Replication note
Openness and Innovation Performance Revisited

Erik A. Mooi[1], Kenneth H. Wathne[2,y] and Ujwal Kayande[3,*]

[1] *University of Melbourne, Australia*
[2] *University of Stavanger and BI Norwegian Business School, Norway*
[3] *Melbourne Business School, Australia*

ABSTRACT

Firms increasingly source new ideas and knowledge from alliances with external partners. Laursen and Salter's (2006) seminal research shows that while such openness in innovation benefits firms, too much openness can have a negative effect on innovation performance. We provide a conceptual replication of this finding, relying on a unique longitudinal panel data set comprising three different innovation performance metrics: product and service innovations, process innovations, and marketing innovations.

Introduction

Innovation is central to firm growth, and an important area of research in marketing (Hauser *et al.* 2006). Increasingly, firms rely on alliances with external partners as sources of new ideas and knowledge (Wuyts and Dutta

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2012), resulting in a more 'open' innovation process (Chesbrough 2006). While firms can benefit from openness in the creation, use, and recombination of ideas and knowledge in relationships with external actors, concerns have been raised about 'over-search' and its potential negative consequences for innovation performance (Laursen and Salter 2006). Specifically, engaging in relationships with external partners in a range of different areas may expose a firm to too many ideas to manage and choose between, eventually resulting in a negative impact on innovation performance (Koput 1997).

This study is a conceptual replication of Laursen and Salter's (2006) seminal finding that while openness helps to improve innovation performance, too much of it can hurt. We operationalize openness as the range of functions for which the firm uses alliances, also referred to as the functional diversity of a firm's alliance portfolio (Jiang *et al.* 2010). Whereas Laursen and Salter (2006) examine the effect of openness on a firm's turnover relating to new and improved products, we extend the model by operationalizing innovation performance as a firm's innovations in three distinct areas; product and service innovations, process innovations, and marketing innovations. Consistent with Laursen and Salter (2006), we expect a curvilinear relationship between alliance portfolio diversity and innovation performance.

Method

Research Context

We rely on the expanded *Business Longitudinal Database* (BLD), maintained by the Australian Bureau of Statistics (ABS) and accessed through the ABS Remote Access Data Laboratory (RADL). The BLD contains yearly data (2006–2010) of 3,075 firms, randomly drawn from the population of Australian businesses. To allow for a representative sample, businesses were compelled to participate in the data collection under the Census and Statistics Act of 1905.

Dependent Variables

Innovation performance is operationalized using three separate measures: product and service innovation (if the business introduced any new or significantly improved goods or services); process innovation (if the business introduced any new or significantly improved operational processes or methods of manufacturing or producing goods or services); and marketing innovation (if the business introduced any new or significantly improved marketing methods

in the design or packaging of a good or service, or through changes in sales or distribution methods). All three measures were treated as binary ($0 = $ no, and $1 = $ yes), and aggregated over two sub-questions each.

Independent and Control Variables

The diversity of an alliance portfolio is operationalized as the number of functions for which the firm has alliances with external partners. Specifically, we count whether the business was involved with external partners in joint research and development, joint buying, integrated supply chain, joint marketing or distribution, and/or other cooperative agreements. To test for the quadratic effect, we added a squared term of this count.

We also included a series of control variables. Firm size is a categorical variable measuring number of full-time employees ($0 = \mathrm{non-employer}$, $1 = 1-5$ employees, $2 = 5-20$ employees, $3 = 20-199$ employees). Other control variables include the age of the firm (the log of the number of years the business has been in operation), the scope of a firm's selling activities (the number of markets in which the firm operates), a dummy if the firm was mainly active in business-to-business markets, and year and industry dummies (to account for unobserved heterogeneity). See Tables 1 and 2 for correlations and descriptive statistics.

Models

To accommodate the three binary dependent variables and repeated observations over time, we deployed random-effects Logit panel models. We estimated three separate models with the three measures of innovation performance as the dependent variable, and the alliance portfolio diversity (squared) plus all aforementioned controls as independent variables.

Results

Findings

As shown in Table 3, we find that openness has an inverted u-shaped relationship with innovation performance, regardless of the innovation performance measure used. The main effects of alliance portfolio diversity are all positive and significant ($p < 0.01$), while the quadratic terms are all negative and significant ($p < 0.01$). The model with quadratic effects provides a better fit to the data than a main-effects only model, as indicated by lower AIC and BIC values.

Table 1: Measures.

Measure	Items
Product and service innovation	Did this business introduce any new or significantly improved (Tick all that apply) 1. Goods 2. Services
Process innovation	Did this business introduce any new or significantly improved operational processes (Tick all that apply) 1. Methods of manufacturing or producing goods or services 2. Other operational processes
Marketing innovation	Did this business introduce any new or significantly improved marketing methods (Tick all that apply) 1. Changes to the design or packaging of a good or service 2. Sales or distribution methods
Alliance portfolio diversity	Was this business involved in any of the following collaborative arrangements during the year ended 30 June (Tick all that apply): 1. Joint research and development 2. Joint buying 3. Integrated supply chain 4. Joint marketing or distribution 5. Other cooperative arrangements
Firm size	Number of persons working for this business during last pay period ending in June
Firm age	As at 30 June, how many years had this business been in operation regardless of changes in ownership 1. Less than 5 years 2. 5 years to less than 10 years 3. 10 years to less than 20 years 4. 20 years or more

(*Continued*)

Table 1: (*Continued*)

Measure	Items
Scope of firm's selling Activities	How would you describe all markets in which this business operated during the year ended 30 June (Tick all that apply)
	1. Local (immediate area, town or city)
	2. Outside of the local area but within the state/territory
	3. Outside of state/territory but within Australia
	4. Overseas
Mainly active in B2B	Was the main source of income from sales of goods or services for this business during the year ended 30 June from other businesses or organisations?

Note: A full description of the data is available on http://bit.ly/1FeXOwC, accessed on the 22nd of October 2015.

Post-hoc Tests

We conducted several robustness tests to ensure that our results were not sensitive to our choice of analysis. First, we used a random-effects model, which is more efficient than a fixed-effects model but may result in biased estimates. A Hausman test ($p < .10$) supports our choice of model (Greene, 2003).

Our three dependent variables each consists of two binary indicators. Disaggregating these into two separate random-effects Logit panel models could reveal heterogeneity. Therefore, we estimated six separate random-effects panel Logit models, the results of which are substantively consistent with our main findings. We include the correlations of all disaggregated innovation and portfolio measures in the Web Appendix.

We also considered if there were any interactions between alliance portfolio diversity (and its squared term) and the aforementioned control variables. Except for a significantly negative interaction effect of firm age and alliance portfolio diversity ($p < .05$), no other effects were significant.

The expected effects of alliance portfolio diversity (squared) on the three dependent variables could also be lagged. BIC and AIC fit statistics indicate that that the best fit is provided by instantaneous effects. We also considered changes in alliance portfolio diversity as an independent variable, but found no significant effects. Finally, we considered if changes in innovation affect the alliance portfolio, but again found no effects.

Table 2: Correlations and other descriptive statistics.

	Product and service innovation	Process innovation	Marketing innovation	Alliance portfolio diversity	Firm size	Firm age	Scope of firm's selling	Mainly active in B2B
Product and service innovation	—							
Process innovation	.351	—						
Marketing innovation	.326	.284	—					
Alliance portfolio diversity	.145	.127	.116	—				
Firm size	.167	.166	.171	.140	—			
Firm age	-.040	-.022	-.068	.065	.139	—		
Scope of firm's selling activities	.125	.159	.160	.138	.185	.081	—	
Mainly active in B2B	.010	-.076	.027	-.028	-.035	-.046	-.302	—
Mean	.184	.134	.098	.197	.921	4.553	.029	.371
Standard deviation	.388	.341	.297	.590	.276	1.846	.278	.483
Minimum	0	0	0	0	.693	1	-.250	0
Maximum	1	1	1	5	1.386	8	.750	1

Description: The descriptives above are derived from careful, population-representative sampling, as conducted by the Australian Bureau of Statistics over the period 2006–2010.

Table 3: Random effects logit panel estimates of alliance portfolio diversity on innovation performance.

	Innovation performance		
	Product and service innovation	Process innovation	Marketing innovation
Alliance portfolio diversity	.904(.124)***	.837(.128)***	.677(.143)***
Alliance portfolio diversity squared	−.167(.041)***	−.152(.042)***	−.107(.045)***
Firm size	1.642(.167)***	1.744(.173)***	2.212(.207)***
Firm age	−.253(.043)***	−.097(.045)**	−.160(.053)***
Scope of firm's selling activities	1.297(.159)***	1.218(.167)***	2.066(.199)***
Firm mainly active in B2B	.126(.097)	−.071(.104)	.580(.119)***
Year fixed effects	Included	Included	Included
Industry fixed effects	Included	Included	Included
Constant	−1.512(.356)***	−4.447(.402)***	−5.012(.457)***
Statistics:			
N	10472	10472	10472
Wald Chi^2	436.32 ($p < .01$)	680.73 ($p < .01$)	578.79 ($p < .01$)
Likelihood-ratio test of	Chi$^2 = 683.54$,	Chi$^2 = 455.23$,	Chi$^2 = 385.23$,
rho $= 0$	$p < .01$	$p < .01$	$p < .01$

Note: $^*p < .1$; $^{**}p < .05$; $^{***}p < .01$, two-sided tests. Standard errors are reported in parentheses adjacent to coefficients.

Discussion

This paper replicates Laursen and Salter's (2006) seminal work on open innovation, in a different research context, using different operationalizations of the focal independent and dependent variables. Consistent with Laursen and Salter (2006), we find an inverted U-shaped relationship between 'openness' and innovation performance. The results suggest that while the shift among firms to an 'open innovation' model (Chesbrough 2006) has benefits, too much exposure may eventually have a negative impact on innovative performance.

While Laursen and Salter (2006) focus on the fraction of a firm's turnover relating to new and improved products, we find similar effects for product and

service innovation, process innovation, and marketing innovation. Moreover, whereas Laursen and Salter (2006) use cross-sectional data to show instantaneous effects, we observe consistent results in a longitudinal setting. Finally, while Laursen and Salter (2006) analyzed firms that have an average of 62 employees, most of the firms in our sample have between 5 and 20 employees, indicating that the findings generalize to smaller firms with the attendant capacity constraints in leveraging alliances for innovation.

Limitations and Issues for Further Research

While we focus on the diversity of an alliance portfolio, other indicators of openness should be considered in future research. Moreover, our secondary data source only provides a measure of the diversity of the alliance portfolio, not the depth of these relations which is a limitation of the current study. Finally, our measure of marketing innovation is not exhaustive. On a positive note, despite the limitations of our measures, we were still able to demonstrate robust effects, consistent with the original study.

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Author/s:
Mooi, EA; Wathne, KH; Kayande, U

Title:
Openness and Innovation Performance Revisited

Date:
2016-10-19

Citation:
Mooi, E. A., Wathne, K. H. & Kayande, U. (2016). Openness and Innovation Performance
Revisited. Journal of Marketing Behavior, 2 (1), pp.69-76.
https://doi.org/10.1561/107.00000028.

Persistent Link:
http://hdl.handle.net/11343/119604

File Description:
Published version