distance	.452	.091
density	-.083	.768
external linkage	.335	.223
BGC	.714**	.003
seclusion	-.612*	.015
gelling	.627*	.012
partition	.393	.148

* significant at 0.05 level ** Significant at 0.01 level

5. CONCLUSIONS

Looking for factors that drive research in the University, correlation of research productivity and a number of department profile metric were evaluated. It is found that only faculty rank, and faculty inflow significantly correlate with Scopus output of academic departments. A network analysis of co-authorship ties indicate that the number of connection is a much better predictor of of research productivity than department profile.

This study shows that to improve research productivity, it is helpful to enhance department profile, especially in constantly recruiting new talents, improving acadmic diversity in terms of recruiting new faculty members from different universities, hiring faculty members with PhD, especially those from foreign universities. It will however normally take years to develop a department along these lines.

This study also shows that research collaborations have much higher impact than the profile of the members of a department. This observation is significant since establishment and maintenance of collaborative research linkages can be undertaken more easily than intensive recruitment in some cases (e.g., in the case of small departments).

A closer look of the University's research production during the high-growth period of 2003 to 2008 shows that this was driven by two factors. The first one is that many departments became active in publishing in Scopus-indexed journals during this period, allowing the University to reach higher sustainable production levels. The second one is primarily responsible for the rapid rise, and this is the establishment of highly productive academic linkages. Most notable of these are: (1) the Osaka University linkage of the Physics department, and to a lesser extent, between Osaka University and the Software Technology department; (2) the tie established by the University's top researcher, R. Tan, and D. Foo at the University of Nottingham's satellite campus in Malaysia.

It is also found in this study that inter- and intra-departmental research collaborations are equally important to research productivity. The highest-ranked department has the most intricate co-authorship network, showing a good mix of internal and external collaborations. This shows that the department is able to develop local capability, which enables it to have sustained growth over many years. The second-ranked department on the other hand, have little internal collaborations, and its high-output rate is limited only to a few years, showing that while external linkages can help boost production, sustainability is possible only with the development of local networks.

That a good mix of internal and external research collaboration is critical to a sustainable drive is further illustrated by the case of the second most prolific researcher of the University, C. Ragasa. While Ragasa has consistently published in Scopus-listed journals for many years in collaboration with a foreign partner, her production is on an upsurge in recent years. Analysis of her outputs indicates that this is brought about by her building of ties with three faculty members from another department, helping her to expand her research activities.

Research production of the University is still largely driven by a small number of individuals, which explains the huge swings in output from year to year. Only 55 faculty members have a total of at least 5 Scopus-listed outputs. This shows that there is still a huge growth potential. The challenge is to trigger the intrinsic motivation of the thus-far dormant individuals. This study shows that there is at least one way by which this could be achieved even in the short term – the development of internal and external research ties. This can easily promoted if there is a conscious drive. For example, the focus of many faculty members in attending conference may still be on presenting a paper. Conferences are in fact potent grounds for network-building, as can be demonstrated by at least the top two researchers of the institution. Presentation of papers should perhaps be viewed as a way for a researcher to attract potential partners, and attending presentations as opportunities for one to identify possible symbiotic partners. Furthermore, participating regularly in annual conferences helps establish one's presence within a global research community, which can again create further opportunities for productivity enhancement. Slight changes in requirements for funding support towards network building might just be able to push the University to higher levels of research production.

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