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Rethinking the role of collaborative product innovation: Antecedents, consequences and multiple external stakeholders

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Abstract: Investigating the associations between interorganisational relationship– and innovation-oriented antecedents and consequences of cooperative multi-stakeholder product innovation and their effects on overall firm performance of Australian manufacturing firms, we found that involving external stakeholders in product innovation indirectly enhanced the quality of stakeholder relationships, but did not predict market- or technical-based product innovation outcomes as hypothesised. The key driver of overall firm performance was market-driven product innovation performance, which was predicted by product innovation strategy and product innovation spending. Our results suggest the need for simultaneous consideration of product innovation- and multiple external stakeholder-based strategic orientations in enhancing business success.

Keywords: multiple stakeholders; interorganisational relationships; stakeholder orientation; relationship quality; product innovation strategy; product innovation performance; collaborative product innovation; firm performance; structural equation modelling; partial aggregation.

Academic interest in analysing the relationship between innovative performance of small firms and their recourse to external resources, especially through interorganisational relationships (IORs) has been growing over the last ten to fifteen years. To date the emerging literature has given limited attention to the systematic empirical assessment of the relationship *and* innovation inputs and outputs of cooperative product innovation. Furthermore, most of the literature focuses on cooperative innovation IORs with customer stakeholders, ignoring the potential role played by other external stakeholder groups, such as suppliers, industry partners and research/advisory organisations.

In this paper we provide a first quantitative investigation of a strategy-structure-performance-based model of cooperative product innovation IORs with multiple external stakeholders. The model is tested in the Australian manufacturing context. Mature industries in developed countries, such as manufacturing in Australia, pose a range of challenges for policy makers and managers. Insights in this respect are important, as they help to inform decision makers on the strategies appropriate to enhance the effectiveness of cooperative stakeholder relationships for innovation.

The paper is structured as follows: First, the research model is outlined and testable hypotheses regarding the multi-stakeholder context of cooperative product innovation are derived from past studies. Second, the data set and methodology employed are summarised. Third, the results of the statistical analysis are presented and, finally, the implications of the results are discussed.

1 Theoretical framework and hypotheses

Although recognition of the interactive nature of much technological development and corporate behaviour has been relatively recent, it has been compensated for in its tardiness by considerable variety and depth of analysis [1]. There is now an increased awareness of the potential benefits of sharing resources and knowledge when developing and applying innovations and new technology, such as achieving innovative success [2-5]. A growing number of researchers are contributing to the literature on collaborative innovation involving a range of single external stakeholders, e.g. *suppliers* [6-14], *competitors* [15, 16], *customers* [17-22] and *research organisations* [23]. Several studies have attempted to capture *multiple* stakeholder groups contributing to a firm's product innovation [24-33].

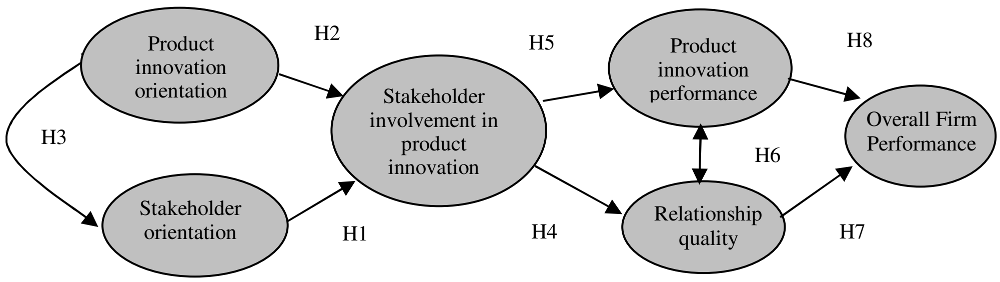
Of the studies which have examined the role of cooperative innovation within a structural model, only three consider both antecedents and consequences [25, 34, 35]. Of these, none have attempted to distinguish economy and polity antecedents *and* consequences of cooperative innovation, as suggested in Robicheaux and Coleman's [36] model of channel relationship structure. Walter [37] and Yli-Renko, Autio et al. [35] employed IOR-specific antecedents. Yet they view relationship quality (or elements thereof) as a determinant of cooperative innovation rather than as an IOR performance variable, as posited by Robicheaux and Coleman's.

A *systems* approach linking the antecedent (strategy) and consequent (performance) variables to cooperative product innovation (structure) has not been attempted to date. Such a model would provide clarity on the interrelationships between the constructs and partly answer calls by marketing researchers [38] to examine which marketing strategies (e.g. stakeholder relationship orientation) will lead to higher performance for a given innovative posture. Hence, our research was motivated by the need to contribute a systems-based model of IOR- and innovation factors to the literature on multi-stakeholder cooperative innovation.

Model development and specification

Our model was informed by a review of extant IOR, product innovation and cooperative innovation literature and prior models of cooperative IORs, notably Robicheaux and Coleman's [36] strategy-structure-performance (SSP)-based conceptual model of marketing channel relationship structure. Figure 1 presents our basic six-factor structural model of cooperative IORs with multiple external stakeholders in product innovation and the eight main hypotheses.

Figure 1 The research model of IORs for cooperative product innovation



The central structural construct in the research model was stakeholder involvement in product innovation (also referred to as cooperative product innovation). Its strategy-related antecedents were stakeholder orientation, product innovation orientation and product innovation spending. The performance-related constructs (consequences) were relationship quality, market-oriented/technical-oriented product innovation performance, overall firm performance. To address the need for a multi-stakeholder perspective, the three IOR-oriented constructs were specified for each of the four external stakeholder groups most likely to be involved in a manufacturer's product innovation – customer, supplier, industry partner and research/advisor). In the following eight hypotheses we sought to systematically examine the role of cooperative product innovation in relation to its hypothesised antecedents and consequences.

Antecedents of cooperative product innovation

In the empirical IOR literature it has been argued that high performing firms tend to maintain a richer, broader, and more complex network of ongoing relationships with people both within and outside the firm [39]. Only those firms, whose culture allows for the openness necessary for collaborative ties to thrive, are capable of engaging in in-depth coordination and collaborative activities [40].

This notion finds support in the product innovation context. For instance, Dougherty [41] observed that successful product innovators spend a great deal of time 'up front' learning about each other and, consequently, were able to work together very quickly. In his research on technological networking, Håkansson [26] found that familiarity with a partner is a precursor to cooperation. If two companies are important to one another in terms of volume of exchange, they are also likely to be important in a technological context. In other words, firms collaborate in the first instance with well-established and familiar customers and suppliers. Similarly, Yli-Renko, Autio et al. [42] concluded that the greater the social interaction (in terms of maintaining close social relationships and knowing the people personally) between a key customer and a young technology-based firm, the greater will be the focal firm's knowledge acquisition from that relationship. This leads us to the following hypothesis:

> *Hypothesis 1 There will be a significant positive association between a firm's stakeholder orientation toward each stakeholder group and its involvement of this stakeholder in product innovation.*

Stakeholder relationships and strategic resource allocation decisions are inseparable, because how managers distribute resources inevitably has implications for the strength of stakeholder relationships [43]. Various authors have offered informative empirical insights into the nature of an organisation's innovation orientation (or innovation strategy) and its degree of stakeholder involvement in innovation. Many propose a positive relationship [44-47], others say the link is inconclusive [24, 26], especially if technological orientation is focused on R&D expenditure. A broader view of product innovation orientation, i.e. one which reflects a firm's strategic posture for innovation, is more likely to be positively associated with collaborative innovation. In the case of product innovation this means that if a firm can articulate its product development strategy and conceptualise its new/improved products, it can also make better use of external participation in the innovation process. Therefore:

Hypothesis 2 There will be a significant positive association between a firm's product innovation orientation and its involvement of each stakeholder group in product innovation.

A number of empirical studies have associated product innovation orientation with a market (or customer) orientation, i.e. a single stakeholder view [48-50]. A broader-based, multi-stakeholder view of stakeholder orientation and its relationship with successful innovation can also be found in the innovation literature [47, 51]. More innovative firms tend to have an outward orientation dominated by clients, suppliers and consultants. They appear to be more concerned with longer-term, qualitative gains in flexibility and service. By contrast, less innovative firms are more "cautious, conservative and rather inwardly oriented" [52]. Firms expecting more technological turbulence, i.e. those facing greater innovation challenges, appear to involve more internal and external stakeholders in the planning process than those who do not anticipate technological turbulence [53]. The research findings summarised above provide support for the view that a firm's strategic posture for product innovation tends to coincide with one that recognises the importance of IORs with key stakeholders. We propose the following:

Hypothesis 3 There will be a significant positive association between a firm's stakeholder orientation toward each stakeholder group and its product innovation orientation.

Consequences of cooperative product innovation

Robicheaux and Coleman's [36] theoretical model of IOR structure captures the linkage between relational structure, including operational integration and polity performance, including relationship quality. The authors proposed a feedback loop between IOR structure and performance. Hence, while operational integration leads to relationship quality, the reverse is also possible. In line with the Confucian saying '*first we try, then we trust*' most of the literature supports the view that relationship quality is predicted by information exchange [54-58] and/or cooperation [59, 60]. The opposing view focuses on relational performance affecting structure [37, 61-63]. The existence of a two-way, mutually reinforcing relationship between the two concepts has also been advanced [54, 64, 65].

This discussion points to a lack of consensus in the IOR literature regarding directionality of the stakeholder involvement-relationship quality relationship. Extant literature does not advance this issue. While support for a bi-directional association is given by Smith et al. [41], two other studies have focused on the one-way relationship between external collaboration and relationship performance [26, 66]. This discussion suggests the need to test the one-way external collaboration-relationship performance association in the context of product innovation involving multiple stakeholders.

Hypothesis 4. There will be a significant positive association between a firm's involvement of each stakeholder group in product innovation and relational quality with this stakeholder.

The nature of the relationship between collaborative innovation relationships and innovation outcomes has received a great deal of attention in the literature of the past three decades. Reviewing research from the 1960s on the sources of innovation success, Freeman [67] concluded that "both empirical and theoretical literature has long demonstrated the importance for successful innovation of both external and internal networks" (p. 501). Our review of more recent interactive innovation literature also found considerable empirical support for the idea that aspects of a firm's product innovation performance are enhanced by cooperating with single [e.g. 68, 69, 70] and multiple [e.g. 25, 29, 71] stakeholder groups in innovation activities. One aim of our study was to test this relationship using enhanced measures of stakeholder involvement and product innovation performance for each of the four distinct stakeholder groups. Therefore:

> *Hypothesis 5. There will be a significant positive association between a firm's involvement of each stakeholder group in product innovation and its product innovation performance.*

According to Robicheaux and Coleman's model, polity performance (relationship quality) and economic performance (such as product innovation performance) are consequences of relationship structure (stakeholder integration in product innovation). However, the authors concede that the link between polity and economic performance is problematic. Are a focal firm's relationships with key innovation stakeholders satisfactory because its innovation performance is strong or is innovation performance strong because the relationships are satisfactory? Support for a bi-directional path is found in the IOR literature [72, 73]. Within the cooperative innovation literature, several studies suggest links between aspects of product success and quality of relationships with single stakeholder groups, though directionality is not investigated [74-76]. We propose the following:

> *Hypothesis 6 There will be a significant positive association between a firm's relationship quality with each stakeholder group and its product innovation performance.*

Quality relationships with a wide range of stakeholders are an essential benchmark of relative business success [77, 78]. Jones [79] and Berman, Wicks et al. [43] argued that that firms which have long-term, mutually trusting relationships with a relatively small number of stakeholder can significantly reduce costs and, therefore, outperform firms that have relatively brief stakeholder relationships. Other evidence for a positive impact of single-stakeholder relationship quality on aspects of firm performance can be found in the IOR literature [63, 72, 73, 78, 80, 81]. We sought to test this in a multi-stakeholder cooperative product innovation context through the following hypothesis:

> *Hypothesis 7 There will be a significant positive association between a firm's relationship quality with each stakeholder group and overall firm performance.*

Numerous studies have shown that successful firms emphasise financial management and not new product development [e.g. 82]. However, without efforts aimed at product development, it is generally accepted that these firms might experience performance declines in the long run. Firms that continue to develop and market new products (thereby meeting changing customer needs) are likely to perform better than firms that are less tuned to their customers [83]. For example, in Booz, Allen and Hamilton's [84] classic study it was found that the most successful companies make a consistent commitment of resources to new product development. Market share growth has also been linked to product innovation in terms of high rate of product introduction and R&D intensity [38].

However, the practical calibration of the linkage between a firm's product innovation performance and its overall performance is difficult, as recognised by Hart and Craig [85] and Hart [86]. Hart's examination into whether new product development success can be measured accurately by using measures of overall financial success produced inconclusive results. Her direct and indirect measures tended to show positive associations with *either* average profits *or* with sales growth. Moreover, given the investment required to make new products successful, there is probably no benefit from measuring financial performance at the company level for the same period as new product-related activities [86]. Some empirical support for a direct association between aspects of product innovation performance and firm success was found in the cooperative innovation literature [25, 45, 83]. This leads us to the final hypothesis:

Hypothesis 8. There will be a significant positive association between a firm's product innovation performance and overall firm performance.

2 Methodology

Sample and data collection

Strategic-level data was required for this research and was obtained as follows. A sample of 425 suitable small and medium-sized manufacturing enterprises (SMMEs) was developed from a sampling frame of 525 members of three manufacturing industry associations. To obtain the strategic-level data required, we surveyed the firm's CEO/General Manager. Standard questionnaire design actions and response management strategies were implemented to address the typical problem of non-response error associated with mail surveys, particularly those targeted at senior managers. We received 151 completed questionnaires, of which 31 were deemed not useable because of missing data or inadequate manufacturing activities. Thus, the effective response rate was 28.2% (120/425). This is comparable with response rates achieved in similar recent studies, e.g. 10% to 14% in an innovation study of US and German auto manufacturing firms [87] and 27% in a study of innovation performance in small Australian firms [88].

The majority of responses (60%) were received from all six classes of the machinery and equipment sector; the remaining responses related to organizations with 'other' manufacturing activities. These sample percentages are approximately representative of the actual manufacturing enterprise population reported by the Australian Bureau of Statistics (ABS) [89]. An exception was the motor vehicle and parts manufacturing sector, which represented one-third of the sample compared with 9% of the actual population [89]. This sector was of particular interest to us because of its R&D record and the pressures to lift competitiveness in the face of growing competition from China and other emerging markets.

Measure development

Measures for 16 constructs were drawn from the extant literature. The three IOR-related measures (stakeholder orientation, stakeholder involvement in product innovation, relationship quality) were measured for each of the four stakeholder groups (customer, supplier, industry partner and research advisory organisation), resulting in 12 measures. In addition we had four non-IOR measures - product innovation orientation, product innovation performance (technical-oriented), product innovation performance (marketing-oriented) and overall firm performance. Two single-item ratio-scaled measures were also included in the model – three-year sales growth (an alternative measure of overall firm performance) and relative product innovation spending[1] (an alternative measure of product innovation orientation). Measures were developed in line with recommended scale development guidelines [e.g. 90, 91]. Table 1 presents the measures and their sources.

The two-step SEM process

A two-step structural equation modeling (SEM) approach was followed, i.e. one that maximises the interpretability of both measurement and structural models [92, 93]. The first step involved confirming the falsifiability of the constructs and variables embedded in the propositions and hypotheses as per Bacharach [94] by *separate* estimation and, where necessary, respecification of the measurement model [92]. The second step in the two-step SEM process was the simultaneous estimation of the measurement and structural submodels [92]. The two steps were not independent, because the estimated paths that link measured items to constructs were involved in computing the structural path estimates. Fit was assessed twice, once for measurement and once for the structural model [93].

Sample size provides the basis for the estimation of sample error and impacts on the ability of the model to be correctly estimated [93]. Bentler and Chou [95] suggest that in SEM the sample size requirements vary for measurement and structural models. For measurement models, a ratio of ten responses per free parameter [95] or ten subjects per item [96] are required to obtain trustworthy estimates. In this research, each of the constructs to be measured had four to seven indicators, i.e. eight to fourteen parameters. Applying Bentler and Chou's rule of thumb, a sample size of 80 to 140 would have been required. Applying Flynn and Pearcy's [96] rule of thumb, a sample size of 40 to 70 sufficed. Hence, the split sample (n = 60) used to cross-validate the model met Flynn and Pearcy's criterion, but fell just below Bentler and Chou's rule.

A ratio of five responses per free parameter is required to obtain trustworthy estimates for a structural model [95]. With a total (maximum) of 153 observables or indicators, i.e. maximum of 306 free parameters, the effective sample size required to test the trustworthiness of the model would be 1530, compared to the 120 achieved. Data reduction was achieved through partial aggregation [97]. This permitted the separate (four stakeholder) dimensions of the three multi-stakeholder or IOR constructs to be retained. It also permitted a model assessment that was less distracted by accumulated error, owing to the large number of items used in the model.

Under partial aggregation each of the 16 constructs of interest was operationalised using a multi-item scale. Unidimensionality was assessed at the facet (first-order construct) level (e.g. for *each* of the four stakeholder groups – customer, supplier, industry partner and research/advisor), rather than for the entire scale, as per Kumar, Stern et al. [73]. Following scale purification, validation (evidence of unidimensionality, convergent and discriminant validity) and cross-validation of the construct or measurement model, all the variables loading highly on each of the measurement models were combined using the simple average unit weighting, and the average score of variables was used as the replacement variable. In other words, new variables were created by replacing each measurement model with a single summated scale or composite. Given a sample size of 120, the resulting 18-variable model (including the

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[1] Total product innovation spending (R&D, acquisition of technology, product introduction-related training, expenditure for tooling-up, marketing and other spending associated with product innovation) adjusted for sales.

two single-item measures) provides an acceptable seven cases per measured variable, compared with Bentler and Chou's [95] requirement of five cases per parameter.

Measure validation

Unidimensionality of measures was gauged by using confirmatory factor analysis (CFA), a methodology which assesses the internal and external consistency of a construct [98]. A first order CFA was run for each construct (measurement model), whereby every item was restricted to load on its a priori specified factor [99]. Further evidence of unidimensionality was provided if none of the measurement errors were correlated and the goodness-of-fit measures indicated adequacy of a model fit [98]. Specifically, the incremental fit measures goodness-of-fit index (GFI) index and comparative fit index (CFI) of $\geq$ 0.90 for each measurement model conveyed strong evidence of unidimensionality [99]. Absolute fit indices recommended for use when evaluating SEM models are chi-square (χ^2) p>0.05, normed chi-square (χ/df^2) 0.5 to 3.0 [100], standardised Root Mean-square Residual (SRMR) $\leq$ .05 [93] and Root Mean-Square Error of Approximation (RMSEA) $\leq$ .10 [93, 101]. The fit indices reported in the Appendix indicate that all the models met these acceptable levels for these values and, hence, fitted the data well. An exception was the measurement model for technical-oriented product innovation performance, which was just-identified and could not be fully evaluated.

Reliability was assessed in terms of repeatability using split-sample cross-validation, as recommended by Anderson and Gerbing [92]. Following recommendations [93, 102-104], composite reliability and average variance extracted (AVE) was computed for every multiple indicator construct in this research. Acceptable levels used for composite reliability were $\geq$ 0.70 and $\geq$ 0.50 for AVE. As shown in Table 2, all constructs met these levels of acceptability.

Convergent validity was indicated by significant standardised latent variable loadings of 0.7 or higher [92, 93]. All items loaded on their respective constructs, and each loading was large and significant at the .01 level. Discriminant validity was tested by comparing the variance-extracted percentages for any two constructs with the square of the correlation estimate (r^2) between those two constructs [104]. The variance-extracted estimates of all paired constructs used in the research was greater than the squared correlation estimate [93, 105], hence the measures passed the discriminant validity test.

Table 1 Details of measures

Stakeholder Orientation (SO) measured for each single top customer, supplier, industry partner and researcher/advisor firm	
[New items based on 53, 63, 106, 107-109];	We collect information about this firm on an ongoing basis We understand the needs and interests of this firm We consult with this firm in developing our business strategy There is a widely shared belief in our business that excellence should be achieved in serving the interests of this firm Our relationship with this firm is important
Stakeholder Involvement in Product Innovation (SIPI) measured for each single top customer, supplier, industry partner and researcher/advisor firm	
[New items based on 26, 35, 62, 72, 110-112]	We provide technical assistance to one another (e.g. problem-solving, education, product trials) The following stages of our project innovation process are undertaken jointly: a) strategic planning for new product opportunities b) concept generation c) screening (technical and market) d) technical development and marketing planning e) commercialisation (test market, launch) Our innovation activities are well-coordinated Monitoring is carried out in technical development & marketing planning (d) and commercialisation (e) to ensure expected performance Involving this firm in our process of finding, developing and commercialising new products is important to us
Relationship quality (RQ) measured for each single top customer, supplier, industry partner and researcher/advisor firm	
[based on 37, 58, 113, 114-120]	Problems that arise in this relationship are treated as joint rather than individual responsibilities There is a high level of trust Flexibility in response to requests is a characteristic of this relationship We expect our relationship to last a long time A strong spirit of fairness exits in our relationship We place long-term cooperation before short term profit Overall, we are very satisfied with our relationship
Product Innovation Orientation (PIO)	
[New items based on 47, 49, 121-126];	Focus on marketing of innovations Actively initiating new product idea search Actively anticipating market needs Being the first to introduce new products Developing new innovative products Importance of product innovation to firm
Product Innovation Performance (PIP) *technical*-oriented	
[New items based on 86, 127];	New product quality has improved Technological breakthroughs achieved Technological superiority of product introductions
Product Innovation Performance (PIP) *market*-oriented	
[New items based on 28, 124, 125, 128-130]	Relative regularity of product introductions Relative market response to product introductions Profitability of product introductions Market share success of product introductions
Satisfaction with Overall Firm Performance (OFP)	
[Based on 131]	Overall business performance Market share Net profit Return on investment

Table 2 Fit indices

	Composite Reliability	AVE	P	χ^2/df	SRMR	RMSEA	GFI	CFI
Stakeholder Orientation (SO)*	.79 to.96	.60-.85	.36-.83	.19-1.10	.01-.06	0-.04	.95-.99	.95-1.00.
Stakeholder Involvement in Product Innovation (SIPI)	.90 to .97	.59-.87	.18-0.47	.96-1.71	.01-.04	0-.10	.95-.97	.98-1.00.
Relationship Quality (RQ)*	.89 to .98	.63-.90	.11-.84	.18-1.79	.01-.02	0-.08	.95-.99	.99-1.00
Product Innovation Orientation (PIO)	.89	.57	.49	.03	.04	0	.96,	1.00
Product Innovation Performance (PIP) *technical*-oriented	.85	.65	no fit indices available, as just-identified with three items.					
Product Innovation Performance (PIP) market-oriented	.91	.72	.33	1.118	.02,	.04	.98	.99
Satisfaction with Overall Firm Performance (OFP)	.89	.67	.52	.65	.02	0	.99	1.00

* measured for single top firm in each of four stakeholder groups – customers, suppliers, industry partners, researcher/advisor

3 Analysis and results

The second step in the two-step SEM approach involved assessing the structural models, which specified hypothesised relations among the theoretical constructs or measurement models [93, 132, 133]. The overall (multi-stakeholder) structural model was tested using SEM AMOS software. Initial fit of the hypothesized model was not satisfactory with all indices exceeding the values indicative of good fit. First attempts at model estimation often result in a poor fit [92], indicating the need for revision (respecification) of the structural model [95, 100, 133].

Model modification was guided by an examination of modification indices [100, 134] and supported by sound theoretical rationale as recommended in the SEM literature [93, 95, 100]. In the original model, it was hypothesised that any effect of product innovation orientation on product innovation performance (technical and market) would be mediated by the involvement of stakeholders in product innovation. Stakeholder involvement in product innovation was also hypothesised to mediate the association between stakeholder orientation and quality of relationships with those stakeholders. The model diagnostics (modification indices) that led to testing a revised model called into question the hypothesised fully mediating nature of these three relationships. Furthermore, while the posited relative product innovation spending to product innovation orientation path was not supported, model diagnostics suggested a path from relative product innovation spending to technical-oriented product innovation performance. The model was respecified to include the following four post-hoc theorised paths so as to test their direction and significance:

PH1: Product innovation orientation is positively associated with technical-oriented product innovation performance.

PH2: Product innovation orientation is positively associated with market-oriented product innovation performance.

PH3: Stakeholder orientation is positively associated with relationship quality.

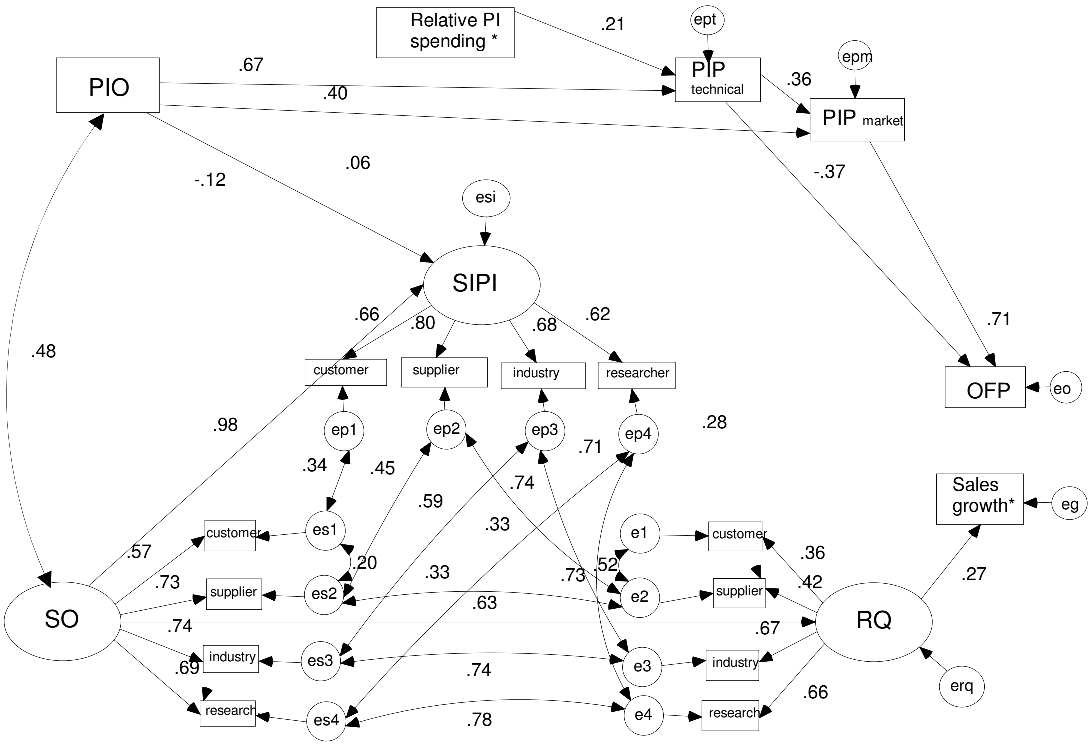
PH4: relative product innovation spending positively associated with technical-oriented product innovation performance.

Furthermore, the use of error correlations between error terms for the 12 composites for the three IOR based constructs was suggested by the modification indices. In spite of proven discriminant validity, these variables had the same measurement scale and represented a series of questions on different aspects of a related topic, i.e. the nature of the interorganisational relationship. In addition, when classifying their attitudes toward their relationship with the top firm in each stakeholder group, the respondent had answered the questions relating to each stakeholder group in the same way. These two reasons provided theoretical support for the use of correlated errors [135-137].

A mostly acceptable fit to the data was found with the post-modification model with critical fit indices falling within acceptable limits: Normed Chi-Square χ^2/df = 1.37; CFI = 0.97. The residual fit indices provided further evidence of satisfactory fit (RMSEA = 0.06; SRMR = 0.06). The probability of significant difference between the observed (empirical) **S** and estimated (implied) Σ covariance matrices was calculated (p = .006). The final model for the overall (multi-stakeholder) model showing significant standardised coefficients is presented in Figure 2. It contains 12 paths significant at $P \leq .05$ and one path (product innovation orientation to stakeholder involvement in product innovation) with a lower significance level (p = .08).

Tables 3 and 4 summarise the model results in relation to the research hypotheses and *post-hoc* research hypotheses respectively. The predicted direction of association, standardised coefficients for direct, indirect and total effects, direct effect significance levels, any mediating variables and overall findings are shown.

Figure 2 Final overall (multi-stakeholder) model of IORs for cooperative product innovation



* single item

Table 3 Summary of model results in relation to research model hypotheses

Hypotheses			*Direct effect*		*Indirect effect std. coeff.*	*Mediating variable*	*Total effect std. coeff.*	*Finding*
No.	*Association*	*Direc -tion*	*Std. coeff.*	*Signifi- cance level*				
H1	SO – SIPI	+	.98	*0*	0		.98	Accept
H2 (a)	PIO – SIPI	+	-.12	*.079*	.47	SO	.36	Reject (see PH 1, 2)
H2 (b)	Relative PI spending – SIPI	+	-.03	*.563*	0		-.03	Reject (see PH 4)
H3 (a)	PIO – SO	+	.48	*0*	0		.48	Accept
H3 (b)	Relative PI spending – SO	+	.06	*.144*	0		.06	Reject
H4	SIPI – RQ	+	.28	*.267*	0		.28	Reject (see PH 3)
H5 (a)	SIPI – PIP *technical*	+	.05	*.514*	0		.05	Reject (see PH 1,4)
H5 (b)	SIPI – PIP *market*	+	.09	*.255*	.01		.10	Reject

Hypotheses			*Direct effect*		*Indirect effect std. coeff.*	*Mediating variable*	*Total effect std. coeff.*	*Finding*
No.	*Association*	*Direc -tion*	*Std. coeff.*	*Signifi-cance level*				
								(see PH 2)
H6 (a)	RQ - PIP *technical*	+	.01	*.906*	0		.01	Reject
H6 (b)	RQ - PIP *market*	+	-.02	*.288*	0		-.02	Reject
H7 (a)	RQ – OFP	+	.09	*.528*	0		.09	Reject
H7 (b)	RQ – Sales growth	+	.27	*0*	.01		.28	Accept
H8 (a)	PIP *technical* – OFP	+	-.37	*0*	.26	PIP market	-.11	Reject
H8 (b)	PIP *market* – OFP	+	.71	*0*	0		.71	Accept
H8 (c)	PIP *technical* – Sales growth	+	-.01	*.930*	.03	PIP market	.02	Reject
H8 (d)	PIP *market* – Sales growth	+	.13	*.336*	.08	OFP	.21	Reject

Table 4 Summary of model results in relation to post-hoc theorised associations

Post-hoc theorised hypotheses				*Direct effect*		*Indi-rect effect std. coeff.*	*Media-ting variable*	*Total effect std, coeff.*	*Fin-ding*
No.	*Original hypotheses*	*Association*	*Direc -tion*	*Std. coeff.*	*Signif . level*				
PH 1	H2a and H5a	PIO – PIP technical	+	.67	*0*	.02	SO	.69	Accept
PH 2	H2a and H5b	PIO – PIP market	+	.40	*0*	.28	PIP tech.	.68	Accept
PH 3	H4	SO – RQ	+	.63	*.011*	.27	SIPI	.90	Accept
PH 4	H2b	Relative PI spending – PIP technical	+	.21	*0*	0		.21	Accept

As shown in the tables, of the eight original hypotheses, one was rejected (H6) and seven were fully supported (H1) or partially supported (H3a, H7b, H8b) in their original form or in terms of post-hoc hypotheses (PH1 for H2a/H5a, PH2 for H2a/H5b, PH3 for H4 and PH4 for H2b).

Hypothesis 1 positing a strong and positive association between a (multi-stakeholder) stakeholder orientation and (multi-stakeholder) stakeholder involvement in product innovation was supported (.98; p<.001). The positive association expected between each of the two product innovation inputs - orientation and relative spending on product innovation – and stakeholder involvement in product innovation (H2a and b) was not supported. Instead, product innovation inputs were found to directly impact product innovation outputs. Specifically, support was found for the *post hoc* hypotheses linking product innovation orientation with technical performance (PH1: .67; p<.001) and market performance (PH2: .40; p<.001). The other product innovation input, relative spending on product innovation was found to be positively associated with technical product innovation performance, as suggested in PH4 (.21; p<.001).

As posited in Hypothesis 3a, a firm's two strategic orientations for product innovation and stakeholders relationships were found to be positively associated (.48; $p<.001$). Surprisingly, model testing showed that stakeholder involvement in product innovation did not fully mediate either the stakeholder orientation-relationship quality (H4) or the product innovation orientation-product innovation performance (market and technical) relationships (H5a,b), as was hypothesised. However, stakeholder involvement in product innovation was found to partially mediate (indirect effect .27; $p<.01$) the strong positive association between (multi-stakeholder) stakeholder orientation and multi-stakeholder relationship quality (total effect .90; $p<.01$) as suggested in PH3. Neither of the two performance measures relating to product innovation and relationship quality were associated, as expected in Hypothesis 6.

Stakeholder relationship quality was found to contribute positively to the firm's sales growth (Hypothesis 7b: .28; $p<.001$) but not its satisfaction with overall firm performance (Hypothesis 7a). While market-oriented product innovation performance was found to be a strong driver of overall firm performance satisfaction, as suggested in Hypothesis 8b (.71; $p<.001$), technical-oriented firm performance was negatively associated with overall firm performance (-.37; $p<.001$), contrary to the expectations expressed via Hypothesis 8a. Product innovation outcomes were found to have no effect on a firm's sales growth, leading to the rejection of Hypotheses 8c and 8d.

Overall, we found that higher (sales) growth manufacturers tend to pay more attention to their relationships with the top firms in each of four stakeholder groups (customers, suppliers, industry partners and advisory/research firms), involve these firms more in product innovation activities and perceive their relationships to be of higher 'quality'. Firms with sound overall firm performance (ROI, net profit, market share and overall business performance) tend to be more product innovation focused (in terms of strategy and spending) and achieve product innovations, which are successful both technologically and market-wise.

4 Discussion, implications and future research directions

Our study made three unexpected findings with regard to the role of multi-stakeholder involvement in a firm's product innovation. Firstly, while the innovation literature generally considers a stronger product innovation strategy to be antecedent to cooperative product innovation [e.g. 47, 138], we found no positive association. This suggests one of three possibilities: (1) Consistent with Urban, Hauser et al.'s [139] view, the firms sampled had adequate internal product innovation resources and tended not to draw on external sources; (2) applying Nyström's [47] and Gemünden and Heydebreck's [45] logic, most firms were non-technology leadership or customer-focused developers and tended not to collaborate with key stakeholders or (3) the firms sampled had difficulty in establishing or maintaining cooperative product innovation relationships, as discussed by Bruce, Leverick et al. [75] and Prahlad and Ramaswamy [140]. Hence, the collaboration premium (the difference between the anticipated return less the opportunity cost and collaboration cost) [141] did not eventuate.

The second finding was the absence of evidence for cooperative product innovation enhancing product innovation outcomes as has been shown in a number of empirical studies [e.g. 45, 76, 142]. Rather, a firm's product innovation strategy was found to be a strong, direct predictor of product innovation performance, as suggested in the product innovation literature [124, 125, 143].

Thirdly, cooperating with stakeholders in product innovation was not found to directly influence the quality of stakeholder relationships, as was posited based on extant empirical research [26, 144]. Instead, cooperation with key stakeholders in product innovation was found to partially mediate the direct effect that a firm's view of key stakeholders had on the quality of its relationships with these stakeholders. Such a direct association has been argued in the IOR literature [63, 145] and, through this study, now finds support in a product innovation context. It shows that the influence of a firm's orientation toward its key stakeholders in product innovation is twice as strong a determinant of stakeholder relationship quality as cooperation with these stakeholders in product innovation.

Our study provides evidence of the value of integrating concepts from the literature on IORs, product innovation and interactive innovation. Hence, when configured as part of a broader, SSP-based model of IORs in product innovation, the direct and indirect effects of cooperative product innovation have been more clearly shown than in extant empirical research in the IOR or interactive innovation literature.

Four primary implications pertaining to public policy and management practice in relation to Australian manufacturing enterprises can be derived from an analysis of the findings reported in this study.

(1) The nature and importance of innovation strategy and appropriate levels of innovation spending – the two drivers of innovation success - needs to be reinforced to the managers of Australian manufacturers through information dissemination, education & training and, where possible, assistance in the form of subsidised specialised research/advisory services. There also needs to be a realisation that manufacturing has become secondary to the design and development of the product [146]. As Australian manufacturers become better at innovation, including brand management and managing the life-cycles of their products, and as they focus on making complex and profitable products [146], they will be in a better position to develop products that are valued in the global market place.

(2) There needs to be more awareness of the distinctions between technically-focused and market-focused product innovation performance and their different impacts on overall firm performance, as was found in this thesis research. *Both* technical- and market-based product innovation performance are needed to innovative effectively, i.e. to commercialise and to achieve overall business success. Capabilities, competencies and resources that relate to understanding and undertaking market-focused and technologically-leading product innovation need to be further developed in manufacturing managers, scientists and politicians.

(3) Manufacturing managers need to boost their competency in managing cooperative product innovation IORs with multiple stakeholders. The study provides a set of measures which could be used to extend existing diagnostic techniques used by managers to improve aspects of cooperative product innovation. Policy initiatives, including subsidising specialist advisory or brokerage services, could also augment managers' cooperative skills.

(4) Manufacturing firms need to enhance their stakeholder orientation to maintain a competitive edge in the global marketplace. Nurturing a widely shared view in the firm that key stakeholders are important and require extra attention has a positive impact on the quality of stakeholder relationships and, consequently, sales growth. While the most profitable marketing strategy is said to focus on the value of the customer [147], a stakeholder lifetime value strategy promises to yield even greater reward.

In testing a cooperative innovation model on a cross-sectional sample of Australian manufacturing firms with varying levels of technological orientation, the study has expanded extant knowledge of the generalisability of cooperative innovation concepts. It builds on existing quantitative studies focusing on select industries, for example high technology firms [28, 70] or on large firms only [148].

Overall, the research indicates that in the Australian manufacturing context, cooperation with key stakeholders may play a different role in product innovation than previously advocated on the basis of studies in other countries. Australia is a small country with a relatively small, declining manufacturing base. The establishments, which Australian manufacturers operate, are also quite small by international standards [149]. It is possible that the results would not hold true in larger, more dynamic manufacturing environments. Hence, replication of the research in other manufacturing sectors and other firms both in Australia and in other countries is recommended to substantiate the findings and foster adoption of our model and its measures.

Another area for future research would be a study of influences of co-opetition and cooperation [150, 151] and cocreation [152] on new product development. Furthermore, the driving and restraining factors of cooperative product innovation perceived by the various stakeholder participants could be explored in a qualitative study based on in-depth interviewing [153].

In conclusion, we note that our research is a small, initial attempt to study a large and complex issue – product innovation involving multiple stakeholders in a rapidly changing competitive and technological environment. We hope this study highlights the opportunity for manufacturing businesses to boost their performance by adopting both a strong innovation orientation and an approach which fosters relationships with key stakeholders – domestically and offshore.

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