Coopetition, formal and informal appropriation mechanisms and the role of environmental dynamism and competition intensity

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Abstract

This paper studies how firms’ use of formal and informal appropriation mechanisms influences their propensity to engage in collaboration with competitors, also referred to in the literature as coopetition. Patents, trademarks, copyrights, and design rights are formal appropriation mechanisms. Secrecy, lead-time, and complexity are examples of informal appropriation mechanisms. The empirical analysis relies on a structural equation model which is estimated on a sample of innovating firms that operate in a large number of industries in the Netherlands in 1998/2000 and 2010/2012. The findings reveal the following pattern of results: firms’ reliance on formal appropriation mechanisms has a positive association with propensity to engage in coopetition, while past engagement in coopetition has a positive association with the subsequent use of informal appropriation mechanisms. External environments, characterized by different levels of industry competition intensity and dynamism, moderate the association between the use of appropriation mechanisms and coopetition. In dynamic industries, firms are more prone to engage in coopetition when using formal IP protection. The reliance on informal appropriation mechanisms, however, negatively affects the likelihood of coopetition. In industries characterized by strong competitive pressures, firms relying on informal appropriation mechanisms have a lower propensity to engage in coopetition. The analysis in this paper contributes to the coopetition literature by advancing our understanding of the link between competitor collaboration and firms’ use of formal and informal appropriation mechanisms (225 words).

Keywords: Coopetition, intellectual property, formal appropriation, informal appropriation, environmental dynamism, competition intensity

JEL-classification: O31, O32
Introduction

Due to the increasing need to stay ahead of competition, firms progressively opt to open their innovation process to gain access to a broader set of resources and skills (K Laursen & Salter, 2014). Previous research has shown that the benefits and risks for firms engaging in collaboration for innovation differ between types of partners, such as customers, suppliers, research institutes and competitors. One specific type of partnership is collaboration with competitors, also referred to in the literature as coopetition. Coopetition has attracted recent scholarly attention because it combines the paradoxical concepts of collaboration and competition – firms engage in coopetition in order to create value together, but also to capture this value for themselves (Gnyawali & Charleton, 2018).

Researchers who studied firms’ partnerships with rivals in the context of innovation have found that they aim to share research and development (R&D) costs (Hagedoorn, 1993; Pellegrin-Boucher, Le Roy, & Gurău, 2013), as well as the risks of market uncertainty (Gnyawali & Park, 2009). Furthermore, by committing complementary resources, firms can improve their innovation processes, resulting in more efficient product development (Gnyawali & Park, 2009; Mitchell, Dussauge, & Garrette, 2002).

Coopetition differs from other types of collaboration, as it entails substantial risks for the involved firms. Appropriation risks are high because competitors have an incentive to exploit their partners and behave opportunistically (Cygler, Sroka, Solesvik, & Dębikowska, 2018). The higher the partners’ resource commitments to the coopetitive relationship, the more opportunities for exploitation may arise (Gnyawali & Charleton, 2018). One way to minimize those risks is by managing the firm’s intellectual property (IP) (Holgersson, 2018). Early work by Cohen, Nelson and Walsh (2000) and Levin et al. (1987) established that both formal and informal appropriation mechanisms are relevant for protecting the innovative efforts of firms. Formal appropriation mechanisms (patents, trademarks, copyrights, and design rights), give innovating firms time-limited rights to exploit their inventions. Additionally, firms can use
informal appropriation mechanisms, such as secrecy, lead-time, and complexity (Hall, Helmers, Rogers, & Sena, 2014).

Recent research that investigated the interplay between coopetition and firms’ use of appropriation mechanisms suggests that firms are more prone to engage in collaboration with their rivals if they are able to protect their IP (Schmiele & Sofka, 2007). This line of research has predominantly focused on the formal protection mechanisms such as patents and copyrights (e.g. Hagedoorn & Ridder, 2012). However, the effectiveness of formal and informal appropriation mechanisms may vary depending on the environmental conditions in which firms operate (Cassiman & Veugelers, 2002; Hagedoorn & Zobel, 2015). In addition, the decision to engage in coopetition may also be context-specific (Ritala, 2012). Consequently, the role of contextual factors seems to be particularly relevant in the study at hand.

Prior studies have seldom examined the environmental conditions under which the reliance on formal or informal mechanisms may increase firms’ propensity to engage in coopetition. To address this gap, this paper examines the boundary conditions of two industry characteristics – competition intensity and dynamism – on the interplay between formal and informal appropriation and competitor collaboration.

The choice to study industry competition intensity and environmental dynamism follows logically from the fact that in dynamic markets, uncertainty is usually high (Chiambaretto & Fernandez, 2016). Consequently, firms often coopete in order to share risks related to this uncertainty (Gnyawali & Park, 2009), which requires them to have proper IP management in place (Holgersson, 2018). On the other hand, high industry dynamism is characterized by fast product turnover, which naturally causes protection mechanisms such as lead-time to become inefficient. Overall, Gnyawali and Charleton (2018) point out that exploring the dynamics of a firm’s environment is important, due to the particularly great
strategic relevance of knowledge. Sharing such knowledge with rivals can be harmful, again highlighting the importance of IP appropriation.

In addition, in highly competitive markets, firms need to work harder to gain and sustain a competitive advantage. They can achieve this by engaging in coopetition (Gnyawali & Charleton, 2018; Gnyawali & Park, 2009). However, it is intuitive that collaboration with rivals in highly competitive industries further increases the risk of exploitation and unintended knowledge spillovers. This requires them to have strong IP protection in place (Ritala & Hurmelinna-Laukkanen, 2009). Additionally, firms often use IP protection to block competitors, e.g. by patenting new inventions (Hall et al., 2014).

In summary, this study addresses the following question: How is the relation between firms’ reliance on formal and informal appropriation mechanisms and propensity for coopetition affected by environmental dynamism and competition intensity? By answering this research question, we respond to a call by scholars to investigate boundary conditions that affect the coopetition – IP relationship (e.g. Huizingh, 2011). In doing so, we study the link between two previously disconnected streams of literature (coopetition and IP protection) and extend the understanding of the phenomenon of coopetition.

We find that especially formal IP protection mechanisms are relevant in a firm’s decision to engage in coopetition. Furthermore, our findings indicate that in dynamic industries, firms using formal protection are more likely to engage in coopetition than firms using informal protection. Similar results are obtained when looking at the industry’s level of competitive intensity. Moreover, we investigate the likelihood to engage in coopetition with partners from countries with weak or strong IP protection regimes respectively, and find that for both, formal mechanisms seem to be preferred, while the effect is stronger in countries with weak IP regimes.

The remainder of this paper is structured as follows: Section 1 provides a review of the current state of research, based on which we formulate a set of hypotheses. In Section 2, we
outline the data, methods and measures, while Section 3 presents the results, and Section 4 their discussion. In Section 5, we point out the theoretical contributions and practical implications of this study, and in Section 6, we reflect on its limitations as well as suggestions for future research. A conclusion sums up the main points.

1. Literature review

Coopetition is frequently understood as the simultaneous pursuit of collaboration and competition (e.g. Bengtsson & Kock, 2000; Bouncken & Fredrich, 2012; Estrada, Faems, & de Faria, 2016; Gnyawali, He, & Madhavan, 2006). The notion of coopetition has first been introduced to academic research by Brandenburger and Nalebuff (1996). Since then, researchers are working on explaining the phenomenon in more and more detail, yet the benefits and risks remain underexplored, and findings are mixed. The reason for that might be reflected in the various theoretical perspectives that exist when looking at coopetition.

One the one hand, prior research highlights the notion of the resource-based view (RBV), under which a firm is considered “as a collection of sticky and difficult-to-imitate resources and capabilities” (Mowery, Oxley, & Silverman, 1998, p. 508). The authors argue that under the RBV, interfirm alliances can be seen as devices to gain access to other firms’ capabilities. Especially in coopetition, partners’ resource bases are often similar and complementary. By pooling their resources and skills, firms can enhance their innovation processes and increase efficiency/effectiveness (Gnyawali & Park, 2009; Mitchell, Dussauge & Garrette, 2002).

On the other hand, research highlights that a firm’s choice to collaborate should also be viewed from the perspective of transaction cost economics, because transaction costs are linked to opportunistic partner behavior and liabilities in value appropriation (Estrada, Faems & de Faria, 2016; Nieto & Santamaría, 2007). As illustrated by Cygler et al. (2018), those are some of the major risks entailed in coopetitive arrangements. Therefore, coopetition requires firms to
carefully manage and protect their resources such that they shield themselves from being exploited.

While thus coopetition can bear many benefits for a firm’s innovative performance, those can only be reaped if the company is able to protect itself from its partner’s opportunistic behavior (Holgersson, 2018). One way to do so is to make use of specific IP protection mechanisms.

1.1 Coopetition & IP protection

Research indicates a positive association between coopetition and IP protection (e.g. Estrada, Faems, & de Faria, 2016; Ritala & Hurmelinna-Laukkanen, 2013). As Czakon (2009), and Ritala and Hurmelinna-Laukkanen (2009) reason, firms can prevent unintended knowledge spillovers in coopetition by limiting access to their IP through appropriation mechanisms. Moreover, Ilvonen and Vuori (2013) argue that IP rights are used to protect knowledge in coopetition against exploitation and opportunistic partner behavior. As those aspects were identified as great risks of coopetition, we can assume that firms are more likely to engage in competitor collaboration if they are able to protect their knowledge. Schmiele and Sofka (2007), and Hall et al. (2014) reason that formal and informal forms of IP protection encourage firms to coopete, indicating the need to make a distinction between appropriation mechanisms. Based on this argumentation, we can formulate the following set of hypotheses:

H1: Firms’ prior collaboration with competitors has a positive association with their use of (a) formal and (b) informal appropriation mechanisms.

H2: Firms’ use of (a) formal and (b) informal appropriation mechanisms has a positive association with collaboration with competitors.
1.2 Environmental dynamism

Dynamic environments require firms to behave differently, as companies need to adapt to the accompanying uncertainty and fast-changing pace of the industry. Hagedoorn and Ridder (2012) highlight that the protection of IP for firms that engage in open innovation is particularly relevant in dynamic markets. Hall et al. (2014) point out that there can especially be differences between the use of formal and informal protection mechanisms. In less dynamic industries in which the rate of change is slow, firms have longer lead-times and might prefer informal mechanisms such as secrecy to keep their knowledge tacit. Using patents requires firms to disclose information, making knowledge explicit and available to competition. This in turn can diminish firms’ competitive advantage in such uncertain conditions. Therefore, formal mechanisms might be more effective in rather dynamic markets. Based on this argumentation, we can hypothesize the following:

$$H3: \text{Environmental dynamism moderates the association between collaboration with competitors and the use of appropriation mechanisms, such that in dynamic industries, firms using formal appropriation mechanisms are more prone to engage in coopetition than those using informal appropriation mechanisms.}$$

1.3 Competition intensity

In competitive environments, it is important for firms to protect their knowledge even more than in non-competitive industries, as the risk of exploitation is higher (Wu, 2012). Hagedoorn and Ridder (2012) identify competition intensity as one of the major contextual drivers for firms to engage in collaboration, while also emphasizing the fact that firms value IP protection more in such environments. This is in line with Cassiman and Veugelers (2002), who argue that firms’ competitive surroundings influence their choice of strategic protection. Hall et al. (2014) furthermore highlight that under high competition, there is a bigger chance of simultaneous innovation of firms. The authors argue that in such industries, firms often choose to use formal
appropriation mechanisms such as patents in order to block their rivals. In addition to that, Laursen and Salter (2014) mention that in contexts of strong competition, informal IP protection mechanisms can vanish quickly, rendering them less effective. Therefore, we can formulate the following hypothesis:

\[ H4: \text{Competition intensity moderates the relationship between coopetition and the use of appropriation mechanisms, such that in more competitive industries, firms using formal appropriation mechanisms are more prone to engage in coopetition than those using informal appropriation mechanisms.} \]

2. Data, methods and variables

This study makes use of data collected through the Dutch Community Innovation Survey (CIS). The CIS is a harmonized survey of firms’ innovation activities, collected biannually in member states of the Organization for Economic Co-operation and Development (OECD). In the Netherlands, the Central Bureau of Statistics (CBS) collects the data. Our dataset is compiled from the CIS 1998, 2000, 2010 and 2012, as information on firms’ use of informal appropriation mechanisms was only available in the CIS 2000 and 2012. Our sample consists of 2,207 innovating firms of which around 130 are included in both time-periods, resulting in 2,337 observations overall.

The reasons why the CIS represents an appropriate source of data for the research at hand are twofold. On the one hand, the CIS as a secondary source of data has several advantages over primary data, such as providing information about a vast number of firms from various industries. On the other hand, the firms included in the database differ in terms of size and resources available. This enables researchers to draw conclusions that are more generalizable.
2.1 Variables

The variable *Coopetition* is binary, where firms indicate whether they collaborate with competitors (1) and or not (0). Furthermore, firms also specify which types of appropriation mechanisms they use. We divide those into *formal*\(^1\) and *informal*\(^2\), and construct binary variables that turn (1) if a firm selects at least one of the mechanisms respectively.

To account for the market dynamism, we construct a measure to assess the *speed of technological change* in the market. We do so by following Belderbos et al. (2004), and dividing the sum of sales of new-to-the-market innovations by the sum of total sales (per industry). To assess competition intensity of the market, we construct a measure based on aspects that illustrate the competitive atmosphere of a firm’s market. In the CIS 2012, firms are asked to indicate the degree to which strong competition in price, as well as in quality and reputation, lack of demand, innovation by competitors, market domination by incumbents and high entry costs hindered them from achieving their goals. Combined, those aspects form the measure *competition intensity*, which a high internal consistency with a Cronbach’s \(\alpha = 0.82\). We assess the mean score per firm across all of the aforementioned factors and transform this to the industry level by again considering the mean. Due to data availability, this measure is only existent for the year 2012.

Besides that, we include *previous coopetition engagement* as independent variable to explain formal and informal appropriation. We do so due to the fact that firms want to capture as much value as possible from engaging in coopetition (Gnyawali & Charleton, 2018; Ritala & Hurmelinna-Laukkanen, 2009), and thus need to safeguard the (novel) knowledge from their rivals. It is measured as the lag of the coopetition variable.

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\(^1\)Formal mechanisms entail patents, trademarks, copyrights, and industrial designs.

\(^2\)Informal mechanisms entail secrecy, complexity, and lead-time.
In order to account for factors that might have an effect on firms’ likelihood to engage in coopetition, we include several control variables. Firms that spend many resources on research and development (R&D) are more likely to engage in collaboration for innovation than firms that spend only few or no resources on it (Belderbos et al., 2004). Therefore, we include a control measure for R&D intensity with a lag of one time-period, as we can expect the effect of R&D investment to be delayed.

In addition to that, we account for the firm size based on the logarithm of the number of employees in the previous period. As highlighted by Belderbos et al. (2004) and Leiponen (2005), big firms usually have more resources to allocate to R&D and to take in information, meaning they are more prone to engage in R&D collaboration (e.g. coopetition) and IP protection.

In line with this, we also identify firms that are part of a foreign multinational enterprise (MNE) by including a binary dummy, which takes value (1) if the headquarters of the firm’s company group is outside the Netherlands. Belderbos et al. (2004) highlight that firms that belong to a larger entity are able to make use of that group’s resources, potentially enhancing their attractiveness as partners. However, access to such resources might also diminish their incentive to collaborate externally.

Additionally, we assess whether firms experienced obstacles to the innovation process in the previous time-period. This accounts for the fact that firms that came across hurdles might be more likely overall to engage in collaboration (e.g. coopetition) to share risks and costs (Belderbos et al., 2004). In order to construct this measure, we look at firms’ responses to a CIS question about the obstacles they faced during the innovation process. More specifically, they indicate whether innovations had been “seriously delayed”, “stopped in the meantime” and “not started at all”. Based on this, we create a 3-point Likert scale of the most common obstacles as identified by Belderbos et al. (2004). Due to data limitations and inconsistencies throughout the
years, we need to restrict our selection to obstacles related to a lack of qualified personnel, lack of knowledge of the technology, lack of financing, high innovation costs, and market uncertainty. We then add up the firm’s score, divide it by the total amount possible, and take the lag of it.

Furthermore, we take into account the collaboration experience of firms. This means that we count the different types of partners a firm collaborates with excluding competitors, and divide it by the overall possible amount. Thereby, we create an average score for each firm, of which we take a one-period lag. Firms that have successfully engaged in collaboration previously are generally more prone to engage in collaboration again, as their future behavior depends on their previous experience (Laursen & Salter, 2006). Nevertheless, it is intuitive to assume that there is a maximum benefit to be achieved from collaboration engagement, as firms are only able to properly manage a certain amount of new knowledge (Laursen & Salter, 2006). Therefore, we include a quadratic term of collaboration experience.

Moreover, we control for the innovation performance of a firm in the previous period. Following the same logic as above, if firms successfully innovated in the past, they can be expected to also do so in the current time-period. This in turn can increase the firms’ likelihood of engagement in coopetition. We measure the innovation performance by dividing the radical innovation sales by the number of employees. As firms report those numbers in thousands in the CIS, we divide the result by 1000 to normalize the scale. In the analysis, we consider the lagged variable.

In order to account for the differences between manufacturing and service industries, we include a service dummy that takes value (1) if a firm is a service firm, and (0) if not as suggested by Belderbos et al. (2004).
2.2 Empirical model specification

The relationship between coopetition and the use of appropriation mechanisms is bi-directional (e.g. Arora, Athreye, & Huang, 2016). To accommodate this, we employ a generalized structural equation model (SEM) of the following form:

\[ Coop_i = \alpha_1 + \beta_1 formallP_i + \beta_2 informalP_i + \gamma_1 z'_{1i} + u_{1i} , \]  
(1)

\[ formallP_i = \alpha_2 + \beta_3 Coop_{i,(t-1)} + \gamma_2 z'_{2i} + u_{2i} , \]  
(2)

\[ informalP_i = \alpha_3 + \beta_4 Coop_{i,(t-1)} + \gamma_3 z'_{3i} + u_{3i} , \]  
(3)

where the subscript \( i \) indicates firm \( i \). \( Coop_i \) represents the coopetition variable, while \( formallP_i \) and \( informalP_i \) indicate firms’ use of formal and informal IP protection respectively. \( Coop_{i,(t-1)} \) represents a firm’s coopetition engagement in the previous period. \( z_i = [z_{1i}, z_{2i}, z_{3i}]' \) denote the (other) independent variables, while \( \gamma_1, \gamma_2 \) and \( \gamma_3 \) are vectors representing their coefficients. \( u_j \) symbolize the structural error terms.

In particular, in equation (1) we regress coopetition on formal and informal IP protection. Equations (2) and (3) complete the system and represent the regressions for formal and informal appropriation. Following Wooldridge (2013), we achieve identifiability of our SEM by ensuring that the exclusion restrictions on the model are fulfilled. The exogenous regressors introduced in the three equations might heavily overlap but are not the same. In other words, \( z_{2i} \) and \( z_{3i} \) contain at least one independent variable, which is not included in \( z_{1i} \) (see Table 3). Furthermore, in order to fulfill the rank condition, the coefficient of at least one of

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3 Within this paper, we consider two versions of equation (1), in which the content of \( z'_{1i} \) differs slightly. When estimating the direct effects, \( z'_{1i} \) contains only the control variables. When considering the effect of environmental dynamism and competition intensity however, \( z'_{1i} \) additionally includes the interaction terms.
these variables is required to be nonzero. We make use of clustered standard errors in order to prevent issues caused by heteroscedasticity.

### 2.3 Descriptive statistics and correlations

Table 1 gives us an idea of the spread of firms using formal and informal appropriation, as well as engaging in coopetition. Our sample consists of 2,337 observations of Dutch innovating firms from various industries in 1998/2000 and 2010/2012. We can see that around 11% of the observations engage in coopetition. Furthermore, 47% of the observations make use of formal appropriation mechanisms, and 65% employ informal ones. This indicates that a number of firms uses both formal and informal IP protection simultaneously.

In addition to the descriptive statistics, the correlations give us a first impression of the associations between the variables (see Table 2). Even though, no causality can be derived from correlations, it can be seen that coopetition and formal IP protection are positively associated \((r = 0.08)\), while the effect is similar but smaller for coopetition and informal IP protection mechanisms \((r = 0.06)\). This is a first notion supporting our expectations. Another interesting aspect to point out is that both the measures of environmental dynamism, as well as of competition intensity are negatively correlated to coopetition engagement \((r_{speed} = -0.04; r_{competition} = -0.06)\). However, they show a positive association with the use of formal \((r_{speed} = 0.16; r_{competition} = 0.21)\) and informal appropriation \((r_{speed} = 0.15; r_{competition} = 0.16)\), indicating the importance of knowledge protection in dynamic and competitive markets.

****Insert Tables 1 and 2 about here****

### 3. Results

Table 3 reports the results of equations (1), (2) and (3), where column I highlights the results of equation (2), and column II those of equation (3). Columns III-V display different variants of equation (1). As our findings indicate, we do not find enough evidence to fully support
hypothesis 1. Rather, we can only derive from the analysis that firms’ prior coopetition engagement has a positive association with informal appropriation mechanisms ($\beta = 0.082$, $p < 0.01$), lending support for H1b. Moreover, when only considering the direct association between appropriation and coopetition, we can only find support for H2a ($\beta_{formal} = 0.340$, $p < 0.05$) but not for H2b. However, when including the interaction terms in the models, we can find support for H2b (column IV: $\beta_{informal} = 0.724$, $p < 0.01$; column V: $\beta_{informal} = 2.889$, $p < 0.10$) but not H2a. As can be seen in column IV, hypothesis H3 can be supported, as the interaction between environmental dynamism and formal appropriation has a positive effect ($\beta = 1.202$, $p < 0.10$), while the one with informal protection is negative ($\beta = -1.757$, $p < 0.01$). In addition to that, H4 can be partially supported, as the interaction effect of competition intensity and informal IP is negative and significant ($\beta = -5.408$, $p < 0.10$), while the one with formal IP is positive but insignificant ($\beta = 3.143$, $p = 0.237$).

****Insert Table 3 about here****

3.1 Control variables

In addition to the main effects of interest, we also consider the role of the control variables. As expected, firms with higher R&D intensity are more likely to engage in coopetition in the future ($\beta = 0.780$, $p < 0.10$). Furthermore, they also are more inclined to choose formal and informal IP protection ($\beta_{formal} = 0.521$, $p < 0.001$; $\beta_{informal} = 0.252$, $p < 0.01$). Similarly, the propensity of firms to engage in collaboration with their competitors, as well as to use formal and informal appropriation is also higher the bigger they get ($\beta_{coopetition} = 0.156$, $p < 0.01$; $\beta_{formal} = 0.052$, $p < 0.001$; $\beta_{informal} = 0.027$, $p < 0.01$).

Another striking fact is that the effect of collaboration experience is indeed of an inverted-U-shape ($\beta_{cooperation(t-1)} = 0.336$, $p < 0.001$; $\beta_{cooperation(t-1)\text{sq.}} = -0.022$, $p < 0.01$). This indicates that collaboration experience encourages firms to engage in coopetition up to a certain point, after which the likelihood declines. Moreover, firms that previously innovated, are more likely to
use formal IP protection mechanisms ($\beta = 0.004$, $p < 0.05$) and to engage in coopetition ($\beta = 0.011$, $p < 0.05$). However, firms that experienced obstacles to their innovation process previously, are more inclined to make use of informal IP protection ($\beta = 0.181$, $p < 0.01$).

Looking at the industry differences, it seems that service firms are less prone to use formal appropriation ($\beta = -0.095$, $p < 0.01$) Furthermore, we can see that in highly dynamic markets, firms generally seem to be more prone of choosing informal IP protection mechanisms ($\beta = 0.132$, $p < 0.05$). In competitive industries, firms select both formal and informal appropriation mechanisms, where the effect is stronger for formal ones ($\beta_{\text{formal}} = 1.552$, $p < 0.001$; $\beta_{\text{informal}} = 0.949$, $p < 0.001$). When looking at firms’ likelihood to engage in coopetition however, competitive intensity has a negative effect ($\beta = -3.367$, $p < 0.05$).

### 3.2 Supplementary analyses

In order to ensure a certain robustness and validity of our results, our sample is selected very conservatively, only including firms that are considered innovators. Firms that are not innovators are not required to fill in the complete CIS. Thereby, lots of missing values and zeros are introduced to the data. By selecting only those firms that innovate, we can diminish such bias. Moreover, we include a selected variety of control variables to account for the effects of both firm- and industry-level factors. We also ran a more extensive model on data from 1998/2000, including a very broad variety of control variables. Due to limitations in the data, we could not include all of those variables in the study at hand. However, the findings of the 1998/2000 model are essentially similar to the ones obtained here. This indicates robustness of the current results, since the effects remain similar, even though we include less control variables.

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4 Results are available upon request.
Next to investigating coopetition engagement overall, we additionally considered coopetition with firms in different countries, as laws and strength of protection can differ. In particular, we split the coopetition variable into *coopetition with firms in countries with a strong appropriation regime*\(^5\) and *coopetition with firms in countries with a weak appropriation regime*\(^6\). In countries with weak laws and regulations for the protection of IP, the risk of unintended knowledge spillovers and exploitation is even higher (Oxley, 1999). In particular, Schmiele and Sofka (2007) point out that firms engaged in international coopetition need to shift from using informal appropriation mechanisms to formal ones.

The outcomes of the analyses are presented in Table 4. As can be seen in columns I-III, almost all coefficients are insignificant when considering the association of appropriation and coopetition in countries with weak IP regimes. One striking aspect to point out, however, is that the association between formal appropriation and coopetition is positive and significant. Columns IV-VI illustrate the relationship between appropriation and coopetition in countries with strong IP protection regimes. As displayed in the table, the effects are rather similar to the general findings of this study. This means that in dynamic and competitive industries, firms seem to be less likely to engage in coopetition with firms in countries such as the US, if they are using informal appropriation mechanisms.

****Insert Table 4 about here****

4. Discussion

In this study, we examine the association between coopetition and formal, as well as informal appropriation mechanisms. In particular, we focus on the moderating role of environmental dynamism and competition intensity. Prior research has not extensively investigated this relationship, and with our findings, we aim to extend the current understanding of the concept

\(^5\) Those are countries such as the US and from the EU.
\(^6\) Those are countries such as India and China.
of coopetition. Within this section, we discuss the outcomes of our study and elaborate on the implications they have for theory and practice.

4.1 Coopetition and IP appropriation

We observe that firms that previously engaged in coopetition are more likely to make use of informal protection mechanisms than those that did not coopete. This means that those firms are more prone to protect their IP with secrecy, lead-time or complexity. Park, Srivastava, and Gnyawali (2014) argue that a firm’s coopetition experience allows it to gain a better understanding of how to manage the tensions entailed by coopetition. The authors reason that high coopetition experience enables firms to diminish the negative effects of coopetition, e.g. by using IP protection (Holgersson, 2018).

Besides previous coopetition experience, we also find that choice of appropriation mechanism is dependent on the competitive intensity of a firm’s industry. While we can see firms choose both formal and informal mechanisms in competitive markets, the effect of the former is bigger. This is in line with our earlier argumentation that under high competition intensity, there is a high chance of multiple firms working on the same inventions. Then formal mechanisms such as patents can be used to block rivals and prevent them from achieving competitive superiority (Hall et al., 2014). In addition to this, we observe that the service dummy negatively affects the likelihood of a firm to use formal appropriation. This is in line with research considering knowledge-intensive business sectors (KIBS), which finds that innovating firms in such industries prefer secrecy to patents (Hall, Helmers, Rogers, & Sena, 2013).

Prior literature has indicated that there is a positive association between firms’ IP protection and their engagement in coopetition (Estrada, Faems, & de Faria, 2016; Ritala & Hurmelinna-Laukkanen, 2013). Our findings generally are in line with this notion. More specifically, we find a positive significant effect of formal IP on propensity to engage in
coopetition in Table 3, column III. Furthermore, in column IV and V of Table 3, informal IP appropriation has a positive significant effect.

4.2 Contextual factors
When considering the role that environmental dynamism plays in the relationship between coopetition and IP appropriation, we observe that in dynamic industries, firms are more prone to engage in coopetition when they use formal IP protection. Contrary to this, when using informal appropriation mechanisms, the propensity to engage in coopetition declines. This indicates that in industries where product turnover is fast, informal mechanisms may not be as effective as formal ones. For instance, lead-times are not an effective means of IP protection anymore, as products change very quickly and have rather short time-to-market. Rather, firms seem to be more comfortable engaging in coopetition under such circumstances, when they have formal appropriation in place.

We find somewhat similar results when considering the intensity of competition of firms’ industries. While the effect of formal appropriation is positive, it is insignificant. However, just as in dynamic markets, it seems detrimental for firms’ propensity to engage in coopetition in highly competitive industries, when the company makes use of informal IP protection. As highlighted by Hall et al. (2014), in competitive industries, various firms could be in the process of innovating the same product simultaneously. In such cases, formal mechanisms such as patents can be used to block competitors and prevent them from inventing the same product. However, informal mechanisms such as secrecy are ineffective in those cases, as they do not help blocking rivals. In addition to that, while both formal and informal appropriation have a positive association with coopetition on their own, in combination with competitive intensity, this changes. As can be seen in column III in Table 3, in highly competitive markets, firms are less prone to engage in coopetition. This effect seems to become even stronger in combination with informal IP protection (column V).
5. Contributions to theory and practice

5.1 Implications for theory

Laursen and Salter (2014) call for future research to establish and explore the connection between the choice of protection mechanisms and different partner types. Our study responds to this call by investigating the association between coopetition and the choice of formal and informal IP appropriation. By doing so, we advance the current state of literature in several ways.

Firstly, we extend literature by investigating the link between two previously disconnected fields of research – coopetition and IP protection. While there is quite some literature studying the role of IP protection in the context of open innovation, most of it considers general aspects of collaboration, rather than focusing on specific partner types. Particularly the aspect of coopetition has been greatly overlooked, while others indicate that coopetition is a very specific type of R&D collaboration (Cygler et al., 2018; Gnyawali & Charleton, 2018).

Secondly, in addition to investigating the general link between firms’ propensity to engage in coopetition and IP appropriation, we also consider the role of contextual factors. By taking into account environmental dynamism and competition intensity, we provide a more detailed picture of this relationship. We show that the association between coopetition engagement and IP protection is not straightforward, but rather is influenced by such external factors.

Thirdly, we do not merely consider IP protection as one construct but rather separate formal and informal ways of protection. As shown by Hall et al. (2014), firms differ in their preferences of protection mechanisms, which indicates the necessity to make a clear distinction. In addition to that, we find that many studies investigate one or two particular IP protection
mechanisms. While this aims at distinguishing between formal and informal protection, we believe that it does not provide a complete picture. We introduce a broader, more generalizable measure, taking into account the fact that firms can make use of more than one form of protection simultaneously. Therefore, we deem it necessary to include a measure for both formal and informal protection that is able to pick up this effect.

5.2 Implications for practice
The practical implications provided by this research are twofold. First, we show that coopetition and IP protection are associated with each other. This is potentially relevant for policy makers, as the appreciation and acceptance of coopetition hinges on the fact that it is beneficial to society rather than leading to collusion. Second, firms’ strategic-decision making can be improved, as they might choose to use different and/or more mechanisms to protect their IP after considering our results. By taking into account the dynamism and competitiveness of various industries, we enhance the decision process even more. This should lead to firms deriving more benefits from coopetition, and increasing protection of IP appropriately, ultimately helping them gain and sustain a competitive advantage.

6. Limitations and future research
Within this section, we highlight some limitations to our study and point out potential future research avenues, both arising from those limitations and our findings. Generally, we face the same issues as many studies that use CIS data. First, it is a survey-based data collection method, entailing potential biases such as self-selection. As firms respond to the survey voluntarily, we might not be able to work with a fully random sample. Furthermore, the questions in the CIS are not specialized to this study but fit a rather broad variety of research projects. This means that we often face restrictions in terms of variable measurement and consistency for instance. Due to such a restriction, the study at hand uses data from 1998/2000 and 2010/2012, as those
are the only two collection waves that ask for information on both formal and informal IP protection.

We suggest that there are still various research avenues to be discovered. Schmiele and Sofka (2007) indicate that there are differences in choice of protection mechanisms. Following up on this, we provide an initial idea of inter-country differences. However, we believe this could be extended. Therefore, future research could for instance investigate the role of other moderating factors, such as geographic aspects in more detail. In addition to that, besides investigating additional boundary conditions, future research could also focus on data from different countries. Since the CIS is collected within all OECD member states, a country comparison would be feasible. This would be interesting as it takes into account the structures and regulations of a firm’s home market.

**Conclusion**

This paper studies then link between two rather disconnected fields of research by investigating the association between coopetition and IP protection. We find that generally, prior engagement in coopetition increases a firm’s subsequent use of informal appropriation mechanisms. Furthermore, both formal and informal IP protection are positively associated with a firm’s likelihood to engage in coopetition. However, those effects are dependent on contextual factors such as competition intensity and environmental dynamism. In dynamic industries, firms are more likely to engage in coopetition, when they protect their IP using formal mechanisms. When making use of informal appropriation however, the propensity decreases. Looking at industry competitiveness, we find that firms’ likelihood to collaborate with rivals decreases when they protect their IP with informal mechanisms. By means of this study, we manage to advance the open innovation literature, as well as research in the fields of coopetition and IP. We are able to shed more light on the role played by formal and informal IP protection mechanisms, as we clearly distinguish between them in our analysis. While we provide a first
investigation of the role of contextual factors in the relationship between coopetition and IP protection, future research in the field should help create a more detailed picture.
References


Hagedoorn, J., & Ridder, A. (2012). Open innovation, contracts, and intellectual property
rights: an exploratory empirical study.


## Appendix

*Table 1: Frequencies*

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<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent of sample</th>
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Table 2: Descriptive statistics and correlations

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<td>Informal IP</td>
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Note: N = 2,337; * p < 0.05
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<td>0.789* (1.69)</td>
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<td>0.027** (3.47)</td>
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<td>0.154** (2.84)</td>
<td>0.156** (2.90)</td>
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<td>0.160 (0.88)</td>
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<td>0.001 (0.71)</td>
<td>0.011* (2.06)</td>
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<td>0.010* (2.06)</td>
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<tr>
<td>Coopetition</td>
<td>0.036 (1.14)</td>
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<td>Cooperation-1</td>
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<td>0.336*** (5.30)</td>
<td>0.340*** (5.33)</td>
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<td>Cooperation-1²</td>
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<td>-2.039* (-2.36)</td>
<td>-2.974* (-2.05)</td>
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**Note:** z-statistics in parentheses; † p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001; N = 2,337
Table 4: Results - generalized SEM (weak and strong IP regime)

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<td>Informal IP</td>
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<td>0.703* (2.53)</td>
<td>3.018* (1.94)</td>
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<td>2.127 (1.60)</td>
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<td>Informal*Comp Int</td>
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<td>2.540 (0.93)</td>
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<td>R&amp;D intensity, t-1</td>
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<td>1.634 (1.60)</td>
<td>1.584 (1.64)</td>
<td>0.757 (1.58)</td>
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<tr>
<td>Ln(Firm size, t-1)</td>
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<td>0.179 (1.29)</td>
<td>0.183 (1.35)</td>
<td>0.131* (2.37)</td>
<td>0.130* (2.34)</td>
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</tr>
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<td>Obstacles to innovation, t-1</td>
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<td>0.393 (0.97)</td>
<td>0.410 (1.02)</td>
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<td>Part of MNE</td>
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<td>Service dummy</td>
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<td>0.179 (0.99)</td>
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<td>-0.001 (-0.23)</td>
<td>-0.001 (-0.23)</td>
<td>0.011* (2.21)</td>
<td>0.012* (2.28)</td>
<td>0.011* (2.21)</td>
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<td>-0.025 (-0.15)</td>
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<td>0.021 (1.57)</td>
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<td>-3.078* (-2.08)</td>
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Note: z-statistics in parentheses; † p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001; N = 2,337