An approach to firm's innovation from the explicit and tacit knowledge spiral

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An approach to firm's innovation from the explicit and tacit knowledge spiral

This study aims to analyse the mediating and moderating roles played by tacit and explicit knowledge in the relationship between organizational capabilities and product innovation. On a sample of industrial organizations, SEM and multigroup analysis have been applied. The findings show that both explicit and tacit knowledge partially mediate the relationship between organizational capabilities and product innovation, being stronger the mediating role played by tacit knowledge. While high levels of tacit knowledge enhance the impact of organizational capabilities on explicit knowledge and product innovation, a moderate level of explicit knowledge maximizes the impact on the relationships between organizational capabilities, tacit knowledge and product innovation. The discussion of the results, the managerial implications and future research lines are included at the end of the paper.

Keywords: ambidexterity; explicit knowledge; organizational economics; organizational learning; product innovation; tacit knowledge

1. Introduction

Knowledge management is about how the acquired knowledge by the organization is integrated with the existing knowledge and channelled to develop new products and services (Grant, 1996a, 1996b; Nonaka, 1991). Generating a continuous pipeline of new products lies at the heart of organizational renewal and sustained performance (O'Reilly & Tushman, 2008; Zhou & Li, 2012). Product innovation is primarily a combination of two tasks: first, invention and second, innovation (Cohen & Caner, 2016). Invention deals with exploration of new ideas and exploitation of such new ideas within the organization (Cohen & Caner, 2016). While the exploration component of invention is tacit knowledge-intensive the exploitation component of invention is explicit knowledge-intensive (Cohen & Caner, 2016; March, 1991). Innovation contrarily is a

combination of a series of tasks that develop such invention into viable commercialized products which are predominantly exploitative in nature (Cohen & Caner, 2016; Hansen & Birkinshaw, 2007; March, 1991; Roberts, 2007). Thus, the product innovation value chain intermeshes the two types of organizational learning tasks, exploration and exploitation (Cohen & Caner, 2016; Lin et al., 2013; March, 1991), for which tacit and explicit knowledge need to be skilfully combined, integrated and channelled into new products (Garicano & Wu, 2012; Jansen et al., 2009). While some previous research has well explicated the differences between explicit and tacit knowledge (Kogut & Zander, 1992; Polanyi, 1966) emphasizing the primary role of organizations as knowledge integrators (Grant, 1996a, 1996b; Nonaka, 1994), the more recent one has focused on linking tacit and codified explicit knowledge to exploration and exploitation, respectively (López-Cabarcos et al., 2020; March, 1991). At this point, organizational capabilities play an important role. The primary role of the top management is to create an organizational design and structure conducive for both acquisition of tacit knowledge through exploration, as well as exploiting and integrating such new knowledge with the existing one in order to deliver new products (Alonso et al., 2008; March, 1991; Smith & Tushman, 2005). It seems logical that organizational capabilities that are effective in combining and integrating knowledge and tasks will result in superior product innovation. Given the unique tasks included in the product innovation value chain and the differences between them regarding the demands for tacit and explicit knowledge (Cohen & Caner, 2016; March, 1991; Roberts, 2007), as well as the organizational design that is required to optimize such knowledge exploration and exploitation (Foss & Mahnke, 2003), this research aims to explicate the role of tacit and explicit knowledge in the transformation of organizational capabilities into product innovation. Specifically, it analyses the moderating and mediating roles played by explicit and tacit knowledge in

the organizational capabilities and product innovation relationship. Two separate models have been built to test the hypotheses; the first one with tacit knowledge as mediator and explicit knowledge as moderator; and the second one with explicit knowledge as mediator and tacit knowledge as moderator. A sample of 153 organizations belonging to the industrial has been used to test these conceptual models, r employing structural equation modelling and multigroup analysis.

The theoretical contribution of this study lies in the fusion of the knowledge-based view (Grant, 1996a, 1996b; Nonaka & Von Krogh, 2009; Nonaka, 1994), the organizational learning theory (Cohen & Caner, 2016; March, 1991; O'Reilly & Tushman, 2008; Tushman & O'Reilly, 1996) and the organizational economics literature (Foss & Mahnke, 2003; Garicano & Wu, 2012; Jansen et al., 2009; Marschak & Radner, 1972). In fact, this study takes an incremental leap by bringing together the organizational economics dimension (Foss & Mahnke, 2003) and "team production" dynamics (Marschak & Radner, 1972), which views "tasks" as building blocks and promote the need for an optimal organizational design to achieve an effective integration and coordination of such tasks in the product innovation value chain (Foss & Mahnke, 2003).

This study provides two incremental contributions. First, it brings together three adjacent theories to specify a robust conceptual model that explicates the role of tacit and explicit knowledge in the transformation of organizational capabilities into product innovation; and second, it uncovers the nuanced linkage that tacit and explicit knowledge play in the product innovation value chain. Thus, this study advances the vital role played by explicit and tacit knowledge and the need for an appropriate organizational design to facilitate such a role, furthering the overall body of knowledge management research agenda.

The rest of the paper is organized as follows; the second section conducts a review of the literature, including the study hypotheses. The third section explains the methodology used. Section four includes the findings obtained. The fifth section conducts the discussion of the results and the conclusions. Finally, the last section highlights the managerial implications and the limitations of the paper and shows the scope for future research.

2. Theoretical framework

Product innovation is well established to be a vital source for organizational growth, profitability, renewal and sustained corporate performance (O'Reilly & Tushman, 2008; Zhou & Li, 2012). In essence, it can be viewed as an integrated flow of primarily two tasks; invention and the development of such invention into commercialized new products (Cohen & Caner, 2016; Hansen & Birkinshaw, 2007; Roberts, 2007). The organizational learning literature argues that both invention and innovation entail exploratory and exploitative capabilities (Cohen & Caner, 2016; Hansen & Birkinshaw, 2007; March, 1991; Roberts, 2007). Exploration and exploitation refer to the learning typologies prescribed by the organizational learning literature. While exploration is about search, discovery, autonomy and requires freedom and flexibility to acquire new knowledge and skills (Jansen et al., 2009), exploitation is about certainty, productivity, efficiency, control, and variance reduction (Cohen & Caner, 2016; Jansen et al., 2009; O'Reilly & Tushman, 2008).

The exploratory tasks that are part of invention includes organizational efforts aimed at experimenting and creating new ideas that requires future orientation and collaboration with outside parties in a complex external social system (Ruvio et al., 2014) including inventors, customers, and competitors (Hansen & Birkinshaw, 2007). It is not only about the deep customer insights gained by scientists and customer facing

employees during the exploratory phase, which is highly tacit in nature, it is also about absorbing such insights within the organization (Kogut & Zander, 1992) through personal interactions across functional teams through face-to-face interactions (Arnett & Wittmann, 2014; Grant, 1996a, 1996b; Raisch et al., 2009). Schmidt, Bell, and Warren (2021) highlight the importance of bringing people together as a team towards a common goal in order to integrate such knowledge into new product development activities. In addition to exploration, invention also includes exploitation tasks that refine and extend the existing deep domain knowledge, competencies, technologies, and paradigms within the organization, considering the new ideas generated (Cohen & Caner, 2016; Roberts, 2007). Such exploitative tasks are about recombining and reconfiguring the existing organizational assets and beliefs (O'Reilly & Tushman, 2008). Kanter (1986) considers these exploitation tasks as a "kaleidoscope thinking", where a shake or a twist to the kaleidoscope creates new patterns.

The innovation value chain primarily entails development and commercialization of invention which are predominantly exploitation tasks, including screening of ideas to decide which of them to pursue and which to abandon, risk assessment, evaluating feasibility of developing new ideas into viable products, committing organizational resources and idea diffusion within and outside the organization (Hansen & Birkinshaw, 2007; Ruvio et al., 2014).

Organizational capabilities are the primary basis on which firms establish competitive advantage and their long-term strategies (Grant, 1996a). According to the knowledge-based view (Grant, 1996b), knowledge is the most important organizational resource, and the essence of organizational capabilities consists of integrating individuals' specialized knowledge dispersed across the firm into new products (Grant, 1996a). In this study organizational capabilities are viewed from an organizational

economics perspective (Foss & Mahnke, 2003), and more specifically from a "team production" angle (Marschak & Radner, 1972), which points to the need for an appropriate organizational design that can help continuously generate new ideas and products (Ruvio et al., 2014). Specifically, this perspective proposes to look inside the firm by examining the coordination of human activities with respect to creating, sharing, and exploiting knowledge (Foss & Mahnke, 2003). Further, in light of organizational learning literature, effective organizational capabilities refer to how organizations explore new possibilities and in parallel exploit old certainties (Cohen & Caner, 2016; March, 1991; Roberts, 2007) by creating an organizational design that is conducive for such learning (Smith & Tushman, 2005). This is achieved when the organizational structure coordinates, integrates and communicates knowledge across the organization (Garicano & Wu, 2012; Jansen et al., 2009). Hence, it seems logical that organizational capabilities in terms of optimal organizational design will translate into superior product innovation.

Knowledge primarily exists in the tacit or explicit form (Polanyi, 1966). Tacit knowledge, reflected in skills, insights, abilities, and experiences (Polanyi, 1962), is intangible, difficult to describe and transmit to others (Guo, 2013). Contrarily, explicit knowledge can be stored, documented, codified, retrieved, and institutionalized within organizations (Grant, 1996b; Kogut & Zander, 1992) in the form of policies, procedures, manuals, and market intelligence data (Schoenherr et al., 2014). Tacit knowledge can be a source of competitive advantage (Kogut & Zander, 1992), but from a strategic point of view is the interaction between explicit and tacit knowledge, termed as the "knowledge spiral" (Nonaka, 1994), that enhances the stock of knowledge within the organization (Nonaka & Von Krogh, 2009). Few recent studies have also proved that explicit knowledge is vital for product innovation (López-Cabarcos et al., 2020;

López-Nicolás & Meroño-Cerdán, 2011) and for corporate knowledge (Choi & Lee, 2003). So, an effective organizational design should intermesh exploration and exploitation tasks (Cohen & Caner, 2016; March, 1991), each of which have unique tacit and explicit knowledge combinations that need to be skilfully combined, integrated and channelled into new products.

2.1. The mediating role of explicit and tacit knowledge

The organizational economics literature, and specifically the team production theory (Marschak & Radner, 1972) underlines the importance of optimal structures based on efficient coordination and integration of knowledge, to overcome constraints such as diversity in tasks, division of labour, asymmetric information, and bounded rationality of individuals (Foss & Mahnke, 2003). This theory argues that members of a team have the same interests and beliefs but do not necessarily share the same information; hence, the need for the scattered information in the organization to be coordinated and integrated for optimal decision making (Marschak & Radner, 1972). Drawing parallels, organizations can be considered as a team with a common objective of excelling in product innovation, where the tacit and explicit knowledge required to effectively conceive and deliver new products are dispersed across the organization. In this context, the top management team play the "organizer" role, coordinating and integrating tacit and explicit knowledge through an optimal organizational design, and organizations can be viewed as "knowledge-based producers" aggregating several specific tasks. In the invention phase, while tasks that deal with generating new ideas are tacit knowledge-intensive, other tasks that combine such new ideas and build on the firm's accumulated prior knowledge, inventions or technologies are highly explicit knowledge-intensive (Cohen & Caner, 2016), the same that those involved in the product development and commercialization phase (Hansen & Birkinshaw, 2007). Hence, intensive tacit

knowledge during exploration is not enough on its own to translate into product innovation; it is vital to integrate the new tacit knowledge with the explicit knowledge scattered throughout the organization (Raisch et al., 2009; Spender, 1992). Organizational economics and team production literature provides support for such effective knowledge integration. Knowledge-intensive exploratory activities which are generally smaller, more decentralized, and more flexible (Raisch et al., 2009; Roberts, 2007) are vertically separated, and such "specialized" tacit knowledge is vertically shared through knowledge hierarchies (Garicano & Wu, 2012). These tacit knowledge-intensive exploratory pockets are horizontally integrated with codified explicit knowledge generating "common knowledge" (Grant,1996b) through seamless coordination and communication processes (Alonso et al., 2008; Foss & Mahnke, 2003; Garicano & Wu, 2012; Grant, 1996a; Jansen et al., 2009), which are deeply ingrained within the organization's operating manuals, standard operating procedures, shared vision, cross training and job rotation (Grant, 1996a), processes, rules and routines that constitute the organization's structural capital (Zhou & Li, 2012). Such architectural design, also termed as "structural differentiation", addresses different aspects of the paradoxical context involving tacit and explicit knowledge, differentiating, integrating, and reinforcing one another (O'Reilly & Tushman, 2008; Smith & Tushman, 2005), and demands the determined action of top and middle managers (Jansen et al., 2009; Nonaka & Takeuchi, 1995; Raisch et al., 2009) to blend knowledge and coordinate tasks (Smith & Tushman, 2005; Zhou & Li, 2012).

According to Cohen and Caner (2016), a higher proportion of exploratory activities that are tacit knowledge-intensive, such as collaboration with external experts, reduce the ability of organizations to absorb such knowledge as well as diluting focus on exploitative tasks (Hansen & Birkinshaw, 2007) resulting in a negative impact on

product innovation. In fact, exploitation during invention, which is explicit and codified knowledge-intensive, contributes more to product innovation than exploration, which is tacit knowledge-intensive (Cohen & Caner, 2016). Recently, some authors have shown that in comparison to explicit knowledge, higher tacit knowledge heterogeneity in research and development teams can negatively influence the firm's innovation climate and in turn innovation performance (Zhang et al., 2020). So, with a number of knowledge management studies emphasizing the importance of explicit knowledge, it is expected to play an equally important role as tacit knowledge in transforming organizational capabilities into product innovation (March, 1991). Previous literature has not explored their mediating role in transforming organizational capabilities into product innovation. Therefore, the following hypotheses are proposed:

Hypothesis (H1a). Explicit knowledge partially mediates the relationship between organizational capabilities and product innovation.

Hypothesis (H1b). Tacit knowledge partially mediates the relationship between organizational capabilities and product innovation.

2.2. The moderating role of tacit and explicit knowledge

Nonaka's "knowledge spiral" (1994) illustrates four modes of knowledge creation; tacit to tacit knowledge exchange (socialization), new explicit knowledge blending with the existing explicit knowledge (combination), tacit knowledge converted into explicit knowledge (externalization) and explicit knowledge converted into tacit (internalization). Without these four modes the knowledge spiral would fail, which leads to make both explicit and tacit knowledge valuable in the knowledge management value chain (Nonaka & Von Krogh, 2009; Nonaka, 1994) and in the product innovation process (López-Nicolás & Meroño-Cerdán, 2011; March, 1991).

Nonaka's "externalization" mode of knowledge creation shows that as a part of the invention phase, exploration of new ideas (tacit knowledge-intensive) blends with the existing repertoire of explicit knowledge creating new concepts giving sense to the "kaleidoscope thinking" (Kanter, 1986). Hence, the study aims to test the following hypotheses:

Hypothesis (H2a). Tacit knowledge positively moderates the relationship between organizational capabilities and explicit knowledge.

Hypothesis (H2b). Tacit knowledge positively moderates the relationship between explicit knowledge and product innovation.

Nonaka's "internalization" mode of knowledge creation describes the conversion of explicit knowledge into tacit knowledge, i.e., the translation of the knowledge resources created through the "externalization" into causally ambiguous, hard-to-imitate, impossible-to-trade resources with the final aim of creating value (McGahan, 2021). Thus, "internalization" mode of knowledge creation forms the heart of organizational learning where new knowledge is internalized and embedded within the company (March, 1991) through various idiosyncratic models including reflexive organizing (Yamauchi, 2015). Integration of explicit knowledge with the already existing tacit knowledge can provide positive outcomes towards innovation. Therefore, the following hypothesis is proposed:

Hypothesis (H3a). Explicit knowledge positively moderates the relationship between organizational capabilities and tacit knowledge.

Contrastingly, Govindarajan (2016) argues that organizations need to selectively forget the past by abandoning practices and ideas that have lost relevance that could otherwise interfere with organization's focus on innovation. This view supports the importance of organizational unlearning or abandoning established practices,

organizational routines, and codified systems for organizational learning (Hislop et al., 2014). The forgetfulness of organizational members enhances the rate of interpersonal learning and diversity of beliefs resulting in superior organizational learning (Miller & Martignoni, 2015). All this leads to the argument that high levels of explicit and codified knowledge, processes and practices based on past successes can hinder future innovations. In this sense, recent research has shown that a higher proportion of explicit knowledge, in comparison to tacit knowledge, lends the firms business model to be more likely to be imitated by competitors thereby eroding the firm's competitive advantage (Chen et al., 2021). Hence, it seems logical to posit that excessive levels of explicit knowledge can play a negative role in the relationship between tacit knowledge and product innovation. Therefore, to analyse its moderating role, the following hypothesis is proposed:

Hypothesis (H3b). Explicit knowledge negatively moderates the relationship between tacit knowledge and product innovation.

During the invention phase, exploratory tasks carried out by scientists and "customer facing" employees interacting with external parties such as inventors, technology providers and competitors provide valuable intangible information vital for product innovation (Cohen & Caner, 2016; Hansen & Birkinshaw, 2007; Ruvio et al., 2014). More than half of all breakthrough innovations have been initiated by tacit knowledge-intensive tasks that explore "market pull" ideas identifying the perceived need or demand for the product or service (Roberts, 2007). Such ideas are then absorbed and dispersed within the organization through personal interactions across functional teams (Arnett & Wittmann, 2014; Grant, 1996a, 1996b) in line with the "socialization" mode of knowledge creation prescribed by Nonaka. Sharing such tacit knowledge becomes a vital component for the organization's innovation capabilities (Ganguly et

al., 2019). Although organizational capabilities in terms of efficient integration and coordination of knowledge through an optimal organization design (Foss & Mahnke, 2003; Garicano & Wu, 2012; Jansen et al., 2009; Smith & Tushman, 2005) have a positive impact on product innovation (Grant, 1996a, 1996b; Nonaka & Takeuchi, 1995), it seems clear that such impact could potentially be magnified with higher levels of tacit knowledge (Cohen & Caner, 2016; Roberts, 2007). Therefore, the following hypothesis is proposed:

Hypothesis (H4a). Tacit knowledge positively moderates the relationship between organizational capabilities and product innovation.

Cohen and Caner (2016) also show that the exploitative invention, which is explicit knowledge-intensive and includes reconfiguring existing information through sorting, adding, re-categorizing, and re-contextualizing leads to new knowledge facilitating effective product development in line with the "combination" mode of knowledge creation prescribed by Nonaka. As this mode of knowledge creation has a stronger positive effect on innovation than exploratory invention, it is expected that explicit knowledge plays an important role in the relationship between the company`s organizational capabilities and its ability to innovate. Therefore, the following hypothesis is proposed:

Hypothesis (H4b). Explicit knowledge positively moderates the relationship between organizational capabilities and product innovation.

3. Methodology

3.1. Participants and procedure

We used the National Institute of Statistics of Portugal to select 521 companies in the industrial sector with more than 50 workers. The managers of the organizations received

a questionnaire with the instructions and the guarantee of confidentiality. The final sample consisted of 153 companies (response rate: 29%) and was predominantly made up of companies with an average age of 20 years (SD=13.74). Most of the sample was comprised by private limited companies (64.5%) with less than 100 employees (57%), followed by public limited companies (33.6%) and companies with 100–249 employees (39%). The data and the hypothesized relationships were analysed using SEM (22.0 SPSS and AMOS package).

3.2. Instruments

Tacit (TK) and explicit knowledge (EK). This study used the four-items scale proposed by Choi and Lee (2003) on a 5-point Likert scale, from 1 (totally disagree) to 5 (totally agree) and included items such as "It is easy for employees to acquire knowledge through direct contact with experts or pairs of work" (TK) and "Knowledge can be easily acquired through formal documents that are available in the organization" (EK).

Product innovation (PI). The company's ability to innovate products was measured with four items proposed by Spanos and Lioukas (2001) on a 5-point Liker scale from 1 (a lot less than the competitors) to 5 (a lot more than the competitors). The scale included items such as "RandD expenditures for product innovations".

Organizational capabilities (OC). This study used the seven-items scale proposed by Spanos and Lioukas (2001) on a 5-point Likert scale from 1 (weaker than competitors) to 5 (stronger than competitors) to what extend the organizational capabilities can be considered a strength relative to their competitors. The scale included items such as "Efficient organizational structure" and "Coordination".

4. Results

4.1. Evaluation of common method bias

As the dependent and independent variables were collected at the same time and in self-reporting measure, the recommendations proposed by Podsakoff et al. (2003) were followed to avoid the common method bias. Additionally, two statistical analyses were performed to minimize the detrimental effects of method biases. The first one was the Harman's single factor test (1967). This test detected four factors (eigenvalues>1) that explained 76.21% of the total variance. The results showed that no single factor is responsible for most of the variance, as the first factor only explained 53.29% (Christmann, 2000). The second analyses carried out was a confirmatory factor analysis (CFA) with one single factor (Korsgaard & Roberson, 1995). The results showed that the single-factor model fitted significantly worse that the measurement model. Therefore, common method variance did not appear to be a problem in this study (Podsakoff et al., 2003).

4.2. Model analysis

Table 1 shows the descriptive statistics. Goodness-of-fit of the measurement models showed good values. ModTK: $\chi 2(df)=128.515(86)$, $p<.001$, GFI=.903, RMSEA=.057, AGFI=.865, NFI=.928, TLI=.969, CFI=.975, CMIN=1.494. ModEK: $\chi 2(df)=119.483(86)$, $p<.001$, GFI=.903, RMSEA=.051, AGFI=.865, NFI=.937, TLI=.977, CFI=.981, CMIN=1.389.

[Insert Table 1 about here]

Goodness-of-fit of the structural model also presented good values. ModTK: $\chi 2(df)=128.515(86)$, $p<.001$, GFI=.903, RMSEA=.057, AGFI=.865, NFI=.928,

TLI=.969, CFI=.975, CMIN=1.494. ModEK: $\chi 2$(df)=119.483(86), p<.001, GFI=.903, RMSEA=.051, AGFI=.865, NFI=.937, TLI=.977, CFI=.981, CMIN=1.389.

The results indicate that in ModTK, OC account for 33.1% of EK, and both OC and EK account for 55.5% of PI. In ModEK, OC account for 63.9% of TK, and both OC and TK account for 59.8% of PI.

4.3. Mediation

The results concluded that EK partially mediates the relationship between OC and PI (Table 2). Two additional models were tested to fully confirm this result (full mediation and direct effect) (Baron & Kenny, 1986). The chi-square of Model 1 (partial mediation) is lower than the chi-square of Model 2 (full mediation) and Model 3 (direct effect) and significantly different in both cases ($\Delta\chi 2$=50.538, Δdf=1; $\Delta\chi 2$=53.047, Δdf=2). The same result holds through Sobel (1982) (Z=5.8834, p<.000) and Goodman (1960) (Z=5.9041, p<.0000) tests, which also supported the mediating effect of EK. In addition, the partial mediation effect of EK is supported since the variance accounted-for (VAF) fell within the range of .20 to .80 (Hair et al., 2014). All previous results concluded the partial mediation of EK in the relationship between OC and PI, supporting H1a.

The same analyses have been made to test the mediation effect of TK in the relationship between OC and PI. Table 2 shows a chi-square lower for Model 1 in relation to Model 2 and Model 3 and significantly different in both cases ($\Delta\chi 2$=11.753, Δdf=1; $\Delta\chi 2$=133.651, Δdf=2). Sobel (Z=13.1162, p<.000) and Goodman (Z=13.1249, p<.0000) tests also supported the mediating effect of TK. The partial mediation effect of TK was supported through the analysis of the VAF (Hair et al., 2014). All previous results concluded the partial mediation of TK in the relationship between OC and PI, supporting H1b.

[Insert Table 2 about here]

4.4. Moderation

Using multigroup analysis, this paper also analysed the moderating effect of TK in the relationships between OC, EK, and PI (ModTK); and the moderating effect of EK in the relationships between OC, TK, and PI (ModEK). The significance of the chi-square differences between a CFA model with the factor loadings constrained and the other without constraints was analysed to test the factor loading invariance among the groups. The chi-square differences were significant for ModTK ($\Delta\chi2=13.055$, $\Delta df=5$, $p<.05$) and ModEK ($\Delta\chi2=21.472$, $\Delta df=5$, $p<.001$), suggesting in both cases that there was no factor loading invariance. Path differences were analysed performing series of multiple group analyses. For ModTK, the results concluded that TK shows a factor loading variant in the relationships between OC and EK, and between OC and PI, supporting hypotheses H2a and H4a. Conversely, TK shows a factor loading invariant in the relationship between EK and PI, rejecting hypothesis H2b. For ModEK, the results concluded that EK shows a factor loading variant in the relationships between OC and TK, between TK and PI, and between OC and PI, supporting hypotheses H3a, H3b and H4b.The moderation effects, the path coefficients and R2 of the relationships moderated by TK and EK are shown in Table 3. All the above-mentioned results are shown in Figure 1.

[Insert Table 3 about here]

[Insert Figure 1 about here]

For ModTK, the relationship between OC and EK and the relationship between OC and PI differ in accordance with the level of TK, and it is necessarily to know how exactly they differ. In both cases, the interaction terms are positive coefficients, so the positive impact of OC on EK or on PI increases as TK increases, however the precise

nature and size of these effects are not easily perceivable by merely examining the coefficients. For this reason, the effects were plotted to be interpreted visually (Dawson, 2014). TK was categorized into three levels (low, moderate, and high) to predict the relationships between OC and EK or PI at these three levels, obtaining three different regression groups. Figure 2.1 shows that a high level of TK has a strong regression effect (R2 Lineal=.422) on OC EK relationship (correlation value=.649), and Figure 2.2 shows that a high level of TK has a strong regression effect (R2 Lineal=.569) on OC PI relationship (correlation value=.754). So, it is demonstrated that the relationship between OC and EK and the relationship between OC and PI are always positive, but far more positive for organizations with higher levels of TK than for those with lower levels.

For ModEK, the relationships between OC and TK, between TK and PI, and between OC and PI differ in accordance with the level of EK; however, it is also not known how they differ exactly. Figure 2.3 shows that a moderate level of EK has a strong regression effect (R2 Lineal=.181) on OC TK relationship (correlation value=.425); Figure 2.4 shows that a moderate level of EK has a strong regression effect (R2 Lineal=.329) on TK PI relationship (correlation value=.573); and Figure 2.5 shows that a moderate level of EK has a strong regression effect (R2 Lineal=.324) on OC PI relationship (correlation value=.569). So, the results demonstrate that the relationship between OC and TK, between TK and PI, and between OC and PI are positive, but far more for organizations with moderate levels of EK than for those with lower or higher levels. Fig. 2.4 also shows that high levels of EK (in comparison to moderate or low levels of EK) has a negative impact on the TK PI relationship.

[Insert Figure 2 about here]

5. Discussion

The results show that both tacit and explicit knowledge partially mediate the relationship between organizational capabilities and product innovation. Organizational capabilities positively impact product innovation, and such effect flows both directly and indirectly through tacit and explicit knowledge highlighting their importance in organizational capabilities transforming into product innovation. These results further highlight that although the direct relationship between organizational capabilities and product innovation is much stronger than the indirect effects through tacit and explicit knowledge; the mediating role played by tacit knowledge is much stronger than that of the explicit knowledge.

The results provide empirical evidence for the importance of an organizational design that must seamlessly coordinate, integrate, and communicate knowledge -tacit and explicit- dispersed across the organization towards product innovation. This result is in line with the philosophy of the knowledge-based view where organizations are perceived as knowledge integrators for effective product innovation (Grant, 1996a, 1996b; López-Cabarcos et al., 2020; Nonaka & Takeuchi, 1995). Our study also provides evidence for not only tacit knowledge, but also explicit knowledge acting as a mediator in the relationship between organizational capabilities and product innovation. This result strengthens the overall philosophy advocated by the organizational economics and team production and ambidexterity literature (Jansen et al., 2009; Lin et al., 2013; March, 1991; O'Reilly & Tushman, 2008; Raisch et al., 2009; Smith & Tushman, 2005) that highlight the importance of coordinating mechanisms where vertically separated tacit knowledge-intensive exploratory tasks, which are "structurally differentiated", are horizontally integrated with explicit knowledge-intensive exploitative tasks through "common knowledge" (Foss & Mahnke, 2003; Grant,

1996b). This study clearly brings out the vitality of both the tacit knowledge-intensive exploratory tasks and the explicit knowledge-intensive exploitative tasks in the overall product innovation value chain. The results of this study are not completely coincident with the results of those studies that conclude that exploitative tasks, which are explicit knowledge-intensive, contribute more to product innovation than tacit knowledge-intensive explorative tasks (Cohen & Caner, 2016; Roberts, 2007), and with those studies that conclude that excessive tacit knowledge heterogeneity can negatively impact innovation (Zhang et al., 2020). However, the results are coherentwith the knowledge management studies that highlight the vitality of both tacit and explicit knowledge in the product innovation value chain (Choi & Lee, 2003; López-Cabarcos et al., 2020; López-Nicolás & Meroño-Cerdán, 2011; Nonaka & Von Krogh, 2009).

One of the key findings is that tacit knowledge is a much stronger mediator than explicit knowledge. Although recent studies have argued that explicit knowledge is also important for innovation (López-Cabarcos et al., 2020; López-Nicolás & Meroño-Cerdán, 2011; Choi & Lee, 2003) and Nonaka's (1994) argument that without explicit knowledge the knowledge spiral would fail, this study clearly brings out the fact that the mediating role played by tacit knowledge in the organization capabilities and product innovation relationship is much stronger than the mediating role played by explicit knowledge. Our findings reiterate the importance of tacit knowledge as a source of competitive advantage, furthering the central theme of the knowledge-based theory of organizational capabilities.

This study also provides evidence for tacit knowledge moderating the organizational capabilities explicit knowledge relationship. The positive impact of organizational capabilities on explicit knowledge is significantly higher when the level of tacit knowledge is higher (Figure 2.1).

The results provide support for the role played by tacit knowledge in enhancing the effectiveness of organizational capabilities in creating explicit knowledge further cementing the role of the organization as a knowledge integrator. This result provides empirical support for Nonaka's knowledge spiral, especially the "externalization" mode of knowledge creation, where new tacit knowledge blends with the existing explicit knowledge to create new knowledge. So, in line with the study of Cohen and Caner (2016), this study supports that new tacit knowledge can be combined with the existing repertoire of explicit knowledge to enhance the firm's overall explicit knowledge base.

This study does not support the moderating role of TK in the relationship between EK and PI. Such moderating role played by TK can be viewed as a reorganization of already existing explicit knowledge along with emerging tacit knowledge (Kanter, 1986), thereby creating new alternatives and possibilities that challenge conventional wisdom and giving meaning to the already mentioned concept of kaleidoscopic thinking. Baron and Tang (2011) reiterate that such creative process that internalizes individual creativity within an organization (Bharadwaj & Menon, 2000) is a key antecedent to firm level innovation. Kanter (1996) further argues that such organizational creativity is nurtured when employees spend more time with people with different perspectives and beliefs, or when facing uncomfortable situations where basic assumptions are challenged. The non-significance of the moderating role of TK in EK PI relationship could stem from external factors to the firm that could impact organizational creativity (Baron & Tang, 2011). More specifically, aspects related to environmental dynamism, i.e., the volatility and ambiguity in the environmental factors affecting the sample companies (Darvishmotevali et al., 2020). In this sense, several authors showed that organizational creativity thrives and results in higher level of innovation when firms are faced with highly dynamic, complex and uncertain

environments in contrast to stable ones. Internal factors of companies, for example firm size, age, functional diversity of top management teams, or a combination thereof, are also documented to impact organizational creativity and consequently firm innovation (Yoon et al., 2016). Hence, the specificity of the sample firms, characterized by being large companies (43% of the sample), a mix of private limited (64.5%) and public limited companies (33.6%), with an average age in the market of more than 20 years and coming from very different industrial sectors, could explain the non-significance of TK's moderating role in the EK and PI relationship in this study.

The results also show that the positive relationship between organizational capabilities and tacit knowledge is strongest in firms where the level of explicit knowledge is moderate in comparison to firms where the level of explicit knowledge is lower or higher (Figure 2.3). The study also demonstrates that with excessive levels of explicit knowledge the tacit knowledge product innovation relationship turns negative, which is otherwise positive at lower or moderate levels of explicit knowledge (Figure 2.4). This result seems to support the view of Govindarajan (2016) on the organization's need to selectively forget practices and ideas of the past that have lost relevance reinforcing the argument that high levels of explicit and codified knowledge, can hinder future innovations. As it was mentioned, this result supports the importance of organizational unlearning (Hedberg, 1981; Hislop et al., 2014) and also the concept of "double loop learning" that advocates questioning and reconstructing existing perspectives (Argyris & Schön, 1978), since an excessive proportion of explicit knowledge can erode the firm's competitive advantage through competitor's imitation (Chen et al., 2021).

Finally, the study throws light on the role played by tacit and explicit knowledge as moderators in the relationship between organizational capabilities and product

innovation. The positive relationship between organizational capabilities and product innovation is strongest in firms where the levels of tacit knowledge are high (Figure 2.2). This supports the claim of proponents of knowledge-based view that tacit knowledge can lead to competitive advantages due to its inimitability (Chen et al., 2021; Ganguly et al., 2019; Grant, 1996b) and further provides evidence for the importance of exploration through tacit knowledge-intensive activities to generate new ideas focused on the product innovation value chain (Cohen & Caner, 2016; Hansen & Birkinshaw, 2007; Ruvio et al., 2014). These results are also in line with the findings that breakthrough innovations are the result of exploratory tasks that captures tacit unmet customer needs (Roberts, 2007), but are contrary to previous studies that conclude that high levels of external tacit knowledge negatively impact innovation. This study also produces counterintuitive findings that the positive relationship between organizational capabilities and product innovation is strongest when explicit knowledge levels are moderate in comparison to firms where the levels of explicit knowledge are higher or lower (Figure 2.5), supporting organizational "unlearning". This result is contrary to Cohen and Caner (2016) results, which show that exploitative invention, which is explicit knowledge-intensive has a stronger positive effect on innovation than exploratory invention.

6. Managerial implications, limitations, and future research

This study succinctly captures and demonstrates the vitality of both explicit and tacit knowledge and their nuanced interplay to managerial practitioners. With the emergence and ubiquity of digital technologies in the form of big data, predictive analytics and machine learning algorithms, the vitality of "externalization" mode of organizational learning is getting further amplified. Recent studies highlight the importance of big data analytics and its contribution to knowledge management strategies, especially for firms

using structural ambidexterity (Ciampi et al., 2020). With the emergence of such technologies, tapping deep customer insights in the exploratory phase of invention through, for example, text mining and specialized semantic analysis is becoming more codifiable within organizations, which brings about a higher degree of customer involvement in the product innovation processes thereby enhancing the new products success rate (Holford, 2019). Thus, capturing and codifying large volumes of rapidly generated new ideas from consumers and communities through crowdsourcing is enriching the generation of new opportunities during the invention phase of product innovation (Hoornaert et al., 2017). For organizations to become more effective in product innovation and more efficient in their knowledge management processes, it is mandatory that they strengthen their ability to extract tacit insights into explicit knowledge and internalize the ability to combine them with existing knowledge. However, this study also brings out the importance of unlearning which is also an important protocol in machine learning algorithms and underpins that a cautious balance of the levels of explicit knowledge is required, since high levels of codified knowledge can be counterproductive to create more tacit knowledge or to achieve effective product innovation.

Further, given this study's key finding highlighting that tacit knowledge is a stronger mediator than explicit knowledge, managers need to appreciate the importance of mechanisms that deepen tacit knowledge by not only facilitating customer facing and R&D personnel to gain market insights but also dissipating such information within the organization encouraging face-to-face personal interactions of cross-functional teams in order to excel in product innovation.

As any other empirical study, this study has certain limitations. While this study captures organizational capabilities in terms of effective organizational design and

structure, it has not dwelled deeper into other external and internal aspects related to the organization that can impact knowledge integration. Since the implications of imperfect managerial meta-knowledge can influence organization design and effectiveness of knowledge integration, there is a further scope to explore how organizational design can efficiently integrate knowledge in the backdrop of organizational culture, communication, incentivization, information asymmetry and bounded rationality in firms. Furthermore, although the product innovation construct in our study captures the overall product innovation value chain, it has not explicated the tacit and explicit knowledge components of the invention and innovation tasks. Capturing product innovation tasks and their knowledge attributes at a more nuanced level within the product innovation value chain can provide scope for an interesting and challenging research agenda.

7. Conclusions

This study provides two incremental contributions. First, it integrates knowledge-based view, organizational learning, and organizational economics to empirically demonstrate the role played by tacit and explicit knowledge in the product innovation value chain. Second, it explicates the nuanced role played by tacit and explicit knowledge both as mediators and moderators in the relationship between organizational capabilities and product innovation. More specifically, this study shows that while both explicit and tacit knowledge partially mediate this relationship, the direct relationships are stronger in both cases. Further the mediating role played by tacit knowledge comes out as much stronger than the mediating role played by explicit knowledge. Although both tacit and explicit knowledge also play a moderating role, their individual effects are however subtly different. This study concludes that high levels of tacit knowledge exert a positive influence on product innovation; however, the levels of explicit knowledge

must be carefully calibrated within organizations since high levels of explicit knowledge can hinder product innovation.

References

Alonso, R., Dessein, W., & Matouschek, N. (2008). When does coordination require centralization? *American Economic Review, 98*(1), 145–179. https://doi.org/10.1257/aer.98.1.145

Argyris, C., & Schön, D. N. (1978). *Organizational learning: A theory of action perspective.* Reading, MA: Addison-Wesley.

Arnett, D. B., & Wittmann, C. M. (2014). Improving marketing success: The role of tacit knowledge exchange between sales and marketing. *Journal of Business Research, 67*(3), 324–331. https://doi.org/10.1016/j.jbusres.2013.01.018

Baron, R. A., & Tang, J. (2011). The role of entrepreneurs in firm-level innovation: Joint effects of positive affect, creativity, and environmental dynamism. *Journal of Business Venturing, 26*(1), 49-60. https://doi.org/10.1016/j.jbusvent.2009.06.002

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182. https://doi.org/10.1037//0022-3514.51.6.1173

Bharadwaj, S., & Menon, A. (2000). Making innovation happen in organizations: Individual creativity mechanisms, organizational creativity mechanisms or both? *Journal of Product Innovation Management*, *17*(6), 424–434. https://doi.org/10.1111/1540-5885.1760424

Chen, J., Wang, L., & Qu, G. (2021). Explicating the business model from a knowledge-based view: Nature, structure, imitability and competitive advantage erosion. *Journal of Knowledge Management, 25*(1), 23–47. https://doi.org/10.1108/JKM-02-2020-0159

Choi, B., & Lee, H. (2003). An empirical investigation of KM styles and their effect on corporate performance. *Information & Management, 40*(5), 403–417. https://doi.org/10.1016/S0378-7206(02)00060-5

Christmann, P. (2000). Effects of "best practices" of environmental management on cost advantage: The role of complementary assets. *Academy of Management Journal, 43*(4), 663–680. https://doi.org/10.2307/1556360

Ciampi, F., Marzi, G., Demi, S., & Faraoni, M. (2020). The big data-business strategy interconnection: A grand challenge for knowledge management. A review and future perspectives. *Journal of Knowledge Management, 24*(5), 1157–1176. https://doi.org/10.1108/JKM-02-2020-0156

Cohen, S. K., & Caner, T. (2016). Converting inventions into breakthrough innovations: The role of exploitation and alliance network knowledge heterogeneity. *Journal of Engineering and Technology Management, 40*, 29–44. https://doi.org/10.1016/j.jengtecman.2016.03.002

Darvishmotevali, M., Altinay, L., & Köseoglu, M. A. (2020). The link between environmental uncertainty, organizational agility, and organizational creativity in the hotel industry. *International Journal of Hospitality Management*, *87*, 102499. https://doi.org/10.1016/j.ijhm.2020.102499

Dawson, J. F. (2014). Moderation in management research: What, why, when, and how. *Journal of Business and Psychology, 29*, 1–19. https://doi.org/10.1007/s10869-013-9308-7

Foss, N. J., & Mahnke, V. (2003). *Knowledge management: What can organizational economics contribute?* DRUID working paper 03–02, Copenhagen.

Ganguly, A., Talukdar, A., & Chatterjee, D. (2019). Evaluating the role of social capital, tacit knowledge sharing, knowledge quality and reciprocity in determining innovation capability of an organization. *Journal of Knowledge Management, 19*(6), 1105–1035. https://doi.org/10.1108/JKM-03-2018-0190

Garicano, L., & Wu, Y. (2012). Knowledge, communication, and organizational capabilities. *Organization Science, 23*(5), 1213–1525. https://doi.org/10.1287/orsc.1110.0723

Govindarajan, V. (2016). *The three-box solution: A strategy for leading innovation*. Boston, MA: Harvard Business Review Press.

Grant, R. M. (1996a). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science, 7*(4), 375–387. http://dx.doi.org/10.1287/orsc.7.4.375

Grant, R. M. (1996b). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(S2), 109–122. https://doi.org/10.1002/smj.4250171110

Guo, H. (2013). Research on making tacit knowledge explicit. In R. Zheng (Ed.), *Proceedings of the 2013 International Conference on Education, Management and Social Science (ICEMSS-13)* (pp. 23–26). AISR.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM).* Thousand Oaks, CA: Sage.

Hansen, M. T., & Birkinshaw, J. (2007). The innovation value chain. *Harvard Business Review, 85*(6), 121–130.

Harman, H. H. (1967). *Modern factor analysis*. Chicago, UEA: University of Chicago Press.

Hedberg, B. (1981). How organizations learn and unlearn. In P. C. Nystrom & W. H. Starbuck (Eds.), *Handbook of organizational design*, vol 1 (pp. 3–27). Oxford University Press, Oxford.

Hislop, D., Bosley, S., Coombs, C. R., & Holland, J. (2014). The process of individual unlearning: A neglected topic in an under-researched field. *Management Learning, 45*(5), 540–560. https://doi.org/10.1177/1350507613486423

Holford, W. D. (2019). The future of human creative knowledge work within the digital economy. *Futures, 105*, 143–154. https://doi.org/10.1016/j.futures.2018.10.002

Hoornaert, S., Ballings, M., Malthouse, E. C., & Van den Poel, D. (2017). Identifying new product ideas: Waiting for the wisdom of the crowd or screening ideas in real time. *Journal of Product Innovation Management, 34*(5), 580–97. https://doi.org/10.1111/jpim.12396

Jansen, J. J., Tempelaar, M. P., Van den Bosch, F. A., & Volberda, H. W. (2009). Structural differentiation and ambidexterity: The mediating role of integration mechanisms. *Organization Science, 20*(4), 797–811. https://doi.org/10.1287/orsc.1080.0415

Kanter, R. M. (1986). Creating the creative environment. *Management Review, 75*(2), 11–12.

Kanter, R. M. (1996). When a thousand flowers bloom: Structural, collective, and social conditions for innovation in organizations. In P. S. Myers (Ed.), *Knowledge management and organisational design* (pp. 93–131). Elsevier.

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science, 3*(3), 383–397.

Korsgaard, M. A., & Roberson, L. (1995). Procedural justice in performance evaluation: The role of instrumental and non-instrumental voice in performance appraisal discussions. *Journal of Management, 21*(4), 657–669. https://doi.org/10.1016/0149-2063(95)90004-7

Lin, H-E., McDonough III, E. F., Lin, S-J., & Lin, Y-Y. (2013). Managing the exploitation/exploration paradox: The role of a learning capability and innovation ambidexterity. *Journal of Product Innovation Management, 13*(2), 262–278. https://doi.org/10.1111/j.1540-5885.2012.00998.x

López-Cabarcos, M. Á., Srinivasan, S., & Vázquez-Rodríguez, P. (2020). The role of product innovation and customer centricity in transforming tacit and explicit knowledge into profitability. *Journal of Knowledge Management, 24*(5), 1037–1057. https://doi.org/10.1108/JKM-02-2020-0087

López-Nicolás, C., & Meroño-Cerdán, Á. L. (2011). Strategic knowledge management, innovation and performance. *International Journal of Information Management, 31*(6), 502–509. https://doi.org/10.1016/j.ijinfomgt.2011.02.003

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 71–87.

Marschak, J., & Radner, R. (1972). *Economic theory of teams*. New Haven, CT: Yale University Press.

McGahan, A. M. (2021). Integrating insights from the resource-based view of the firm into the new stakeholder theory. *Journal of Management*, *47*(7), 1734–1756. https://doi.org/10.1177/0149206320987282

Miller, K. D., & Martignoni, D. (2016). Organizational learning with forgetting: Reconsidering the exploration–exploitation tradeoff. *Strategic Organization, 14*(1), 53–72. https://doi.org/10.1177/1476127015608337

Nonaka, I. (1991). The knowledge-creating company. *Harvard Business Review, November–December*, 96–104.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14–37. https://doi.org/10.1287/orsc.5.1.14

Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. New York, NY: Oxford University Press

Nonaka, I., & Von Krogh, G. (2009). Perspective–Tacit knowledge and knowledge conversion: Controversy and advancement in organizational knowledge creation theory. *Organization Science, 20*(3), 635–652. https://doi.org/10.1287/orsc.1080.0412

O'Reilly III, C. A., & Tushman, M. L. (2008). Ambidexterity as a dynamic capability: Resolving the innovator's dilemma. *Research in Organizational Behavior, 28*, 185–206. https://doi.org/10.1016/j.riob.2008.06.002

Podsakoff, P. M., Mackenzie, S. B., Podsakoff, N. P., & Lee, J. Y. (2003). The mismeasure of man(agement) and its implications for leadership research. *The Leadership Quarterly, 14*(6), 615–656. https://doi.org/10.1016/j.leaqua.2003.08.002

Polanyi, M. (1962). *Personal knowledge: Towards a post critical philosophy*. London, UK: Routledge.

Polanyi, M. (1966). The logic of tacit inference. *Philosophy, 41*(155), 1–18.

Raisch, S., Birkinshaw, J., Probst, G., & Tushman, M. L. (2009). Organizational ambidexterity: Balancing exploitation and exploration for sustained performance. *Organization Science, 20*(4), 685–695. https://doi.org/10.1287/orsc.1090.0428

Roberts, E. B. (2007). Managing invention and innovation. *Research-Technology Management, 50*(1), 35–54. https://doi.org/10.1080/08956308.2007.11657418

Ruvio, A. A., Shoham, A., Vigoda-Gadot, E., & Schwabsky, N. (2014). Organizational innovativeness: Construct development and cross-cultural validation. *Journal of Product Innovation Management, 31*(5), 1004–1022. https://doi.org/10.1111/jpim.12141

Schmidt, R., Bell, R., & Warren, V. (2021). Keeping the wheels of the automotive industry turning: The use of tacit knowledge by product development workers in a multinational automotive manufacturer. *Journal of Intellectual Capital, 22*(6), 1106–1125. https://doi.org/10.1108/JIC-07-2020-0257

Schoenherr, T., Griffith, D. A., & Chandra, A. (2014). Knowledge management in supply chains: The role of explicit and tacit knowledge. *Journal of Business Logistics, 35*(2), 121–35. https://doi.org/10.1111/jbl.12042

Smith, W. K., & Tushman, M. L. (2005). Managing strategic contradictions: A top management model for managing innovation streams. *Organization Science, 16*(5), 522–536. https://doi.org/10.1287/orsc.1050.0134

Sobel, M. E. (1982). Asymptotic intervals for indirect effects in structural equations models. In S. Leinhart (Ed.), *Sociological methodology* (chapter 7). San Francisco, CA: Jossey-Bass.

Spanos, Y. E., & Lioukas, S. (2001). An examination into the causal logic of rent generation: Contrasting Porter´s competitive strategic framework and the resource-based view perspective. *Strategic Management Journal, 22*(10), 907–934. https://doi.org/10.1002/smj.174

Spender, J. C. (1992). Limits to learning from the West: How Western management advice may prove limited in Eastern Europe. *The International Executive, 34*(5), 389–413. https://doi.org/10.1002/tie.5060340503

Tushman, M. L., & O'Reilly III, C. A. (1996). Ambidextrous organizations: Managing evolutionary and revolutionary change. *California Management Review, 38*(4), 8–29. https://doi.org/10.2307/41165852

Yamauchi, Y. (2015). Reflexive organizing for knowledge sharing: An ethnomethodological study of service technicians. *Journal of Management Studies, 52*(6), 742–765. http://dx.doi.org/10.1111/joms.12136

Yoon, W., Kim, S. J., & Song, J. (2016). Top management team characteristics and organizational creativity. *Review of Managerial Science*, *10*(4), 757-779. https://doi.org/10.1007/s11846-015-0175-7

Zhang, R., Wang, J., & Hao, J-X. (2020). How does knowledge heterogeneity affect transactive memory system in innovation? Evidence from a field study. *Journal of Knowledge Management, 24*(8), 1965–1985. https://doi.org/10.1108/JKM-01-2020-0008

Zhou, K. Z., & Li, C. B. (2012). How knowledge affects radical innovation: Knowledge base, market knowledge acquisition, and internal knowledge sharing. *Strategic Management Journal, 33*(9), 1090–1102. https://doi.org/10.1002/smj.1959

Table 1. Descriptive statistics

	M	*SD*	OC	EK	PI	TK	Average Variance Extracted	Composite Reliability
OC	3.23	.82	.930				.662	.932
EK	3.21	.90	.523**	.900			.698	.902
PI	2.94	.95	.666**	.446**	.907		.684	.896
TK	3.26	.94	.738**	.478**	.651**	.903	.705	.905

Note: N = 153. Cronbach's α on the diagonal.
*p<.05, **p<.01

Table 2. Fit results, path coefficients, and BC percentile coefficients

Explicit Knowledge								
	$\chi^2(df)$	GFI	RMSEA	AGFI	NFI	TLI	CFI	χ^2/df
Model 1	128.515 (86)	.903	.057	.865	.928	.969	.975	1.494
Model 2	179.053(87)	.881	.083	.836	.900	.934	.946	2.058
Model 3	181.562(88)	.874	.084	.829	.899	.934	.945	2.063

Standardized coefficients and (*t*-values)			
	Model 1	Model 2	Model 3
OC→PI	.657(8.01)***		.733(15.60)***
OC→EK	.572(8.80)***	.603(9.14)***	
EK→PI	.131(1.98)*	.546(7.69)***	

BC percentile method - direct and indirect effects					
Direct effects	Effect	BootSE	*p*	BootLLCI	BootULCI
OC→EK	.601	.063	.000	.471	.717
EK→PI	.551	.067	.000	.406	.674
Indirect effects	Effect	BootSE	*p*	BootLLCI	BootULCI
OC→EK→PI	.331	.066	.000	.203	.461

Tacit Knowledge								
	$\chi^2(df)$	GFI	RMSEA	AGFI	NFI	TLI	CFI	χ^2/df
Model 1	119.483 (86)	.903	.051	.865	.937	.977	.981	1.389
Model 2	131.236(87)	.898	.058	.860	.930	.970	.975	1.508
Model 3	253.134(88)	.846	.111	.791	.865	.889	.907	2.877

Standardized coefficients and (*t*-values)			
	Model 1	Model 2	Model 3
OC→PI	.417(3.09)**		.733(15.60)***
OC→TK	.798(19.95)***	.817(22.08)***	
TK→PI	.393(3.05)**	.750(16.30)***	

BC percentile method - direct and indirect effects					
Direct effects	Effect	BootSE	*p*	BootLLCI	BootULCI
OC→TK	.815	.035	.000	.729	.875
TK→PI	.752	.050	.000	.841	.843
Indirect effects	Effect	BootSE	*p*	BootLLCI	BootULCI
OC→TK→PI	.613	.056	.000	.492	.715

*p<.05, **p<.01, ***p<.001

Table 3. Moderation effects, paths and R^2 coefficients

Moderator: Tacit Knowledge								
Multiple group CFA								
	χ2(df)	*χ2/df*	*Δχ²(Δdf)*	CFI	RMSEA	*p*-value	Invariant	
Baseline (no constraints)	257.133(172)	1.495		.922	.057			
Factor loading invariance	270.188(177)	1.526	13.055(5)	.914	.059	.023	No	
Multiple Group SEM Models								Moderation
	χ2(df)		*Path invariance*			*p*-value	Invariant	
Const OC→EK	260.118(173)		259.843			<.10	No	Yes
Const OC→PI	260.459(173)		259.843			<.10	No	Yes
Const EK→PI	258.574(173)		259.843			*n.s*	Yes	No
	Low	High		Low	High			
Relationships	*β*			*R^2*			*Mod. Confidence*	
OC→EK	.477	.476		.233	.234		.90	
OC→PI	.324	.322		.192	.308		.90	
Moderator: Explicit Knowledge								
Multiple group CFA								
	χ2(df)	*χ2/df*	*Δχ²(Δdf)*	CFI	RMSEA	*p*-value	Invariant	
Baseline (no constraints)	261.957(172)	1.523		.944	.059			
Factor loading invariance	283.429(177)	1.601	21.472(5)	.933	.063	.001	No	
Multiple Group SEM Models								Moderation
	χ2(df)		*Path invariance*			*p*-value	Invariant	
Const OC→TK	265.252(173)		264.667			<.10	No	Yes
Const TK→PI	265.779(173)		265.767			<.051	No	Yes
Const OC→PI	264,849(173)		264.667			<.011	No	Yes
	Low	High	Low	High				
Relationships	*β*		*R^2*				*Mod. Confidence*	
OC→TK	.823	.691	.680	.481			.90	
TK →PI	.307	.353	.525	.521			.95	
OC→PI	.393	.604	.388	.479			.90	

p<.1* (.90 confidence), *p*<.05** (.95 confidence), *p*<.01*** (.99 confidence)

Figure 1. Structural model.

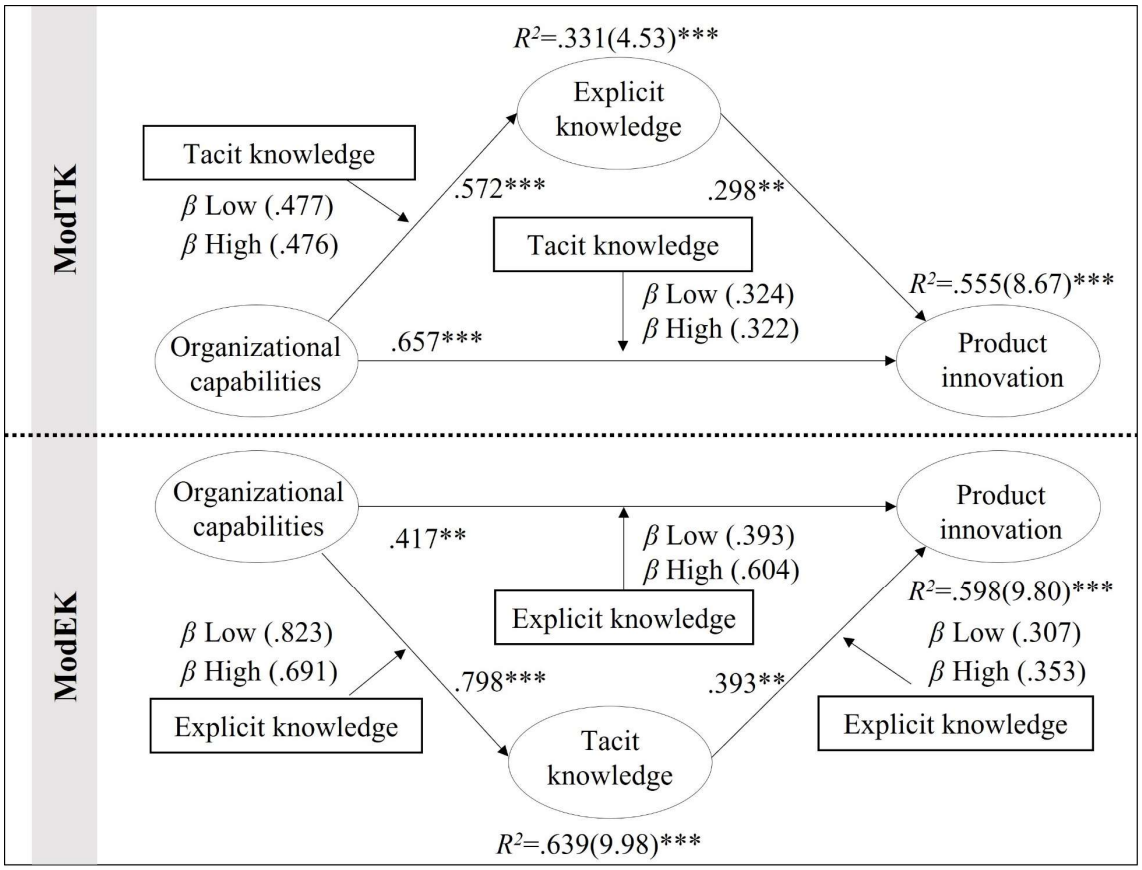
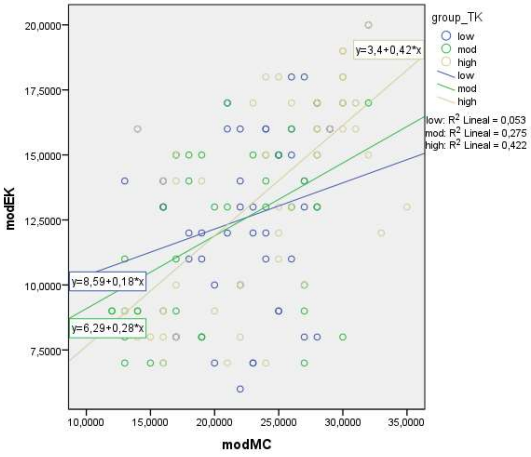
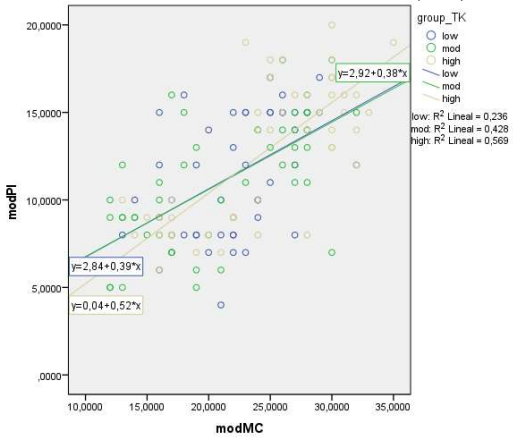


Figure 2. Graph of regression effects on different levels of tacit and explicit knowledge.

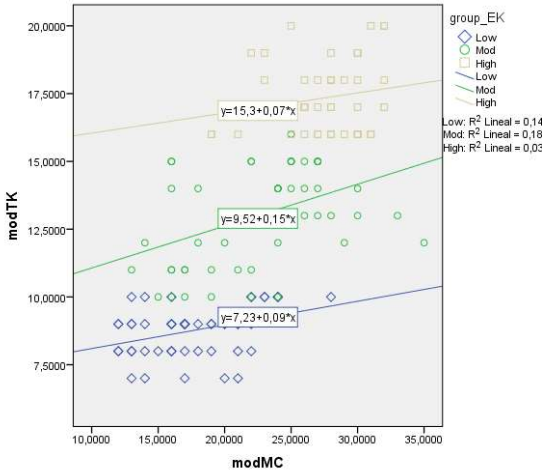
Organizational capabilities vs Explicit knowledge – TK moderator (2.1)



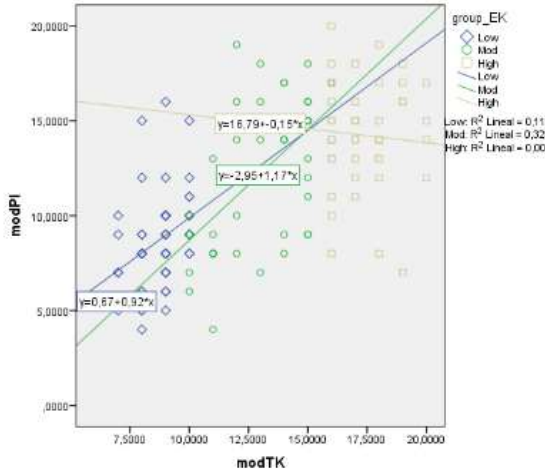
Organizational capabilities vs Product innovation – TK moderator (2.2)



Organizational capabilities vs Tacit knowledge – EK moderator (2.3)



Tacit knowledge vs Product Innovation – EK moderator (2.4)



Organizational capabilities vs Product innovation – EK moderator (2.5)