International Journal of Information Science and Management
Vol. 13, No. 2, 2015, 1-10

Does the Centrality Degree of Latin American Countries Predict their Citation Based Performance on Management Research?

Guillermo Armando Ronda-Pupo
Catholic University of Northern, Chile
University of Holguín, Cuba
gronda@ucn.cl

Abstract

The aim of this paper is to determine if the centrality degree and density of Latin-American and Caribbean countries (LA-C) predicts their citation based performance in academic research in the management discipline. For our analysis, we use publication data of the Social Science Citation Index in the field of ‘‘Management’’ between 1988 and 2013, extracted from ISI Web of Science. The resulting database contained 1,079 articles reflecting the contributions of 19 LA-C countries. For the quantitative analysis we used a combination of Bibliometric and Social Networks Analysis techniques. To test the hypothesis a Multiple Linear Regression model with bootstrapping was run. The results show that the centrality degree of LA-C countries is positively associated to their citation based performance. The centrality degree of LA-C countries predicts a 54% of variance in their citation based research performance within the management discipline.

Keywords: Academic collaboration; Centrality degree, Citation based performance, Latin America, Management Discipline, Social Network Analysis

Introduction

The aim of this paper is to determine if the centrality degree and density of LA-C countries predicts their citation based research performance in the management discipline. Clarification of these relationships at the country level may highlight the importance of developing collaboration networks to foster scientific performance of emergent economy regions in general and to the field of management as an academic discipline in particular.

Co-authorship networks are an important class of social networks and they have been used to determine the structure of scientific collaboration, as well as the status of individual researchers, within the network structure. Although somewhat similar to the much studied citation networks in scientific literature, co-authorship implies a much stronger social relationship than citation (Liu, Bollen, Nelsonb, & Van de Sompel, 2005). The study of the structure of the collaboration network and its influence in the citation performance of research in the management discipline at the country level in developing regions is important. Establishing networks of collaboration is an effective strategy of closing the gap with respect to more developed nations (Vogel, 1997).

In recent years, across all academic disciplines, studies on the association between social network analysis (SNA) measures and citation based performance have increased considerably (Alireza, Altmann, & Hossain, 2011; Alireza, Altmann, & Hwang, 2010; Alireza, Hossain, & Leydesdorff, 2012; Badar, Hite, & Badir, 2012; Badar, Hite, & Badir, 2014; Cimenler, Reeves, & Skvoretz, 2014). However, in the management discipline we found only the study by Acedo, Barroso, Casanueva, and Galán (2006). This study was the first to analyze collaboration networks in the management discipline using SNA for exploring co-authorships networks in scientific journals on management.

The two questions which have not been explored yet are whether citation based performance is effected by 1) the structure of the international collaboration networks or 2) the LA-C country's cohesion (density) in that network. Therefore the study of the possible influence of a country´s degree of centrality and also its density on that country´s citation based research performance would contribute knowledge on the importance of fostering collaboration networks for strengthening the management discipline in developing countries.

Thus, the research question posed for the study is:

1. Do the centrality degree and density of LA-C countries predict their research citation based performance in the management discipline?

To answer the research question, we analyzed all the articles of LA-C authors published from January 1, 1990 to December 31, 2010 in 119 journals of the Social Science Citation Index database in the category "*Management*".

Literature Review

SNA is a powerful strategy for the information sciences and could be defined as a set of individuals or groups which have connections of some kind to some or to all of the others (Alireza, Hossain, et al., 2012). It could also be defined as a broad strategy for investigating social structures (Otte & Rousseau, 2002). SNA has attracted considerable interest in recent years and plays an important role in many disciplines (Liu et al., 2005). The structure and the sociology of scientific collaborations are receiving increasing interest, especially in a world characterized by complex problems, dynamic growth of knowledge, and specialized areas of expertise (Racherla & Hu, 2010).

Association between a countries' centrality and its citation based performance

Frenken, Hoolzl, and de Vor (2005) found that networks´ underlying collaborative knowledge production serve as a vehicles of knowledge diffusion. Both aspects contribute to the citation impact of publications. Studies on the influence of centrality measurements in the research performance at the country level are particularly scarce.

In previous studies by (Alireza et al., 2011; Alireza, Chung, & Hossain, 2012; Badar et al., 2012; Badar et al., 2014; Cimenler et al., 2014) a positive association between centrality measurements and performance at the micro level have been reported. In another study by (Alireza, Chung, et al., 2012) the relationship between network density and performance have been studied. The main difference between these studies lies in the centrality measure used

and how performance was measured. For example, (Alireza, Chung, et al., 2012; Badar et al., 2012) use degree, closeness and betweenness centrality. Cimenler et al. (2014) uses the eigenvector centrality, Alireza, Hossain, et al. (2012) use betweenness and Alireza et al. (2011) use normalized degree, closeness and betweenness. As a measure of performance either the h-index (Cimenler et al., 2014) or g-index (Alireza et al., 2011; Alireza, Chung, et al., 2012) have been used. According to the results of previous studies at the micro level we expect that LA-C countries with high centrality degree have a higher citation performance, thus we pose as the first hypothesis:

Hypothesis 1a: *The more central a LA-C country is in the structure of the collaboration network, the higher* its *citation performances is.*

Association between a countries' density and its citation based performance

de Nooy, Mrvar, and VBatagelj (2008) state that there is an inverse relationship between density and group size. Alireza, Chung, et al. (2012) analyzed the relationship between density and performance. These authors found that the density of a researcher's collaboration network negatively correlates to performance. $r = -.538$, $p < .05$. In the present study we hope that the density of LA-C countries in the collaboration network would predict their citation based performance. Thus, we pose a second hypothesis:

Hypothesis 1b: *The more density a LA-C country has in the structure of the collaboration network, the higher* its *citation based performance is.*

Methodology

In previous studies, to map the structure of collaborative activity by investigating co-authorship linkages, authors have used multidimensional scaling. This sometimes tends to be a distorting method (Katz, 1994; Peters & Van Raan, 1993a, 1993b). In this research, we used SNA techniques to discover and map the latent structure of the LA-C international collaboration network on management research. For this, we used the following procedure:

First: we developed the following search strategy in the database *ISI Web of Knowledge*, ISI digital version (WOS) as follows: Advanced search CU = (Country) AND WC = (Management), Time span: from January 1st, 1990 to December 31 2010, Language: all, Citation database: SSCI, Document type: article. We made a second filter to each result selecting only the articles on the Web of Science category "management". We ranked the records by country/territories using a minimum record count (threshold) of one. This allows the determination of which countries each LA-C country collaborate with in their published articles during the time spam analyzed.

Second: we created a two-mode matrix (*m x n*) by placing as unit of analysis (rows), the nineteen LA-C countries that published at least one article in the time spam analyzed, and as variables (columns) the countries with which they collaborated with. When coding the data in the variable (countries) we found two situations. 1) The author signs with a single country. In these cases, we assign a point to each country for each signatory author. 2) We found 44 articles (4.07%) published by a single author in which the author signed with two or more countries. To code these cases, we adjusted appearances using the methodology described by

Heck and Cooley (1988); Morrison and Inkpen (1991) and, Shane (1997) in their studies. This way, for an author that signs with two countries, each country receives .50 of a credit; in the event of three countries 1/3, and so on.

Third: We graphically represented the international collaboration network using the software Pajek (Batagelj & Mrvar, 1996). We used the technique designed by Kamada and Kawai (1989) for space distribution of countries in the network. Once we determined the latent structure of the collaboration network, we calculated the centrality degree for each country. To do this we used the procedure described by Alireza, Hossain, et al. (2012, see Formula 1).

Variables and its operationalization

Dependent variable

Latin American countries citation performance on management research: In recent years to measure scientific impact many indexes have been created and/or modified. The more popular indexes are the Hirsch index (Hirsch, 2005) with all its modifications and the g-index (Egghe, 2006). Although these two indexes made important advancement in the way citation based performance is measured both indicators have the limitation of being size dependent. That is, bigger countries have more opportunities of having higher numbers of citations thus, higher h and g- indexes.

For the present study to measure the citation based performance of LA-C countries on management research we used the Adjusted Citation Index (ACI) which is very similar to the Community Productivity Index created by (Alireza, Altmann, & Hwang, 2009). To obtain the value of ACI for each La-C country first we calculated the Adjusted Citation Performance by means of the formula ACP = (TC – SC)/(RY – PY)*AA. In the formula TC stands for the number of times the article is cited, SC for self-citations, RY for the year of review, PY for the publication year of the article and AA for adjusted appearances. The AA is calculated by the formula AA = 1/Number of signing authors of the article. This way, the ACP is the result of dividing the total number of external citations each article received by the number of years lapsed from the appearance of the article until the moment that the review is carried out, in this case, the year 2014 multiplied by the adjusted appearances.

The difference of this index to that of (Alireza et al., 2009) is that we exclude self-citations from the analysis. Then, the Adjusted Citation Impact (ACI) for each country is calculated in a similar way of that described by Alireza et al. (2009). The ACI is defined as follows. Given all the articles published by a county and are ranked in decreasing order of their ACP, the ACI value is the largest number such that the top x countries have at least in average a value of x for their ACP. This index indicates the number of top countries with a productive collaboration network.

Independent variables

Centrality degree: once we calculated the centrality degree for each LA-C country, to test the hypothesis we centered the variable centrality on 0 to make the value of the intercept

more interpretable. To do this, we subtracted the mean of centrality degree from the centrality degree of each LA-C country. This procedure revealed to what extent the LA-C countries increased their citation based performance per each point of centrality increase.

Density: density describes how strong the relationships between the members within the structure of a network are. We calculated the density dividing the total of the values of the relationships by the possible relationships. We calculated the density value for each country using the software Pajek (Batagelj & Mrvar, 1996).

Analysis

Figure 1 shows the structure of the LA-C international collaboration research network on management between 1990 and 2010. The density of the network is .108, which is considered high. The connectivity is 23.45, the clusterability .51, and the balance 6.43. These values of the collaboration network show a pattern of a network at a development stage with the prevalence of a Core - Periphery structure. The structure of the network is shaped by a core integrated by Brazil and Mexico. A periphery integrated with Argentina, Barbados, Bolivia, Colombia, Chile, Costa Rica, Cuba, Ecuador, Grenada, Guatemala, Guyana, Jamaica, Nicaragua, Panama, Peru, Uruguay and Venezuela, see Table 1.

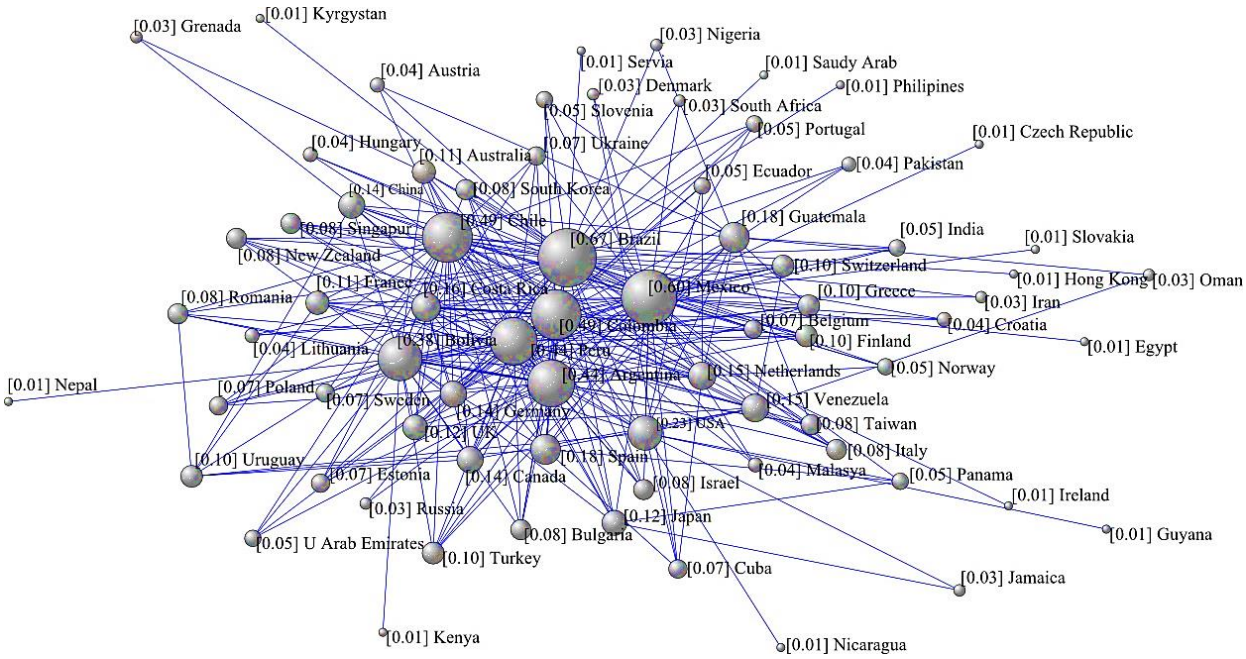

Figure 1. Latin American Research Collaboration network in the field of management. Value between brackets indicates the centrality degree.

Table 1 shows the descriptive of the variables in the study. Three countries, Brazil, Chile and Mexico account for 82.59% of the citation performance on the research on management in Latin America. Only nine LA-C countries received more than 100 citations counts in the 21 year time spam analyzed. Four countries received less than 10 citations.

Table 1

Scientific output, citation performance and centrality measures of 19 LA-C countries, N= 1,079.

Country	Scientific Output		Citation performance		Network values	
	N	%	Times Cited	ACI	Centrality degree	Density
Argentina	48	4.4	423	9.900	0.438	.033
Barbados	10	.9	124	4.454	0.001	.000
Bolivia	3	.3	109	8.000	0.386	.013
Brazil	476	44.1	3,929	21.714	0.671	.156
Colombia	74	6.9	231	4.000	0.493	.051
Chile	149	13.8	2,013	9.052	0.493	.077
Costa Rica	13	1.2	134	7.600	0.164	.014
Cuba	2	.2	1	.055	0.068	.002
Ecuador	4	.4	1	.142	0.054	.002
Granada	1	.1	4	.800	0.027	.001
Guatemala	1	.1	82	10.125	0.178	.006
Guyana	1	.1	49	2.526	0.013	.000
Jamaica	4	.4	17	1.000	0.027	.001
Mexico	148	13.7	1,867	11.125	0.602	.081
Nicaragua	4	.4	1	.166	0.013	.000
Panama	2	.2	17	.882	0.054	.001
Peru	20	1.9	147	9.900	0.438	.027
Uruguay	10	.9	87	2.076	0.095	.006
Venezuela	109	10.1	218	3.400	0.150	.017
Total	1,079	100	9,454			

Results and Discussion

We ran a Multiple Linear Regression (MLR) model to determine if Degree and Density of countries in the structure of the collaboration network predicted their Adjusted Citation Impact. The assumptions of linearity, normally distributed errors (Normality Test Shapiro-Wilk Passed p = 0,308), Constant Variance Test: Passed (p = 0,667), and uncorrelated errors were checked and met.

The right number of unit of observations for a MLR analysis with two independent variables would be 30. As our sample consist of 19 cases we checked the accuracy of the use of the MLR test taking into consideration two indicators 1) the Power of the test, and 2) the effect size. We defined as a desired value for power of .60 and a large effect size. According to these values the correct sample size should be 25 cases according to Newton and Rudestam (2013, see Table 11.1). The result of the MLR test shows a value of r= .769, and Power = .983. The sample size for these values is exactly 19 cases. Although, these values ensure the reliability of the results, as a precaution we ran the MLR test with bootstrapping to establish the confidence intervals for testing the research hypothesis.

The means and standard deviation, and inter-correlations can be found in Table 2.1. The ACI

is positively correlated to centrality degree. The association between ACI and density is negative which is a similar result as presented by Alireza, Chung, et al. (2012) for Information Science. There is a positive and significant correlation between the independent variables Degree and Density r= .570. In order to test for the existence of multi-collinearity, a check was made to see whether the tolerance value is lower than 1- R^2 (.667 > .408), with the conclusion being that there is no multi-collinearity between the independent variables. What's more, the variance's inflation factor is low 1.499, well below 10, which is the boundary value for defining whether the correlation between the independent variables poses a problem of collinearity.

Table 2.1

Means and standard errors for ACI and predictor variables Degree and Density (N = 19).

Variables	*Mean*	*Std. Deviation*	Degree	Density
ACI	4.598	4.015	.620**	-.14
Degree	.229	.227		.570***
Density	.026	.040		

*** p < .001.

The combination of centrality degree and density significantly predicted ACI F(2, 18)= 20.014, p = .001. The adjusted R^2 value was .541. This indicates that 54% of the variance in the Adjusted Citation Index of Latin American citation performance on management research was explained by the model. Power of performed test with alpha = 0,050: 0,983. According to Cohen (1988), this is a large effect. The variable Degree predicts significantly ACI. As the coefficient falls outside the lower limit of 8.587 (see Table 2.2), the associated p value is below .001 level, the first hypothesis is sustained.

Regarding the variable Density; although the p value shows a significant statistical result, when we observe the Confidence interval in Table 2.2, has a lower limit of -114.149, which is below zero, we conclude that the second hypothesis is not sustained. The beta weights, presented in Table 2.2, suggest that countries having higher centrality degree in their collaboration network contribute to achieving higher citation based performance on management research.

Table 2.2

Simultaneous Multiple Regression Analysis Summary for Degree and Density Predicting ACI (N= 19).

	B	*SEB*	*β*	BCa 95% Confidence Interval	
				Lower	Upper
Degree	16.604	3.448	.942**	8.587	42.449
Density	-55.343	19.414	-.557*	-114.149	-4.074
(Constant)	2.228	.900			

Note: R^2= .541 F(2, 18)= 20.014, p = .001.

** p < .001, p< .05.

Conclusion

The latent structure of the LA-C network of international collaboration in the research on management portrayed in the study, shows that it is composed of 75 countries with a structure of Core – Periphery type. Of the 19 Latin American countries that published at least one article in the time spam of the study, just Brazil and Mexico are located in the core. The LA-C international collaboration network structure shows cohesion according to its density value of .108, which is considered high.

The centrality degree of LA-C countries in the structure of the network predicts the 54% of the variance of their citation based performance. The theoretical explanation of this behavior could be found in the theory of the absorptive capacity. Tsai (2001) demonstrated that the higher the centrality of the enterprise in the network is, the better its absorptive capacity is. The LA-C countries take advantage of the research capacities of the countries with higher centrality in the international collaboration network. Thus, more central countries serve as a bridge for LA-C countries to get into the international conversation on management research.

The LA-C research on management shows a prevalence of technology assimilation through technological transfer above innovation or the generation of new knowledge. This makes the Latin American region an eminently receptive and not a transmitter of knowledge on the management discipline. The collaboration networks constitute a strategy of leverage for LA-C countries for their development of social capital. This is achieved by the links of LA-C researchers to the researchers coming from the most advanced countries in the research on management. Akcomak (2011) found the importance of the use of social networks for developing the social capital of researchers and the network's positive repercussion on their research performance.

The practical implications of the results indicate that as a strategy for fostering the citation performance of Latin American research on management the LA-C countries should focus their institutions and researchers on the solution of the main problems in the most advanced research fronts of the discipline in collaboration with researchers coming from the most central countries of the international research network of the discipline.

Finally, the study demonstrates that the evolution and future development of the structure of the collaboration network in the Latin American region depends on the generation of new knowledge on the most important research fronts of the management discipline, especially those concerning the advance of managerial performance.

Acknowledgements

The author thank Editor Naseri and two anonymous reviewers for their intuitive and insightful comments.

References

Acedo, F. J., Barroso, C., Casanueva, C., & Galán, J. L. (2006). Co-Authorship in Management and Organizational Studies: An Empirical and Network Analysis. *Journal of Management Studies, 43*(5), 957-983.

Akcomak, S. (2011). Social Capital of Social Capital Researchers. *Review of Economics and Institutions, 2*(2), 2-28.

Alireza, A., Altmann, J., & Hossain, L. (2011). Identifying the effects of co-authorship networks on the performance of scholars: A correlation and regression analysis of performance measures and social network analysis measures. *Journal of Informetrics, 5*(4), 594-607. doi: 10.1016/j.joi.2011.05.007

Alireza, A., Altmann, J., & Hwang, J. (2009). Evaluating scholars based on their academic collaboration activities: two indices, the RC-index and the CC-index, for quantifying collaboration activities of researchers and scientific communities. *Scientometrics, 83*(1), 1-13. doi: 10.1007/s11192-009-0139-2

Alireza, A., Altmann, J., & Hwang, J. (2010). Evaluating scholars based on their accademic collaboration activities: two indices, the RC-index and the CC-index, for quantifying collaboration activities of researchers and scientific communities. *Scientometrics, 83*(1), 1-13.

Alireza, A., Chung, K. S. K., & Hossain, L. (2012). Egocentric analysis of co-authorship network structure, position and performance. *Information Processing & Management, 48*(4), 671-679. doi: 10.1016/j.ipm.2011.09.001

Alireza, A., Hossain, L., & Leydesdorff, L. (2012). Betweenness centrality as a driver of preferential attachment in the evolution of research collaboration networks. *Journal of Informetrics, 6*(3), 403-412. doi: 10.1016/j.joi.2012.01.002

Badar, K., Hite, J. M., & Badir, Y. F. (2012). Examining the relationship of co-authorship network centrality and gender on academic research performance: the case of chemistry researchers in Pakistan. *Scientometrics, 94*(2), 755-775. doi: 10.1007/s11192-012-0764-z

Badar, K., Hite, J. M., & Badir, Y. F. (2014). The moderating roles of academic age and institutional sector on the relationship between co-authorship network centrality and academic research performance. *Aslib Journal of Information Management, 66*(1), 38-53. doi: 10.1108/ajim-05-2013-0040

Batagelj, V., & Mrvar, A. (1996). Pajek (Version 1.24) [Free for noncomercial use]: Vladimir Batagelj and Andrej Mrvar.

Cimenler, O., Reeves, K. A., & Skvoretz, J. (2014). A regression analysis of researchers' social network metrics on their citation performance in a college of engineering. *Journal of Informetrics, 8*(3), 667-682. doi: 10.1016/j.joi.2014.06.004

Cohen, J. (1988). *Statistical Power and Analysis for the Behavioral Sciences* (2 ed.). New Jersey: Lawrence Erlbaum.

de Nooy, W., Mrvar, A., & VBatagelj, V. (2008). *Exploratory Social Network Analysis with Pajek*. New York: Cambridge University Press.

Egghe, L. (2006). Theory and practise of the g-index. *Scientometrics, 69*(1), 131-152. doi: 10.1007/s11192-006-0144-7

Frenken, K., Hoolzl, W., & de Vor, F. (2005). The citation impact of research collaborations: the case of European biotechnology and applied microbiology (1988–2002). *Journal of Engineering and Technology Management, 22*, 9-30.

Heck, J., & Cooley, P. (1988). Most frequent contributors to the finance literature. *Financial*

Management, Autumm, 100-108.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proc Natl Acad Sci U S A, 102*(46), 16569-16572. doi: 10.1073/pnas.0507655102

Kamada, T., & Kawai, S. (1989). An algorithm for drawing general undirected graphs. *Processing Letters, 31*(1), 7–15.

Katz, R. L. (1994). Geographical Proximity and Scientific Collaboration. *Scientometrics, 31*(1), 31-43.

Liu, X., Bollen, J., Nelsonb, M. L., & Van de Sompel, H. (2005). Co-authorship networ ks in the digital library research community. *Information Processing & Management, 41*, 1462–1480.

Morrison, A. J., & Inkpen, A. C. (1991). An Analysis of Significant Contributions to the International Business Literature *Journal of International Business Studies, 22*(1), 143-153.

Newton, R. R., & Rudestam, K. E. (2013). *Your statistical consultant: Answers to your data analysis questions* (V. Knight Ed. 2 ed.). USA: SAGE Publications Ltd.

Otte, E., & Rousseau, R. (2002). Social network analysis: a powerful strategy, also for the information sciences. *Journal of Information Science, 28*(6), 441-453.

Peters, H. P. F., & Van Raan, A. F. J. (1993a). Co-Word-based maps of chemical engineering. Part I: representations by direct multidimentional scaling. *Research Policy, 22*(1), 23-45.

Peters, H. P. F., & Van Raan, A. F. J. (1993b). Co-word-based science maps of chemical engineering. Part II: Representations by combined clustering and multidimensional scaling. *Research Policy, 22*, 47-71.

Racherla, P., & Hu, C. (2010). A social network perspective of tourism research collaborations. *Annals of Tourism Research, 37*(4), 1012-1034. doi: 10.1016/j.annals.2010.03.008

Shane, S. A. (1997). Who is Publishing the Entrepreneurship Research? . *Journal of Management, 23*, 83-95.

Tsai, W. (2001). Knowledge Transfer in Intraorganizational Networks: Effects on Network Position and Absortive Capacity on Business Unit Innovation and Performance *Academy of management Journal, 44*(5), 996 - 1004.

Vogel, E. E. (1997). Impact factor and international collaboration in Chilean physics: 1987-1994. *Scientometrics, 38*(2), 253-263.