Impact of Internal Environmental Uncertainty and Knowledge Leveraging on Manufacturing Plant's Financial Performance

ABSTRACT

Businesses are unclear about which levels of knowledge leveraging from suppliers and customers increase the financial performance in internal uncertain business environments. Therefore, this study first aims to explore how the leveraging of supplier and customer knowledge, which are driven by different motivations, impact the financial performance in modern days. Also, this study further investigates the impact of internal business environmental uncertainty dimensions of dynamism, munificence, and complexity on a business' knowledge leveraging practices and financial performance. This study used empirical data from 513 plants, across 9 countries, and 21 industries and invokes Knowledge-Based View with environmental uncertainty literature. Leveraging of supplier and customer knowledge improve the financial performance and internal environmental uncertainty dimensions moderate those relationships.

Key words: Knowledge Leveraging Practices, Internal Environmental Uncertainty and Knowledge-Based View

INTRODUCTION

The existing literature concentrates mainly on accessing relatively scarce knowledge in the supplier and customer bases separately (Grant, 2002; Kristal, Huang, & Roth, 2010; Li, Wu, Zong, & Li, 2017). While these insular approaches have their own merits, there are doubts about such an approach. An aspect that is under-represented in the literature is the simultaneous consideration of knowledge leveraging practices in both supplier and customer sides together. It has the potential to generate a more rigorous understanding of how these practices affect businesses since joint sense-making is the root of knowledge leveraging (Wang, Arnett, & Hou, 2016). Specifically, in the knowledge leveraging process, businesses must scan internal environments for successful joint sense-making of knowledge exchange between businesses to increase innovation performance (Li et al., 2017; Wang et al., 2016). Hence, this study investigates the influences of the business' internal environmental uncertainty dimensions and knowledge leveraging practices on financial performances.

The Knowledge-Based View that mostly extended Resource-Based Theory reasoning suggests a business outperforms mainly by possessing relatively scarce resources, such as knowledge (Barney, 1991; Felin & Hesterly, 2007; Grant, 1996; Hitt, Carnes, & Xu, 2016). Alternatively, the Practice-Based View advises businesses to test the impact of imitable practices on performance primarily due to the impracticalness of finding rare and difficult to imitate resources as suggested by Resource-Based Theory

(Bromiley & Rau, 2014, 2016). Since knowledge leveraging is more appropriate to understand as an imitable practice, this study relies on both Practice-Based View and Resource-Based Theory reasoning together with the main theoretical lens of Knowledge-Based View.

The external environmental uncertainty is characterised mainly by the dimensions of dynamism, munificence, and complexity, and consequently, recent research suggests complexity is the most appropriate dimension in the context of internal environmental uncertainty (Bozarth, Warsing, Flynn, & Flynn, 2009; Flynn & Flynn, 1999; Wiengarten, Ahmed, Longoni, Pagell, & Fynes, 2017). Since the other dimensions of dynamism and munificence also epitomise the nature of the internal environment, this study ascribed these two dimensions to internal environmental uncertainty, as well (Pagell, Krumwiede, & Sheu, 2007; Swamidass & Newell, 1987; Ward, Duray, Leong, & Sum, 1995). In light of all of these theoretical underpinnings, this study aims to address the following question:

1. How do the internal environmental uncertainty dimensions and practices of leveraging supplier and customer knowledge impact a business' financial performance?

This study analyses these relationships in the empirical setting: a global manufacturing data set from 513 plants, across 9 countries, and 21 industries. The database used in this study is the fifth edition of the Global Manufacturing Research Group survey.

This study makes a number of useful contributions to the literature. A significant step is taken toward recognising the leveraging of supplier and customer knowledge as separate practices that are imitable into different businesses in light of Practice-Based View. Empirical results confirm that leveraging of customer knowledge increases the financial performance, but munificence lowers this positive effect. The positive association between leveraging of supplier knowledge and financial performance increases at higher levels of dynamism, munificence, and complexity dimensions, but this positive association does not exist in the absence of uncertainty dimensions. This study further validates the new constructs of internal dynamism and munificence.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Knowledge Leveraging Practices and Financial Performance

Merely accessing supplier or customer knowledge does not lead to performance rewards (Barney, 1991; Weigelt, 2013). Instead, it is the internal enforcement practices, such as leveraging, which are likely to result in performance variance among businesses that own or access similar knowledge and technical capabilities (Choi & Lee, 1997; Lorenzoni & Lipparini, 1999; Sirmon, Hitt, & Ireland, 2007). The expected role of knowledge leveraging is to make the relevant knowledge accessible and seek applications for new knowledge obtained via existing supply chain relationships (Grant, 2002; Choi & Lee, 1997; Wang et al., 2016). The primary objectives of leveraging of supplier knowledge are to maximise the value of a business's supply base through substantial reductions in the true cost of materials, increased flexibility to dynamic situations, and faster cycle times which can increase the market share (Herrmann & Hodgson, 2001; Lorenzoni & Lipparini, 1999; Weigelt, 2013). The leveraging of supplier knowledge occurs when some businesses treat suppliers as knowledge generators while relying on them extensively in the early stages of product development (Becker & Zirpoli, 2003; Birou, Germain, & Christensen, 2011). This practice simultaneously controls and coordinates supplier knowledge to reduce contract governance cost and increase the rate of innovation while enhancing financial performance (Prajogo & Oke, 2016; Wang et al., 2016). Hence, this study proposes the following hypothesis.

Hypothesis 1: There is a positive association between a business's practice of leveraging supplier knowledge and its financial performance.

Customer knowledge leveraging plays a decisive role in generating profits by sensing how to access and organise customer relationships rather than just dropping unprofitable customers from the list. This practice maximises the benefits of the business' existing knowledge such as promoting innovation collaboration while minimising the market uncertainty (Handoko, Bresnen, & Nugroho, 2018; Nguyen & Harrison, 2018). It also provides businesses the opportunity to improve their internal processes and to transform the existing knowledge into new knowledge profitably (Grant, 2002; Nguyen & Harrison, 2018). This practice promotes sensing new innovations as customers include the end users

as well and hence increase the financial performances such as market share and cost efficiencies (Nguyen & Harrison, 2018). Hence, this study suggests the following hypothesis.

Hypothesis 2: There is a positive association between a business's practice of leveraging customer knowledge and its financial performance.

Moderating Effects of the Internal Environmental Uncertainty Dimensions

Although a business may employ the same knowledge leveraging practices, this may bring varying performance results in uncertain internal environments. A business struggles more with internal uncertainty than with external uncertainty, to align knowledge integration from suppliers and customers with business's absorptive capacity, to improve performance (Becker & Zirpoli, 2003; Birou et al., 2011; Wang et al., 2016). This study ascribes the external uncertainty dimensions to the internal environment and proposes how they interact with knowledge-leveraging practices to jointly determine financial performance.

External dynamism describes the fluctuations in innovations, customer preferences, and organisational decision-making (Bourgeois, 1980; Heeley, King, & Covin, 2006; Ward, Duray, Leong, & Sum, 1995). Internal dynamism shares the same attributes as survey-based items used to measure the external dynamism mostly represent the business's internal operations used as proxies of external dynamism (Pagell et al., 2007; Tamayo-Torres, Roehrich, & Lewis, 2017; Ward et al., 1995). Managers frequently make discontinuous decisions in dynamic internal environments. This decision making involves quick matching of contemporary needs and solving short-term issues attached to unpredictable change in demand, technology, and competitors (Demeester, De Meyer, & Grahovac, 2014; Swamidass & Newell, 1987; Ward et al., 1995). The motivation behind leveraging of supplier knowledge is to achieve time compressions in product and process developments and search for new technologies and innovation opportunities that mitigate market uncertainties (Birou et al., 2011; Lorenzoni & Lipparini, 1999). When demand uncertainties are higher, businesses rely excessively on supplier relationships

moving away from internal absorption strategies within corporate boundaries to increase sales and market share (Li et al., 2017; Lorenzoni & Lipparini, 1999; Prajogo & Oke, 2016). Therefore,

Hypothesis 3: Dynamic internal environment leads to a stronger positive relationship between a business's practice of leveraging supplier knowledge and its financial performance.

In contrast, Ofek & Sarvary (2001) posit that businesses that practise excessive leveraging of customer knowledge, to improve product quality and customer base, may actually hurt profits and lead to industry shakeouts in a dynamic setting. Though customers use their potential power to claim benefits from businesses, businesses cannot similarly use the power, due to the risk of customers shifting to their rivals (Kim & Wemmerlöv, 2015). Accordingly, businesses should influence only the extent to which customer expectations play a role in their demand (Ofek & Sarvary, 2001). Hence,

Hypothesis 4: Dynamic internal environment leads to a weaker positive relationship between a business's practice of leveraging customer knowledge and its financial performance.

Munificence is the resource generosity that can sustain the growth of a business in an industry (Heeley et al., 2006; Ward et al., 1995). Applying this definition to the internal context, internal munificence is the business's resource generosity that may attenuate the resource slack. Though competitive advantage is rooted within a business, in assets that are valuable and inimitable (Barney, 1991), the business's practice of leveraging supplier knowledge somewhat marshals these assets to generate superior financial performance. For instance, a business mostly enjoys the pull model of innovation, where the business initiates demanding supplier innovation outputs in new product and process development efforts (Wagner & Bode, 2014). Internal munificent environments would stimulate a business's control over knowledge and technology flow from suppliers and innovation selection to match with available resources (Grant & Baden-Fuller, 2004). So, businesses can limit unnecessary wastages in time, cost and resources. Therefore,

Hypothesis 5: Munificent internal environment leads to a stronger positive relationship between a business's practice of leveraging supplier knowledge and its financial performance.

Having a more significant number of customers is always beneficial to the business, whether they are profitable or not, but a business must impose boundaries for the richness of knowledge when revealing and collecting information about each customer segment and characteristic separately (Kim & Lee, 2007). When the business is internally capable of having higher levels of skilled labour and unique product and process technologies comparative to rivals, unreasonable leveraging of customer knowledge might bring adverse financial reactions from the demand side (Barney, 1991; Modi & Mishra, 2011; Ward et al., 1995). Whether investments made on leveraging of customer knowledge bring marginal sales and profits to the business, when the business possesses unique technical knowledge and labour (Grant, 2002; Hitt et al., 2016; Kim & Lee, 2007), is questionable. Hence,

Hypothesis 6: Munificent internal environment leads to a weaker positive relationship between a business's practice of leveraging customer knowledge and its financial performance.

Internal complexity in a manufacturing context refers to the number of raw materials and semi products, types of manufacturing processes, planning and control systems, and the stability of manufacturing schedules from one period to the next (Bozarth et al., 2009; Flynn & Flynn, 1999). Practices of leveraging supplier and customer knowledge are interwoven in complex internal environments, as supply-side, knowledge-related applications must match with demand-side goal diversity that focuses on product variety, volume, and markets (Flynn & Flynn, 1999; Wang et al., 2016). Leveraging of supplier knowledge simplifies operational processes, resolving conflict and competition among products and processes, technologies, quality standards, and market segments increased by proliferation (Lorenzoni & Lipparini, 1999; Meyer & Lehnerd, 1997). This practice lowers supply side opportunistic behaviour that enhances their reliability, lead time, and supply base management (Bozarth et al., 2009). For instance, businesses establish strategies, such as pull model of innovation and co-opetition where a business organises cooperative and competitive behaviours among suppliers, thereby capturing value from the supplier relationships (Kim & Wemmerlöv, 2015; Pathak, Wu, & Johnston, 2014; Wagner & Bode, 2014). Accordingly, this study posits the following hypothesis.

Hypothesis 7: Complex internal environment leads to a stronger positive relationship between a business's practice of leveraging supplier knowledge and its financial performance.

Businesses use customer knowledge leveraging strategies, such as 'efficient consumer response' and 'collaborative planning, forecasting and replenishment' to control product proliferation by maintaining an optimum selection of products and avoiding unnecessary new product introductions (Bozarth et al., 2009). However, the multiplicity of products with shorter cycle times and inventory levels offer limited opportunities for leveraging of customer knowledge, especially in a very fragmented customer base (Birou et al., 2011; Cousins & Menguc, 2006). For instance, customers' dependence on multiple manufacturers for products such as smartphones devalues the leveraged knowledge about the expected quality improvements, delivery performance and enhanced sales forecasting (Cousins & Menguc, 2006). Therefore, complex internal environments that deal with a wide range of products, suppliers and customers degrades the positive relationship between leveraging of customer knowledge and financial performance.

Hypothesis 8: Complex internal environment leads to a weaker positive relationship between a business' practice of leveraging customer knowledge and its financial performance.

Figure 1 illustrates the relationships among internal environmental uncertainty dimensions, knowledge leveraging practices and financial performance as proposed in hypotheses.

Insert Figure 1 about here

RESEARCH METHODOLOGY

Data and Operational Definitions

This study used data from the fifth edition of the Global Manufacturing Research Group's survey in line with the recent researches done with a similar focus. The existing researches well explain the credibility of the survey as one of the latest and suitable data sources specially to measure supplier and customer knowledge leveraging, internal complexity and financial performance (Nguyen &

Harrison, 2018; Schoenherr, 2018; Wiengarten et al., 2017). They also confirm the validity and no respondent bias in the sample. Survey group collected data from directors of operations/manufacturing, and the sample consists of 968 manufacturing facilities, from 21 industrial classifications, and 18 countries. After eliminating cases with information missing, data from 513 manufacturing facilities in 9 countries (Australia, Croatia, USA, Vietnam, Poland, Ireland, Hungary, China and Taiwan) were available for the analysis. The unit of analysis is the manufacturing plant.

Definition and Measurement of Constructs

Table 1 indicates the definition of each variable and the relevant measures and scales used from the questionnaire, with supporting literature. It further includes the control variables and instrumental variables used for the endogeneity tests.

Insert Table 1 about here

Validity, Reliability and Endogeneity

The study conducted an exploratory principal component factor analysis with Promax rotation and it converged in 6 iterations. It suggests that items used in this study ensure discriminant validity of the constructs. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is 0.75 which is commendable, and Bartlett's test of sphericity shows the appropriateness of the factor analysis by being significant at 0.000. Table 2 shows the underlying structure of the constructs used for the analysis and the factor loadings of principal components factor analyses with the varimax rotation which support the convergent validity of the constructs. In both tests, the average factor loading of each construct is higher than 0.70. Cronbach's alpha was used to assess the reliability of the proposed scales. In this study, all the constructs exceed the 0.70 thresholds, as indicated in Table 2.

Insert Table 2 about here

This study performed linear transformations such as squared terms of knowledge leveraging practices and logarithmic transformation of internal complexity to meet the expectations of normal distributions. Table 3 indicates the descriptive statistics. The lower correlations among the dimensions of internal environmental uncertainty are possible, due to their simultaneous occurrences. However,

multicollinearity tests suggest none of the variables has a multicollinearity problem. The multicollinearity tests confirm that the variance inflation factor does not exceed 2.0 for any of the four models tested in the analysis and it is below the critical level of 10.

Insert Table 3 about here

Endogeneity tests were performed to check whether all of the explanatory variables are independent of the residuals. A Two-Stage Least Squares regression analysis was performed, using the instrumental variable procedure, to check the endogeneity for the dependent variable of financial performance. The instrumental variables were used for all of the independent and moderator variables, as indicated in Table 1. Since the robust endogeneity test statistics are not significant (at $p<0.05$), endogeneity does not exist in the proposed variables.

RESULTS

Hierarchical moderated regression analysis was used to test the proposed hypotheses. Table 4 shows the results. The first model controls for firm size, country, and industry effects, and accounts for a variance of 3% in financial performance. The second model includes the knowledge leveraging practices and provides an incremental variance of 1.6% in financial performance, while the inclusion of moderators in the third model accounts for a 2.3% increase in the model variance. The fourth model includes the product of each of the mean centred knowledge leveraging variables with each of the mean centred internal environmental uncertainty variables. The interactions account for an incremental variance of 3.5% in financial performance while the overall effect of the fourth model explains 10.4% of the variance. All of the associated F tests are significant at $p<0.01$.

Insert Table 4 about here

The results support five hypotheses. Though the results do not support H1 which is the positive association between leveraging of supplier knowledge and financial performance, dynamism, munificence and complexity positively moderate that association, supporting H3, H5, and H7. The findings confirm that one additional unit of the squared term of leveraging of customer knowledge increases financial performance by 1%, supporting H2. However, only munificence negatively

moderates that positive association, supporting H6. Surprisingly, the results reveal that neither dynamism nor complexity are dominant dimensions that change this relationship.

The moderation graphs in Figure 2 graphically affirm the above results. Only the moderation results significantly below 0.05 probability levels are shown. The graphs show how the relationship between the independent variable and the dependent variable varies at three levels of the moderator, such as mean minus 1 standard deviation, mean, and mean plus 1 standard deviation. The straight lines indicate the significant relationships. The leveraging of the supplier knowledge and financial performance relationship is evident at the higher level of internal dynamism and both the mean and high levels of internal complexity. Leveraging of customer knowledge and financial performance is only evident at the mean and low levels of internal munificence with a diminishing positive slope.

Insert Figure 2 about here

Further, this study carried out some tests to check the normality conditions of the proposed models. First, heteroskedasticity was checked using both the Breusch-Pagan/Cook-Weisberg test ($p=0.2139$) and Cameron and Trivedi's decomposition test ($p=0.1275$), as the final model includes the interaction terms. Both tests confirmed there was no heteroscedasticity present in the tested model. Second, there are no omitted variables in the proposed model, as the Ramsey Reset test result is not significant (at $p= 0.281$). Finally, the Link test confirmed there are no model specification errors with a nonsignificant hat square (at $p=0.611$). Hence, the proposed model is well-defined.

DISCUSSION

The primary objective of this study is to understand how knowledge leveraging practices impact financial performance in uncertain internal environments. According to results, leveraging of supplier knowledge increases financial performance in dynamic, munificent and complex internal environments. In dynamic internal environments, businesses rely more on supplier knowledge for product development to mitigate demand uncertainties (Herrmann & Hodgson, 2001; Wang et al., 2016). Munificent internal environment motivates businesses to leverage supplier knowledge to mitigate losses from excess and scrap inventories and non-value adding tasks (Birou et al., 2011; Herrmann & Hodgson, 2001). Further,

complex internal environment urges the importance of flexible and simple process development and part commonalities in product development by leveraging supplier knowledge with strategies, such as coopetition and alliances (Grant & Baden-Fuller, 2004; Meyer &Lehnerd, 1997; Pathak et al., 2014).

Leveraging of customer knowledge increases financial performance. Only munificence lowers this positive association, while the other two internal dimensions do not affect. If businesses promote cooperative behaviours with customers to gather knowledge, businesses can increase the profits than the values created by the leveraging of customer knowledge (Kim & Wemmerlöv, 2015). Therefore, businesses may not need to stress the customer base even under highly dynamic or complex internal environments to gather knowledge (Lorenzoni & Lipparini, 1999) but they can leverage supplier knowledge for cost reductions and innovations to mitigate the demand uncertainties.

Theoretical Contributions

This study confirms that knowledge leveraging practices generally improve a business's financial performance by contradicting the existing literature about nonlinear performances of knowledge leveraging. This study also provides a clear conceptualisation for the leveraging of supplier and customer knowledge separately and explores the simultaneous effects of both supplier and customer knowledge leveraging on financial performance which are somewhat lacking in current literature. Empirically-grounded studies propose complex internal environment as an antecedent of operational performance (Bozarth et al., 2009; Wiengarten et al., 2017). In addition to complexity, the other dimensions of dynamism and munificence that can be ascribed to the internal environment may also have important implications for performance. Hence, this study conceptualises and proposes new items for these two dimensions in the guise of external environmental uncertainty literature that used survey-based items. In the knowledge leveraging process, internal environmental uncertainty dimensions are more appealing as moderators than as antecedents of performance. In broader aspects, the study reveals and empirically validates how internal environmental uncertainty dimensions moderate the relationships between a business's knowledge-leveraging and financial performance. In doing so, this study mainly

integrates Knowledge Based View, Practice Based View and the literature of environmental uncertainty, supply chain and performance.

Managerial Implications

This study responds to the perceptions businesses had as to what extent to leverage supply chain knowledge without compromising financial rewards. It reveals that leveraging of customer knowledge improves financial performance but diminishes this relationship in munificent internal environments. Also, in dynamic, munificent, and complex internal environments, supplier knowledge leveraging continues to increase financial performance. The rise of digital technology platforms that connect multiple suppliers and customers in milliseconds eliminate the cost and time restrictions for increased knowledge leveraging and hence, the existing beliefs, such as that too much leveraging decreases business performance, become insignificant. Manufacturing plants, and by extension businesses, increase their competencies by possessing relatively scarce knowledge and unique product and process technologies that encourage supplier involvement in the early stages of product development (Grant, 1996; Weigelt, 2013). Leveraging of customer knowledge enhances financial performance by controlling product waste and satisfying customers with quality and optimum product range (Nguyen & Harrison, 2018).

CONCLUSION

This study responds to the ambiguity as to the extent to practice knowledge-leveraging with former beliefs of too much or too little leveraging causing negative performances. Further, the simultaneous pursuit of supplier and customer knowledge-leveraging as separate practices extends opportunities to improve financial performance but remains poorly understood in the existing literature. Hence, this study provides a clear conceptualisation of these two practices and empirically validates that the leveraging of customer knowledge improves financial performance. The complexity of internal environments is conceptualised mainly as an antecedent of performance (Bozarth et al., 2009; Wiengarten et al., 2017). Dynamism and munificence are abandoned from internal contexts and, therefore, this study uses new survey-based items to validate these two constructs. Technology

revolutions and updates have changed the way businesses operate in both internal and external environments and, hence, the influence of internal environmental uncertainty, as well. To understand these effects, the study develops a conceptual model in light of Practice Based View, Knowledge Based View, literature of supply chain, environmental uncertainty and performance. This study empirically validates that internal uncertainty dimensions are more potent as moderators to knowledge-leveraging and financial performance relationships than their direct effects on financial performance.

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LIST OF TABLES

Table 1: Construct development and supporting literature

Variable definition	Measures and scales	Supporting literature
Independent variables		
Leveraging of supplier knowledge (SKL): Synchronised control and coordination of supplier knowledge to reduce a business' variable costs and increase the innovation rate and efficiency.	SKL1: We are able to obtain a tremendous amount of technical know-how from our suppliers SKL2: We rapidly respond to technological changes in our industry by applying what we know from our suppliers. SKL3: As soon as we acquire new knowledge from our suppliers, we try to find applications for it. *1-7 Likert scale from strongly disagree to strongly agree*	(Grant, 2002; Grant & Baden-Fuller, 2004; Herrmann & Hodgson, 2001; Kristal et al., 2010; Lorenzoni & Lipparini, 1999; Schoenherr's 2018; Tamayo-Torres et al., 2017; Weigelt, 2013)
Leveraging of customer knowledge (CKL): Simultaneous acquisition and application of customer knowledge to ensure return sales and growth in sales network by enhancing the quality of products and information offered by the business.	CKL1: We are able to obtain a tremendous amount of technical know-how from our customers. CKL2: We rapidly respond to technological changes in our industry by applying what we know from our customers. CKL3: As soon as we acquire new knowledge from our customer, we try to find applications for it. *1-7 Likert scale from strongly disagree to strongly agree*	(Kim & Lee, 2007; Kristal et al., 2010; Nguyen & Harrison, 2018; Ofek & Sarvary, 2001; Sirmon et al., 2007; Tamayo-Torres et al., 2017)
Moderators		
Internal dynamism (ID): The fluctuations in innovations, customer preferences and organisational decision-making.	ID1: Most innovations come from monitoring competitors and/or using suppliers. ID2: We are constantly looking outside our facility for useful ideas. ID3: Operational decisions are always set to quickly match current needs. ID4: We devote most of our time to solving immediate, short term issues. *1-7 Likert scale from not at all to great extent*	(Birou et al., 2011; Bourgeois, 1980; Demeester et al., 2014; Dess & Beard, 1984; Pagell et al., 2007; Swamidass & Newell, 1987; Tamayo-Torres et al., 2017; Ward et al., 1995)

Internal munificence (IM): Business's resource generosity that may attenuate the resource slack.	IM1: Plant has state-of-the-art manufacturing processes. IM2: Workforce has superior technological skills. IM3: Plant has unique manufacturing process capabilities. IM4: Plant has superior technological know-how. *1-7 Likert scale from not at all to great extent*	(Demeester et al., 2014; Dess & Beard, 1984; Heely et al., 2006; Pagell et al., 2007; Ward et al., 1995)
Internal complexity (IC): Heterogeneity in product and process ranges and operation schedules.	Considering your plant's most important product line, please answer the next questions: IC1: Approximately how many part numbers are on a typical end-item BOM for this product line? *(7 ranges from <10 to > 1000)* IC2: Approximately how many permanent changes are made on a typical end-item BOM for this product line annually? *(7 ranges from 0 to >1000)* Considering your plant's highest value product line, please answer the next questions: IC3: How many items are listed on your bill of materials (BOM) for this highest-value product line? *(7 ranges from <50 to >500)* IC4: How many of these items are produced in your plant? *(7 ranges from <50 to >500)*	(Bozarth et al., 2009; Child, 1972; Flynn & Flynn, 1999; Wiengarten et al., 2017)
Dependant variable		
Financial Performance (FP): Financial indicators of business' sales and profits.	How did the following financial measures change in the last fiscal year (check one box for each item)? FP1: Total sales of goods and services. FP2: Profitability. FP3: Market share. *7 ranges from reduced more than 25% to increased more than 25%*	(Modi & Mishra, 2011; Nguyen & Harrison, 2018; Wiengarten et al., 2017)
Control variables		
CV1: Country effects as developed and developing countries based on United Nations' list. CV2: Industry effects as products and commodity-based industries. CV3: plant size as the natural logarithmic transformation of the number of employees.		(World Bank Group, 2014) (Swamidass & Newell, 1987) (Wiengarten et al., 2017)
Instrumental variables		
IV1 for ID: Your industry is subject to rapid technological change. IV2 for IM: Demand for your products is difficult to predict. IV3 for IC: Too much stability is seen as bad and not progressive. IV4 for SKL: To what extent do this plant's first-tier suppliers use your AVL to select second- and third-tier suppliers? (Check "0" if you do not know.) IV5 for CKL: The competitive intensity in your industry is high. *1-7 Likert scale from not at all to great extent*		(Pagell et al., 2007; Nguyen & Harrison, 2018; Wiengarten et al., 2017)

Table 2: Exploratory factor analyses, discriminant validity, and reliability results

Item	Factor loading	Component	Cronbach's Alpha

		1	2	3	4	5	6	
SKL1	0.851	0.895						0.860
SKL2	0.869	0.889						
SKL3	0.814	0.828						
CKL1	0.842		0.881					0.871
CKL2	0.883		0.916					
CKL3	0.826		0.843					
ID1	0.666			0.661				0.733
ID2	0.753			0.738				
ID3	0.751			0.775				
ID4	0.748			0.778				
IM1	0.790				0.811			0.829
IM2	0.799				0.810			
IM3	0.746				0.759			
IM4	0.850				0.873			
IC1	0.833					0.831		0.826
IC2	0.762					0.762		
IC3	0.867					0.868		
IC4	0.761					0.771		
FP1	0.912						0.921	0.871
FP2	0.905						0.913	
FP3	0.839						0.835	

SKL- Supplier knowledge leveraging, CKL- Customer knowledge leveraging, ID- Internal dynamism,

IM- Internal munificence, IC – Internal complexity, and FP- Financial performance

Table 3: Descriptive and correlations between scale variables

Variable	Mean	Standard Deviation	1	2	3	4	5	6
1.Supplier knowledge leveraging	21.989	10.578	1.000					
2.Customer knowledge leveraging	25.581	11.170	0.434*	1.000				
3.Internal dynamism	4.481	1.049	0.217*	0.278*	1.000			
4.Internal munificence	4.743	1.092	0.321*	0.266*	0.142*	1.000		
5.Internal complexity	0.782	0.532	0.117*	-0.015	0.116*	0.105**	1.000	
6.Financial performance	4.143	1.198	0.093**	0.134*	0.092**	0.187*	0.022	1.000

* $p<0.01$, ** $p<0.05$

Table 4: Moderated regression for financial performance

Variables	Model 1	Model 2	Model 3	Model 4	Hypothesis
No. of employees	0.0851**	0.0832**	0.0820**	0.0621***	
Country	0.161	0.148	0.126	0.0936	
Industry	0.257**	0.245**	0.257**	0.247**	
Leveraging of supplier knowledge		0.00345	-0.00104	-0.00487	H1: No
Leveraging of customer knowledge		0.0122**	0.00842***	0.00959***	H2: Yes

Internal dynamism			0.0432	0.019	
Internal munificence			0.172*	0.192*	
Internal complexity			-0.0636	-0.0436	
Leveraging of supplier knowledge * Internal dynamism				0.0104**	H3: Yes
Leveraging of customer knowledge * Internal dynamism				0.00342	H4: No
Leveraging of supplier knowledge * Internal munificence				0.00865***	H5: Yes
Leveraging of customer knowledge * Internal munificence				-0.0130*	H6: Yes
Leveraging of supplier knowledge * Internal complexity				0.0212**	H7: Yes
Leveraging of customer knowledge * Internal complexity				-0.0093	H8: No
Constant	3.654*	3.281*	2.528*	2.641*	
Observations	513	513	513	513	
R-squared	0.03	0.046	0.069	0.104	
R-squared change	0.03	0.016	0.023	0.035	
F test	5.17***	4.42***	4.35***	3.96***	

* p<0.01, ** p<0.05, *** p<0.1

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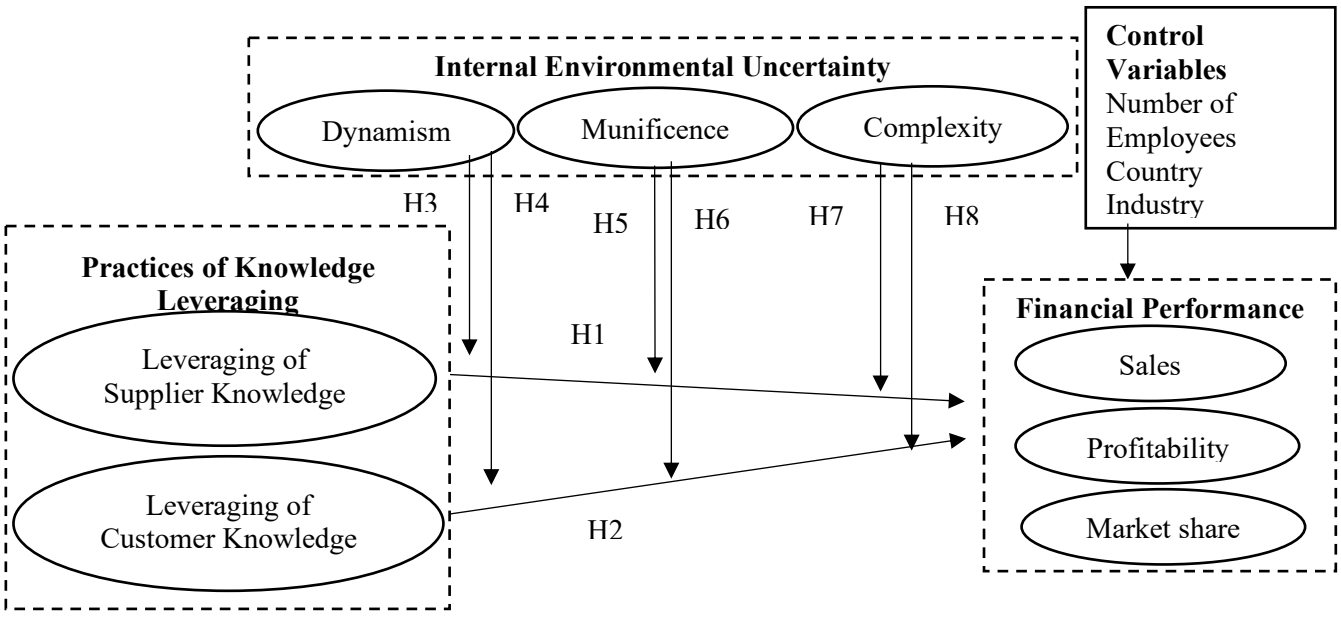
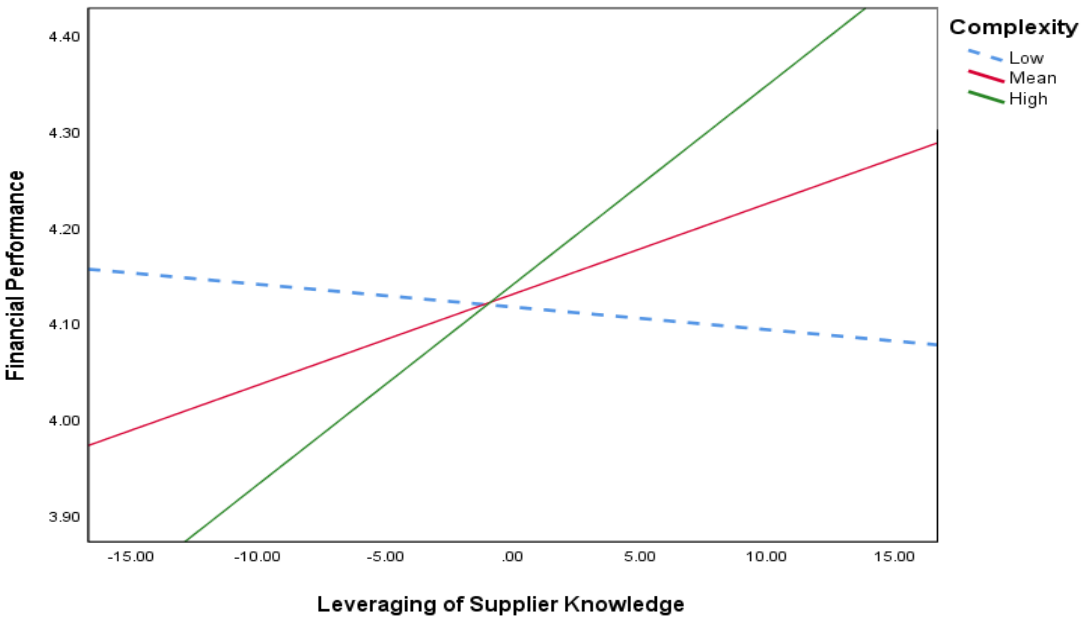


Figure 1: Conceptual model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Mean
High
Financial Performance
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4.30
4.20
4.10
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3.90
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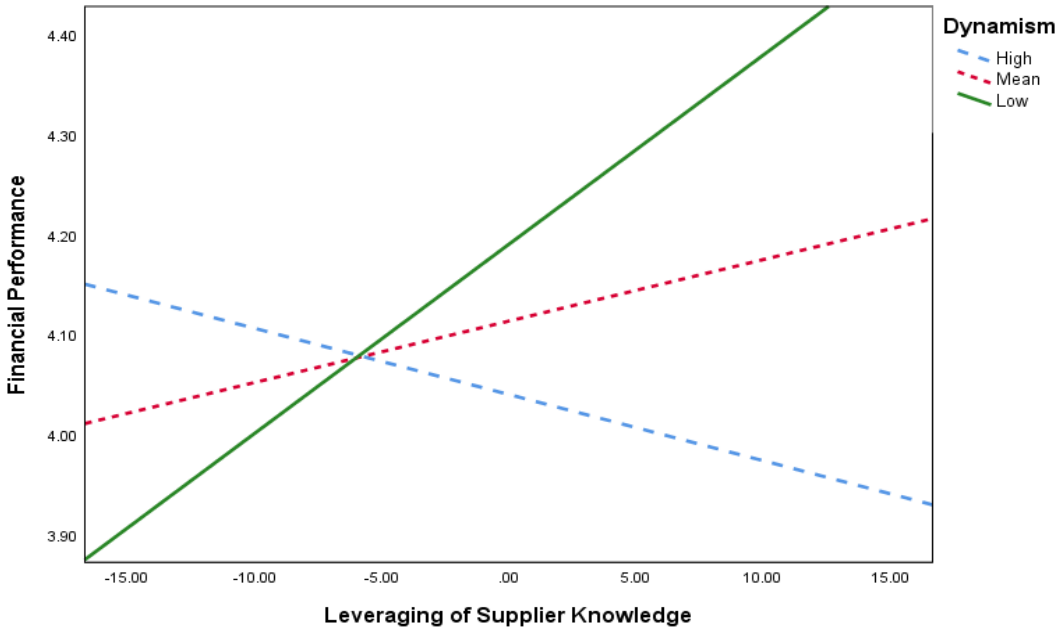
-5.00
.00
5.00
10.00
15.00
Leveraging of Supplier Knowledge


Dynamism
High
Mean
Low
Financial Performance
4.40
4.30
4.20
4.10
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-5.00
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5.00
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15.00
Leveraging of Supplier Knowledge

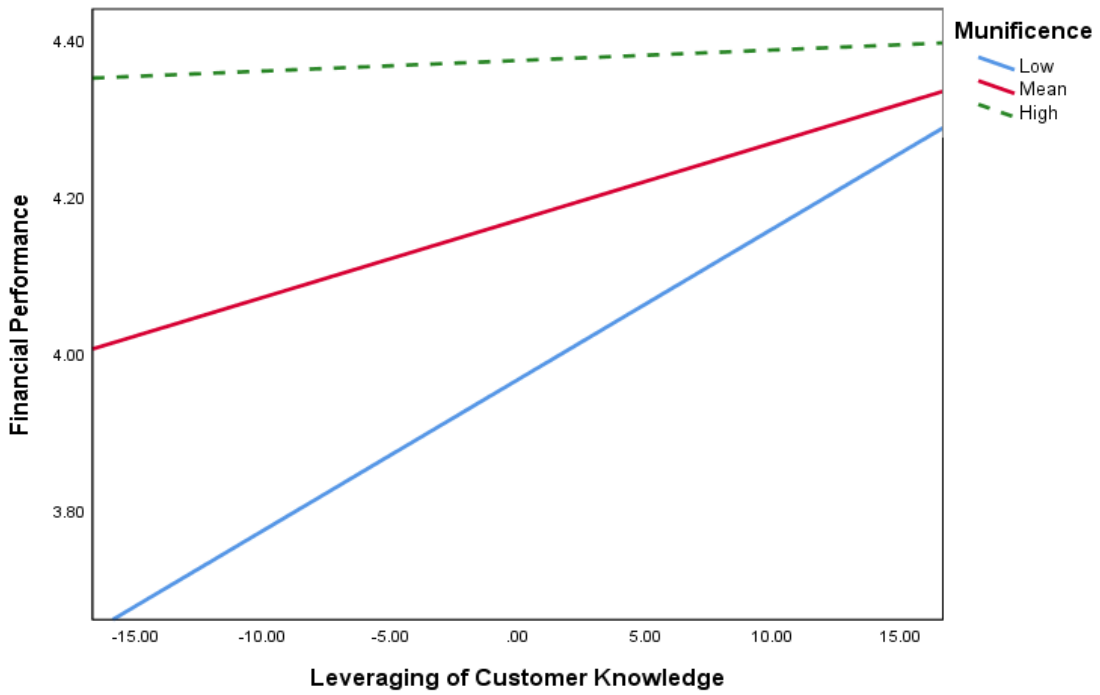

Figure 2: Graphs of moderation results