

# Unveiling the relationships among intellectual property strategies, protection mechanisms and outbound open innovation

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Many articles in the open innovation literature studied the link between intellectual property protection mechanisms and openness, obtaining contrasting results. This paper bridges the literature on protection mechanisms and the one on intellectual property strategy. It leverages three high-level intellectual property strategies—defensive, collaborative and impromptu—recently defined in the literature to identify how they entail different intellectual property protection mechanisms and approaches to outbound open innovation. The article advances that defensive, collaborative and impromptu are characterizing factors of intellectual property strategies. An exploratory analysis of 73 manufacturing firms allowed identifying five intellectual property strategies: defensive, purposely defensive, collaborative, developing impromptu and impromptu. The article describes their differences in intellectual property protection mechanisms and outbound open innovation. Furthermore, a fuzzy-set qualitative comparative analysis identifies the optimal combination of formal, semiformal and informal intellectual property protection mechanisms to nurture outbound open innovation. The results are discussed in view of the extant literature, and implications for scholars and practitioners are presented.

## KEYWORDS

appropriability, intellectual property protection mechanisms, intellectual property strategy, outbound open innovation

## 1 | INTRODUCTION

Inter-organizational information and knowledge sharing increasingly shapes the innovation process. To describe this phenomenon, Chesbrough (2006) defined open innovation (OI) as 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation'. While openness greatly benefits firms, it also increases their risk of being imitated by their partners and losing their competitive edge (Veer et al., 2016). In

this context, intellectual property protection mechanisms (IPPMs) are essential to balance the need to protect innovations and the opportunity to share knowledge (Bogers, 2011; Gretsche et al., 2020; Hagedoorn & Zobel, 2015; Veer et al., 2016; Wikhamn, 2013). Indeed, firms can use IPPMs both to protect their novel products while maintaining an open approach (Alexy et al., 2009; Fisher & Oberholzer-Gee, 2013) and to exclude competitors from the market.

The role of IPPMs as enhancers or disablers of OI has been largely debated (Alexy et al., 2009; Bogers, 2011; Gretsche et al., 2020;

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Henttonen et al., 2016; Wikhamn, 2013). Several authors recognized that IPPMs support OI (Alexy et al., 2009; Hagedoorn & Zobel, 2015; Veer et al., 2016), while Alexy et al. (2009) observed that IP and particularly patents (which are important IPPMs) could disable OI under certain circumstances. Among these circumstances, Alexy et al. specifically mentioned the missed integration between IP and OI strategies. The mixed results obtained in previous studies on the link between IPPMs and OI suggest that IPPMs may not be good predictors of a firm's openness. Indeed, the same IPPM (e.g., a patent) may be used to build bridges or fences, according to the firm's IP strategy (IPS). Consistently, Brem et al. (2017), who analysed how SMEs benefit from IPPMs, called for future research on the possible strategic approaches underlying IP management. In this vein, Grimaldi et al. (2021) defined an IPS framework comprising three IPSs: the 'defensive' strategy, which aims to avoid knowledge spillovers and build barriers to competition; the 'collaborative' strategy, which aims to collaborate with other organizations and enter new markets; and the 'impromptu' strategy, which describes firms protecting their IP without a predetermined purpose. IPSs define how a firm purposely shares certain pieces of knowledge with external organizations, under which conditions, using (or not using) certain IPPMs. Hence, from a managerial perspective, a clear strategy is necessary to use IPPMs and deliberately share or retain knowledge.

This article aims to leverage Grimaldi et al.'s IPS framework and address its three research limitations. First, the authors used a single item to assess whether the firms in their sample were defensive, collaborative or impromptu. Such an item had limited chances to describe the complexity underlying IPSs and could also bear a social desirability bias, as the authors themselves affirm. Hence, there is a need for items capable of accurately describing IPSs. Such items could be used in larger scale studies to explore their effect on OI and performance measures or lead firms to self-assess their strategies. Second, the authors introduced three archetypal strategies but could not link them with the IPPMs used by the firms in their sample. Hence, their conjectures on the three strategies' use of IPPMs remained without an empirical test. A better comprehension of such preferences is essential to understanding IPSs' nature and characteristics. Third, given the second gap, there is no evidence about which combinations of IPSs and IPPMs could help firms increase their adoption of the OI paradigm. Filling such a limitation would connect the literature on IPPMs and OI and the literature that focuses on IPSs from an OI perspective, creating fertile ground for future research. It would also allow shedding light on the actual capability of IPPMs to enable/disable OI.

While addressing the third limitation, we focus on outbound OI, which describes the inside-out flows of knowledge and technology and is associated with the exploitation of a firm's IP from an OI perspective (Obradović et al., 2021). Despite the importance of outbound OI to capitalize on firms' know-how, the paucity of studies on it has been remarked in research agendas for years (e.g., Hossain et al., 2016; Obradović et al., 2021; West & Bogers, 2017). Hence, this study also responds to the call for more research on the determinants of outbound OI.

Therefore, in this article, we (1) propose more articulated constructs to assess IPSs; (2) characterize IPSs according to IPPMs; and (3) study how IPSs and IPPMs are associated with outbound OI. We pursue these aims by analysing a sample of Italian manufacturing firms resorting to a mix of cluster analysis and fuzzy-set qualitative comparative analysis (fsQCA).

## 2 | THEORETICAL BACKGROUND

Innovation processes entail complex IP management, particularly when OI occurs. Indeed, because multiple actors are involved in OI, their proportion of participation and contribution to creating the novelty is difficult to assess. Proper IP management in OI projects is essential, and it often leverages IPPMs. This section will briefly introduce the most relevant IPPMs, discuss their role in outbound OI and finally emphasize the prevailing importance of strategy, bridging IPPMs and IPSs.

### 2.1 | Intellectual property protection mechanisms

IPPMs can be clustered into three groups: formal, semiformal and informal (Aloini et al., 2017).

Patents, trademarks, industrial designs and copyrights belong to the formal mechanism category. A patent denotes a right conferred to a firm to preclude third parties from using a protected technology (Chirico et al., 2020). A trademark can be a word, name, symbol or device (or combinations of them) to identify a company's goods and services, distinguishing them from goods provided by others (WIPO, 2020). An industrial design concerns the appearance of the whole or part of a product resulting from its features. Finally, copyright describes the creators' IP rights over their literary, scientific and artistic works.

Semiformal mechanisms include contracts and agreements. Contracts are legally binding agreements between two or more parties intended to create a legal obligation or a set of obligations (Hagedoorn & Zobel, 2015). Non-disclosure agreements (NDAs) are a widespread form of contract to avoid undesired knowledge leakages.

The most common informal IPPM is trade secret, a piece of commercially valuable information that is not in the public domain and is subject to reasonable efforts to maintain secrecy (Hallenborg et al., 2008).

### 2.2 | The role of IPPMs in outbound OI

Inside-out innovation processes entail exploiting a firm's knowledge by taking it to the outside environment. Such processes may involve free revealing, licensing mechanisms or the sale of IP rights (Aquilani et al., 2017). While IPPMs may protect a firm from undesired information spillovers during inter-organizational collaboration, they may also bring rigidities in the collaboration process. Consequently, OI and its

desired outcomes may be hindered. The tension between information sharing and protection in outbound OI describes the ‘paradox of openness’ (Foege et al., 2019; Laursen & Salter, 2014). Because ill-managed outbound OI activities may cause the loss of future competitive advantage (Helm et al., 2019), choosing what to share and how to share it is crucial. Indeed, firms may need to protect both their core knowledge and the knowledge that was not initially deemed as core (Frishammar et al., 2015).

The relationship between IPPMs and outbound OI could be framed in the appropriation versus appropriability dichotomy. Indeed, appropriability describes ‘an innovator’s potential to benefit from an innovation’, which would be leveraged by ‘instruments of appropriability’ (including IPPMs) (Hurmelinna-Laukkanen & Yang, 2022). However, appropriation, which describes the realization of the appropriability potential in terms of private and social returns, is by no means guaranteed. Indeed, it depends on many contextual and situational factors and the choice of the appropriability mechanisms. Hence, Hurmelinna-Laukkanen and Yang (2022) emphasized the importance of defining an appropriation strategy to align appropriability instruments and appropriation process to benefit from innovation.

Given the complex relationship between OI and IP protection, several authors have conducted empirical research to shed light on it (Aloini et al., 2017; Freel & Robson, 2017; Stefan & Bengtsson, 2017; Zobel et al., 2017). In such studies, certain IPPMs or IPPM groups are related to firms’ measures of openness to ascertain if and how IPPMs enable or disable OI. Nevertheless, there is no agreement so far on the results achieved. Interestingly, the econometric study of the link between outbound OI and IPPMs has been neglected in the literature. This is particularly surprising if we consider that outbound OI implies inside-out flows that leverage a firm’s IP to obtain additional revenue streams (Caputo et al., 2016; Helm et al., 2019).

The extent to which a firm activates multiple inside-out knowledge flows can describe how ‘open’ it is. Indeed, such behaviour is antithetical to the one triggered by the not-sold-here (NSH) syndrome. Such a syndrome characterizes firms believing that if they cannot create value from a certain technology, no one else will be able to (Aquilani et al., 2017). Hence, the NSH syndrome causes organizations to consider knowledge sharing a loss of control and triggers an unfavourable attitude towards it (Engelsberger et al., 2021). Therefore, to fully grasp the benefits of inside-out flows, the strategic selection of partners is essential (Aquilani et al., 2017).

Nonetheless, the number of partners or partner categories for inside-out flows—which we may define ‘outbound breadth’, mimicking Laursen and Salter’s (2006) widely used terminology for outside-in flows—offers only a part of the picture. Indeed, on the one hand, a firm may have plenty of active inside-out channels where the knowledge flows are feeble (e.g., encompassing the limited exchange of a few pieces of information). On the other hand, another firm could prefer a few high-intensity exchanges with selected partners. Hence, ‘outbound depth’ should also be considered to capture the essence of a firm’s outbound OI strategy.

## 2.3 | Intellectual property strategy

WIPO (2020) defined intellectual property strategy as a set of measures formulated and implemented to encourage and facilitate the effective creation, development, management and protection of IP. Until the ‘90s, IP discussions were considered a legal issue that did not occur in the boardrooms (Leone, 2016). Then, managers started to understand the IP potential as a source of large, additional cash flows. However, such a potential remained underused in most firms, possibly due to the lack of connection between IP management and innovation processes (Chesbrough et al., 2006). In this vein, Chesbrough and Ghafele (2014) remarked on the importance of shifting the perspective from an IP right to an IP management paradigm to leverage IP and unleash the full potential of OI. As Leone (2016) remarks, ‘successful IP management choices entail a high level of integration with firm’s strategy, organisation and IP assets’ (p.15). Similarly, Di Minin and Faems (2013) observed that IP management has evolved from a way to mitigate imitation risk to something that—matched with business strategy—can ‘fence or steer technological paths’, ‘operate on secondary markets for technology’, ‘respond to competitive moves’ and ‘implement alternative business models’ (p. 7).

While most of the literature on IP is still dominated by legal aspects (Chesbrough & Ghafele, 2014), many OI scholars recognized the importance of IP and studied it from a managerial perspective, as mentioned in the previous subsections. Nonetheless, IPSs received very limited attention (e.g., Alexy et al., 2009; Fisher & Oberholzer-Gee, 2013; Grzegorzczuk, 2020; Hurmelinna-Laukkanen & Yang, 2022). In addition, several other authors mentioned IPSs in their studies but rather focused on IPPMs (e.g., Brem et al., 2017; Lee et al., 2018; Teixeira & Ferreira, 2019).<sup>1</sup>

Yet, strategy is fundamental to determining whether and how certain innovations should be revealed to partners (Brunswick & Chesbrough, 2018). Indeed, Manzini and Lazzarotti (2016) observed how the absence of an IPS could cause costly litigations. Alexy et al. (2009) offered a first normative analysis of IPS considering the role of OI. They presented four possible scenarios: (1) ‘Sign It, Seal It and Get It Delivered’, which is closest to the closed innovation perspective; (2) ‘If You Give It Away, They Will Come’, which suits turbulent contexts with many potential knowledge sources and often entails the free access to portions of IP; (3) ‘Spread the Problem, Secure the Solution’, which describes stable contexts with many potential knowledge sources that enable crowdsourcing initiatives; and (4) ‘For Many Eggs, Get Many Baskets’, which refers to turbulent contexts with few knowledge sources and implies collaboration agreements with clear rules on IP management. Kutvonen (2011) discussed a set of possible strategic objectives associated with external technology commercialization (such as learning from knowledge transfer, multiplication of own technologies and controlling technological trajectories) but did not link them to IP. Fisher and Oberholzer-Gee (2013) remarked that IP-related decisions are strategic but often not handled by business executives. They presented a framework to overcome functional silos and offered a cross-disciplinary perspective on the possible strategic options related to IP. Grzegorzczuk (2020)

emphasized that patent-owners could go beyond the typical defensive and offensive patent strategies and consider leveraging strategies, which often entail interaction with other organizations. This article is particularly valuable because it implies that the same patent-holder could achieve different outcomes based on the underlying strategy. The most recent contribution on the topic was advanced by Hurmelinna-Laukkanen and Yang (2022), who discussed three possible appropriation processes. The exclusion-oriented process aims to prevent others from exploiting innovation and the related knowledge. The leverage-oriented process aims to profit from innovation, for instance, through licensing, without necessarily impeding others from using the focal firm's IP. The disclosure-oriented process describes a use of IP that welcomes the free use of the innovation and the related knowledge.

Finally, Grimaldi et al. (2021) proposed an IPS framework comprising three possible IPSs (defensive, collaborative and impromptu). A firm with a defensive IPS is anchored to the closed innovation paradigm and will use its IPPMs to prevent competitors from producing and commercializing its innovations. A firm with a collaborative IPS leverages the OI paradigm to increase its know-how and revenues; it can choose what information to share with its partners and whether and how to retain legal control. Finally, a firm with an impromptu strategy lacks a clear purpose in its IP management and would use IPPMs inconsistently. According to the authors, even though any formal, semiformal or informal IPPM could be used by firms driven by any IPS, different preferences may exist. Indeed, different IPSs could prefer different IPPMs, according to which provide the strongest protection (defensive strategy), which favour collaboration the most (collaborative strategy) and which are easier to implement (impromptu strategy). Hence, defensive firms may prefer formal and semiformal IPPMs because they guarantee the strongest legal protection. In contrast, collaborative firms could flexibly choose the IPPM that suits them the most based on the situation. Finally, impromptu firms may prefer informal and semiformal IPPMs due to their lower costs and complexity. The resulting IPS framework brought the discourse on IPS to a higher level of abstraction than the previous studies. Indeed, such studies described specific strategies such as the four options identified by Alexy et al. (2009) or 'use of market power', 'mutual hold up' (Grzegorzczak, 2020), 'license' and 'donate' (Fisher & Oberholzer-Gee, 2013), to name a few. Indeed, before discussing any of the latter options, business executives should delineate the essential strategic character of their firm (defensive or collaborative) and avoid not having any.

## 3 | METHODS

### 3.1 | Data

We submitted our survey to 164 manufacturing firms based in three Italian provinces with similar socio-economic characteristics (Frosinone, Latina and Caserta) in January 2021. The target firms were selected among the respondents to a previous survey, which targeted

the whole population of manufacturing firms in the zone. Such firms are unsophisticated (i.e., rarely aware of the academic discussions on IPPMs and OI), which could guarantee less biased responses than targeting listed companies.

From the 77 responses we received, we excluded incomplete answers and answers from respondents who did not have a managerial position, obtaining 73 valid responses. The resulting firms' size is distributed as follows: 67% microenterprises, 22% small-sized, 8% medium-sized and 3% large. In terms of their innovativeness (Eurostat, 2017), 33% are low-tech, 25% medium-low-tech, 23% medium-high-tech and 19% high-tech.

### 3.2 | Variables

#### 3.2.1 | Outbound OI

We operationalize outbound OI as the aggregation of eight items corresponding to as many organization classes interacting with the focal firm (material suppliers, software suppliers, small- or medium-sized customers, large customers,<sup>2</sup> competitors or other companies in the same sector, consultants and private R&D labs and institutes, universities, and government and public research institutions). Each item asks whether, from 2017 to 2019, organizations in each of the eight classes received and benefited from the firm's inside-out flows of knowledge to a high, average, low level or whether they did not employ them at all. Such an evaluation was estimated by the respondent from the focal firm, assuming that—in an OI process—the firm's partners would share with it at least qualitative information about their usage of its knowledge and technology. We associate the answers to scores of 3, 2, 1 and 0, respectively, and sum the scores to obtain a general outbound OI variable. Given the lack of studies on outbound OI, such an approach draws inspiration from previous studies that operationalized inbound OI by summing the scores for each organization category (e.g., Drechsler & Natter, 2012; Greco et al., 2019).

We also introduced measures of *outbound breadth* and *outbound depth*, following Laursen and Salter's (2006) approach for *search breadth* and *search depth* for inbound OI. The distinction between breadth and depth has been widely adopted in studies on inbound OI since Laursen and Salter's paper (Ebersberger et al., 2021; Schroll & Mild, 2012). This distinction is essential because an overall indicator of outbound OI offers a general perspective on the firm's behaviour but does not clarify whether the firm prefers a few strong links with partners rather than many weak links (and all the nuances between the two opposite approaches). Hence, breadth and depth are important to better understand our main dependent variable's characteristics. Using the scores associated with each item, we defined *outbound breadth* as the count of the organization classes benefiting from the firm's inside-out flows, regardless of their intensity (3, 2 or 1). Similarly, we defined *outbound depth* as the count of the organization classes benefiting from the firm's inside-out flows at a high intensity (only 3).

### 3.2.2 | IPPMs

We introduced seven dummy variables that derive from questions asking interviewees whether their firms resorted to the following IPPMs from 2017 to 2019: patents (*IPPM\_patent*), trademarks (*IPPM\_trademark*), utility models (*IPPM\_utility*), designs (*IPPM\_design*), copyrights (*IPPM\_copyright*), contracts and NDAs (*IPPM\_semiformal*) or secrecy (*IPPM\_informal*). We also briefly explained each item to avoid ambiguities or uninformed answers. We also set up the count variable *formalIPPM* as the sum of *IPPM\_patent*, *IPPM\_trademark*, *IPPM\_utility* and *IPPM\_design*.

### 3.2.3 | IP strategies

We leveraged Grimaldi et al.'s (2021) definitions of defensive, collaborative and impromptu strategies to specify eight items capable of describing them. An ideal approach would have been to identify a set of items specific for each strategy and aggregate them controlling for reasonably high Cronbach's alpha. However, the contiguity among the three strategies would not allow such an approach. Therefore, we developed the set of 5-point Likert items (5, *strongly agree*–1, *strongly disagree*) presented in Table 1. We predicted the expected average response for each and discussed the rationale behind such a prediction.

## 3.3 | Cluster analysis

We aim to distribute the firms in our sample in homogeneous clusters based on their IPSs, leveraging the items described in Table 1 to interpret the existing strategic differences. Even though there is no conclusive method to define the optimal number of clusters, we adopted Makles' (2012) approach. We generated 100 different *k*-means cluster solutions with  $k = 1, \dots, 20$  (i.e.,  $k = 1$  generates a single cluster,  $k = 2$  generates two clusters, ...). We found that cluster sets with  $k = 4$  and  $k = 5$  often have better quality statistics than  $k = 3$ , the value we would have expected based on three IPSs defined earlier. Instead, clusters with  $k > 5$  offered slight improvements (and sometimes even worsening) in the statistics that we deemed unsatisfactory to justify the fragmentation of the sample that defining too many clusters would have caused. Hence, we collectively analysed five sets of clusters for  $k = 4$  and  $k = 5$  using descriptive statistics and radar graphs of the IPS items. We concluded that the five sets of clusters for  $k = 4$  varied too much in their IPS items composition, while the sets with  $k = 5$  had recurring characteristics in most circumstances.

Then, three authors assessed the resulting five clusters individually, studying their average values and standard deviations on the IPS items, matching them with their underlying strategic rationale (following closely Table 1 and comparing such values with the predictions for each item).

Finally, the three researchers' perspectives were synthesized, conflicting views were discussed and solved and the clusters'

characteristics were described. Hence, we selected the cluster that could be characterized according to five different strategic approaches to IP more clearly than the other ones.

## 3.4 | Fuzzy-set QCA

Given the relatively high number of clusters compared with the sample size, we discarded an econometric approach to data analysis and opted for fsQCA, a largely applied method in business management disciplines (Seny Kan et al., 2016). QCA aims to investigate the relationship between causally relevant conditions and a specified outcome. Unlike conventional techniques, the method combines quantitative and qualitative aspects to explain a phenomenon. The method returns recipes defined by comparing configurations of conditions (Marx et al., 2013). The main phases of QCA include calibration, analysis of the necessary conditions to achieve the outcome and analysis of the sufficiency conditions with the construction of the truth table (Ragin, 2008; Schneider & Wagemann, 2012). The calibration of the conditions and outcomes changes the variables into condition set membership scores. QCA can be implemented in either a crisp or a fuzzy-set form. In crisp QCA, all conditions are expressed through dichotomous values (0/1), while fsQCA allows enclosing all conditions in the range of values [0,1], allowing partial memberships. On the extremes, 0 indicates the not belonging to the set (full not membership), whereas 1 indicates the belonging (full membership). The number of membership levels can vary inside the interval, ranging from a minimum of three to an unlimited number of sets (Ragin, 2008; Schneider & Wagemann, 2012).

The simultaneous presence of a casual condition and the outcome are required for the necessary analysis. In other words, the outcome is not possible without the condition's presence, while the condition cannot produce outcomes alone (Ragin, 2008; Schneider & Wagemann, 2012). In QCA, consistency and coverage are the main parameters of fit. The former measures the goodness of the relationship between one (or more) conditions and an outcome. The latter measures the degree to which a necessary condition is relevant for an outcome. We investigated the relationships between three causal conditions (formal, informal and semiformal IPPMs) and three outcomes (*outbound*, *outbound depth* and *outbound breadth*).

To test the necessary condition, we use the main fit parameters suggested in the literature: the consistency of the necessary condition (Cons.Nec), the coverage of the necessary condition (Cov.Nec) and the relevance of the necessary condition (RoN). In line with the literature (Ragin, 2008; Schneider & Wagemann, 2012), we used a consistency threshold close to one and a coverage and RoN threshold equal to 0.5 (Schneider & Wagemann, 2012).

The simultaneous presence of a casual condition and the outcome is required for sufficient analysis, but the casual condition is not essential to the outcome. The truth table represents the core part of a sufficiency condition analysis: It returns all the possible casual conditions with their outcome. For the sufficiency

**TABLE 1** Characterization of the IPS items

Item	Code	Rationale	Defensive	Collaborative	Impromptu
We protect our innovations to profit from them through third parties (e.g., licensing)	IPS1	Profiting from innovation through licensing is a classic approach for both defensive and collaborative firms (the latter would also establish some form of collaboration with the licensee). At the same time, it would be unusual for impromptu firms, which are less used to exploiting their IP.	Agree	Agree	Disagree
Our collaborations with third parties are mainly based on mutual trust	IPS2	The word 'mainly' in the item emphasizes the key role of trust in a collaboration, as we may expect in collaborative and impromptu firms. Defensive firms could want, to a lesser extent, to emphasize the importance of trust in their collaborations, but their collaborations are more likely to be 'mainly' based on IP rights.	Agree	Strongly agree	Strongly agree
Intellectual property rights are a platform to collaborate with other organizations	IPS3	This item emphasizes an organic view of IP rights as enablers for collaboration, which is at the heart of the OI paradigm. Such an organic perspective is unlikely in impromptu firms. Defensive firms could also agree with this item, seeing IP as a 'currency' for their inter-organizational interactions.	Agree	Strongly agree	Disagree
We protect our innovations to avoid the risk of them being copied	IPS4	The fear of being copied significantly emerges in defensive firms, while it would be neglected in collaborative and impromptu ones.	Strongly agree	Disagree	Disagree
We have strict rules to share the firm's information with third parties	IPS5	Defensive firms formalize rules to avoid the undesired spillover of knowledge. To a lesser extent, also collaborative firms may be equipped with guidelines for their inter-organizational collaboration, while we do not expect impromptu firms to have formalization of this kind.	Strongly agree	Agree	Strongly disagree
We constrain the information we share with the organizations we collaborate with	IPS6	Constraints to information sharing are a known barrier to OI. Hence, they would hamper a collaborative IPS, while they would probably characterize a defensive firm approach. Impromptu firms may either agree or disagree with this item.	Strongly agree	Strongly disagree	Neutral
We protect our innovations rarely due to the costs	IPS7	Impromptu firms are often not used to protecting their IP because they perceive this as a costly activity. On the contrary, defensive firms would disagree with this item. We cannot a priori hypothesize collaborative firms' position, which may or may not use formal IPPMs.	Strongly disagree	Neutral	Strongly agree
There is an organizational function (a manager or office) aimed to make decisions regarding intellectual property	IPS8	The lack of a function dedicated to IP management predicts an impromptu approach. Otherwise, such a function could either have defensive or collaborative purposes.	Neutral	Neutral	Strongly disagree

Abbreviations: IP, intellectual property; IPPMs, intellectual property protection mechanisms; IPS, intellectual property strategy; OI, open innovation.

analysis, we considered a consistency cut-off of 0.8, which is more than 0.75, the minimum threshold requested (Rihoux & Ragin, 2009).

Three different solutions can be discussed: complex, intermediate and parsimonious. The conservative solution formula is the most complex because it does not simplify assumptions in the analysis and



TABLE 2 Descriptive statistics of the five clusters

Item/variable	C1: Defensive			C2: Purposely defensive			C3: Developing impromptu			C4: Collaborative			C5: Impromptu		
	Obs	Mean (SD)	Min-max	Obs	Mean (SD)	Min-max	Obs	Mean (SD)	Min-max	Obs	Mean (SD)	Min-max	Obs	Mean (SD)	Min-max
IPS1	11	1.82 (0.405)	1-2	18	3.28 (1.074)	1-5	12	2.58 (0.9)	1-4	15	3.73 (0.961)	2-5	17	2.06 (0.659)	1-4
IPS2	11	3.55 (1.508)	1-5	18	2.72 (0.575)	2-4	12	3.58 (1.084)	1-5	15	4.07 (0.704)	2-5	17	3.65 (0.996)	2-5
IPS3	11	3.09 (0.944)	2-4	18	3.11 (0.758)	2-5	12	2.92 (0.9)	2-5	15	3.53 (0.915)	2-5	17	2.65 (0.862)	2-4
IPS4	11	4.64 (0.505)	4-5	18	3.83 (0.786)	3-5	12	3.33 (0.778)	2-4	15	4.53 (0.516)	4-5	17	2.18 (0.809)	1-4
IPS5	11	3.18 (1.168)	2-5	18	3.22 (0.878)	2-5	12	3.83 (0.718)	2-5	15	3.33 (0.9)	2-4	17	2.18 (0.636)	1-4
IPS6	11	4.36 (0.505)	4-5	18	2.61 (0.502)	2-3	12	3.58 (0.9)	2-5	15	4.00 (0.655)	2-5	17	2.53 (0.874)	2-4
IPS7	11	1.73 (0.467)	1-2	18	2.5 (0.786)	1-4	12	4.17 (0.389)	4-5	15	3.6 (1.183)	1-5	17	2.65 (1.169)	1-5
IPS8	11	3.09 (1.3)	2-5	18	3.56 (0.784)	3-5	12	2.33 (1.073)	1-5	15	2.73 (1.033)	1-4	17	2.29 (0.849)	1-4
Outbound	11	9.36 (4.178)	0-14	18	7.94 (6.795)	0-19	12	7.83 (4.218)	1-14	15	9.27 (3.474)	0-13	17	6.88 (4.136)	0-12
Outbound breadth	11	5.36 (2.111)	0-8	18	4.61 (3.517)	0-8	12	5.42 (2.61)	1-8	15	5.47 (1.885)	0-8	17	4.71 (2.995)	0-8
Outbound depth	11	0.64 (0.924)	0-3	18	0.89 (1.491)	0-5	12	0.25 (0.452)	0-1	15	0.4 (0.737)	0-2	17	0.35 (0.606)	0-2
IPPM_patent	11	0.45 (0.522)	0-1	18	0.17 (0.383)	0-1	12	0 (0)	0-0	15	0.2 (0.414)	0-1	17	0.12 (0.332)	0-1
IPPM_trademark	11	0.73 (0.467)	0-1	18	0.28 (0.461)	0-1	12	0.58 (0.515)	0-1	15	0.4 (0.507)	0-1	17	0.24 (0.437)	0-1
IPPM_utility	11	0.09 (0.302)	0-1	18	0.17 (0.383)	0-1	12	0.42 (0.515)	0-1	15	0.33 (0.488)	0-1	17	0.29 (0.47)	0-1
IPPM_design	11	0.18 (0.405)	0-1	18	0.06 (0.236)	0-1	12	0.08 (0.289)	0-1	15	0.07 (0.258)	0-1	17	0 (0)	0-0
IPPM_copyright	11	0.09 (0.302)	0-1	18	0.06 (0.236)	0-1	12	0 (0)	0-0	15	0.27 (0.458)	0-1	17	0 (0)	0-0
IPPM_semiinformal	11	0.73 (0.467)	0-1	18	0.33 (0.485)	0-1	12	0.42 (0.515)	0-1	15	0.53 (0.516)	0-1	17	0.18 (0.393)	0-1
IPPM_informal	11	0.18 (0.405)	0-1	18	0.22 (0.428)	0-1	11 <sup>a</sup>	0.27 (0.467)	0-1	15	0.20 (0.414)	0-1	17	0.18 (0.393)	0-1

Note: Values in bold font are the highest in the row; values in italics are the lowest in the row.

Abbreviations: IPPM, intellectual property protection mechanism; IPS, intellectual property strategy.

<sup>a</sup>One missing value for IPPM\_informal in Cluster 3.

is based only on empirically observed evidence. The parsimonious solution formula is the least complex solution because it reduces the causal recipes to the fewest possible conditions. The intermediate solution is often less complex than the conservative solution and more complex than the parsimonious solution (Schneider & Wagemann, 2012). We adopted a complex solution for our analysis and used the R software package.

## 4 | RESULTS

### 4.1 | Characterizing the intellectual property strategies

As described in the methodology section, we identified a suitable clustering comprising five different strategic approaches. The descriptive statistics of the five clusters are reported in Table 2. We leveraged the eight IPS items described in Table 1 to delineate the strategic characteristics of the five clusters, achieving the first aim of the study, which is to propose more articulated constructs to assess IPS. The descriptive statistics of the IPPMs allow achieving the second aim of the study, that is, to characterize each IPS according to its use of IPPMs.

#### 4.1.1 | Cluster 1—Defensive

The firms in this cluster do not see IP protection as a source of profits, while they consider it essential to avoid the risk of being copied. Indeed, the costs to protect their innovations do not discourage them. Furthermore, they limit the information they share with their partners. Firms in this cluster have comparable levels (slightly above the overall mean) of the outbound variables than the others, statistically significantly exceeding only those in Cluster 5 (impromptu) for *outbound*.

The defensive firms make the largest use of most formal IPPMs—particularly patents and trademarks—and semiformal IPPMs (NDAs and contracts). All other clusters exceed their use of secrecy as an informal IPPM except Cluster 5, where secrecy is similarly used (*t*-test on proportions not statistically significant).

#### 4.1.2 | Cluster 2—Purposely defensive

The firms in this cluster do not constrain the information they share with their partners. However, they protect their innovations to avoid the risk of being copied. They have an organizational function to manage their IP and do not neglect IP protection due to its cost. Their outbound OI measures are not significantly different from any other cluster, except for *outbound depth*, which is larger than in Cluster 3 (developing impromptu) and Cluster 5 (impromptu). Hence, purposely defensive firms are more likely involved in multiple, high-intensity inside-out flows of knowledge and technology than impromptu firms.

Purposely defensive firms use patents, trademarks and NDAs statistically significantly less than defensive ones, while their use of other IPPMs is not different from Cluster 1. On average, Cluster 1 uses patents, trademarks and utility models more than Cluster 3 (developing impromptu). Instead, their use of IPPMs is not statistically different from Cluster 4 (collaborative) and Cluster 5, except for copyright (which is more used in the last cluster).

#### 4.1.3 | Cluster 3—Developing impromptu

The firms in this cluster have marked signs of impromptu strategy: They rarely protect their IP due to their costs, are not equipped with an organizational function to manage their IP and do not protect their IP to draw profits from them. However, they have rules and constraints on sharing their information with other organizations. Their level of *outbound* is not statistically different from any other cluster.

None of the firms labelled as ‘developing impromptu’ resorted to patents or copyrights, but their use of trademarks and semiformal IPPMs is significantly larger than Cluster 5 firms. Furthermore, their use of utility models is quite advanced, being significantly larger than Cluster 1 and Cluster 2.

#### 4.1.4 | Cluster 4—Collaborative

The firms in this cluster protect their IP due to the fear of being copied; they leverage IP to obtain additional profits and consider it a platform that enables collaboration. Their collaborations strongly rely on reciprocal trust with their partners. They pay attention to how information is shared with their partners. Firms in this cluster have similar *outbound* levels to the others, significantly exceeding those in Cluster 5 (impromptu).

Collaborative firms use formal IPPMs (patents, trademarks and utility models) significantly less than defensive firms. Still, they are similar to them in the use of semiformal IPPMs. Indeed, they use semiformal IPPMs significantly more than impromptu firms. Collaborative firms' use of copyrights significantly exceeds almost all other clusters' firms, except for defensive ones.

#### 4.1.5 | Cluster 5—Impromptu

The firms in this cluster fit perfectly with the ideal view of impromptu strategy. Indeed, they rarely protect their IP due to their costs; they ground their collaborations on trust; they are not equipped with an organizational function to manage their IP; and they do not protect their IP to draw profits from them. They do not have rules or constraints to protect their information.

Impromptu firms use IPPMs to a limited extent, with no firm reporting designs or copyrights, while patents and trademarks are significantly less used than in defensive firms. Semiformal IPPMs



are also significantly less used than in other clusters (except for the purposely defensive cluster, whose proportion is not significantly larger).

## 4.2 | fsQCA results

The necessary condition analysis shows that those cases achieving the reference value for necessary conditions are inconsistent. This consideration stems from the analysis of the relevance of necessity (RoN) score, which allows checking whether the necessary condition is trivial or not (Ragin, 2008; Schneider & Wagemann, 2012). In our study, the RoN values<sup>3</sup> are all below the 0.5 threshold requested, confirming that the necessary condition is trivial. Our results align with the literature claiming that a necessary condition is rare empirically (Ragin, 2008; Schneider & Wagemann, 2012).

The results show that no single recipe can improve the outcomes (*outbound*, *outbound depth* and *outbound breadth*) under all circumstances for all IPSs. This paragraph will analyse all emerged solutions from the individual strategies in each cluster. Table A1 describes the sufficient solutions resulting from the fsQCA in the five clusters, while Figure 1 offers recommendations regarding IPPMs to practitioners according to their firms' IPS.

### 4.2.1 | Cluster 1—Defensive

The results show that formal instruments suffice to increase *outbound* for defensive firms while combining semiformal and informal instruments without formal instruments worsens it. Instead, defensive firms



















that either do not use informal instruments or use semiformal instruments without formal ones have fewer high-intensity inside-out flows of knowledge and technology (smaller *outbound depth*). Finally, defensive firms' variety of inside-out flows (*outbound breadth*) improves when they do not use informal instruments or resort to semiformal and informal instruments without formal IPPMs.



Overall, defensive firms benefit from using formal IPPMs in terms of *outbound*, while not using informal IPPMs improves *outbound breadth* at the expense of *outbound depth*.

### 4.2.2 | Cluster 2—Purposely defensive

Purposely defensive firms that combine semiformal and informal instruments increase *outbound*. In contrast, using semiformal instruments without formal and informal ones worsens it. Regarding *outbound depth*, several recipes exist. The variable increases for firms using formal instruments without informal and semiformal ones. It also increases for firms not using formal instruments with semiformal and informal instruments. On the contrary, *outbound depth* worsens for firms that use semiformal instruments without both formal and informal ones and for firms that do not use semiformal and informal instruments. Finally, *outbound breadth* improves for firms using semiformal instruments, but such instruments should be paired with informal instruments.

Overall, purposely defensive firms can benefit from NDAs and contracts in each of the three outbound measures. Still, these need to be paired with informal IPPMs to impact the intensity of the inside-out flows (i.e., to enhance *outbound* and *outbound depth* measures).

Clusters/Strategies	<i>outbound</i>	<i>outbound depth</i>	<i>outbound breadth</i>
Cluster 1 – Defensive	 Formal instruments  Semiformal AND Informal instruments	 Informal instruments	
Cluster 2 – Purposely defensive	 Semiformal AND informal instruments	 Formal instruments OR  Semiformal AND informal instruments	 Semiformal instruments
Cluster 3 – Developing impromptu		 Any IPPM	 Semiformal instruments only  Formal instruments only
Cluster 4 – Collaborative	 Formal instruments	 Formal AND informal instruments OR  Informal instruments only	 Formal instruments only
Cluster 5 - Impromptu	 Formal AND not informal instruments OR  Semiformal AND informal instruments	 Formal AND informal instruments	 Semiformal instruments only

 Instruments recommended to improve the effect of the strategy on outbound OI  
 Instruments not recommended for the strategy, since they may hamper outbound OI

**FIGURE 1** Overview of the recommendations to firms according to their intellectual property strategies. IPPM, intellectual property protection mechanism; OI, open innovation

### 4.2.3 | Cluster 3—Developing impromptu

Developing impromptu firms that combine formal and semiformal instruments without informal ones increase *outbound*. However, the absence of semiformal instruments from this combination causes the opposite effect. Furthermore, either no IPPM or semiformal instruments without informal ones decrease *outbound depth*. Finally, *outbound breadth* improves for firms that use semiformal instruments without formal and informal ones. In contrast, it worsens for firms that prefer formal instruments without semiformal and informal ones.

The sufficient recipes we found need to be chosen as alternatives to improve (or not hinder) the outbound measure preferred by the top management. Overall, disregarding formal IPPMs while focusing on NDAs and contracts could allow developing impromptu firms to increase both *outbound depth* and *outbound breadth*.

### 4.2.4 | Cluster 4—Collaborative

Collaborative firms using semiformal instruments without formal ones and those not using both semiformal and informal instruments have greater *outbound*. Moreover, the firms that combine formal and semiformal instruments, as well as the firms that do not use formal and informal instruments worsen *outbound*. Instead, *outbound depth* worsens for firms that do not use formal and informal instruments, as well as for firms that combine the use of formal and semiformal instruments without informal ones. Finally, *outbound breadth* improves for firms that use formal instruments without semiformal and informal ones.

Overall, formal IPPMs may hamper *outbound*, whereas they may favour *outbound breadth* and—paired with informal IPPMs—*outbound depth*.

### 4.2.5 | Cluster 5—Impromptu

Impromptu firms that either use informal instruments without formal ones or do not use semiformal and informal instruments have worse *outbound*. Differently, *outbound depth* worsens for firms that do not use formal and informal instruments. Finally, *outbound breadth* improves for firms that use semiformal instruments without formal and informal ones.

Impromptu firms have a harder time increasing their outbound OI measures, with a few sufficient conditions returned by the fsQCA. The presence of formal instruments paired with not informal instruments and the presence of semiformal instruments paired with informal instruments may improve *outbound*. Instead, formal instruments paired with informal instruments increase *outbound depth*; finally, semiformal instruments only may concur to increase *outbound breadth*.

## 5 | DISCUSSIONS

Di Minin and Faems (2013) discussed the concept of ‘appropriation advantage’ as an organization’s capability to outperform its

competitors by extracting value from its IP. Hence, IPS, IP management and IPPMs emerge as the building blocks of appropriation advantage. In the last decade, also thanks to the OI paradigm’s growing popularity, management studies increasingly approached IP in two main streams of the literature. On the one hand, studies on IPPMs (particularly patents) naturally emerged (Aloini et al., 2017; Lee et al., 2018; Manzini & Lazzarotti, 2016) also due to the presence of multiple and reliable data sources. On the other hand, the strategic side of IP research was dominated by studies that normatively offered recommendations to managers, often inspired by remarkable success cases. Among these studies, Alexy et al. (2009) suggested how to adapt IPSs based on the OI environment; Bogers (2011) focused on when an ‘open knowledge exchange’ should be preferred to a more protective ‘layered collaboration scheme’; while Peters et al. (2013) discussed how and why firms should combine patenting and strategic disclosure activities. Very recently, Hurmelinna-Laukkanen and Yang (2022) emphasized how firms should be equipped with a coherent appropriation strategy to benefit from their innovations.

Our article bridges the two literature streams and offers a positive perspective on how firms (particularly SMEs) approach IPS and IPPMs. We leveraged Grimaldi et al.’s (2021) definition of three archetypal IPSs to explore them in our sample. We challenge the authors’ conception and advance that such archetypes should be considered *characterizing factors* of IPSs rather than IPSs themselves. In turn, such factors may originate hybrid IPSs such as the purposely defensive and the developing impromptu strategies described in this article. Indeed, we identified five clusters of firms based on the similarities in these characterizing factors’ nuances. Still, such clusters should not be considered a conclusive set of IPSs unless further research on different samples confirms or extends our results. We argue that the corresponding five IPSs constitute a novel perspective on appropriation strategies because they describe how firms realize their potential by leveraging their appropriability mechanisms (i.e., the IPPMs).

We observe a close conceptual link between the defensive IPS and Hurmelinna-Laukkanen and Yang’s (2022) ‘exclusion-oriented process’. Indeed, they both describe firms aiming to protect IP with a proprietary approach and deter knowledge spillovers. However, as the defensive IPS’ large *outbound* mean value testifies, such a cautious attitude does not necessarily mean that inside-out knowledge flows are sealed. Quite on the contrary, it might make a firm more comfortable interacting with external organizations, knowing that formal IPPMs will safeguard the flows. This tension towards formal IPPMs may induce different inter-organizational technology governance mechanisms (Holgersson et al., 2018) but does not necessarily imply a ‘closed innovation’ paradigm.

Hurmelinna-Laukkanen and Yang (2022) also described a ‘leverage-oriented process’ where profiting from inside-out flows is emphasized over protection. Such a process permeates the collaborative characterizing factor and its different nuances in the purposely defensive, developing impromptu and collaborative IPSs.

Instead, the impromptu IPS remains a novelty in the extant innovation management literature to the best of our knowledge. Indeed, even though a few authors observed that some firms either do not

have an explicit IPS (Eppinger & Vladova, 2013) or do not protect their IP (Kitching & Blackburn, 1998; Thomä & Bizer, 2013), a debate on how such two attitudes intertwine and how they impact on inside-out knowledge flows is missing. This article contributes to filling this gap by showing the characteristics of the impromptu IPS in terms of IPPMs and outbound OI and discussing how different combinations of formal, semiformal and informal IPPMs contribute to outbound OI.

We found that—on average—firms in the five clusters are not dissimilar in their outbound OI practices, with two exceptions. Impromptu firms have significantly lower *outbound* than both defensive and collaborative firms, while purposely defensive firms have more high-intensity inside-out flows of knowledge (*outbound depth*) than both impromptu and developing impromptu ones. The results integrate Grimaldi et al.'s (2021) findings because, in their study, defensive firms had a higher level of *outbound* than both impromptu and collaborative ones. The defensive firms' high propensity towards inside-out knowledge flows has two key implications. First, performance may not grow proportionally with the number and intensity of inside-out knowledge flows. Future research should verify how the prevalence of a defensive characterizing factor affects the link between inside-out flows and performance. Second, the amount of inside-out flows should not be considered a proxy of the 'collaborative' nature or leverage-oriented attitude of a company because the essence of such flows may be dramatically different in defensive and collaborative firms, encompassing very formal interactions as opposed to more spontaneous ones, respectively.

We found that defensive firms make larger use of patents than any other cluster. In comparison, collaborative firms use several formal IPPMs to a lower extent but use semiformal IPPMs more. These results reinforce Hagedoorn and Zobel's (2015) findings regarding the particular interest that firms engaged in OI have in using contracts (i.e., semiformal IPPMs). Instead, the results somewhat contradict Holgersson et al. (2018), who affirmed that firms actively engaged in OI might want to patent even more than firms engaged in closed innovation.

## 6 | CONCLUSIONS

This study explored the link among IPPMs, IPSs and outbound OI by analysing a sample of Italian SMEs through fsQCA. This section discusses the resulting implications for scholars and practitioners and the limitations of the study.

### 6.1 | Theoretical implications

Our article has several implications for the OI literature.

First, the article's focus on IPSs and its findings offer a new perspective to assess IPPMs and OI relationships, which could greatly impact future econometric studies. We found confirmation that the same IPPM class may either enable or disable the same outbound OI measure depending on the firm's IPS (e.g., formal IPPMs were

recommended to increase *outbound* for defensive firms and not for collaborative firms). Furthermore, no single IPPM suits all strategies. This implies that using IPPM classes as independent variables without accounting for the underlying strategies could return unpredictably biased results, confirming Grimaldi et al.'s (2021) conjectures.

Second, the article describes the relevance of the lack of an IPS. Even though many firms do not have a structured IPS (or have a very weak one), the literature neglected how this can affect their openness and performance. We encourage future research aimed to unveil these relationships.

Third, countless possible research opportunities are unlocked by understanding the role of the three characterizing factors and the IPSs they can trigger. Which IPSs achieve the best innovation and financial performance? Which contextual factors moderate the IPSs' effect on performance and openness? Among such contextual factors, how IPSs should consider the turbulence of the technological environment and the distribution of knowledge in their innovation ecosystem (Alexy et al., 2009)? How do IPSs relate to different outbound OI practices (Battistella et al., 2017)? How could IPSs be framed in the revealing (i.e., the extent to which internal know-how and technology are revealed externally with non-pecuniary returns) versus selling (i.e., the commercialization of a firm's inventions and technologies) dichotomy Dahlander and Gann (2010) proposed? How do IPSs evolve with time, and how do their outbound OI measures and innovation performance vary accordingly? Finally, how can IPSs be adapted to a firm's different markets, partners, age and stages of the innovation process?

Fourth, to our knowledge, this is the first study to explore outbound breadth and depth. The extent to which these measures can affect innovation or financial performance is unknown and deserves future research.

Finally, while our study focused on the link between IPSs, IPPMs and outbound OI, future research could extend our analysis to assess how IPPMs and IPSs affect the benefits and costs stemming from outbound OI. Furthermore, the recipes we identified through fsQCA could be analysed more thoroughly through in-depth case studies. Finally, further studies could investigate how the optimal combinations of IPPMs and IPSs change with partner types (e.g., suppliers, competitors and customers) or firms' internal climate (Lazzarotti et al., 2016).

### 6.2 | Practical implications

Our findings also have implications for practitioners because they offer recipes to combine IPPMs to nurture outbound OI, according to the firm's IPSs. Hence, managers could find the best fit for their firms if supported by self-assessment tools regarding the strategy. The items we provided could serve this purpose and increase the strategic dimension of IP management (Fisher & Oberholzer-Gee, 2013; Grzegorzczak, 2020).

Interestingly, we found that impromptu firms have two possible paths to improve their outbound OI. The first is based on formal IPPMs (which suggests an evolution towards a defensive strategy).

The second is based on semiformal and informal IPPMs (which suggests an evolution towards a collaborative strategy). Hence, once they recognized their IPS, managers could purposely steer their firm in the desired direction, also considering their contextual factors.

### 6.3 | Limitations

This study is limited because it resorted to a relatively small sample of manufacturing firms and used a qualitative approach to characterize IPSs. Because we cannot exclude a selection bias in our sample and fsQCA cannot resort to the inferential statistics notions to test the representativeness of the results (Schneider & Wagemann, 2010), our results may not be generalized to different contexts. Similarly, because our sample includes only two large firms, the findings may not hold for large firms and might be biased by SMEs' approach to (and perspective on) IP and OI. Furthermore, we analysed outbound OI in terms of organizations' variety, whereas different outbound OI practices (e.g., out-licensing and spin-off) could require different IPSs and IPPMs. Hence, we encourage future research on this topic. Finally, our outbound OI measures imply that the respondents know whether their firms' knowledge and technology are used by their partners, which may not be the case when opportunistic behaviour occurs.

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### DATA AVAILABILITY STATEMENT

The authors elect to not share data.

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### ENDNOTES

<sup>1</sup> For instance, Lee et al. (2018) considered IPSs as the different possible combinations of IPPMs used by a firm and studied their effect on innovation performance.

<sup>2</sup> We created two classes for customers due to the feedback we obtained during the cognitive interviews that took place in the pre-test phase. Indeed, several entrepreneurs remarked that a large-sized customer behaves in a radically different way from a smaller one (in relational and procedural terms).

<sup>3</sup> The RoN values are not included in the text for brevity.

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## APPENDIX A

**TABLE A1** Optimal recipes (sufficient conditions)

Cluster	Outbound	~Outbound	Outbound depth	~Outbound depth	Outbound breadth	~Outbound breadth
1 Defensive	~S*~I F	~F*S*I		~I F*S*~I	~I ~F*S*I	
2 Purposely defensive	~F*S*I S*I	~F*S*~I	F*~S*~I ~F*S*I	~F*S*~I ~S*~I	~F*S*I S	~F*S*~I
3 Developing impromptu	F*S*~I	F*~S*~I		~F*~S*~I ~F*S*~I F*S*~I	~F*S*~I	F*~S*~I
4 Collaborative	~F*S ~S*~I	F*S F*~I		~F*~I F*S*~I	F*~S*~I	
5 Impromptu		~F*I ~S*~I		~F*~S*~I ~F*~I	~F*S*~I	

Abbreviations: ~, denied; F, formal IPPMs; I, informal IPPMs; IPPMs, intellectual property protection mechanisms; S, semiformal IPPMs.