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WHEN MORE IS LESS: THE MODERATING ROLE OF CROSS-FUNCTIONAL INTEGRATION AND ORGANIZATIONAL KNOWLEDGE COMPLEXITY ON PRODUCT INNOVATION PERFORMANCE

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Abstract

Innovation has become the cornerstone for achieving high performance and competitive advantage and is currently one of the principal topics of debate in the management literature. In order to develop innovations, firms need to deal with complex knowledge that comes from its different areas or departments through cross-functional integration. Using a unique sample of Spanish wineries, this paper shows that cross-functional integration moderates innovation- firm's performance relationship, and that this moderation is conditioned by the degree of organizational knowledge complexity. These findings add to the innovation literature, showing that cross-functional integration has a direct positive relationship with firm performance, but a negative moderating effect on the relationship between product innovation and firm performance. However, this negative effect remains consistent only when the degree of knowledge complexity the organization has to manage is low and becomes positive (although not significant) when the degree of organizational knowledge complexity is high.

Keywords: Product innovation; cross-functional integration; knowledge complexity; firm performance

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1. INTRODUCTION

With the increase in globalization and technological interconnections, organizations must innovate in order to be competitive and improve their performance (Markides and Crainer, 2010). As Hitt, Hoskisson and Kim (1997) argued, the ability of firms to develop new products, processes, and technologies is at the heart of competitive advantage. Despite this general agreement, previous research findings are not conclusive, indicating that the relationship between innovation and performance is more complex than initially thought. Unless innovation is bounded and contingency models are used to contextualize this relationship, it is difficult to integrate research findings in a comprehensive and consistent account (Damanpour, 1991; De Clercq, Thongpapanl and Dimov, 2011; Pérez-Luño, Gopalakrishnan and Valle-Cabrera, 2014). Based on this assumptions, this paper aims to explain that, in order to develop innovations that reinforce performance, firms need to deal with complex knowledge that comes from its different areas or departments and one way of doing this is cross-functional integration.

Scholars generally define innovation as the development and use of new ideas or behaviors in organizations which manifest in the form of a new product, service, method of production, creation of a new market, organizational structure or administrative system (Damanpour and Gopalakrishnan, 1998). This paper focuses on product innovation, which can be defined as the introduction into the market of technologically new or improved products (OECD, 1997). Among the different types of innovations, product innovation is usually seen as the main source of competitive advantage (Pérez-Luño et al., 2014).

When organizations involve in product innovation, coordinating knowledge and information across specific areas like R&D and marketing (Sherman, Berkowitz and Souder, 2005), sales, marketing and R&D (Ernst, Hoyer and Rübsaamen, 2010) or R&D, marketing and manufacturing (Brettel, Heinemann, Engelen and Neubauer, 2011; Song, Thieme and Xie, 1998) has positive effects in different stages of new product development and in new product performance.

Cross-functional integration, defined as the degree of interaction, communication and information sharing across functional areas (Troy, Hirunyawipada and Paswan, 2008; Griffin, 1997), is thus a critical conditioning factor in product innovation process. It improves horizontal communication linkages and helps to transfer knowledge and information across areas, stimulating creativity and innovation and reducing inefficiencies (Troy, Hirunyawipada and Paswan, 2008; Song, Thieme and Xie, 1998).

While some studies show that integrating specific combinations of two or three functional areas will positively affect different stages of new product development (Ernst, Hoyer and Rübsaamen, 2010; Sherman, Berkowitz and Souder, 2005), others point out that simultaneously involving more than two areas will negatively affect each stage of the process, due to the management costs that it involves (Song, Thieme and Xie, 1998). However, to our knowledge, no study has specifically explored how the breadth of cross-functional integration conditions the degree of innovation of the new product and its relationship with firm performance. This is important because although cross-functional integration may increase the costs of the innovation process, it may also reduce uncertainty, help to manage complexity and consequently improve the quality of the decisions made (Troy, Hirunyawipada and Paswan, 2008; Song, Thieme and Xie, 1998). By helping organizations to deal with uncertainty and complexity, it can lead to the development of more innovative products that have potential to pay off better in terms of profit making than products developed in conditions of strict functional approach (where functional areas work independently) or narrow cross-functional integration. Therefore, cross-functional integration can be particularly beneficial to organizations that have to manage a high degree of knowledge complexity in their product innovations (Troy, Hirunyawipada and Paswan, 2008).

Complexity can come from both the particular degree of change the new product involves and from the degree of complexity of organizational knowledge in general. While the first has been emphasized as the underlying explanatory mechanism in studies that reported a positive interaction between cross-functional integration and high levels of change in product innovation (Olsen et al., 1995, 2001; Song and Xie, 2000), studies exploring how organizational knowledge complexity conditions the role of cross-functional integration in product innovation performance are lacking.

Therefore, this study analyzes how knowledge complexity and breadth of cross-functional integration condition the relationship between product innovation and firm performance. Specifically, we propose that the breadth of cross-functional integration moderates the relationship between product innovation and firm performance and that this moderating effect is in turn moderated by the degree of complexity of organizational knowledge.

We test these relationships in a sample of 108 wineries from Spain. Spanish wine industry is a mature industry, comprising more than 4,500 wineries, distributed in different regional clusters. The choice of this industry is justified by (1) its impact on the economy: it accounts for 1% of the Spanish GDP, employs about 6.7% of workers in food industry and generates a turnover of 5.886 million Euros (ICEX, 2014); (2) its importance in the international arena, as Spain is the second largest wine exporter in the world in terms of volume and third in terms of value; (3) the recent changes the industry has

experienced in terms of technology, organization of productive factors and the way of selling products (all examples of different types of innovation).

The results obtained confirm the existence of significant triple interaction effect of cross-functional integration, knowledge complexity and product innovation in firm performance. Together, our findings contribute to innovation literature addressing the role of cross-functional integration and knowledge complexity in product innovation and firm performance. First, we show the specific role that cross-functional integration plays at organizational level, complementing previous works that focused mainly on a project level. We find that cross-functional integration has a direct positive relationship with firm performance, but a negative moderating effect on the relationship between product innovation and firm performance. Second, while most studies on cross-functional integration have focused on the role of coordination between specific functional dyads, ignoring how a broader integration would affect the innovation-performance link, we show that attempting to simultaneously integrate various areas doesn't help to translate the innovation efforts into increased performance. Third, we explicitly test the conditional effect of organizational knowledge complexity, confirming that cross-functional integration plays a positive role (although not significant) when the degree of knowledge complexity the organization has to manage is high and a negative and significant role when the degree of organizational knowledge complexity is low. Last, we analyze performance using objective and subjective measures and find that innovation; and find that knowledge complexity and cross-functional integration have similar influences on both manager's perceptions and real performance.

The paper has a classical structure, where the next section introduces the conceptual background, followed by the presentation of hypotheses. The third and fourth sections present the empirical test of the relationships proposed. Finally, the main conclusions, contributions, limitations and future lines of research are presented.

2. THEORY AND HYPOTHESES

The role of product innovation in stimulating firm performance remains an open question, as previous studies offer inconclusive results (Pérez-Luño et al., 2014). On the one hand, product innovation appeared to negatively influence performance in manufacturing firms (Freel and Robson, 2004). On the other hand, previous research has acknowledged innovation as a critical determinant of organizational performance (Damanpour, 1991; Smith, Collins and Clark, 2005). In order to try to solve these inconsistencies, Thornhill (2006) highlighted that the interaction between knowledge, market dynamism and innovation influenced firm performance; he then showed that when knowledge assets are high, the effect of new

product innovations on revenue growth was greater for high-technology firms. Other studies have demonstrated that when organizations identify the appropriate type of strategy consistent with the environmental conditions that they operate in, they are able to gain higher performance. (Pérez-Luño et al., 2014). These results have prompted a contingent approach on the relationship between product innovation and firm performance, suggesting that the type of innovation, the amount and characteristics of knowledge, the company's strategy, environmental conditions, among others, moderate this relationship (see for example Miller and Friesen, 1978). A contingent approach assumes that there is no "one best way" to structure or strategize, nor is there one best size for the firm; it all depends on coalignment among a number of factors. When the factors are aligned, firms experience above average performance than when they are not (Damanpour and Gopalakrishnan, 2001).

While innovation and contingent literatures talk about a number of factors that may condition the relationship between product innovation and firm performance, hitherto we know very little about how cross-functional integration and, particularly, the breadth of cross-functional integration may affect this relationship. Cross-functional integration can play a determinant role in new product development and performance by helping firms to reduce uncertainty and enhance the quality of their decisions (Song, Thieme and Xie, 1998). It improves horizontal communication, information and knowledge sharing between areas and integrates overlapping activities which in turn can improve efficiency, stimulate creativity and reduce the time to the market of new products (De Visser et al., 2010; Ernst, 2002; Song, Thieme and Xie, 1998; Brown and Eisenhardt, 1995).

Studies of cross-functional integration have evaluated its impact on performance at the level of new product development project. Several studies report a positive interaction between cross-functional integration and product innovativeness which improves project performance (Olsen et al., 1995, 2001; Song and Xie, 2000). However, to our knowledge these relationships have been scarcely analyzed at firm level. An exception in this sense is the study of De Visser et al. (2010) which shows that firms involved in radical product innovation will increase innovation turnover when they apply a cross-functional organizational structure.

The issue of integration and coordination between functional areas and its impact on innovation and performance has also been approached by marketing scholars. Previous research in the area of marketing has used the concept of interfunctional coordination, defined as the integration and collaboration of various functional areas within an organization with the aim of enhancing communication and information sharing (Narver and Slater, 1990). Previous studies have conceptualized interfunctional coordination as a dimension of market orientation and indicated that market orientation has a positive

influence on business performance and it is an important antecedent of firm innovation (Yang et al., 2012; Raju et al., 2011; Grinstein, 2008). Regarding the particular role of interfunctional coordination, although there is some evidence of a negative relationship with innovation (Henard and Szymanski, 2001), most of research acknowledges a positive relationship with both firm performance and innovation (Grinstein, 2008; Kara et al., 2005; Salavou, 2002; Pelham, 2000; 1999). However, as in the case of cross-functional integration, previous studies fail to give an account of the extent of inter-functional coordination that is beneficial for firm innovation and performance, as it measures interfunctional coordination as a generic concept, that doesn't specify particular areas or how many areas.

The foregoing discussion suggests that cross-functional integration conditions the effect of product innovation on performance. We propose that a broader cross-functional integration positively moderates the relationship between product innovation and performance, in the sense that innovations lead to higher performance when functional integration spans more areas (De Visser et al., 2010). Therefore, we propose the following hypothesis:

Hypothesis 1: The relationship between product innovation and performance is stronger for firms with high cross-functional integration than for firms with low cross-functional integration.

Notwithstanding the benefits named above, previous research also highlights a dark side of cross-functional integration. Constant interaction between different functional areas that often have different logics and goals, can also generate confusion, conflict and work overload (Song et al., 1998). Reaching consensus is more time consuming and costly, slowing the process of decision making. Spanning integration to several functional areas can thus delay the process of innovation, increase its cost, decrease productivity and lead to poor decision making. However, Swink and Song (2007) show that although integration between marketing and manufacturing may increase the new product development time, the added benefits in terms of product competitive advantage and project return on investment outweigh this drawback.

Previous research on the role of breadth of cross-functional integration in product innovation and its relationship to performance is scarce and provides apparent contradictory explanations. Song, Thieme and Xie (1998) found that integrating several functional areas has a negative influence on each stage of new product development process, while De Visser et al. (2010) find that a cross-functional organizational structure is positively related to the performance of radical innovation projects. This apparent contradiction suggests that other variables might be conditioning the effect of broad cross-functional on innovation performance. Although broad cross-functional integration may delay and increase the costs of the innovation process, previous research suggests that it may be particularly useful when the process of

product innovation is complex and requires integrating knowledge from different functional areas (De Visser et al., 2010). In these situations, it can help the organization to manage complexity and consequently improve the quality of the decisions made (Troy, Hirunyawipada and Paswan, 2008). Therefore, we propose that the role cross-functional coordination plays in the relationships between innovation and performance is contingent on the degree of complexity of the organizational knowledge.

Pringle (1951) defines knowledge complexity as the number of parameters needed to define a system. Gopalakrishnan and Bierly (2001) associate knowledge complexity with originality, suggesting that knowledge is more difficult to understand when it is associated with the uncertainty derived from originality. Such originality will lead to higher levels of novelty. That novelty, if applied to new products, could be translated into innovations. A high degree of knowledge complexity involves distinct and interacting elements that an individual cannot understand easily (McEvily and Chakravarthy, 2002); therefore, it will require the higher levels of interaction and knowledge coordination that cross-functional integration provides.

Our arguments for this triple moderation are twofold. First, cross-functional collaboration is particularly effective when innovations involve high novelty, because this kind of innovations are likely to involve substantial task interdependence and a development process marked by high levels of uncertainty (De Visser et al., 2010; Olsen et al., 1995). Such interdependences and uncertainty involve knowledge complexity (Pelz, 1985). In these contexts, functional collaboration across several areas can help the organization to manage dependencies through direct information and knowledge transfers (Narver and Slater, 1990; Slater and Narver, 1994), enhancing dissemination of knowledge within the organization (Lukas and Ferrell, 2000; Gatignon and Xuereb, 1997) and creating a culture of collaboration and resource sharing (Kahn, 2001). Knowledge exchange and collaboration can increase efficiency (Raju et al., 2011), stimulate creativity, enhance problem solving (Gatignon and Xuereb, 1997) and generate valuable new knowledge and information. These, in turn, reduce uncertainty and help to make better decisions in the innovation process leading to better firm performance. In this sense, Gomes, de Weerd-Nederhof, Pearson and Cunha (2003) report a positive interaction between the degree of novelty of the new product and collaboration between different functional areas, emphasizing that new product development projects perform better when both cross-functional integration and degree of change of the innovation are high. De Visser et al. (2010) also find that a cross-functional organizational structure improves the performance of radical innovations. The reason way radical innovation requires higher levels of cross-functional integration is because it is associated to knowledge tacitness and complexity (Damanpour, 1991).

Therefore, knowledge complexity justifies the managerial need of collaboration and coordination between different areas.

Second, a broader cross-functional integration provides a context favorable to developing more innovative and successful projects. It does so by increasing awareness about the resources available within the different units of the organization, allowing the firm to mobilize discarded resources towards innovation projects and creatively combine resources. Making-do with resources at hand can lead to radical innovations with high potential returns (Baker and Nelson, 2005). Interfunctional coordination can also lead to new and unique resources combinations and creation of new knowledge (Dougherty, 1992) to support the initiation and implementation of radical innovation projects that can award first mover advantages. In this sense, Atuahene-Gima (2005) has found that the search for entirely new competences leads to innovation in the presence of interfunctional coordination. As we have discussed above, cross-functional integration is required when organizations deal with complexity. As organizations vary in the degree of knowledge complexity they have to manage, they will also vary in their necessity for cross-functional integration. Therefore, we expect the effect of cross-functional integration to vary depending on the degree of organizational knowledge complexity. These assumptions lead to our second and third hypotheses:

Hypothesis 2. At high levels of knowledge complexity, the relationship between product innovation and performance is stronger for firms with high knowledge interfunctional integration than for firms with low interfunctional integration.

Hypothesis 3. At low levels of knowledge complexity, the relationship between product innovation and performance is stronger for firms with low interfunctional integration than for firms with high interfunctional integration.

3. METHODS

3.1. Sample and Data Collection

Spanish wine industry is a key player in the international arena: it is the largest world producer of wine and the second largest exporter by volume, but the third by value (ICEX, 2014). As this data suggests, one of Spanish wineries' main challenges within this international scenario is related to value generation. Despite significant investments in improving installations and equipment (around 800 million Euros since 2000), the industry still faces significant difficulties in generating value. This problem has been related to

the structure of the industry which is dominated by small and medium-sized local firms. According to Ruiz and Riaño (2011) there are more than 4.500 wineries in Spain, with more than 20.000 trademarks, many of them family firms or cooperatives, usually characterized by a lack of resources and capacities to generate international brands, a low qualification of the workforce employed (except for the oenologist) which often impedes the firm to fully exploit the potential of the new installations and equipment, a high amount of tacit and contextualized knowledge (Giuliani, 2007) and lack formal knowledge management systems to disseminate and apply knowledge. These are critical challenges for small and medium wineries aiming to innovate to increase the value of their wines (McDermott et al, 2009; Giuliani, 2007; Wong and Aspinwall, 2004).

To obtain the data to explore these questions we conducted the following process. First, the SABI database (the most comprehensive database of company information in Spain) facilitated identification of the Spanish wineries that would represent our population. Second, in order to get the primary data, the research team contacted the group of target firms by telephone. The interview began with verification that the firm belonged to the sample frame, that is, that the company indeed was a winery selling wine and that their annual selling was above 100,000 Euros. The study excluded firms that did not meet these requirements. Third, the research team asked the remaining 520 firms if they would agree to receive the questionnaire. Between the second semester of 2013 and the first semester of 2014, 111 wineries responded to this questionnaire; of the responses, 108 were valid (after eliminating those cases with missing data in any item), corresponding to a usable response rate of 20.77% of the firms in the target population. The questionnaire was directed to the manager of the firm. In order to safeguard against bias and verify the quality of the responses, we surveyed secondary respondents (enologists) of 33 firms, allowing us to establish inter-rater reliability. Fourth, objective information about performance was obtained from SABI/AMADEUS database, reducing the risk of common method bias. Finally, in order to check for non-response bias, the study uses a chi-squared test (using Yates's correction for continuity) applied to a contingency table with the companies of the populations included and not included in the sample. The outcome was not statistically significant ($\chi^2(1)=2.36$, $pN0.05$). A one-way ANOVA test showed that the difference between the mean scores was not statistically significant for the two groups of companies in terms of the number of employees ($F(1)=0.141$, $pN0.05$), turnover ($F(1)=0.000$, $pN0.05$) and age ($F(1)=0.375$, $pN0.05$). It seems that the problem of non-response bias as related to company size or age is not present in the data.

Measures. Dependent variables. *To evaluate firm performance, we used two different measures: an objective measure based on the 2013 P/L before tax reported by the firm in its financial statements and a*

subjective measure based on the reported degree of satisfaction with several aspects of firm performance which are detailed in the appendix of this manuscript. The data referred to the 2013 P/L before tax was obtained from the SABI/AMADEUS database, which contains information about financial statements, financial ratios, activities, ownership and management of over a million Spanish companies. The subjective measure of performance is based on a seven-point Likert scale adapted from previous literature.

Independent variables. We used the Oslo Manual to directly measure *product innovation* in the previous three years. Product innovation was measured through an index that includes changes in the wine (new mixes of grapes), new wine products (white, red...), the cork of the bottle, completely new products (cava, vinegar...) and new alcoholic graduations in the wine. This measure is indexed going from 0 to 1.

We measured cross-functional integration using an indicator of the extent to which the oenologist involved in different functional areas of the firm. The oenologist is a key employee in a winery and the main responsible for new product development. For each functional area we coded 1 if the oenologist was involved in and 0 if he/she wasn't. We then built the interfunctional coordination indicator by aggregating the dummy variables. We chose this way of measuring interfunctional coordination and not the scales used in previous studies to adjust our measure the particularities of the firms included in our sample. Many of these firms had a very simple organizational structure, with no formal departments defined. The scales used to measure interfunctional coordination included items referring to coordination between departments (Narver and Slater, 1990), that couldn't be applied to these firms. Moreover, several in-depth interviews with managers of the wineries showed that oenologist involvement in several functional areas of the organization was a common practice between these firms to coordinate activities and knowledge.

Knowledge complexity: The study included a four-item scale following proposals by Gopalakrishnan et al., (1999), Subramaniam and Venkatraman, 2001 and Winter (1987). The items are included in the final appendix of this manuscript. The value of the Cronbach Alpha of this scale (0,733) indicates sufficient internal consistency and reliability.

Control Variables. Environmental dynamism was measured using Baum and Wally's (2003) scale (seven-points Likert scale). This scale has been employed in several innovation studies and consists of five items which are included in the final appendix. The Cronbach's alpha of the scale was 0,673 suggesting sufficient internal consistency and reliability. We also controlled for organizational size (measured by the number of employees), organizational age, export sales (percentage of sales corresponding to exports), number of employees involved in product/service/process improvement, how important was for the firm

improving its capability of developing new products/processes (five-points Likert scale), whether the idea of product innovation came from the firm or other collaborators (dichotomous variable), whether during the last five years the firm has internalized new activities (dichotomous variable). All these variables allow us to control for the effect of innovation efforts, resources endowments of the organization and environmental dynamism when assessing the relations between innovation and firm performance. We expect that firms which are more committed to innovation and count on larger resource endowments to perform better than firms which don't have these characteristics.

4. RESULTS ANALYSIS

Descriptive statistics and correlations for the variables included in our empirical analysis are displayed in Table 1. To ensure that multicollinearity was not an issue, Value Inflation Factors (VIFs) were computed (but are not reported here because of space limitations). No VIFs were greater than 2, indicating that we did not encounter multicollinearity.

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Objective Performance	448.01	2231.57	-											
2. Subjective Performance	3.18	0.89	0.11	1										
3. Cross-functional integration	2.11	1.17	-0.18	0.12	1									
4. Product Innovation	0.60	0.29	0.06	0.19	0.20*	1								
5. Knowledge Complexity	2.75	0.75	0.08	0.09	-0.02	0.04	1							
6. Firm Size	38.32	119.96	0.31**	0.21*	0.02	0.11	0.030	1						
7. Firm Age	53.18	73.19	-0.09	0.24*	0.08	0.29**	0.025	0.52**	1					
8. Export Sales	31.50	32.52	-0.07	0.17	-0.02	-0.01	0.085	0.12	-0.14	1				
9. Employees dedicated to improvements	3.74	9.99	0.39**	0.23*	-0.01	0.20*	0.119	0.65**	0.35**	0.05	1			
10. Importance of the innovation capability	3.45	0.85	-0.10	0.66**	0.17	0.15	0.034	0.15	0.09	0.11	0.18	1-		
11. Environmental Dynamism	2.42	0.77	0.15	0.17	0.01	0.37**	0.156	0.04	-0.03	0.12	0.20	0.18	1	
12. Source of ideas for product innovation	1.15	0.43	0.02	0.17	0.02	0.01	0.127	-0.04	0.06	0.16	0.06	0.13	0.08	1
13. Internalization of activities	0.45	0.49	-0.13	0.03	0.01	0.14	0.036	-0.09	-0.09	0.12	0.05	0.06	0.01	0.08

Table 1. Means, standard deviations and correlations.

Our hypotheses propose that knowledge complexity moderates the influence of cross-functional integration on the relationship between product innovation and firm performance. Given that our data didn't meet the condition of normality required by OLS regression analysis, we tested these hypotheses using a moderated moderation (triple moderation) test involving bootstrapping to estimate the confidence intervals for the indirect effects (Hayes, 2013; Hayes, 2012). This technique is not restricted by the normality assumptions of parametric tests and is particularly recommended when parametric assumptions are not viable (like in small convenience samples) and hypothesized models involve interaction effects, because they have more statistical power than moderated regression analysis (Hayes, 2013; Russell and Dean, 2000).

Bootstrapping uses multiple resampling of the data to estimate the values of conditional indirect effect. Sorting the values of the conditional indirect effect from low to high, the confidence interval for the indirect effect is derived. When 0 is not within the confidence interval, the null hypothesis of no conditional indirect effect can be rejected (Preacher et al., 2007).

Figure 1. Conceptual model

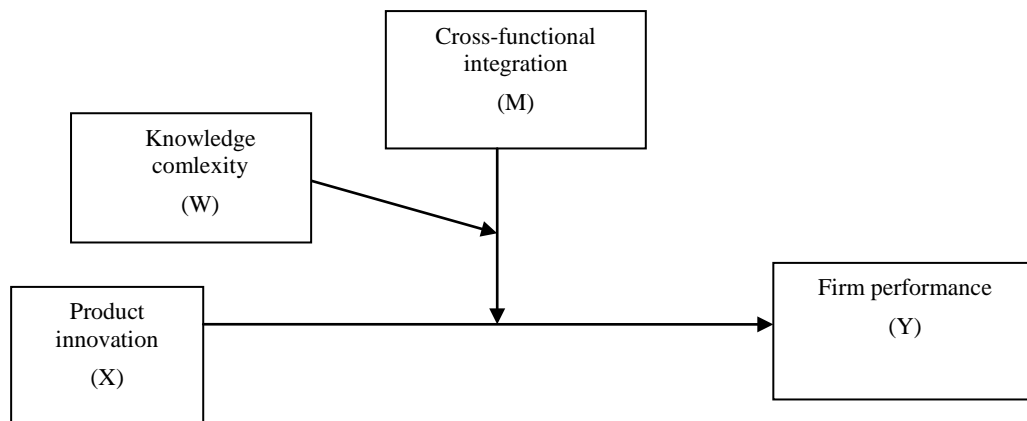
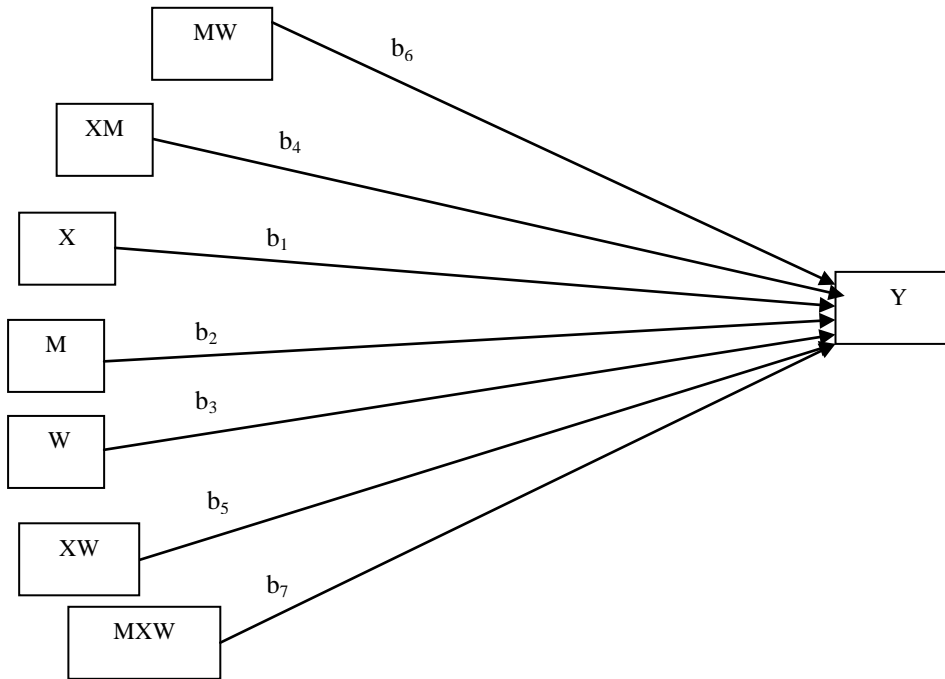


Figure 2 presents the statistical diagram of our theoretical model which is drawn in Figure 1. The triple moderation test allows us to probe the change in the interaction between innovation and cross-functional integration according to the level of organizational knowledge complexity.

Figure 2. Statistical Diagram



$$\text{Conditional effect of } X \text{ on } Y = b_1 + b_4M + b_5W + b_7MW$$

The conditional effect of X (product innovation) on Y (firm performance) is a multiplicative function of M (cross-functional integration) and W (knowledge complexity), whose expression is: $b_1 + b_4M + b_5W + b_7MW$. The three-way interaction (moderated moderation) is present if b_7 is statistically different from zero.

We used the software implementation of these procedures via the SPSS macro “PROCESS”, developed by Hayes (2013). PROCESS conducts tests of triple-interaction effects when assessing moderated moderation, as described in Hayes (2014; 2012) and reports both the conditional effect of X on Y at values of the moderators and the conditional effect of X*M interaction at values of W, together with the R-square increase due to three-way interaction.

Resampling 5000 times for the bootstrap estimates, we obtained the results presented in Tables 2 to 5. Table 2 reports the coefficients of regressing for both objective and subjective measures of firm performance on the independent variables, interaction terms and control variables. Model 1 reports the results of the regression on the 2013 P/L before tax.

Table 2. Regressions on objective and subjective measures of firm performance

	Model 1		Model 2	
	P/L before tax		Satisfaction with firm results	
Firm Size	12.833	***	0.001	
Firm Age	-5.562	*	0.001	
Export Sales	-12.357	**	-0.002	
Employees dedicated to improvements	72.528	***	0.000	
Importance of the innovation capability	-346.920	*	0.401	***
Environmental Dynamism	334.458		0.078	
Source of ideas for product innovation	138.122		0.063	
Internalization of new activities	-787.633	**	-0.008	
Product Innovation (PI)	14319.543	**	4.339	*
Cross-functional integration (CfI)	3058.985	*	1.187	**
Knowledge complexity (KC)	2670.398	*	0.998	*
PI x CfI	-5170.289	**	-1.724	**
PI x KC	-4491.061	**	-1.313	*
CfI x KC	-1010.628	*	-0.326	*
PI x CfI x KC	1598.841	*	0.474	*
Adjusted R ²	0.851		0.615	
F	22.231	***	7.055	***

(* p < 0.05; ** p < 0.01; *** p < 0.001)

The significant and positive sign of the β coefficient of all independent variables, suggests that they have a positive relationship with firm performance. Contrary to our expectation, the interaction term between product innovation and cross-functional integration has a negative and significant coefficient, indicating a negative moderating effect of cross-functional integration on the relationship between product innovation and firm performance. Therefore, our first hypothesis is rejected. As expected, the coefficient of the multiplicative term between product innovation, cross-functional integration and knowledge complexity is positive and significant, suggesting the presence of a three-way interaction. Model 2 reports the results of the regression analysis on the subjective measure of firm performance. As it can be observed in Table 2, the coefficients of all independent variables and interaction terms follow the same pattern described in Model 1.

The only difference between Model 1 and Model 2 concerns the role of the control variables, which have significant relationships with firm objective performance, but not with subjective

performance. The only significant control variable in Model 2 is the importance a firm gives to innovation capability which is positively associated with satisfaction with firm results.

Table 3 shows the R-square increase due to three-way interaction for both Model 1 and 2 (0,017 and 0,028) respectively, indicating that the change in R-square is significant in both cases.

Table 3. R-square increase due to three-way interaction

	R-square change	F(1, df2)	df2	p
PI x Cfi x KC In Model I	0.017	6.841	58	0.011
PI x Cfi x KC In Model II	0.028	4.810	66	0.031

Tables 4.1 and 4.2. show the conditional effect of X on Y at values of the two moderators for Model 1 and 2, respectively. An effect is considered significant if its 95% confidence interval from the 5000 bootstrapped samples does not include the value 0. As we can observe, when both knowledge complexity and cross-functional integration are low, the effect of product innovation is positive and significant (the confidence interval for the estimate doesn't contain 0). For low levels of knowledge complexity, as cross-functional integration increases, the effect becomes not significant and negative.

Table 4.1. Conditional effect of X on Y at values of the moderators (Model 1)

Conditional effect of X on Y at values of the moderators							
KC	Cfi	Effect	SE	t	p	LLCI	ULCI
2.010	0.969	3395.284	944.411	3.595	0.000	1504.828	5285.741
2.010	2.114	1154.384	708.479	1.629	0.108	-263.800	2572.568
2.010	3.260	-1086.516	1063.321	-1.021	0.311	-3214.998	1041.965
2.719	0.969	1308.699	613.777	2.132	0.037	80.082	2537.316
2.719	2.114	367.068	537.028	0.683	0.497	-707.916	1442.052
2.719	3.260	-574.563	823.755	-0.697	0.488	-2223.497	1074.371
3.429	0.969	-777.885	1043.213	-0.745	0.458	-2866.116	1310.344
3.429	2.114	-420.248	763.624	-0.550	0.584	-1948.818	1108.322
3.429	3.260	-62.610	1001.616	-0.062	0.950	-2067.575	1942.355

Values for quantitative moderators are the mean and plus/minus one SD from mean.

Table 4.2. Conditional effect of X on Y at values of the moderators (Model 2)

Conditional effect of X on Y at values of the moderators							
KC	Cfi	Effect	SE	T	p	LLCI	ULCI
2.020	0.947	0.959	0.388	2.472	0.016	0.184	1.734
2.020	2.115	0.063	0.270	0.235	0.814	-0.475	0.602
2.020	3.284	-0.832	0.330	-2.516	0.014	-1.492	-0.172
2.734	0.947	0.342	0.234	1.460	0.149	-0.125	0.811
2.734	2.115	-0.157	0.194	-0.809	0.421	-0.546	0.231
2.734	3.284	-0.658	0.284	-2.316	0.023	-1.225	-0.090
3.448	0.947	-0.274	0.390	-0.702	0.484	-1.053	0.504
3.448	2.115	-0.379	0.281	-1.346	0.182	-0.940	0.182
3.448	3.284	-0.483	0.376	-1.283	0.203	-1.236	0.268

Values for quantitative moderators are the mean and plus/minus one SD from mean.

At medium levels of knowledge complexity and low levels of cross-functional integration, the triple interaction effect is still positive and significant. However, as cross-functional integration increases, the effect again becomes not significant and negative. When knowledge complexity is high, as cross-functional integration increases, the effect of innovation improves, as it goes up from -777,885 to -62,610, but remains negative and not significant. The same pattern of relationships can be observed for Model 2, with the difference that when knowledge complexity is high, a higher level of cross-functional integration seems to lead to an increasing negative effect of product innovation on satisfaction with firm results.

Table 5.1. and 5.2. show the conditional effect of the interaction between cross-functional integration and product innovation at values of the moderator knowledge complexity for both objective and subjective measures of performance, respectively. The interaction between cross-functional integration and product innovation has a negative and significant effect in P/L before tax when knowledge complexity is low and becomes positive, but not significant, when knowledge complexity increases, confirming the relational path identified in Table 4.1. When evaluating the effect of the same interaction term on satisfaction with firm results, we observe that it is negative and significant when knowledge

complexity is low, but this negative effect diminishes, although loses significance, as knowledge complexity increases.

Table 5.1. Conditional effect of the interaction between cross-functional integration and product innovation at values of the moderator knowledge complexity (Model I)

Conditional effect of X*M interaction at values of W						
KC	Effect	SE	t	p	LLCI	ULCI
2.010	-1956.415	623.077	-3.139	0.002	-3203.647	-709.182
2.719	-822.089	427.034	-1.925	0.059	-1676.897	32.718
3.429	312.235	593.828	0.525	0.601	-876.448	1500.918

Values for quantitative moderators are the mean and plus/minus one SD from mean.

Table 5.2. Conditional effect of the interaction between cross-functional integration and product innovation at values of the moderator knowledge complexity (Model II)

Conditional effect of X*M interaction at values of W						
KC	Effect	SE	t	p	LLCI	ULCI
2.020	-0.766	0.204	-3.749	0.000	-1.175	-0.358
2.734	-0.428	0.148	-2.889	0.005	-0.724	-0.132
3.448	-0.089	0.223	-0.401	0.689	-0.534	0.355

Values for quantitative moderators are the mean and plus/minus one SD from mean.

Together, these results confirm that a high level of cross-functional integration has a negative effect on the capacity of the firm to improve performance through product innovation when knowledge complexity is not high, validating our third hypotheses. Although the pattern of relationships between the variables for high levels of knowledge complexity suggests that the effect of cross-functional coordination might become positive, the results are not significant, so we reject our second hypothesis.

5. DISCUSSION AND CONCLUSIONS

This research reveals that breadth of cross-functional integration has a negative moderating effect on the relationship between product innovation and performance and that this effect varies according to the level of complexity of organizational knowledge. These results are consistent with those of Song, Thieme and Xie (1998) who find that trying to simultaneously integrate more than two functional areas negatively impact the process of new product development. A broad cross-functional integration seems to involve

management costs that are superior to the benefits paid by coordination in terms of innovation performance. However, this negative effect may turn positive, although not significant, when organizations have a high degree of knowledge complexity. Therefore, although coordination across several functional areas is not recommended when the level of complexity of organizational knowledge is low, it may help to develop innovations that generate positive outcomes at organizational level when organizations have to manage complex knowledge. This finding is consistent with previous results like those obtained by De Visser et al. (2010), Olson et al. (2001) or Song and Xie (2000) who suggest that, due to the inherent complexity involved in developing products with a high degree of novelty, coordinating innovation activities across several functional areas improves decision-making and, consequently, performance of the innovation project.

Cross-functional integration is a widespread practice among firms involved in new product development (De Visser et al., 2010; Troy, Hirunyawipada and Paswan, 2008) and its consequences for firm performance are not clear (De Visser et al., 2010). Our results contribute to literature on product innovation, shedding light on the role that breadth of cross-functional integration plays in the relationship between product innovation and performance.

Our contribution is threefold. First, previous studies on the role of cross-functional integration in new product development have focused mainly on project performance (Olson et al., 2001; Song and Xie (2000) and, with a few exceptions (e.g. De Visser et al., 2010), they ignored innovation performance at firm level. This is important because the implications of cross-functional integration at organizational level may be different from those at project level. For example, while at project level a broader cross-functional integration may negatively impact project performance by delaying the different stages of product development (Song, Thieme and Xie, 1998), the consequences of coordination between several functional areas may lead to better firm performance by creating new valuable knowledge through facilitation of knowledge transfer within the organization (Lukas and Ferrell, 2000; Slater and Narver, 1994) and increasing efficiency through problem solving (Raju et al., 2011; Gatignon and Xuereb, 1997). Our findings seem to support this premise as cross-functional integration has a direct positive relationship with firm performance, but a negative indirect effect on the relationship between product innovation and performance.

Second, most studies on cross-functional integration have focused mainly on the role of coordination between specific functional dyads, ignoring how a broader integration would affect innovation performance, especially in environments with a high degree of perceived knowledge complexity, when coordination requires spanning several areas. Our measure captures thus a more

accurate view of the breadth of cross-functional integration than in previous studies by considering coordination across several areas, including general management, and illustrates a negative role of this breadth in product innovation performance, particularly when the degree of knowledge complexity is low.

Third, previous research has assumed knowledge complexity as being consubstantial to radical innovation (De Visser et al., 2010) or to products with a high level of innovativeness (Olson et al., 2001) and claimed that when organizations have to deal to a high level complexity, a broader cross-functional integration is required to improve product innovation performance. However, no prior research has explicitly tested the conditional effect of organizational knowledge complexity. In this sense, our study provides empirical evidence for this general assumption, confirming that cross-functional integration plays a more positive role when the degree of knowledge complexity the organization has to manage is high.

Innovation is commonly considered a key aspect in firms aiming to compete successfully in the markets (Otero-Neira et al., 2009). From a practitioner perspective, this study evaluates the potential of specific practices – i.e. involving the oenologist in several functional areas of the organization- to enhance value-creation through product innovation in wine industry. Our findings suggest that unless the winery has to deal with a high degree of knowledge complexity, involving the oenologist in several functional areas for coordination purposes, may detract resources from product innovation effort and lead to a poorer performance.

Like all studies, ours has some limitations that future research should address. First, trying to really understand the idiosyncrasy of the industry, we have focused on the Spanish wine industry, and adapted our measures accordingly. While we believe that this is an appropriate approach, given our research interest, we would like to emphasize the limits of generalizing our findings to other industries. In addition, our data were collected only in Spain, which further limits generalizability.

Second, the data we relied on were mainly cross-sectional. Therefore, it is impossible to infer causality in any strict sense. The theory we used assumes specific causal directions, and while we tested for alternative models and found no significant relationships, other causal models cannot be ruled out. Future research needs to consider these issues carefully.

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APPENDIX A

Variable	Items
Satisfaction with Performance	P1. Economic profitability P2. Financial profitability P3. Sales growth P4. Net contribution margin P5. Market share P6. Reduction of the response time to clients and suppliers P7. Improvement of the capability to develop new products or processes P8. Improvement of the information exchange between the firm and its business and institutional collaborators P9. Introduction of new products for new groups of clients P10. Introduction of new products in new geographical markets
Product Innovation	Please state if you have include any change in the last 3 years in: I1. The cork of the bottle I2. New mix of grapes I3. New wines I4. New wines' degrees of alcohol I5. New products (vinegar, other driks...)
Knowledge Complexity	K1. The knowledge used in your organization requires prior learning in other technologies and related knowledge; K2. Description of the knowledge used in your organization requires a large amount of information; K3. The knowledge used in your organization is technologically sophisticated and difficult to implement; K4. The knowledge used in your organization is complex (vs. simple)
Environmental dynamism	D1. In our industry, our firm must change its products frequently D2. In our industry, the rate of obsolescence is very high D3. Actions of competitors are quite easy to D4. Demand and consumer tastes are fairly easy to D5. The production/service technology change often and in major ways