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Abandonment of core knowledge areas and innovation performance

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ABSTRACT

Within a constantly evolving technological environment, it is imperative for innovative organizations to be able to successfully respond and adapt to environmental changes. To achieve this, they must have the ability to efficiently and timely modify their innovation resources by divesting and reorganizing them, even if these are their core ones. Although divestiture of core innovation resources is an important managerial phenomenon, the literature is rather silent on this issue. To address this significant gap, this study examines how the abandonment of core knowledge areas is related to innovation performance and how this relationship is moderated by absorptive capacity. Two hypotheses are developed about these research questions and tested on a sample of firms from the pharmaceutical, biotechnology, and chemical industries. Findings suggest that the abandonment of core knowledge areas is a negative predictor of innovation performance; however, when the abandonment interacts with absorptive capacity the effect becomes positive.

1. Introduction

Divestiture is an integral part of the organizational becoming and of similar significance with growth strategies for organizations' survival and success (Kim et al., 2021). Although research on divestiture has attracted considerable attention (Brauer, 2006; Kaul et al., 2018), the issue that explores the linkages of divestiture with innovation is less studied (Lee and Roh, 2020; Tsinopoulos et al., 2019). Whether driven by continuous technological change or failures in the innovation process, divestiture of the resources used in the innovation process (i.e., innovation resources) is a common procedure of paramount importance for all innovative firms. However, relevant literature does not offer a deep understanding of the several aspects of this phenomenon and neither provides adequate managerial implications based on empirical evidence (Berry, 2010; Khanna et al., 2016; Leoncini, 2016; Peruffo et al., 2014).

For organizations, the only viable option to cope with the radical change and adapt to the uncertain technological environment is to develop the ability to efficiently and timely update their innovation resources (Katila, 2002; Kim et al., 2021; Sørensen and Stuart, 2000; Zheng and Huang, 2022). This is true even if these innovation resources are the core innovation resources. In particular, firms whose R&D activities take place in certain technological domains for several consecutive years inevitably will have to abandon some of them at a point in time to achieve a better fit with their environment (Berry, 2010; Peruffo et al., 2014).

Despite the fact that the divestiture of core innovation resources and abandonment of core knowledge areas concern all firms that are systematically engaged in R&D activities, the extant literature does not offer any insights on the causes or the effects of the divestiture of core innovation resources. Focusing on the effects, this paper addresses this research gap by examining theoretically and empirically how the abandonment of core knowledge areas (i.e., technological domains in which a firm performs R&D activities for

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several consecutive years) is related to innovation performance. In addition, by considering the divestiture of core innovation resources as an organizational capacity to purposefully modify firm's resources (Moliterno and Wiersema, 2007), it would be of great interest to examine whether this capacity is enhanced or weakened by one of the most important organizational capacities, that is, the absorptive capacity (i.e., a firm's ability to identify, assimilate, and exploit external knowledge). To this end, this study explores whether the relationship between the abandonment of core knowledge areas and innovation performance can be moderated by absorptive capacity, a research question that has not been explored in prior literature.

In addition to the potential theoretical interest, these research examinations could also be useful for management practitioners. To a greater or lesser extent, every innovative firm deals with the renewal of its core innovation resources, and, thus, a deeper understanding of this phenomenon and any empirical insights concerning its potential effects on firm performance could be very helpful for the management decision-making process (Lanza et al., 2016; Tsinopoulos et al., 2019).

These research issues are examined in the context of the biotechnology, pharmaceutical, and chemical industries, using longitudinal, secondary data from the Derwent Innovation Index (patent data) and the EU Industrial R&D Investment Scoreboard (economic data). Concerning the findings of the present study, the results of the empirical analyses indicate that the abandonment of core knowledge areas is a negative predictor of innovation performance. However, this effect can turn positive if the abandonment is combined with an increased capacity to absorb external knowledge developments.

The remainder of the paper is structured as follows. The next section presents the theoretical background of this study, while in the third section the two hypotheses are developed. The fourth section describes the data, the variables, and the statistical analysis. The fifth section presents the results of the regression analyses, and finally, in the last section, a discussion of the theoretical and managerial implications, limitations, and directions for future research follows.

2. Theoretical background

Embedded within a constantly changing and uncertain environment, organizations have no option but to respond and adapt to environmental changes, or else their survival chances are greatly reduced (Katila, 2002; Sørensen and Stuart, 2000). Technological change and environmental turbulences demand organizational changes and, consequently, divestiture activities (Brauer, 2006; Tangpong et al., 2015). Divestiture activities can be regarded as manifestations of the organization-environment fit, and in particular as organizations' adjustments and responses to new opportunities, failures, challenges, and threats, incorporated in a broader strategy to increase competitiveness (Berry, 2010; Hopkins, 1991; Peruffo et al., 2014). Inevitably, knowledge becomes obsolete, better opportunities for firm resources arise, firm performance can decline, and therefore strategic refocus through divestiture activities is a major issue concerning all firms (Berry, 2010; Brauer, 2006; Hitt et al., 1996).

Literature on divestiture has long recognized the importance of divesting and has emphasized its positive effects on firm performance (Kim et al., 2021; Lanza et al., 2016; Lee and Madhavan, 2010; Lee and Roh, 2020; Moliterno and Wiersema, 2007; Sirmon et al., 2007). Due to the finiteness of their resources, firms must often make decisions about which resources to divest in order to focus on higher-value resources (Sirmon et al., 2007). This reorientation of resources through divestment could provide important benefits to firms, such as cost reduction (Festel, 2014; Kim et al., 2021; Zheng and Huang, 2022), allocation of capital resources to more profitable businesses (Brauer, 2006; Kim et al., 2021), risk reduction (Festel, 2014), organizational inertia restriction (Kim et al., 2021), and increased vigilance concerning new external opportunities or internal threats (Peruffo et al., 2014; Zheng and Huang, 2022), which, in turn can improve corporate efficiency and create competitive advantages (Brauer, 2006; Moliterno and Wiersema, 2007).

Focusing on the divestiture of innovation resources (i.e., all kinds of resources used in the innovation process), a number of researchers have approached this phenomenon as an indication of failure, arguing that failure is an integral element of the innovation process that can positively affect innovation performance (Khanna et al., 2016; Leoncini, 2016; Tsinopoulos et al., 2019). In particular, the organizational response to failure stemming from abandoned innovation activities could lead to new search activities, technological trajectories, and approaches to technological problems, increasing the firm's tolerance to failure and its tendency to trial-and-error procedures and experimentations (Kim et al., 2021; Khanna et al., 2016; Leoncini, 2016; Tsinopoulos et al., 2019; Zheng and Huang, 2022). However, an interesting question would be whether these positive aspects of the divestiture of innovation resources can still emerge when the divestiture concerns core innovation resources.

To examine this research question, I view divestiture as a firm's capability to reconfigure its resources by strategically dispositioning assets from its resource portfolio, in an effort to develop competitive advantages (Moliterno and Wiersema, 2007; Procher and Engel, 2018; Sirmon et al., 2007). In particular, by considering the abandonment of core knowledge areas as an activity of divestiture of part of a firm's prior basic innovation resources, this paper endeavors to explore the effect of this activity on innovation performance and, additionally, to investigate the moderating effect of absorptive capacity on this relationship.

By divesting core innovation resources, a firm actually abandons portion of its core competencies and capabilities. Core competencies refer to the most important firm assets and resources, upon which potentially idiosyncratic strategic growth alternatives are developed (Holahan et al., 2014; Lei et al., 1996; Nicolai and Dautwiz, 2010; Onufrey and Bergek, 2021; Vanhaverbeke et al., 2012). For some scholars, organizational knowledge is what constitutes core competencies, viewing them as a collection of knowledge sets capable of providing competitive advantages (Leonard-Barton, 1992; Scarbrough, 1998). Organizational knowledge stemming from the long-lasting innovation activities in specific knowledge areas can be considered as one of the most important core competencies that a firm can develop and the basis for sustainable competitive advantage. Therefore, the abandonment of the innovation activities from knowledge areas in which a firm has spent significant time and effort can be considered as a divestiture of its core competencies.

Either way, core competencies are not static in nature but dynamic (Lei et al., 1996). As markets change, core competencies are

constantly challenged (Walsh et al., 2005). Divesting core competencies and refocusing on new ones (or intensifying existing ones) are key determinants of firm survival, growth, and performance as strategic responses to rapid environmental changes (Hitt et al., 1996; Seddighi and Mathew, 2020). And even though, as mentioned above, there are some positive aspects of divestiture, the loss (or the non-use) of important organizational knowledge, as the knowledge developed from the long-lasting engagement of a firm in specific technological domains for R&D purposes, could be detrimental and harmful for its competitiveness and performance (Holan and Phillips, 2004; Sirmon et al., 2007).

3. Hypotheses

3.1. Divestiture of core innovation resources and innovation performance

By abandoning knowledge areas within which a series of inventions have been developed in the previous years, a firm inevitably discards critical core competencies and capabilities. And although the firm may transfer its R&D endeavors to other knowledge areas that might appear more promising, the short-term impact of this abandonment on innovation performance is expected to be negative. Knowledge resources from technological domains within which a firm systematically produces new knowledge are valuable and idiosyncratic resources, capable of creating important competitive advantages (Kim et al., 2016; Lei et al., 1996). Divesting this kind of resources will probably lead to the loss of active competitive advantages by weakening the firm's capability to develop successful innovations in the near future (Sirmon et al., 2007).

Divesting core innovation resources and reallocating them to new technological domains opens up new opportunities, but, on the other hand, it leads to significant organizational change (Moliterno and Wiersema, 2007). Most importantly, R&D is a strongly path-dependent process and, as such, replacing R&D activities in knowledge areas within which significant effort has been made with R&D activities in new areas is a challenging and difficult task, entailing intense complexity, uncertainty, and ambiguity (Kim et al., 2021; Moliterno and Wiersema, 2007; Sirmon et al., 2007). Consequently, R&D dysfunction caused by the divestiture of core knowledge resources may result in a reduction of innovation output (Kim et al., 2021).

The existing relevant literature does not provide empirical evidence on the effect of the abandonment of core knowledge areas on innovation performance. However, there are studies that address relevant research questions. For example, Khanna et al. (Khanna et al., 2016) examined how R&D failures, measured as the voluntary discontinuation of patents, can influence R&D performance. Their findings suggested that an increase in failures in R&D leads to an increase in the quality of R&D (patent citations) but to a decline in R&D output (number of patents). Nevertheless, compared to this study, abandoning core technological domains could have fundamental differences from abandoning any other technological domain.

Consequently, based on the above rationale, it is anticipated that discarding core knowledge areas will harm important competitive advantages, even if this divestiture could entail the transfer of resources to more promising technological domains. Thus, the following hypothesis is proposed:

Hypothesis 1. The effect of the abandonment of core knowledge areas on innovation performance will be negative.

3.2. The role of absorptive capacity

Nonetheless, it is expected that the effect of the abandonment of core knowledge areas on innovation performance would be reversed if this effect is moderated by the firm's absorptive capacity. Absorptive capacity, that is, the ability of a firm to recognize, understand, and assimilate potentially valuable external knowledge and to create new knowledge and commercial outputs by using the assimilated knowledge, plays an important role in the firm's ability to develop successful innovations (Cohen and Levinthal, 1990; Lichtenthaler and Lichtenthaler, 2009; Naqshbandi and Jasimuddin, 2022; Petti et al., 2019; Wang and Guo, 2020). When the discarding of core knowledge areas is accompanied by an increased capacity to recognize, understand, and assimilate external knowledge, then it is reasonable to anticipate that these major reallocations of R&D resources could lead to higher innovation performance.

In particular, in a rapidly changing context, a firm must consistently scan its external environment to detect and evaluate new technological trends and potential promising technological advances that could update or replace its current technologies (Grimpe and Kaiser, 2010; Holan and Phillips, 2004; Sirmon et al., 2007). Although existing core technologies used by a firm might have been successful, this does not mean that they will continue to be without being open to new external knowledge (Lai et al., 2020). Divestiture of core innovation resources gives an opportunity to evaluate current internal technological resources and juxtapose them with external technological trends. Absorptive capacity facilitates the firm's divesting decisions and resource rearrangements by providing better monitoring, understanding, and use of external knowledge developments (Kim et al., 2021). Therefore, absorptive capacity may be capable of altering the effect of the abandonment of core knowledge areas and causing a positive impact on innovation performance.

Prior literature has emphasized that important technological innovations developed by rivals could lead a firm to significant resource rearrangements, such as acquisitions and divestments, as a response to the new technological advances (Kaul, 2012; Sirmon et al., 2007). However, to successfully respond and benefit from rivals' technological achievements, a firm must have the ability to recognize, assess, and assimilate the new knowledge. In other words, it must have developed increased absorptive capacity to be able to divest from the proper core knowledge areas and to effectively invest in other technological trends (Leoncini, 2016).

Divestiture can be characterized as a proactive strategic tool to respond to opportunities arising from the external environment (Peruffo et al., 2014). Absorptive capacity is probably the most important factor in a firm's effort to identify and manage promising

external opportunities (Kim et al., 2016; Lichtenthaler and Lichtenthaler, 2009). Higher absorptive capacity can lower the uncertainty, misunderstanding, and confusion that inevitably emerges when dealing with new technological opportunities. During the phase of reallocation of resources from core knowledge areas to new ones, absorptive capacity significantly facilitates the detection of the most suitable (for the firm) opportunities and the effective utilization of the new technologies.

Related to this rationale, Tsinopoulos et al. (Tsinopoulos et al., 2019) emphasized that the organizations' openness to external knowledge sources can moderate the relationship between the experience of abandoning an innovation activity and innovation performance. According to these authors, openness expands the scope of learning and contributes, on the one hand, to the understanding of the errors that led to the abandoning of innovation activities and, on the other hand, to the identification of new opportunities. In the same vein, during a major reallocation of knowledge resources, absorptive capacity can help firms reshape the direction of their R&D portfolio and open new innovative avenues by absorbing more knowledge from the external environment, in a deeper way (Khanna et al., 2016; Leoncini, 2016).

Therefore, all the above-mentioned theoretical arguments lead to the following hypothesis:

Hypothesis 2. The effect of the abandonment of core knowledge areas on innovation performance will be positively moderated by absorptive capacity.

4. Methodology

4.1. Research setting and sample

Pharmaceutical, biotechnology, and chemical industries were used as the research setting of this study. These industries are characterized by intense R&D activity and technological competition that lead to a rapid pace of technological change, which in turn increases the likelihood of divestiture, as industries' innovations become obsolete relatively quickly (Brauer, 2006; Khanna et al., 2016; Kim et al., 2021). Additionally, these industries provide a relatively strong appropriability regime that motivates firms to use the patent system to effectively protect their proprietary intellectual property, making patents a reliable indicator of firms' innovation output (Cozzolino and Rothaermel, 2018; Sørensen and Stuart, 2000; Vanhaverbeke et al., 2012).

The present paper drew on the EU Industrial R&D Investment Scoreboard (Scoreboard) and Derwent Innovation Index Database (DII), which provide economic data of the top R&D investors and patent data, respectively (Alencar et al., 2007; Filippetti and Archibugi, 2011; Gittelman and Kogut, 2003; Lettl et al., 2009); Moncada-Paternò-Castell et al., 2010; (Wang et al., 2020); (Wiesenthal et al., 2012). Data were collected for 139 firms (29 biotechnology, 46 pharmaceutical, and 64 chemical firms) that were present every year in the Scoreboard (i.e., balanced panel) for the period from 2003 to 2008. Extra data about their patenting activity were obtained from the DII.

5. Variables

5.1. Dependent variable

To compute innovation performance, I employed forward patent citations (i.e., patent citations received by a firm's patents), relying on the assumption that the increased usefulness and impact of patents can be considered as a manifestation of higher innovation performance (Onal Vural et al., 2013; Papazoglou and Spanos, 2021; Su and Moaniba, 2023; Taques et al., 2021). In addition to the quantitative dimension of R&D output, patent citations offer an indication of the quality of patented inventions (Magelssen, 2019; Rothaermel and Alexandre, 2009; Rothaermel and Hess, 2007; Yayavaram and Chen, 2015). There is ample evidence in innovation literature concerning the correlation between the importance of inventions and the number of patent citations received by the patents that protect these inventions, establishing the use of patent citations as a valid proxy for innovation performance (Hagedoorn and Cloodt, 2003; Khanna et al., 2016). More specifically, *Innovation Performance* was measured as the total number of citations a firm's patents filed in year t ($2003 \leq t \leq 2008$) received by the end of 2011.

5.2. Independent variable

5.2.1. Abandonment of core knowledge areas

To compute the extent to which a firm abandons core knowledge areas in a given year, I used the international patent classes (IPCs), that is, the technological domains to which the patent examiner assigns each patent. More specifically, a firm is considered to abandon a core knowledge area when it does not apply for a patent in an IPC in which it had applied for in the previous four consecutive years, based on the assumption that a technological domain in which a firm was active for the last four consecutive years is considered as a core knowledge area (Vanhaverbeke et al., 2012). Therefore, for each firm-year observation, I measured *Abandonment of Core Knowledge Areas* as the percentage of the number of IPCs in which a firm had applied for a patent in the previous four consecutive years but not in the current year to the total number of core knowledge areas. As a robustness test, I computed this variable based on five consecutive years, instead of four.

Table 1
Descriptive statistics and correlations.

Variable	Mean	Std dev	Min	Max	1	2	3	4	5	6	7	8	9	10
1. Innovation Performance	172.67	408.83	0	6427	1.00									
2. Abandonment of Core Knowledge Areas	6.48	11.96	0	100	-0.07	1.00								
3. Absorptive Capacity	610.03	1322.25	0	17,017	0.82	-0.09	1.00							
*4. Firm Size**	8.40	1.89	2.71	11.71	0.40	-0.10	0.45	1.00						
*5. R&D Expenditure**	4.73	1.54	1.75	8.75	0.45	-0.08	0.46	0.76	1.00					
*6. Firm Profitability**	12.35	0.58	0.02	14.16	0.18	-0.04	0.27	0.38	0.45	1.00				
*7. Knowledge Stock**	5.52	1.80	0	9.10	0.42	-0.05	0.43	0.72	0.59	0.26	1.00			
8. Number of IPCs	2.79	0.96	0	11	-0.03	-0.10	-0.04	-0.20	-0.01	-0.01	-0.21	1.00		
*9. Designated States**	4.10	1.07	0	4.86	-0.12	0.06	-0.08	-0.18	0.04	0.06	-0.54	0.34	1.00	
10. Patent Family Size	5.49	3.00	0	19	0.12	-0.06	0.08	-0.09	0.13	0.09	-0.32	0.51	0.59	1

*Variables are logged.

5.3. Moderating variable

5.3.1. Absorptive capacity

Two of the most common measures of absorptive capacity are R&D expenditure and patent data (Ebers and Maurer, 2014; Patterson and Ambrosini, 2015). The present study used the number of backward patent citations made to external patents (i.e., patents not owned by a given firm) to measure firms' absorptive capacity (Appio et al., 2019; Hu and Mathews, 2008; Zahra and George, 2002). External backward patent citations can be regarded as evidence that a firm recognized and assimilated external knowledge elements, which were incorporated in the cited patents, and it applied them to its internal stock of knowledge, resulting in the patented inventions that include those backward citations (Crescenzi and Gagliardi, 2018; Su and Lin, 2018). More specifically, for each firm-year observation, *Absorptive Capacity* was computed as the number of all backward citations that the firm's patents made to prior patents, excluding all self-citations (i.e., only external knowledge).

5.4. Control variables

To reduce any potential omitted variable bias, a number of control variables were included in the empirical models. In particular, I controlled for *Firm Size* (i.e., the log of the number of employees) (Argyres and Silverman, 2004; Lahiri and Narayanan, 2013), *R&D Expenditure* (i.e., the log of R&D Expenditure) (Katila, 2002; Rothaermel and Alexandre, 2009), *Firm Profitability* (i.e., the log of operating profit) (Ahuja and Morris Lampert, 2001; Yayavaram and Ahuja, 2008). In addition, I accounted for *Knowledge Stock* (i.e., the log of the number of patents a firm had applied for in the previous five years) (Petruzzelli et al., 2012; Quintana-García and Benavides-Velasco, 2008), *Number of IPCs*, (i.e., the average number of the distinct IPCs per patent) (George et al., 2008; Petruzzelli et al., 2018), and *Designated States* (i.e., the log of the average number of states the patent has designated as territories in which to take effect) (Harhoff and Reitzig, 2004). Furthermore, because DII builds its patent data based on the full patent family and not on single patents (i.e., all the patents related to the same invention are incorporated in one patent family), I controlled for *Patent Family Size* (i.e., the average number of patents of each patent family) to remove the bias caused by counting the same invention multiple times (Gittelman and Kogut, 2003; Lettl et al., 2009). Finally, I included country (Lahiri and Narayanan, 2013; Yayavaram and Ahuja, 2008), industry (Leone and Reichstein, 2012; Nemet and Johnson, 2012), and year dummies (Mayer et al., 2015; Petruzzelli et al., 2018).

Table 2
Fixed-effects negative binomial regressions of *Abandonment of Core Knowledge Areas* on *Innovation Performance*.

	Model 1	Model 2	Model 3	Model 4
Abandonment of Core Knowledge Areas	-0.079**	-0.089**	-0.121***	-0.137****
	(0.027)	(0.029)	(0.033)	(0.034)
Abandonment of Core Knowledge Areas × *Absorptive Capacity*		0.028*	0.023*	0.028**
		(0.012)	(0.010)	(0.009)
Absorptive Capacity		0.139****	0.101****	0.111****
		(0.021)	(0.018)	(0.018)
Firm Size			0.206+	0.162
			(0.125)	(0.126)
R&D Expenditure			0.019	0.046
			(0.105)	(0.106)
Firm Profitability			0.006	0.006
			(0.006)	(0.006)
Knowledge Stock			0.466***	0.450**
			(0.133)	(0.137)
Number of IPCs			-0.027	-0.024
			(0.047)	(0.047)
Designated States			-0.040	-0.041
			(0.068)	(0.068)
Patent Family Size			0.161***	0.156***
			(0.044)	(0.044)
Year Dummies Included				
Countries Dummies Included				
Industry Dummies Included				
_cons	-0.535**	-0.451*	-0.100	-0.099
	(0.185)	(0.186)	(0.203)	(0.205)
Log likelihood	3012.64	3358.14	3731.43	3744.50
N	754	754	732	716

Standard errors in parentheses
+ p<0.10,
* p<0.05,
** p<0.01,
*** p<0.001,
**** p<0.0001

5.5. Statistical analysis

As the dependent variable (i.e., forward patent citations) is a non-negative integer count variable, I employed a time-series, cross-sectional negative binomial model, which is the appropriate model for this kind of variable, capable of correcting for over-dispersion in the data (Capaldo et al., 2017; Dai et al., 2018; McFadyen et al., 2009; Onal Vural et al., 2013); (Petruzzelli et al., 2018); (Wang et al., 2020); (Zhao et al., 2022). A fixed-effects specification was used to account for the unobserved, time-invariant explanatory variables that may affect the response variable (Kelley et al., 2013). Finally, all independent variables were standardized in order for their estimated coefficients to be comparable (Carnabuci et al., 2015; Operti and Carnabuci, 2014; Rothaermel and Hess, 2007).

6. Results

Table 1 shows the descriptive statistics and correlation matrix for all variables used in the study. A variance inflation factor (VIF) analysis was conducted to examine whether there exists a multicollinearity problem. The VIF values, which were ranged from 1.05 to 3.85, do not indicate a multicollinearity issue (Vasudeva and Anand, 2011).

Table 2 presents the results of the fixed-effects negative binomial regressions of the *Abandonment of Core Knowledge Areas* on *Innovation Performance*. Model 1 is the baseline model, in which only the independent variable is included. In Model 2, the variables *Absorptive Capacity* and its interaction with the *Abandonment of Core Knowledge Areas* are added. Finally, in Model 3, all the control variables are added to the regression model. It is important to note that in all models, year, country, and industry dummies are included. The reported coefficients are the standardized beta coefficients while the numbers in parentheses are the standard errors.

Hypothesis 1. predicted that the effect of discarding core knowledge areas on innovation performance would be negative. As Table 2 shows, the coefficients of *Abandonment of Core Knowledge Areas* are negative and significant in all three models ($b = -0.079$, $p < 0.01$ in Model 1; $b = -0.089$, $p < 0.01$ in Model 2; $b = -0.121$, $p < 0.001$ in Model 3). These findings indicate that the more a firm abandons its core knowledge areas in a given year, the more its innovation performance declines in this particular year, providing support for Hypothesis 1.

Hypothesis 2. suggested that absorptive capacity exerts a positive moderating effect on the relationship between the abandonment of core knowledge areas and innovation performance. Apart from the direct, positive, and statistically significant effect of *Absorptive Capacity* on *Innovation Performance* ($b = 0.139$, $p < 0.0001$ in Model 2; $b = 0.101$, $p < 0.0001$ in Model 3), Table 2 also shows that the coefficients of the interaction between *Abandonment of Core Knowledge Areas* and *Absorptive Capacity* are positive and statistically significant in models 2 and 3 ($b = 0.028$, $p < 0.05$ in Model 2; $b = 0.023$, $p < 0.05$ in Model 3). To better understand the interaction effect, Fig. 1 depicts how the impact of *Abandonment of Core Knowledge Areas* on *Innovation Performance* changes at different levels of *Absorptive Capacity*. It is evident that at lower levels of *Absorptive Capacity* (e.g., mean and one standard deviation above the mean), the effect of *Abandonment of Core Knowledge Areas* on *Innovation Performance* remains negative, whereas at higher levels (e.g., four and six standard deviations above the mean), the same effect turns positive. Consequently, findings support the prediction that when the divestiture of core innovation resources is combined with strong absorptive capacity, the effect on innovation performance is reversed

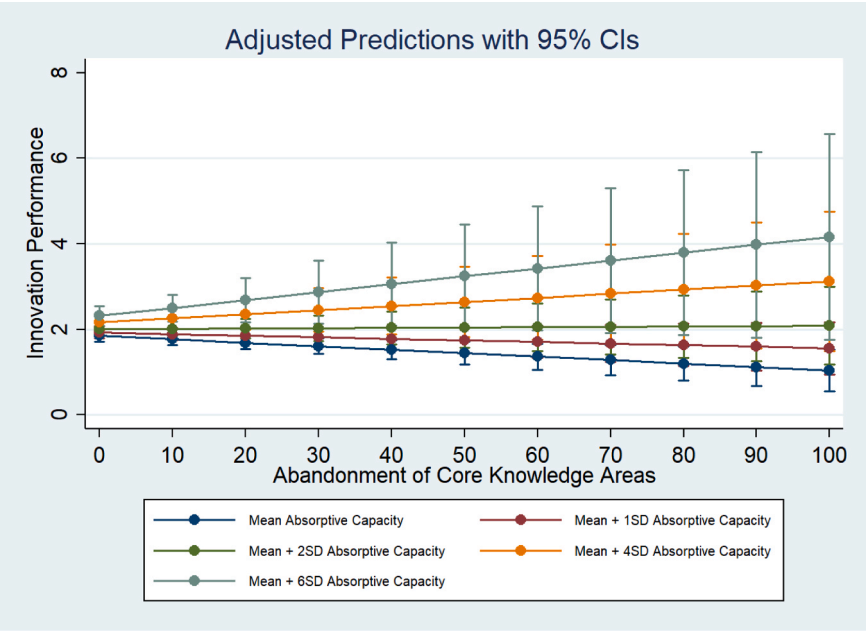

Fig. 1. Adjusted predictions of *Abandonment of Core Knowledge Areas* at different levels of absorptive capacity.

and becomes positive.

As mentioned earlier, a robustness test was conducted to assess the sensitivity of our results to alternative measures of the independent variable. More specifically, the empirical model was re-estimated using the independent variable (*Abandonment of Core Knowledge Areas*), computed as the number of IPCs in which a firm had applied for a patent in the previous five consecutive years but not in the current year (instead of four). The results of this regression analysis are presented in Model 4. In support of the previous findings, the coefficients and p-values of the independent and moderating variables remain substantively unchanged.

7. Discussion

Organizations function within a constantly evolving environment that demands permanent alert and efficient ability to adapt. Within this fluid context, organizations inevitably need to change and update the technological domains within which their R&D activities take place, even if these technological domains are their core ones. Despite its importance, one can argue that the divestiture of core innovation resources and its effect on the firm is a rather unexplored phenomenon, even though there are some studies that focus on how the abandoning of non-core innovation activities is related to firm performance (Kim et al., 2021; Lanza et al., 2016; Sirmon et al., 2007; Tsinopoulos et al., 2019).

Exploring this particular topic, this study investigated theoretically and empirically the relationship between the abandonment of core knowledge areas and innovation performance and, additionally, it examined the moderating effect of absorptive capacity on this relationship. These research questions were tested on secondary, longitudinal, economic and patent data from the pharmaceutical, biotechnology, and chemical industries.

As suggested by the findings, divesting core innovation resources exerts a negative effect on innovation performance, while the direct effect of absorptive capacity on innovation performance is positive. However, when divesting interacts with increased absorptive capacity the effect becomes positive, meaning that at higher levels of absorptive capacity, the abandonment of core knowledge areas exerts a positive influence on innovation performance. Attempting to examine what these findings could imply, we present below some potential implications for theory and managers.

7.1. Theoretical implications

This study contributes to a deeper understanding of the relationship between divestiture of knowledge assets and innovation performance, focusing in particular on the abandonment of core knowledge areas. Although there are some studies that explore how the abandoned innovation activities are related to R&D output (Khanna et al., 2016; Kim et al., 2021), there is no prior research on the examination of the impact of divestiture of core innovation resources on innovation performance.

Our empirical findings suggest that the discarding of core knowledge areas exerts a negative effect on innovation performance. It appears that divesting core innovation resources harms active and productive R&D activities, whose outcome cannot be adequately replaced by the possible rearrangement of R&D activities and the transfer of research effort to more promising technological domains. R&D path dependence seems to be too strong not to create dysfunctions in the R&D process when significant changes take place, such as the reallocation of resources from core knowledge areas to others.

Additionally, this paper examined how absorptive capacity moderates the relationship between the abandonment of core knowledge areas and innovation performance, a research question that has not yet been addressed in the literature. As the results indicate, absorptive capacity can alter the effect of divestiture of core innovation resources by causing a positive impact on innovation performance. These findings suggest that important organizational changes concerning knowledge processes must be accompanied by a broad, deep, open, and up-to-date knowledge base that would lead the firm to the appropriate divesting and investing decisions about its innovation activities (Kim et al., 2021).

7.2. Managerial implications

Responding to rapid technological changes, managers should continuously assess firm knowledge resources and be prepared to change firm technological capabilities to fit new and dynamic environments (Carnes et al., 2021; Kim et al., 2021; Sirmon et al., 2007). To achieve this, divestiture of knowledge assets is considered a normal and inevitable procedure. However, as the results indicate, they must be very cautious in divesting core innovation resources (Holan and Phillips, 2004).

Decision-making on divestiture activities should always take into consideration the firm's capability to efficiently rearrange its resources and satisfactorily transfer them to more promising knowledge areas. And this capability originates from its absorptive capacity, which seems capable of causing a positive effect of divestiture of core innovation resources on innovation performance. Consequently, this study's findings suggest that to successfully abandon core knowledge areas, managers should aim at developing stronger absorptive capacity by encouraging the openness of R&D activities to the changing technological environment and striving to create new inventions taking into consideration the externally developed knowledge (Kim et al., 2021; Tsinopoulos et al., 2019).

7.3. Limitations and direction for future research

Several limitations of this research should be noted. The major limitation of the present study is that it did not examine the long-term impact of the divestiture of core innovation resources but only the short-term. This kind of organizational change, which involves

important resource reallocation, often requires a considerable period of time to be completed and reveal its effect on innovation performance. Another limitation stems from the use of patents and patent citations to detect core innovation areas and measure innovation performance, respectively, since not all innovations are patentable. Additionally, in some cases, patent citations do not indicate higher R&D quality, as firms often develop “patent fences” around their important patents to prevent rivals from inventing around and drawing upon their protected knowledge (Capaldo et al., 2017); (Kim et al., 2016); (Papazoglou and Spanos, 2021); (Rudy and Black, 2018). Moreover, although the oldness of our data does not make our argument less valid (i.e., R&D and patent data obtained for the period from 2003 to 2008), several technological, economic, and social changes have occurred since that period that could have an effect on our findings. A final limitation of this study is that absorptive capacity was measured using backward citations to external patents and, thus, this measure cannot capture the capacity of a firm to absorb unpatented external knowledge and innovations.

This work concludes by offering some promising suggestions for future research. First, as already mentioned, future studies could investigate the medium and long-term impact of abandoning core knowledge areas on innovation performance (Tsinopoulos et al., 2019). Second, future research efforts could focus on the moderating role of other firm-level factors such as technological collaboration, scientific intensity, exploration-exploitation, and so forth. Third, it would be interesting to explore whether the findings will be the same if we focus on the divestiture of non-core knowledge areas instead of core ones. Finally, it would also be interesting to explore whether the findings of the present study may be generalizable to different industries, time periods, and research contexts.

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