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When more is less

The role of cross-functional integration, knowledge complexity and product innovation in firm performance

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Abstract

Purpose – The purpose of this paper is to analyze the role of a specific mechanism for cross-functional integration (CFI) in the relationship between product innovation and firm performance. It takes a contingency perspective, accounting for how these relationships vary depending on the degree of organizational knowledge complexity.

Design/methodology/approach – Hypotheses are tested via regression analysis with interaction effects in a sample of 105 wineries from Spain, using both objective and subjective firm performance data.

Findings – The results obtained confirm the existence of significant triple interaction effect of CFI, knowledge complexity and product innovation on firm performance. CFI has a negative moderating effect on the relationship between product innovation and performance and this effect varies according to the degree of organizational knowledge complexity.

Research limitations/implications – This paper looks at variables that have been hitherto studied at the project or product level, at the firm level, in an attempt to untangle the relationship between innovation, CFI, knowledge complexity and firm performance. Study's main limitations lie in the use of a cross-functional design and its focus on a single industry.

Practical implications – Firms dealing with complex organizational knowledge could use this CFI mechanism in the development of new products when their size and resources do not allow the creation of more formal temporal structures, such as cross-functional teams. However, unless the winery has to deal with a high degree of knowledge complexity, involving the oenologist in several functional areas for the purpose of coordination, may detract resources from product innovation effort and lead to a poorer performance.

Originality/value – This study showcases a mechanism of CFI not explored in previous research, but used in practice at many firms, i.e. the cross-pollination of ideas across different functional areas through the participation of the responsible for the product development, and tests its role in the relationship between product innovation and different types of firm performance.

Keywords Product innovation, Firm performance, Knowledge complexity, Cross-functional integration

Paper type Research paper

1. Introduction

Product innovation, defined as the introduction of a new product or service to meet an external user need (Damanpour, 1991, 2017), is crucial for the long-term competitive survival of organizations (Pérez-Luño *et al.*, 2014). Although some studies have associated product innovation with positive firm-level outcomes (Tung, 2012; Song *et al.*, 2011), others have

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shown that innovation does not always lead to superior performance (Freel and Robson, 2004; Damanpour, 2017; Duran *et al.*, 2017). Therefore, the relationship between product innovation and firm performance remains unclear. Researchers have addressed this ambiguity by adopting a contingency approach, applying diverse factors to better specify the context in question, and, thus, clarify the innovation–performance relationship (Gopalakrishnan and Damanpour, 2000; Pérez-Luño *et al.*, 2014). Among contingency factors that have been shown to influence this relationship are the firm's external connectedness (Li *et al.,* 2018; Trantopoulus *et al.*, 2017), its market dynamism (Pérez-Luño *et al.*, 2014), its networking ability (internal and external) (Mitrega *et al.*, 2017) and the degree of internal connectedness (Nakata and Im, 2010).

From a contingency perspective, it is generally agreed that the product innovation–performance relationship is complex and nuanced and requires firms to orchestrate knowledge, combining information flows and activities, both within the firm and in external areas, in order to be successful (Hirunyawipada *et al.*, 2010; Mitrega *et al.*, 2017; Zhang *et al.*, 2018). Following De Luca and Atuahene-Gima (2007) and Nakata and Im (2010), the present study uses two contingency factors – cross-functional integration (CFI) and knowledge complexity – to identify and resolve ambiguities in the product innovation–performance relationship.

CFI, which has been defined as "the degree of interaction, communication, and information sharing across functional areas" (Troy *et al.*, 2008), is a key factor that facilitates coordination and enables product innovation. CFI improves horizontal communication linkages, reduces conflict between areas, increases product novelty via total quality management (Ellegaard and Koch, 2014; Sethi and Sethi, 2009) and helps transfer and transform tacit knowledge and information across functional areas. Moreover, it stimulates creativity, improves the quality of development efforts, reduces the development time of products and processes by promoting lean production methods and just-in time inventory strategies (Ohno, 1988; Hayati *et al.*, 2017), and reduces overall inefficiencies and costs in the process (Hirunyawipada *et al.*, 2010; Troy *et al.*, 2008). On the other hand, CFI may also provoke information overlaps, increase workplace conflict, compromise product appropriateness and generate work overload (Song *et al.*, 1998; Sethi and Sethi, 2009). On balance, thus, CFI provides some positive outcomes, but it could also consume additional time and resources and slow product innovation (Swink and Song, 2007; Karlsson and Ahlstrom, 1996), resulting in decreased profits and poorer innovation performance.

These contradictory findings suggest that another contextual or contingency variable might also impact on the relationship between CFI, product innovation and firm performance. It has been suggested that CFI may be particularly useful when the innovation incorporates complex knowledge and requires the integration of knowledge streams from different functional areas (De Visser *et al.*, 2010; Majchrzak *et al.*, 2012; Gemser and Leenders, 2011) or when the degree of change involved in the product innovation is high and, therefore, complex. Hence, we propose that the role played by CFI in the relationship between product innovation and performance is also contingent on the degree of complexity of the knowledge involved in product innovation. In product innovation, knowledge complexity, defined as the number of parameters needed to define a system (Pringle, 1951), can emanate from the degree of change involved in the new product or from the complexity of the knowledge involved with the product in general.

In view of the above considerations, this paper addresses the following research questions:

RQ1. Is the product innovation–firm performance relationship contingent on CFI?

RQ2. How does the level of knowledge complexity further specify the moderating role of CFI in the product innovation–performance relationship?

To answer these questions, we consider both subjective and objective measures of firm performance: on the one hand, satisfaction with the company's results, and on the other, the pre-tax profit/loss.

The above relationships were tested by analyzing a sample of 105 small and medium-sized wineries operating in Spain. The wine sector is a prominent industry in terms of economic activity in many countries, making significant contributions to employment and revenue (Bigliardi and Galati, 2013; Vrontis *et al.,* 2016). The Spanish wine industry is a mature one containing over 4,500 wineries, distributed in various regional clusters. The industry has undergone major changes and has had considerable success in striking a balance between traditional and innovative approaches. Product innovation in the wine industry tends to be both complex and sophisticated. Scientific knowledge is applied for technological development in areas, such as fermentation, botanical analysis and soil management, all of which are needed to create a good quality product (Doloreaux and Lord-Tarde, 2013). For these reasons, we believe that the Spanish wine-producing industry is a particularly useful arena for exploring how knowledge complexity and CFI interact to enhance performance.

The results obtained in this study confirm the existence of a significant triple interaction effect, by CFI, knowledge complexity and product innovation, on firm performance. Our findings contribute to the understanding of product innovation by confirming that a contingent approach is needed to better understand the innovation–performance relationship and by identifying the roles played by CFI and knowledge complexity in this relationship. Specifically, we report the following. First, that CFI has a significant negative moderating effect on the relationship between product innovation and firm performance. This organizational-level finding enhances innovation and knowledge management literature by extending previous findings obtained at the project level. Second, while most studies of CFI have focused on the role of coordination between specific functional dyads, ignoring how a broader type of integration may affect the innovation–performance relation at the organizational level, we demonstrate that attempting the simultaneous integration of various functional areas does not automatically translate into improved firm performance. Moreover, our study highlights an aspect of CFI that has not been explicitly considered in previous research, but which is used in practice at many firms, namely the cross-pollination of ideas across different functional areas through the participation of a key employee (in our case, the oenologist) responsible for product innovation. Third, we explicitly test the conditional effect of knowledge complexity on innovation, confirming that CFI plays a negative role when there is a low degree of knowledge complexity. Finally, we analyze performance, using both objective and subjective measures, and find that innovation, knowledge complexity and CFI have similar levels of influence on both perceptual and objective measures of performance, which corroborates the validity of the results presented.

2. Theoretical framework and hypotheses

As discussed in the previous section, recent studies have adopted a contingency approach to resolve the inconsistencies in the product innovation–firm performance relationship and to better specify the context and understand this relationship (Gopalakrishnan and Damanpour, 2000; Pérez-Luño *et al.*, 2014; Li *et al.,* 2018). A contingency approach assumes that there is no single "best way" to structure or strategise, nor is there a single best size for the firm; everything depends on alignment among a number of factors. When the factors are aligned, firms achieve superior performance than when they are not (Damanpour and Gopalakrishnan, 2001). Taking into account previous literature on product innovation, we identify two relevant contingent factors: the role of CFI and knowledge complexity. We then examine how these factors moderate the innovation–performance relationship. Our study hypotheses are developed in two steps. First, we examine the moderating role of CFI on the relationship between product innovation and firm performance. Then, we consider how knowledge complexity moderates the relationship between CFI, product innovation and firm performance.

In earlier research, it has been argued that CFI plays a positive role in the relationship between innovation and firm performance, for the following reasons. First, cross-functional teams improve horizontal communication, reduce conflict (Ellegaard and Koch, 2014), facilitate knowledge sharing between areas, integrate overlapping activities (Hirunyawipada *et al.*, 2010) and help the organization reach a strategic consensus about goals and strategies (Rosado Feger, 2014). Second, CFI improves connectedness between disciplines, and functions at the organizational level, enabling its members to overcome the different thought worlds and cultures that may exist within the firm (Dougherty, 1992). Third, CFI is a less demanding structural solution, contributes to ambidexterity and, thus, enhances the overall quality orientation, enabling lean manufacturing solutions while keeping the firm innovative (Sethi and Sethi, 2009). Jointly, these factors improve efficiency, reduce waste, stimulate creativity, increase the absorptive capacity of disparate teams and reduce the time needed to develop and market new products (Ohno, 1988; De Visser *et al.*, 2010; Song *et al.*, 1998; Brown and Eisenhardt, 1995).

Many studies of CFI have evaluated its impact on performance at the level of new product development, and have reported a positive interaction between CFI-product innovation and performance at the project level (Olson *et al.*, 1995, 2001; Song and Xie, 2000; Nakata and Im, 2010). However, relatively little research has been conducted at the firm level. An exception is a study by De Visser *et al.* (2010), who showed that firms seeking radical product innovation can improve performance in this respect by making use of cross-functional organizational teams.

In the area of marketing, researchers have used CFI to denote integration across various functional areas within an organization, aimed at enhancing communication and information sharing (Narver and Slater, 1990). Inter-functional coordination, viewed as a dimension of market orientation, has a positive influence on business performance and is an important antecedent of firm innovation (Grinstein, 2008).

In this context, two broad issues need to be clarified and further discussed. First, in which ways can CFI be conceived? In terms of narrow functional integration or via the broader integration of areas? How does this affect the relationship between product innovation and firm performance? Second, How is performance measured at the firm level? By the revenues obtained? (De Visser *et al.*, 2010), or by operational performance? (Turkulainen and Ketokivi, 2012). The answers to these questions may be directly relevant to how CFI affects the relationship between innovation and firm performance.

With respect to the first questions, in many cases the concept of CFI has been used interchangeably with that of inter-functional collaboration. Previous studies of CFI have been criticized for ignoring the context in which CFI takes place and the forms it might take in different types of organizations (Frankel and Mollenkopf, 2015). Although CFI refers to integration among functional areas, it has also been operationalized in the context of specific processes, such as new product development and the creation of process-based units. In the context of small firms with few or no differentiated functional units, CFI can also be achieved through mechanisms like joint participation, co-location, information and communication technologies or decision coordination systems (Gonzalez-Zapatero *et al.*, 2016; Rosado Feger, 2014). In the present study, we focus on a CFI mechanism that is specific to small and medium-sized firms. This mechanism belongs to the category that Gonzalez-Zapatero *et al.* (2016) label "joint participation," i.e. the cross-pollination of ideas across different functional areas through the involvement of a single key employee (such as the oenologist, in the wine industry), responsible for product development and innovation, in production activities, marketing, management or other areas.

With respect to the second question, we take organizational performance to mean the firm's financial and overall performance (thus, it is a broad assessment of managers' satisfaction with both financial and operational performance), as our study goal is to provide a fine-grained analysis of the impact made by product innovation on different measures of firm performance. These measures provide a comprehensive conceptualization of business performance at firm level (Morgan *et al.,* 2009; Venkatraman and Ramanujam, 1986), by including both primary and secondary performance data.

CFI is an organization-level construct that mirrors the degree of integration and coordination between different functional areas, an aspect of direct relevance to the firm's overall financial performance, via the costs thereby incurred or saved (Brettel *et al.*, 2011; De Visser *et al.*, 2010; Gemser and Leenders, 2011). In addition to its impact on financial performance, studies have shown that CFI may also influence operational aspects, such as reducing the time needed to market new products. Clearly, if the firm can enter the market earlier, innovation performance will be improved (De Visser *et al.*, 2010; Song *et al.*, 1998).

We hypothesize that CFI has a positive moderating impact on the relationship between product innovation and performance; product innovation will improve corporate performance when integration spans more areas of the firm's activities (De Visser *et al.*, 2010). Broad-based CFI will make the firm more responsive to new ideas, reduce conflicts in the implementation of innovations and help incorporate market needs into the proposed innovation. Involving key employees with responsibility for new product development in multiple functional areas can help transcend knowledge boundaries between these areas by increasing communication and enabling knowledge pooling. To reflect these considerations, we propose the following hypothesis:

H1. The relationship between product innovation and performance is stronger for firms with high CFI than for firms with low CFI.

In contrast to the benefits described above, research has also highlighted a negative side to CFI. At the project level, cross-functional teams sometimes have difficulty in integrating team members, with varying levels of knowledge and diverse abilities, in order to create a consensus opinion (Randel and Jaussi, 2003; Song *et al.*, 1998). Differences in backgrounds, priorities and thought worlds can also create conflict, impeding the innovation process (Karlsson and Ahlstrom, 1996). We argue such research inconsistencies might be resolved by reference to second contingency factor: differences in knowledge complexity in the decision making context. Previous (albeit fragmented) research results suggest that teams using CFI may perform better in the case of radical innovations (De Visser *et al.*, 2010) or when novel ideas arise, calling for ongoing creative engagement and flexibility (Majchrzak *et al.*, 2012), or when teams are faced with significant market and technological risk (Gemser and Leenders, 2011).

In view of these previous results, it might be useful to consider knowledge complexity as a second contingent factor that influences the effect of CFI on innovation performance at the firm level. Although broad-based CFI could delay the process and increase the costs of the innovation, it might be particularly useful when the focal product innovation is complex. In these situations, CFI can help the organization manage complexity by increasing the team's absorptive capacity, thus providing a more resilient approach to tackling and resolving issues (Majchrzak *et al.*, 2012). Therefore, we propose that the role played by CFI in the relationship between innovation and performance is contingent on the degree of knowledge complexity.

Pringle (1951) defined knowledge complexity as the number of parameters that are needed to define a system. Gopalakrishnan and Bierly (2001) and Pérez-Luño *et al.* (2011) associate knowledge complexity with originality, suggesting that knowledge is more difficult to assimilate when it is associated with the uncertainty derived from originality.

Clearly, the greater the originality, the higher the level of novelty. And this novelty, focused on the creation of new products, results in innovation. A high degree of knowledge complexity involves distinct, interacting elements that an individual may not readily understand (McEvily and Chakravarthy, 2002); therefore, it will require the higher levels of interaction and knowledge coordination that are provided by CFI.

We present three arguments in favor of this three-way interaction. First, cross-functional collaboration is particularly effective when innovations involve a high degree of novelty, because such innovations are likely to involve substantial task interdependence, they are complex, they incorporate tacit knowledge and their development is marked by high levels of uncertainty (De Visser *et al.*, 2010; Olson *et al.*, 1995; Damanpour, 1991). In this respect, Majchrzak *et al.* (2012) found that cross-functional teams (CFTs), when faced with novel situations, created intermediate scaffolds around the problem that encouraged continued creative engagement and flexibility so that solutions could be modified repeatedly. In such cases, CFTs facilitated co-creation, dialogue and sustained engagement, and enabled individual streams to be seamlessly integrated into the collective (Majchrzak *et al.*, 2012).

The second argument is that many of the practices described help to create greater absorptive capacity, which has been related to product success in the case of complex projects (Acikgoz *et al.*, 2016). This idea is supported by De Luca and Atuahene-Gima (2007), who argue that CFI can lead to the creation of knowledge integration mechanisms, thus improving the firm's information processing abilities. When complex knowledge must be confronted, the knowledge acquired through the interaction of CFI team members further enhances the firm's ability to assimilate market information and incorporate it into the product, which in turn increases product acceptance and organizational performance. Therefore, when firms deal with new, complex knowledge, CFI helps them absorb and integrate it, and subsequently translate it into product innovations, thus producing a positive impact on firm performance.

Finally, the breadth of CFI provides an organizational context that is conducive to developing more innovative projects. It does so by increasing awareness about the resources available within the different parts of the organization, allowing discarded resources to be mobilized toward innovation projects and resources to be creatively re-combined. In this sense, Atuahene-Gima (2005) observed that the search for entirely new competences leads to innovation in the presence of cross-functional coordination. As discussed above, CFI is required when organizations must respond to complexity. As organizations manage varying degrees of knowledge complexity, their CFI necessities will also vary. Therefore, we expect the effect of CFI to vary according to the degree of knowledge complexity involved. These assumptions are incorporated in the following hypotheses:

H2a. At high levels of knowledge complexity, the relationship between product innovation and performance is stronger for firms with high CFI than for firms with low CFI.

H2b. At low levels of knowledge complexity, the relationship between product innovation and performance is stronger for firms with low CFI than for firms with high CFI.

3. Methodology

3.1 Sample and research design

We tested the study hypotheses by considering a sample of wineries form Spain. The Spanish wine industry is a key player in the international arena, making Spain the largest world producer of wine and the second largest exporter by volume, although only the third by value (ICEX. Estadísticas sobre Vino en España, 2014). As these data suggest, one of the main challenges faced by Spanish wineries in the international context is that of generating value. Despite significant investments in improving installations and equipment (around €800m since 2000), the industry continues to face significant difficulties in this respect. To a large degree, the problem is 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 over 4,500 wineries in Spain, with more than 20,000 trademarks. Many of these are family firms or cooperatives, usually characterized by limited resources and with little or no capacity to generate international brands. In addition, the workforce is not highly skilled, except for the oenologist, and this factor, too, makes it difficult for the firm to fully exploit the potential of new installations and equipment. In most cases, the oenologist has considerable tacit and contextualized knowledge (Giuliani, 2007), but these firms otherwise lack formal knowledge management systems with which to disseminate and apply knowledge. Nevertheless, to be successful, the firm must understand both the artistic and the economic aspects of wine production, as well as the complex dynamics that impact on customers' purchase decisions. Thus, many different aspects of production and marketing are involved and must be coordinated. These issues pose a crucial challenge to small and medium-sized wineries seeking to innovate in order to increase the value of their wines (Giuliani, 2007; Wong and Aspinwall, 2004).

The following process was employed to obtain the data to explore the study questions. First, the SABI/AMADEUS database (the most comprehensive database of company information in Spain) facilitated identification of the Spanish wineries that represent our target population. These firms were then contacted and interviewed by telephone to obtain the primary data. The interview began with verification that the firm belonged to the sample frame, i.e. that it was indeed a wine producer and that its annual sales revenue exceeded €100,000. Firms that did not meet these requirements were excluded from the study. Each of the remaining 520 firms was then asked if they were willing to receive and complete the questionnaire on which the study was based. Between September 2013 and June 2014, 111 wineries responded to this questionnaire; after eliminating those lacking data for any of the questionnaire items, 108 of the responses were found to be valid, corresponding to a usable response rate of 20.77 percent of the firms in the target population. From this initial sample of 108, we excluded three that were large firms, and clear outliers in the sample. The remaining 105 firms were small or medium-sized wineries. In every case, the questionnaire was addressed to the managing director of the firm. In order to safeguard against bias and to verify the quality of the responses obtained, we also surveyed secondary respondents (oenologists) at 33 firms, which enabled us to establish inter-rater reliability. The risk of common-method bias regarding company performance was reduced by the use of objective information, obtained from the SABI/AMADEUS database. Finally, to detect possible non-response bias, a χ^2 test (using Yates's correction for continuity) was applied to a contingency table with the companies included and with those not included in the sample. The outcome was not statistically significant. Moreover, one-way ANOVA showed that the difference between the mean scores for the two groups of companies was not statistically significant in terms of the number of employees, sales turnover or age of the firm. Hence, there was no problem of non-response bias in terms of the firms' age or size.

3.2 Measures

Many of the constructs included in the study were measured with multi-item scales and indexes. Various precautions were taken to ensure data validity and reliability. First, all the measures were pre-tested, in 25 interviews with managers and oenologists, who were asked to review the questionnaire regarding the clarity of the questions and to ascertain whether the scales and indexes obtained the desired information. Special attention was paid to the innovation index to ensure that it only included the items that these wine experts considered product innovations in the industry. We then revised any potentially confusing items before submitting the questionnaire. All the scale-based measures used in the study, together with the results of the validity and reliability analysis, are shown in the Table AI. The index-based measures are explained below.

Dependent variables. In order to avoid common-method bias and to ensure the robustness of our model, two different measures of firm performance were used: an objective measure based on the 2013 profit/loss results before tax, as reported by the firm in its financial statements, and a subjective measure based on general managers' reported degree of satisfaction with several aspects of firm performance (detailed in the Table AI). The data for 2013 profit/loss results were 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 firm performance is based on a five-point Likert scale proposed by Zahra (1996). We believe it is important to obtain this global assessment of satisfaction with firm performance because CFI can affect both financial and operative aspects of this question (De Visser *et al.*, 2010; Song *et al.*, 1998). Our combination of primary and secondary data on the firms' financial performance is in line with the recommendations made in a recent study of CFI (Frankel and Mollenkopf, 2015), and enables us to examine convergence from alternate sources (Venkatraman and Ramanujam, 1986) and, thus, to test the robustness of our model.

Independent variables. We used the Oslo Manual (OECD/Eurostat, 1997) to measure product innovation in the previous three years. This parameter was measured according to an index with five elements: changes in the wine (new mixes of grapes); new wine products (white, red, etc.); how the bottle was corked; completely new products (such as cava or vinegar) and new degrees of alcoholic strength in the wine. The measure was scored from 0 to 1 on this index. Thus, 0 would mean that the company had made no changes to its products, while a score of 1 would mean that it had introduced changes in all five of the items considered by a panel of experts to be the main indicators of product innovation in the wine sector.

Most previous studies in this field have measured CFI using scales that evaluated the degree of communication and exchange between functional departments involved in new product development (e.g. Brettel *et al.*, 2011) or more generally, the degree of joint involvement of functional departments in specific activities related to new product development (e.g. Swink and Song, 2007; Song *et al.*, 1998). Seeking to respond to previous criticism about the lack of adaptation of the CFI concept and measures to the context in which it takes place (Frankel and Mollenkopf, 2015), we developed a specific indicator for measuring CFI and chose not to use the scales employed in previous studies. This decision is based on the following reasons.

First, we wished to suit our measure to the specifics of the firms included in the sample. As explained above, the Spanish wine industry is dominated by SMEs. These firms have simple organizational structures, in many cases with no formal departments defined and no formal planning activities. The scales used in previous analyses to measure CFI included items referring both to inter-departmental coordination and to formal planning activities (Brettel *et al.*, 2011; Swink and Song, 2007; Song *et al.*, 1998; Narver and Slater, 1990) and were not applicable to the SMEs in our sample. Moreover, our in-depth interviews with the managers of the wineries in question revealed that involvement of the oenologist in several functional areas of the organization, to coordinate activities and knowledge, was a common practice among these firms.

Second, our interest lies in the impact of CFI in general on the degree of product innovation and performance, not in the process of new product development. Therefore, we needed a measure referring to information and knowledge exchange between functional areas in their daily operations, not to specific activities related to new product development.

Finally, previous studies, such as Genç and Di Benedetto (2015), Rauniar *et al.* (2008) and Longoni and Cagliano (2015), have shown that involving key employees like environmental specialists, executives or product development managers with members of other functional areas can enhance the introduction of the new product by favoring strategic alignment, ensuring that the project mission is shared and clarifying project targets.

For all of these reasons, we decided to measure CFI using a specific indicator, belonging to the "joint participation" category of CFI mechanisms (Gonzalez-Zapatero *et al.*, 2016). This indicator evaluates the extent to which the oenologist is involved in different functional areas of the firm. This involvement is defined in the questionnaire in general terms as participation in firm activities that belong to other areas, namely production, marketing, general management and others (respondents were asked to indicate which of these other areas was referred to). Each functional area was assigned the code 1 if the oenologist was involved in it and 0 if he/she was not. The CFI indicator was then constructed by aggregating the dummy variables. For the winery, the oenologist is a key employee and the main person responsible for product innovation. His/her involvement in activities such as harvesting or advertising helps the winery to coordinate knowledge, information and activities across areas and constitutes a good proxy for CFI. Moreover, this measure reflects the degree and coverage of CFI, thus overcoming some of the limitations observed in other measures, as pointed out by Frankel and Mollenkopf (2015, p. 22): "individuals' actions across functional boundaries form the basis for what is often measured as firm-level CFI." Therefore, this measure provides a deeper insight and extends our understanding of the micro-foundations of CFI.

Knowledge complexity. Taking into account proposals by Gopalakrishnan *et al.* (1999) and Winter (1987), among others, a four-item scale was considered for knowledge complexity.

Control variables. Environmental dynamism was measured using the five-point Likert scale described by Baum and Wally (2003). We also controlled for firm size (measured by the number of employees), age, export sales (as a percentage of total sales), number of employees involved in product/service/process improvement, how important it was for the firm to improve its capability of developing new products/processes (responses on a five-point Likert scale), whether the idea of product innovation came from the firm or other collaborators (dichotomous variable), and whether during the last five years the firm had internalized new activities (dichotomous variable). Jointly, these variables allowed us to control for the effects of innovation effort, the organization's access to resources and environmental dynamism when assessing the relationship between innovation and firm performance. Our expectation was that firms which are more committed to innovation and which have greater resource endowments will outperform firms lacking these characteristics.

4. Analysis and results

Table I shows the descriptive statistics obtained and the correlations for the variables included in our empirical analysis.

All the scales used in the questionnaire were validated by confirmatory factor analysis, the results of which are shown in the Table AI. Thus, the measures used meet the requirements for validity and reliability. The Cronbach α and composite reliability values are above the generally accepted limit of 0.7 for all scale variables (Nunally and Bernstein, 1994), showing good internal consistency and reliability, except for the Cronbach α for environmental dynamism, which is 0.68. As this value is close to the generally accepted limit of 0.7 and as the composite reliability value, which is a stricter and more revealing indicator of internal consistency (Sijtsma, 2009), is above 0.7, we believe this Cronbach α value can be considered acceptable. The average variance extracted values are also above 0.5 (Hair *et al.*, 2014) for all the variables except for the subjective evaluation of firm performance, which is 0.406. However, as observed by Fornell and Larcker (1981, p. 46), the composite

Table I. Means, standard deviations and correlations

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Objective performance	318.150	1,208.853	–											
2. Subjective performance	3.149	0.899	0.211	–										
3. Cross-functional integration	2.108	1.173	−0.212*	0.112	–									
4. Product innovation	0.596	0.301	0.085	0.179	0.208*	–								
5. Knowledge complexity	2.849	0.699	0.108	0.100	−0.057	0.070	–							
6. Firm size	19.136	30.957	0.423**	0.185	−0.080	0.170	0.140	–						
7. Firm age	47.889	61.526	0.083	0.181	0.060	0.310**	0.036	0.387**	–					
8. Export sales	30.759	32.609	−0.189	0.158	−0.031	−0.022	−0.131	−0.054	−0.250**	–				
9. Employees dedicated to improvements	2.639	5.187	0.349**	0.261*	0.050	0.245*	0.195	0.255**	0.124	−0.018	–			
10. Importance of the innovation capability	3.456	1.191	−0.003	0.692**	0.106	0.278**	0.066	0.146	0.180	0.258*	0.221*	–		
11. Environmental dynamism	2.417	0.773	0.152	0.181	0.016	0.374**	0.163	0.012	−0.045	0.124	0.188	0.352**	–	
12. Source of ideas for product innovation	1.154	0.435	0.081	0.185	0.026	0.013	−0.037	0.050	0.114	−0.154	−0.046	0.092	0.091	–
13. Internalization of activities	0.454	0.486	−0.267**	0.042	0.005	0.157	−0.012	−0.198*	−0.057	0.128	0.118	0.048	0.007	−0.086

Notes: $*p < 0.05$; $**p < 0.01$

reliability is a more conservative indicator and its value is above 0.7, and, therefore, on the basis of the composite reliability indicators alone "the researcher may conclude that the convergent validity of the construct is adequate, even though more than 50 percent of the variance is due to error." Finally, our measures meet the requirements for discriminant validity, as the Fornell and Larcker (1981) criterion is met and the factors have a stronger association with their own constructs than with the others.

According to our hypotheses, CFI moderates the relationship between product innovation and firm performance (*H1*) and this moderation, in turn, is moderated by knowledge complexity (*H2a* and *H2b*). We tested these hypotheses first by applying a moderation test and then by a moderated moderation (three-way interaction) test involving bootstrapping to estimate the confidence intervals for the indirect effects (Hayes, 2013). This technique is not restricted by the normality assumptions of parametric tests and is particularly recommended when parametric assumptions are not viable (as is the case in small convenience samples) and when the models hypothesized involve interaction effects, because it provides greater statistical power than moderated OLS regression analysis (Hayes, 2013; Russell and Dean, 2000). Our theoretical model is illustrated in Figure 1.

The above procedures were implemented using the SPSS macro "PROCESS" (Hayes, 2013). After resampling 5,000 times for the bootstrap estimates, we obtained the results for the simple interaction model (Table II) and for the three-way interaction model (Table III).

Table II presents the results of the simple moderated regression analysis on the objective (Model 1) and subjective (Model 2) measures of firm performance and shows how changes in the level of CFI affect the relationship between product innovation and firm performance, according to both objective and subjective measures.

The latter results do not support our first hypothesis, as for low levels of CFI the effect of product innovation on firm performance is positive, but for high levels, this effect is negative (the results are significant only in the case of subjective performance). Taken together, the results of the two regression analyses contradict our first hypothesis (see Figure 2), thus

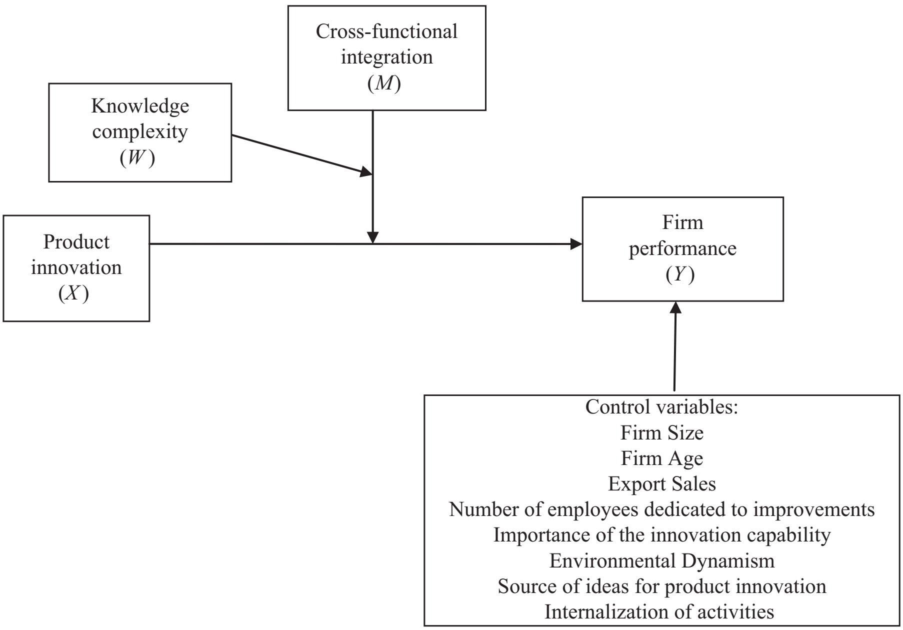

Figure 1.
Conceptual model

	Model 1 P/L before tax	Model 2 satisfaction with firm results
Firm size	12.875**	0.002
Firm age	−4.688****	0.000
Export sales	−9.778*	−0.001
Employees dedicated to improvements	53.774*	0.016
Importance of the innovation capability	−205.241	0.244***
Environmental dynamism	232.529	0.031
Source of ideas for product innovation	178.971	0.234
Internalization of new activities	−690.349*	0.001
Product innovation (PI)	1,992.647*	0.880*
Cross-functional integration (CfI)	128.876	0.367**
PI × CfI	−650.679	−0.514**
Adjusted R^2	0.494	0.388
F	5.520***	4.040***

Conditional effect of X on Y at values of the moderators (Models 1 and 2)[a]

Model 1		Model 2	
CfI	Effect	CfI	Effect
0.936	1,383.048*	0.918	0.408
2.101	625.342	2.103	−0.202
3.265	−132.363	3.289	−0.812*

Notes: [a]Values for quantitative moderators are the mean and ± 1 SD from mean. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; ****$p < 0.10$

Table II. Regressions on objective and subjective measures of firm performance of the interaction between product innovation and cross-functional integration

indicating that CFI has a negative moderating effect on the relationship between product innovation and firm performance.

Table III shows the results of the three-way interaction regression analyses of the objective (Model 1) and subjective (Model 2) measures of firm performance, and the conditional effect of *X* on *Y* at values of the two moderators for Models 1 and 2, respectively. As expected, the coefficient of the multiplicative term between product innovation, CFI and knowledge complexity is positive and significant, reflecting the presence of a three-way interaction in Models 1 and 2. However, in order to validate *H2a* and *H2b* we must evaluate the significance of the interaction effect for different values of the two moderators.

As shown in the lower part of Table III, when both knowledge complexity and CFI are low, the effect of product innovation on firm performance is positive and significant. For low levels of knowledge complexity, as CFI increases, the effect becomes non-significant and negative for objective performance, but significant and negative for subjective performance. These results confirm that a high level of CFI has a negative effect on the firm's capacity to improve performance through product innovation when knowledge complexity is low, and so *H2b* is validated (see Figures 3 and 4).

Table III also shows that at medium levels of knowledge complexity and low levels of CFI, the three-way interaction effect remains positive and marginally significant in both models. However, as CFI increases, the effect again becomes non-significant and negative. When knowledge complexity is high, as CFI increases, the effect of innovation strengthens, but it remains negative and non-significant for objective performance. The same pattern of relationships can be observed in the model of subjective performance, with the difference that when knowledge complexity is high, a higher level of CFI seems to produce a stronger negative but non-significant effect of product innovation on satisfaction with firm results. The lack of significance of the effects found for high levels of knowledge complexity does not allow us to corroborate *H2a*.

	Model 1 P/L before tax	Model 2 satisfaction with firm results
Firm size	14.650***	0.002
Firm age	−4.327****	0.000
Export sales	−12.557**	−0.002
Employees dedicated to improvements	57.652**	0.014
Importance of the innovation capability	−288.573*	0.185**
Environmental dynamism	439.531*	0.046
Source of ideas for product innovation	15.082	0.068
Internalization of new activities	−685.425*	−0.084
Product innovation (PI)	17,078.397***	4.819*
Cross-functional integration (CfI)	3,270.437*	1.811***
Knowledge complexity (KC)	2,896.303**	1.364**
PI × CfI	−5,956.961**	−1.983**
PI × KC	−5,453.042***	−1.367*
CfI × KC	−1,083.558*	−0.513**
PI × CfI × KC	1,892.857**	0.526*
Adjusted R^2	0.605	0.493
F	5.725***	4.148***

Conditional effect of X on Y at values of the moderators (Models 1 and 2)[a]

Model 1			Model 2		
KC	CfI	Effect	KC	CfI	Effect
2.161	0.969	3,483.627***	2.159	0.946	1.066*
2.161	2.118	1,340.175****	2.159	2.118	0.073
2.161	3.267	−803.276	2.159	3.291	−0.919*
2.824	0.969	1,086.177****	2.831	0.946	0.482****
2.824	2.118	383.643	2.831	2.118	−0.095
2.824	3.267	−318.889	2.831	3.291	−0.683****
3.486	0.969	−1,311.272	3.503	0.946	−0.101
3.486	2.118	−572.887	3.503	2.118	−0.264
3.486	3.267	165.497	3.503	3.291	−0.427

Notes: [a]Values for quantitative moderators are the mean and ±1 SD from mean. $*p < 0.05$; $**p < 0.01$; $***p < 0.001$; $****p < 0.10$

Table III. Regressions on objective and subjective measures of firm performance of the triple interaction effect

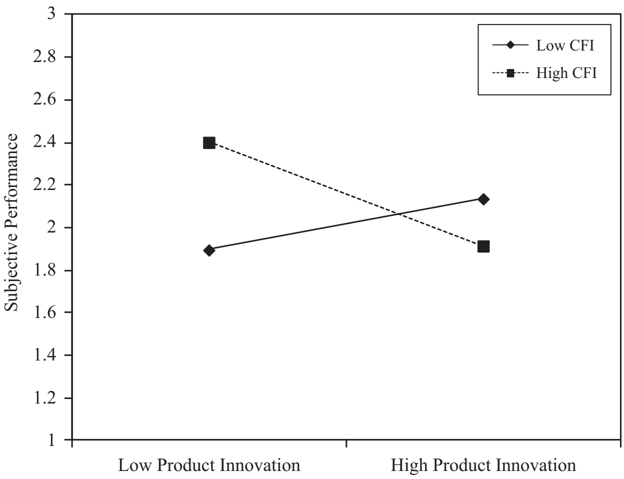

Figure 2. The moderating effect of cross-functional integration on the relationship between product innovation and satisfaction with firm results

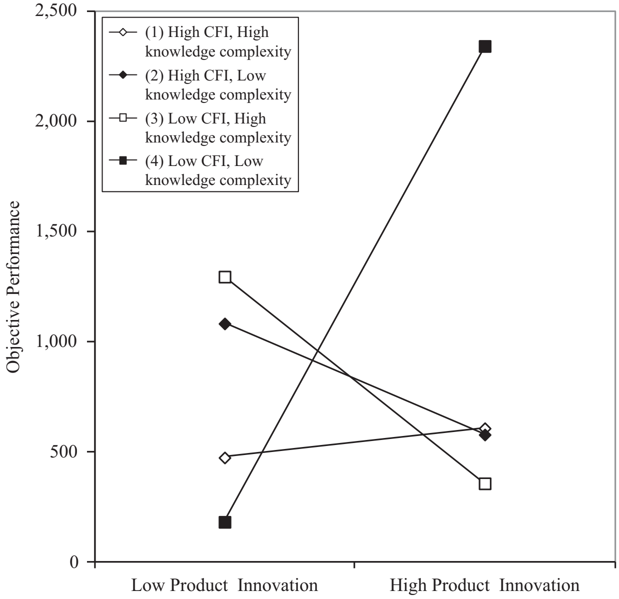

Figure 3.
The three-way interaction effect on objective performance

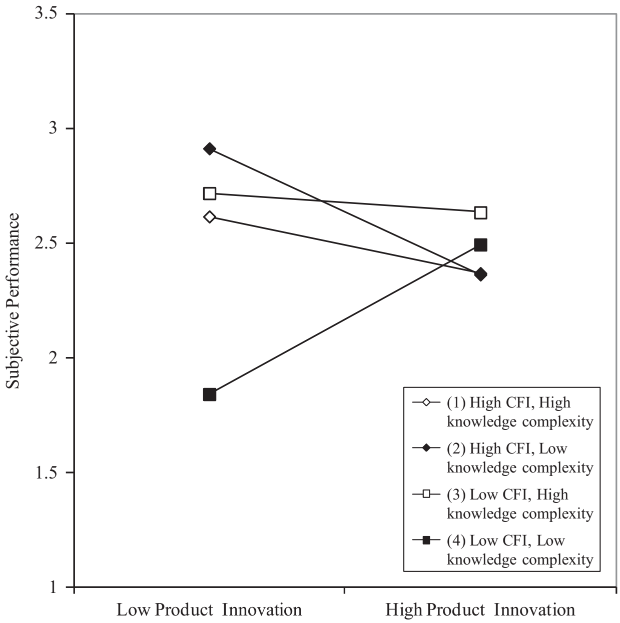

Figure 4.
The three-way interaction effect on subjective performance

5. Discussion, limitations and future lines of research

The aim of this study is to achieve a better understanding of the innovation–performance relation, doing so by analyzing the influence of two moderators – CFI and knowledge complexity – that act as contingency factors and better specify the context of the relationship (Pérez-Luño *et al.*, 2014; Li *et al.,* 2018). The first main result obtained is that, contrary to our hypothesis, the breadth of CFI has a negative moderating effect on the relationship between product innovation and performance. This suggests that the role played by CFI in the relationship between product innovation and performance may be industry specific, which challenges the commonly accepted theme of lean manufacturing, for example, in the automobile industry, regarding the generally positive effect of CFI on innovation and on certain measures of performance (Hayati *et al.,* 2017; Rauniar *et al.*, 2008). However, firms in the automobile industry and in other manufacturing industries where CFI has been used tend to be significantly larger than those in the wine industry. Moreover, the mechanisms through which CFI can be achieved differ greatly between these two situations, and this is also relevant to our findings (Rauniar *et al.*, 2008; Hayati *et al.*, 2017).

In fact, the wine industry could represent a good example, showing that CFI may not always be beneficial to the innovation–performance relationship. In general, wine production involves a combination of tacit and complex knowledge (about the grapes, the vineyard, aromas, etc.) that is embedded in local traditions and scientific knowledge. This knowledge, in most cases, belongs to the personal domain of the oenologist, who works with a large number of unskilled workers (Plataforma Tecnológica del Vino, 2012). Therefore, although CFI might improve innovation, there are many other techniques that must be brought to bear as an interrelated whole if a successful link is to be achieved between innovation and firm performance in this industry (Grinstein, 2008).

Our study also revealed varying impacts made by the different measures of performance, which is in line with the findings of Brettel *et al.* (2011). Thus, the negative effect of CFI on the relationship between product innovation and performance is significant for the subjective evaluation of global performance, but not for its objective evaluation. This divergence might be due to the cross-sectional nature of the objective parameter financial performance', which in the short run might not reflect the negative effect perceived by managers. The broad positive impact of CFI on the relation between innovation and performance seems to arise from management costs that are significantly higher and not compensated by the benefits of superior coordination and better integration. These results are consistent with those of Song *et al.* (1998), Randel and Jaussi (2003) and Brettel *et al.* (2011), who found that attempting to integrate more than two functional areas simultaneously has a negative impact on product innovation.

We observed certain differences between the effects produced in contexts of low and high knowledge complexity. In the former, firms obtained better financial and operational performance if CFI was at a low level, limited to a very few areas. These results suggest that in the case of small- and medium-sized wineries for whom the knowledge used in product innovation is not perceived as complex, the oenologist should not become involved in multi-area activities. On the contrary, his/her specialized knowledge should be applied to a limited number of areas, such as harvesting, that directly affect product development. Incremental innovations or simple ones that could be implemented with low CFI might incur lower costs and, hence, produce superior performance, both objective and perceived. On the other hand, in a context where product innovation is perceived to involve a high degree of knowledge complexity, the need for CFI seems to add to this perception, due to the broader coordination required. This circumstance would make managers more cautious in their evaluation of firm performance. This is in line with previous study findings according to which in manufacturing industries, wine production being one such, perceptions of profitability are strongly related to a team's ability to coordinate efforts and share common goals (Peters and Fletcher, 2004). In terms of objective performance, a broader-based CFI has a positive effect when knowledge complexity is high. Nevertheless, in our analyses these results are not statistically significant, and so we cannot put forward recommendations for practice in this situation.

Our results help advance the discussion on the performance implications of CFI on product innovation, which previous research has shown to be contingent on several factors. In addition to contingencies such as the degree of innovativeness (Griffin, 2002; Langerak and Hultink, 2006) of the new product (Olson *et al.*, 2001), the competitive intensity of the environment (Tsai and Hsu, 2014) and the cultural context (Song and Thieme, 2006), we show that the degree of knowledge complexity is a crucial contingent factor in the role played by CFI in product innovation.

Additionally, and in line with other recent studies (Gonzalez-Zapatero *et al.*, 2016; Hirunyawipada *et al.*, 2010), our findings highlight the role of specific mechanisms for CFI and knowledge management in firm innovation. The participation of key employees in functional areas is a mechanism that has not been considered in previous research but which forms part of the practice of small firms that have no formal departmental structure, and constitutes a useful proxy for CFI (Wee and Chua, 2013; Durst and Edvardsson, 2012; Wong and Aspinwall, 2004). In SMEs, knowledge management is often conducted on an informal basis, through cross functionality, overlapping roles or physical proximity (Wee and Chua, 2013; Durst and Edvardsson, 2012; Wong and Aspinwall, 2004) and knowledge sharing takes place on a short-term basis, through informal conversations between the members of the organization (Durst and Edvardsson, 2012). Therefore, in small firms the manager and senior employees are key drivers of knowledge management processes such as knowledge creation, transfer or utilization (Wee and Chua, 2013). Our study reveals the different effects produced by this specific CFI mechanism on the innovation performance of SMEs, depending on the degree of knowledge complexity they have to manage.

Like all studies, ours have some limitations that future research should address. First, in seeking a profound understanding of the idiosyncrasies encountered, we focus exclusively on the Spanish wine industry, adapting our measures accordingly. While we believe that this is an appropriate approach, given our research interest, there are limits to which our findings can be generalized to other industries. Moreover, our data were collected only in Spain, which further limits their generalizability.

Second, the data considered are 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. Additionally, the use of cross-sectional data does not allow us to evaluate the long-term effects of CFI. The positive effects of improving communication and enhancing information and knowledge exchange across several areas may become manifest only in the medium-long term; if so, longitudinal data would be required to enable proper evaluation.

6. Conclusions

Our paper contributes in four essential areas to researchers and practitioners interested in understanding innovation and firm performance. First, previous studies of the role of CFI in new product development have focused mainly on project performance (Olson *et al.*, 2001; Song and Xie, 2000) and, with few exceptions (e.g. De Visser *et al.*, 2010), they have ignored innovation performance at the firm level. This is important because the implications of CFI for innovation at the organizational level may differ from those at the project level. Our findings support the premise that CFI exerts two contrasting effects: a direct positive influence on firm performance and a negative indirect one when it interacts with product innovation. In general, our results at the organizational level are similar to those reported previously for projects or products. Furthermore, our study extends empirical testing of the model proposed by Turkulainen and Ketokivi (2012), who showed that CFI is positively and directly related to various dimensions of subjective operational performance (except product innovativeness) and may also be associated with overall business performance. Our results indicate that CFI is positively related to both objective and subjective measures of overall business performance. For the wine industry in particular, and taking into account our other results, this finding suggests that CFI may be beneficial to the winery's overall performance, but not specifically to its innovation performance. In other words, the CFI of the oenologist in areas such as marketing or general management could help wineries enhance their performance, but not specifically through the development of product innovations.

Second, most studies of CFI focus mainly on the role of coordination between specific functional dyads (Ernst *et al.*, 2010; Brettel *et al.*, 2011; Song *et al.*, 1998), paying less attention to how a broader degree of integration might affect innovation performance, especially in environments with a high degree of perceived knowledge complexity, in which coordination requires various areas to be addressed. Our measure of CFI, thus, captures a more accurate view of the breadth of CFI, by considering coordination across several functional areas, including that of general management. The findings of this study suggest that breadth of coordination and the integration of several functional areas do not contribute to translating product innovation into significant improvements in performance at the firm level, particularly when the degree of knowledge complexity is low. Our study also identifies a specific CFI mechanism that has not been analyzed previously, but which is used in practice by many firms, namely the cross-pollination of ideas across different functional areas through the participation of a key employee (such as the oenologist) who is responsible for product innovation, and indicates when and how this mechanism affects product innovation and firm performance. Our results, together with those of Genç and Di Benedetto (2015), Rauniar *et al.* (2008) and Longoni and Cagliano (2015), suggest that the cross-functional involvement of key employees constitutes an alternative CFI mechanism that is available to organizations when the degree of knowledge complexity is high and when the creation of more complex organizational structures for CFI is not justified by the firm's size or access to resources.

Third, in previous research it is assumed that knowledge complexity is concurrent with radical innovation (De Visser *et al.*, 2010) or with products presenting high levels of innovativeness (Olson *et al.*, 2001). In consequence, it has been claimed that when organizations are faced with high-level complexity, broad-based CFI is required to improve product innovation performance. However, no prior study has explicitly tested the conditional effect of knowledge complexity. Our study provides empirical evidence for this general assumption, suggesting that CFI might play a more positive role when there is a high degree of knowledge complexity to be managed. These conclusions are in line with those of earlier research, which has highlighted the critical role of dialogue in knowledge transformation and integration in complex, novel situations (Hirunyawipada *et al.*, 2010).

Finally, the use of both objective and subjective measures of performance enables us to show that these results are applicable to both types of measure. Contrary to many earlier studies (Pérez-Luño *et al.*, 2014; Gopalakrishnan, 2000), our results for the objective and subjective measures of performance are close mirror images of each other. This is very important, because it shows that the managers in our sample have a real understanding of their companies and industry and that their perceptions of performance coincide with the objective reality.

From the practitioner's standpoint, this study evaluates the potential of specific practices – i.e. involving the oenologist in different functional areas of the organization – to enhance value creation through product innovation in wine industry. Our findings suggest that, unless the winery needs to cope with a high degree of knowledge complexity, involving the oenologist in various functional areas for the purpose of coordination may detract resources from the product innovation effort and result in poorer performance.

References

Acikgoz, A., Gunsel, A., Kuzey, C. and Secgin, G. (2016), "Functional diversity, absorptive capability and product success: the moderating role of project complexity in new product development teams", *Creativity and Innovation Management*, Vol. 25 No. 1, pp. 90-109.

Atuahene-Gima, K. (2005), "Resolving the capability-rigidity paradox in new product innovation", *Journal of Marketing*, Vol. 69 No. 4, pp. 61-83.

Baum, J. and Wally, S. (2003), "Strategic decision speed and firm performance", *Strategic Management Journal*, Vol. 24 No. 11, pp. 1107-1129.

Bigliardi, B. and Galati, F. (2013), "Innovation trends in the food industry: the case of functional foods", *Trends in Food Science & Technology*, Vol. 31 No. 2, pp. 118-129.

Brettel, M., Heinemann, F., Engelen, A. and Neubauer, S. (2011), "Cross-functional integration of R&D, marketing, and manufacturing in radical and incremental product innovations and its effects on project effectiveness and efficiency", *Journal of Product Innovation Management*, Vol. 28 No. 2, pp. 251-269.

Brown, S.L. and Eisenhardt, K.M. (1995), "Product development: past research, present findings, and future directions", *Academy of Management Review*, Vol. 20 No. 2, pp. 343-378.

Damanpour, F. (1991), "Organizational innovation: a meta-analysis of effects of determinants and moderators", *Academy of Management Journal*, Vol. 34 No. 3, pp. 555-590.

Damanpour, F. (2017), *"Organizational Innovation", Oxford Research Encyclopedia of Business and Management*, Oxford University Press, Oxford.

Damanpour, F. and Gopalakrishnan, S. (2001), "The dynamics of the adoption of product and process innovations in organizations", *Journal of Management Studies*, Vol. 38 No. 1, pp. 45-65.

De Luca, L.M. and Atuahene-Gima, K. (2007), "Market knowledge dimensions and cross-functional collaboration: examining the different routes to product innovation performance", *Journal of Marketing*, Vol. 71 No. 1, pp. 95-112.

De Visser, M., de Weerd-Nederhof, P., Faems, D., Song, M., van Looy, B. and Visscher, K. (2010), "Structural ambidexterity in NPD processes: a firm-level assessment of the impact of differentiated structures on innovation performance", *Technovation*, Vol. 30 Nos 5-6, pp. 291-299.

Doloreaux, D. and Lord-Tarde, E. (2013), "The organisation of innovation in the wine industry", *European Journal of Innovation Management*, Vol. 16 No. 2, pp. 171-189.

Dougherty, D. (1992), "Interpretive barriers to successful product innovation in large firms", *Organization Science*, Vol. 3 No. 2, pp. 179-202.

Duran, P., Kammerlander, N., van Essen, M. and Zellweger, T. (2017), "Doing more with less: innovation input and output in family firms", *Academy of Management Journal*, Vol. 59 No. 4, pp. 1224-1264.

Durst, S. and Edvardsson, I.R. (2012), "Knowledge management in SMEs: a literature review", *Journal of Knowledge Management*, Vol. 16 No. 6, pp. 879-903.

Ellegaard, C. and Koch, C. (2014), "A model of functional integration and conflict: the case of purchasing-production in a construction company", *International Journal of Operations & Production Management*, Vol. 34 No. 3, pp. 325-346.

Ernst, H., Hoyer, W.D. and Rübsaamen, C. (2010), "Sales, marketing, and research-and-development cooperation across new product development stages: implications for success", *Journal of Marketing*, Vol. 74 No. 5, pp. 80-92.

Fornell, C. and Larcker, D.F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50.

Frankel, R. and Mollenkopf, D.A. (2015), "Cross-functional integration revisited: exploring the conceptual elephant", *Journal of Business Logistics*, Vol. 36 No. 1, pp. 18-24.

Freel, M.S. and Robson, P.A.J. (2004), "Small firm innovation, growth and performance: evidence from Scotland and Northern England", *International Small Business Journal*, Vol. 22 No. 6, pp. 561-575.

Gemser, G. and Leenders, M. (2011), “Managing cross-functional cooperation for new product development success”, *Long Range Planning*, Vol. 44 No. 1, pp. 26-41.

Genç, E. and Di Benedetto, C.A. (2015), “Cross-functional integration in the sustainable new product development process: the role of the environmental specialist”, *Industrial Marketing Management*, Vol. 50, pp. 150-161.

Giuliani, E. (2007), “The wine industry: persistence of tacit knowledge or increased codification? Some implications for catching-up countries”, *International Journal of Technology and Globalisation*, Vol. 3 Nos 2/3, pp. 138-154.

Gonzalez-Zapatero, C., Gonzalez-Benito, J. and Lannelongue, G. (2016), “Antecedents of functional integration during new product development: the purchasing–marketing link”, *Industrial Marketing Management*, Vol. 52, pp. 47-59.

Gopalakrishnan, S. (2000), “Unraveling the links between dimensions of innovation and organizational performance”, *Journal of High Technology Management Research*, Vol. 11 No. 1, pp. 137-153.

Gopalakrishnan, S. and Bierly, P. (2001), “Analyzing innovation adoption using a knowledge-based approach”, *Journal of Engineering and Technology Management*, Vol. 18 No. 2, pp. 107-130.

Gopalakrishnan, S. and Damanpour, F. (2000), “The impact of organizational context on innovation adoption in commercial banks”, *IEEE Transactions Engineering Management*, Vol. 47 No. 1, pp. 14-25.

Gopalakrishnan, S., Bierly, P. and Kessler, E.H. (1999), “A reexamination of product and process innovations using a knowledge-based view”, *The Journal of High Technology Management Research*, Vol. 10 No. 1, pp. 147-166.

Griffin, A. (2002), “Product development cycle time for business to business products”, *Journal of Product Innovation Management*, Vol. 31 No. 4, pp. 291-304.

Grinstein, A. (2008), “The effect of market orientation and its components on innovation consequences: a meta-analysis”, *Journal of the Academy of Marketing Science*, Vol. 36 No. 2, pp. 166-173.

Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2014), *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, Sage, Thousand Oaks, CA.

Hayati, A., Naufal, A. and Khusaini, N.A. (2017), “Kaizen event assessment through performance and investment analysis”, *International Journal of Business and Administrative Sciences*, Vol. 3 No. 1, pp. 1-7.

Hayes, A.F. (2013), *Introduction to Mediation, Moderation and Conditional Process Analysis*, The Guilford Press, New York, NY.

Hirunyawipada, T., Beyerlein, M. and Blankson, C. (2010), “Cross-functional integration as a knowledge transformation mechanism: implications for new product development”, *Industrial Marketing Management*, Vol. 39 No. 4, pp. 650-660.

ICEX. Estadísticas sobre Vino en España (2014), “El vino en cifras 2013”, ICEX, Madrid, available at: www.winesfromspain.com/icex/cda/controller/pageGen/0,3346,1559872_6763355_6778152_0,00.html

Karlsson, C. and Ahlstrom, P. (1996), “The difficult path to lean product development”, *The Journal of Product Innovation Management*, Vol. 13 No. 4, pp. 283-300.

Langerak, F. and Hultink, J.E. (2006), “The impact of product innovativeness on the link between development speed and new product profitability”, *Journal of Product Innovation Management*, Vol. 23 No. 3, pp. 203-214.

Li, J., Xia, J. and Zajac, E. (2018), “On the duality of political and economic stakeholder influence on firm innovation performance: theory and evidence from Chinese firms”, *Strategic Management Journal*, Vol. 39 No. 1, pp. 193-216.

Longoni, A. and Cagliano, R. (2015), “Cross-functional executive involvement and worker involvement in lean manufacturing and sustainability alignment”, *International Journal of Operations and Production Management*, Vol. 35 No. 9, pp. 1332-1358.

McEvily, S.K. and Chakravarthy, B. (2002), "The persistence of knowledge-based advantage: an empirical test for product performance and technological knowledge", *Strategic Management Journal*, Vol. 23 No. 4, pp. 285-305.

Majchrzak, A., More, P.H.B. and Samer, F. (2012), "Transcending knowledge differences in cross-functional teams", *Organization Science*, Vol. 23 No. 4, pp. 951-970.

Mitrega, M., Forkmann, S., Zaefarian, G. and Henneberg, S.C. (2017), "Networking capability in supplier relationships and its impact on product innovation and firm performance", *International Journal of Operations and Production Management*, Vol. 37 No. 5, pp. 577-606.

Morgan, N., Vorhies, D.W. and Mason, C. (2009), "Market orientation, marketing capabilities, and firm performance", *Strategic Management Journal*, Vol. 30 No. 8, pp. 909-920.

Nakata, C. and Im, S. (2010), "Spurring cross-functional integration for higher new product performance: a group effectiveness perspective", *Journal of Product Innovation Management*, Vol. 27 No. 4, pp. 554-571.

Narver, J.C. and Slater, S.F. (1990), "The effect of a market orientation on business profitability", *Journal of Marketing*, Vol. 54 No. 4, pp. 20-35.

Nunally, J.C. and Bernstein, I. (1994), *Psychometric Theory*, McGraw-Hill, New York, NY.

OECD/Eurostat (1997), *Oslo Manual. Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*, Head of Publications Service, OECD, Paris.

Ohno, T. (1988), *Toyota-Production Systems: Beyond Large-Scale Production*, Productivity Press, Portland.

Olson, E.M., Walker, O.C. Jr and Ruekert, R.W. (1995), "Organizing for effective new product development: the moderating role of product innovativeness", *Journal of Marketing*, Vol. 59 No. 1, pp. 48-62.

Olson, E.M., Walker, O.C. Jr, Ruekerf, R.W. and Bonnerd, J.M. (2001), "Patterns of cooperation during new product development among marketing, operations and R&D: implications for project performance", *Journal of Product Innovation Management*, Vol. 18 No. 4, pp. 258-271.

Pérez-Luño, A., Gopalakrishnan, S. and Valle-Cabrera, R. (2014), "Innovation and performance: the role of environmental dynamism on the success of innovation choices", *IEEE Transactions on Engineering Management*, Vol. 61 No. 3, pp. 499-510.

Pérez-Luño, A., Cabello Medina, C., Carmona Lavado, A. and Cuevas Rodríguez, G. (2011), "How social capital and knowledge affect innovation", *Journal of Business Research*, Vol. 64 No. 12, pp. 1369-1376.

Peters, L.D. and Fletcher, K.P. (2004), "Communication strategies and marketing performance: an application of the Mohr and Nevin framework to intra-organisational cross-functional teams", *Journal of Marketing Management*, Vol. 20 Nos 7-8, pp. 741-770.

Plataforma Tecnológica del Vino (2012), "Agenda Estratégica de Innovación", Madrid, available at: www.ptvino.com/phocadownload/general/Agenda_Estrategica_Innovacion_PTV.pdf

Pringle, J.W.S. (1951), "On the parallel between learning and evolution", *Behavior*, Vol. 3 No. 3, pp. 175-215.

Randel, A.E. and Jaussi, K.S. (2003), "Functional background identity, diversity, and individual performance in cross-functional teams", *Academy of Management Journal*, Vol. 46 No. 6, pp. 763-774.

Rauniar, R., Doll, W., Rawski, G. and Hong, P. (2008), "The role of heavyweight product manager in new product development", *International Journal of Operations and Production Management*, Vol. 28 No. 2, pp. 130-154.

Rosado Feger, A.L. (2014), "Creating cross-functional strategic consensus in manufacturing facilities", *International Journal of Operations and Production Management*, Vol. 34 No. 7, pp. 941-970.

Ruiz, A. and Riaño, C. (2011), "Las marcas privadas en el sector vinícola español", working paper, Departamento de Economía y Empresa, Universidad de la Rioja. Logroño.

Russell, C.J. and Dean, M.A. (2000), "To log or not to log: bootstrap as an alternative to parametric estimation of moderation effects in the presence of skewed dependent variables", *Organizational Research Methods*, Vol. 3 No. 2, pp. 167-185.

Sethi, R. and Sethi, A. (2009), "Can quality oriented firms develop innovative new products?", *Journal of Product Innovation Management*, Vol. 26 No. 2, pp. 206-221.

Sijtsma, K. (2009), "On the use, the misuse, and the very limited usefulness of Cronbach's Alpha", *Psychometrika*, Vol. 74 No. 1, pp. 74-107.

Song, M. and Thieme, R.J. (2006), "A cross-national investigation of the R&D–marketing interface in the product innovation process", *Industrial Marketing Management*, Vol. 35 No. 3, pp. 308-322.

Song, M., Im, S., van der Bij, H. and Song, L.Z. (2011), "Does strategic planning enhance or impede innovation and firm performance?", *Journal of Product Innovation Management*, Vol. 28 No. 4, pp. 503-520.

Song, X.M. and Xie, J. (2000), "Does innovativeness moderate the relationship between cross-functional integration and product performance?", *Journal of International Marketing*, Vol. 8 No. 4, pp. 61-89.

Song, X.M., Thieme, R.J. and Xie, J. (1998), "The impact of cross-functional joint involvement across product development stages: an exploratory study", *Journal of Product Innovation Management*, Vol. 15 No. 4, pp. 289-303.

Swink, M. and Song, M. (2007), "Effects of marketing-manufacturing integration on new product development time and competitive advantage", *Journal of Operations Management*, Vol. 25 No. 1, pp. 203-217.

Trantopoulus, K., von Krogh, G., Wailin, M.W. and Woerter, M. (2017), "External knowledge and information technology: implications for process innovation performance", *MIS Quarterly*, Vol. 41 No. 1, pp. 287-308.

Troy, L.C., Hirunyawipada, T. and Paswan, A.K. (2008), "Cross-functional integration and new product success: an empirical investigation of the findings", *Journal of Marketing*, Vol. 72 No. 6, pp. 132-146.

Tsai, K.-H. and Hsu, T.T. (2014), "Cross-functional collaboration, competitive intensity, knowledge integration mechanisms, and new product performance: a mediated moderation model", *Industrial Marketing Management*, Vol. 43 No. 2, pp. 293-303.

Tung, J. (2012), "A study of product innovation on firm performance", *International Journal of Organizational Innovation*, Vol. 4 No. 3, pp. 84-97.

Turkulainen, V. and Ketokivi, M. (2012), "Cross-functional integration and performance: what are the real benefits?", *International Journal of Operations and Production Management*, Vol. 32 No. 4, pp. 447-467.

Venkatraman, N. and Ramanujam, V. (1986), "Measurement of business performance in strategy research a comparison of approaches", *Academy of Management Review*, Vol. 11 No. 4, pp. 801-814.

Vrontis, D., Bresciani, S. and Giacosa, E. (2016), "Tradition and innovation in Italian wine family businesses", *British Food Journal*, Vol. 118 No. 8, pp. 1883-1897.

Wee, J.C.N. and Chua, A.Y.K. (2013), "The peculiarities of knowledge management processes in SMEs: the case of Singapore", *Journal of Knowledge Management*, Vol. 17 No. 6, pp. 958-972.

Winter, S.G. (1987), *Knowledge and Competence as Strategic Assets: The Competitive Challenge: Strategies for Industrial Innovation and Renewal*, Ballinger, Cambridge, MA.

Wong, K.Y. and Aspinwall, E. (2004), "An empirical study of the important factors for knowledge-management adoption in the SME sector", *Journal of Knowledge Management*, Vol. 9 No. 3, pp. 64-82.

Zahra, S.A. (1996), "Technology strategy and new venture performance: a study of corporate-sponsored and independent biotechnology ventures", *Journal of Business Venturing*, Vol. 11 No. 4, pp. 289-321.

Zhang, M., Qi, Y., Wang, Z., Pawar, K.S. and Zhao, X. (2018), "How does intellectual capital affect product innovation performance? Evidence from China and India", *International Journal of Operations and Production Management*, Vol. 38 No. 3, pp. 895-914.

Further reading

Slater, S. and Narver, J. (1994), "Does competitive environment moderate the market orientation–performance relationship?", *Journal of Marketing*, Vol. 58 No. 1, pp. 46-55.

Appendix

Variable	Items	Source	Cronbach α	Composite reliability	Average variance extracted
Satisfaction with firm performance	Indicate your degree of satisfaction with: Economic profitability Financial Profitability Sales growth Net contribution margin Market share Reduction of the response time to clients and suppliers Improvement of the capability to develop new products or processes Improvement of the information exchange between the firm and its business and institutional collaborators Introduction of new products for new groups of clients Introduction of new products in new geographical markets	Zahra (1996)	0.849	0.870	0.406
Knowledge complexity	Description of the knowledge used in your organization requires a large amount of information The knowledge used in your organization is technologically sophisticated and difficult to implement The knowledge used in your organization is complex (vs simple)	Gopalakrishnan *et al.* (1999), Winter (1987)	0.774	0.868	0.686
Environmental dynamism	Our firm must frequently change its products and practices to keep up with competitors Products/services quickly become obsolete in our industry. Technology changes more quickly in our industry than in other industries	Baum and Wally (2003)	0.679	0.756	0.524

Table AI. Measures, sources and results of the reliability and validity analysis

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