

THE TIMING AND TYPE OF ALLIANCE PARTNERSHIPS IN THE NEW  
PRODUCT DEVELOPMENT PROCESS

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PRODUCT DEVELOPMENT PROCESS

By:

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## **ABSTRACT**

Recent years have witnessed a growing concern for the ability of firms to effectively manage their new product innovation in the face of disruptive technological changes, increased global competition, and rising costs of research and development. These concerns notwithstanding, firms are additionally required to launch radical new products to the market, as incremental new products provide their developers with only short-term sales and profitability. In response to these challenges, firms have entered into collaborative alliances to share the risks and costs involved in the new product development (NPD) process and to enhance their product innovation performance.

Turning research discoveries into marketable radical new products through collaborative alliances is even more important for relatively small firms operating in technologically intensive industries. Such firms are often underfunded and unable to undertake a full NPD cycle internally due to an inability of assembling the right mix of internal capabilities. The inevitable need to access capabilities from alliance partners may lead some small firms to form collaborative alliances under unfavourable situations, which make alliances prone to failure (70% by some estimates) to reach new product innovation goals. The substantial rate of alliance failure is embedded in a clash between the logic of radical new product innovation management (the need for flexibility between alliance partners), and recommendations for alliance management (the need to determine the responsibilities of each partner from the onset of the alliance). Despite the benefits of alliances in providing required resources, alliances can impose substantial transaction costs to focal small firms. Thus, it is crucial to investigate how firms, particularly small

firms, can make a balance between the benefits and costs involved in alliances, to mitigate alliance risks and increase the probability of new product radicalness.

In this thesis, I introduce a new typology and demonstrate its application to product performance. The typology categorizes alliance partnerships along two dimensions of partnership timing (the stage of the NPD process during which alliance is formed) and partnership type (the role of alliance partner during the NPD process). I use this this typology to determine the interaction effects of partnership timing and type on the probability of product innovativeness (radicalness). To this end, I rely on insights from Transaction Cost Economics (TCE) and Resource Based View of the firm (RBV) theories as well as the absorptive capacity concept to develop testable hypotheses. I use a sample of 230 drugs developed by 85 biotechnology firms in collaborative alliances with 384 alliances in 1982-2016 with universities and research institutes, other biotechnology firms, and pharmaceutical firms formed during discovery, development, and prelaunch stages of the new drug development process.

I find that the probability of drug radicalness increases when alliances with universities and research institutes, as well as other biotech firms, are formed during the discovery or development stages of the new drug development. However, results indicate that partnership with pharma firms during the discovery or development stages reduces the likelihood of drug radicalness. During the prelaunch stage, except for negative relation between alliances with other biotech and drug radicalness, results failed to find a significant relationship between university as well as pharmaceutical partnership and drug radicalness.

By disintegrating alliances along two dimensions of partnership type and timing, this thesis substantially increases the understanding of the benefits and costs of each partnership type and during each stage of the NPD process. This helps relatively small firms to better understand when and with whom during the process of NPD they need to initiate alliances to increase their likelihood of product radicalness. This thesis also contributes to the current theoretical insights of TCE and RBV theories by considering costs and benefits of each partnership type variant along different stages of the NPD process. Methodologically, instead of focusing on analysis using firm level outcome variables (count number of new products), this thesis turns the unit of analysis to product level (innovativeness of the product) and links each product to its designated alliance attributes (timing and type) to provide more subtle and fine-grained implications.

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## **CHAPTER I**

### **INTRODUCTION**

#### **A new delineation and application of alliances for developing new products**

The focus in this thesis is on the innovativeness (radicalness) of ready-to-launch products by turning the lens on the history of collaborative alliances formed to create these products by their focal developers (firms). To this end, I introduce a typology for collaborative alliances along two dimensions, alliance partnership timing and alliance partnership type. Table 1 summarizes the relevant prior studies and the novel points of departure of this thesis that differentiate it from previous work in the literature. The following sections outline the relevant background and the motivation behind conducting this thesis, followed by a list of theoretical, methodological, and practical contributions that this study offers to the literature of collaborative alliances, product innovations and new product development (NPD), and marketing strategy. In this thesis, product innovativeness and radicalness are used interchangeably.

#### **Background and motivation**

New product innovations largely determine firm growth and profits (Booz, Allen, & Hamilton, 1982). Developing new products is essential for the success of companies and has long been recognized as an imperative source of increasing competitive strengths and creating new capabilities (e.g. Kotabe & Swan, 1995; Sivadas & Dwyer, 2000). However, due mainly to constant technological change, standardization, and globalization, organizations are increasingly facing challenges associated with product

innovations during the process of NPD. These challenges include rising costs of research and development (R&D), shorter product life-cycles, and rapid reduction in profit margins (Rindfleisch & Moorman, 2001; Teece, 1987). Research also shows that, on average, nearly 50% of new products fail after their introduction to the market (Castellion & Markham, 2013). This considerable rate of product failure further exacerbates and magnifies these challenges during the process of developing new products.

In the face of these forces, firms need to apply strategies that enable them to not only mitigate NPD challenges, but also maintain their strategic advantage in the market (Calantone, Di Benedetto, & Meloche, 1988) by generating more innovative new products. A firm can develop multiple incremental product innovations by relying either on market-based transactions or on in-house resources and expertise (Dickson, 1992). Developing incremental product innovations through such strategies is less risky and more structured than developing radical innovations (Utterback, 1987). Although incremental new product innovations may seem to be feasible strategies in addressing the myriad of NPD challenges, research has demonstrated that incremental innovations often provide firms with short-term benefits only (e.g. Hauser, Tellis, & Griffin, 2006). On the other hand, radical product innovations are often disruptive to the existing internal resources and require a vast array of resources to develop and bring to market (D'Aveni, 1994). The increasing needs of firms for developing radical new products, along with the significant challenges mentioned earlier, suggest that it is imperative to study interorganizational strategies and their effects on the innovation performance of firms. Such strategies enable firms to gain access to a variety of resources as well as reduce the

risks and costs associated with product innovation and the NPD process (Sivadas & Dwyer, 2000).

The performance effects of interorganizational new product development strategies have received attention through empirical studies in marketing strategy and the product innovation literature. Early studies (Hagedoorn & Schakenraad, 1994; Kotabe & Swan, 1995; Powell, Koput, & Smith-Doerr, 1996; Mitchell & Singh, 1996; Stuart, 2000), for the most part, compared the performance effects of firms choosing interorganizational (alliances) versus organizational (market-based and in-house NPD) strategies. However, these studies currently offer only limited implications to product innovation research and firms operating in technologically-intensive industries. This is due to the inception of a paradigm shift from market-based transactions and in-house strategies to interorganizational arrangements which began in the 1990s (Webster, 1992). For example, Saxton (1997) states that nearly all organizations practice some form of interorganizational strategies, reducing the implications of discussions regarding the superiority of interorganizational over organizational strategies. Thus, an upsurge in the popularity of alliances has further called into question and rendered the results of previous studies comparing the performance effects of organizational versus interorganizational strategies less useful.

Notwithstanding the interorganizational paradigm shift, previous research in product innovation suggest contradictory findings. For example, a study by Kotabe and Swan (1995) concludes that products developed by multiple organizations are less innovative than those developed by single firms. On the other hand, a more recent study

by Stuart (2000) concludes that the innovation performance of firms that rely on alliance collaborations is significantly higher than comparable firms without such arrangements. Even results of studies where the primary focus is on alliance-performance linkages offer controversial conclusions. For example, in their seminal work, Dyer and Singh (1998) provide evidence that external R&D collaborations (relational view) enhance performance (relational rents), while more recent studies (e.g. Salge, Farchi, Barrett, & Dopson, 2013) cast doubt on the use of external R&D resources as a panacea for NPD success. Such alliance-performance inconsistencies suggest that important contingencies affecting the link between firms' alliances and performance have been overlooked (Gesing, Antons, Piening, Rese, & Salge, 2015). This indicates an oversimplification of alliance relationships in prior studies, leading to aggregation biases and controversial results (Hoang & Rothaermel, 2010).

Powell et al. (1996) consider alliances as inherently complex and multifaceted system of interorganizational relationships. Yet, current studies have overly simplified these relationships by focusing on aggregate measures of alliances (e.g. raw numbers) and their effects on the firm's performance outcomes, overlooking the significant variations across such relationships (exceptions are Baum, Calabrese, & Silverman, 2000; Lavie & Rosenkopf, 2006; Rothaermel & Deeds, 2006). This is a clear gap in the literature and current alliance-performance findings are at the risk of aggregation bias unless further studies systematically explore different facets of interorganizational relationships and examine how variations among them impact the outcomes of product innovation.

Aside from an oversimplification of new product alliance-performance, one of the chief problems in understanding the innovation effects of alliances has been the lack of meaningful measures (proxies) to represent innovation performance (Capon, Farley, Lehmann, & Hulbert, 1992; Utterback, 1987). Kotabe and Swan (1995) argue that prior studies largely used aggregate measures of R&D expenditure and patents and ignored investigating product innovativeness using the inherent attributes and features of the product itself. As a result, findings from prior studies may not reflect a true account of the advantages, disadvantages, and innovation performance effects of alliances. Given the popularity and complexity of new product alliances among different organizations (Powell et al., 1996), and the convergence of many cutting-edge technologies (Kotabe & Swan, 1995), a lack of empirical studies in response to these gaps in product innovation and NPD research is surprising.

More specifically, implications derived from the current body of research in this domain put forward three important gaps. First, in response to increasing NPD challenges, relying on incremental types of new product innovation introduced to the market may not lead to a firm's competitive advantage. Also, focusing on the number of innovation outcomes instead of product innovativeness may result in misleading insights. Since radical innovations provide the firm with substantially more sustainable competitive advantages in the market than incremental innovations (Kotabe & Swan, 1995), it is important to study how firms can develop radical product innovations while facing NPD challenges. Second, due to the popularity of new product alliances (a paradigm shift from in-house to alliance arrangements) for NPD, the current alliance-



performance studies comparing firm performance through the comparison of in-house versus alliance strategies have become ineffective. Third, more recent studies with a primary focus on the effects of alliances on firm performance demonstrate measurement issues, contradictory results, and aggregation bias due to overlooking the complexity and variations across alliance relationships. To address these gaps in the literature, a more relevant question is how the innovativeness of a firm's product is related to the attributes of alliances.

Having recognized these gaps in the literature, the objective in this thesis is to build on prior studies and extend innovation research and contribute to the existing body of innovation and marketing strategy literature and, further, to provide updated managerial implications in this regard. More specifically, I examine the innovativeness of new products (measured as incremental vs. radical new products) and investigate their association with new product alliances formed during different stages of the NPD process with different partners.

Following the definition of a business alliance in the marketing and strategy literature (e.g. Rindfleisch & Moorman, 2001), I define a *new product alliance* as a formal interorganizational relationship between two or more independent organizations to achieve a common NPD objective. I consider new product alliances as a product development governance mode applied to the process of NPD. The process of NPD spans from discovery through development and prelaunch stages (Fang, Lee, & Yang, 2015). On the other hand, partner selection (Shah & Swaminathan, 2008) and, therefore, partnership type is one of the most influential factors in the success of alliance

performance. Following the conceptualization used in Baum et al. (2000) in terms of alliance partnership types as well as NPD process conceptualization employed by Fang et al. (2015), I distinguish the alliances that a focal firm enters into for the purpose of developing its product into two dimensions of ‘alliance partnership type’ (consisting of three partnership types) and ‘alliance partnership stage’ when the firm chooses to initiate alliances (consisting of discovery, development, and prelaunch stages of the NPD process). In particular, I conceptualize and empirically test the interactive effects of alliance partnership type and alliance stage on the innovativeness of products instead of the raw numbers of products introduced to the market.

To address the aforementioned gaps in the literature and introduce a theoretical framework to the literature as a basis for testing hypotheses in this study (presented in chapter 3), I rely on transaction cost economics (TCE) (Heide & John, 1990) and resource-based view (RBV) (Barney, 1991; Hitt, Dacin, Levitas, Arregle, & Borza, 2000) theories as well as the concept of absorptive capacity and the interorganizational learning literature (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998). While the insights provided by TCE are, for the most part, cost-oriented with a focus on reducing the risk of opportunism and transaction costs, RBV and interorganizational learning provide more benefit-oriented insights. Therefore, a combination of these theoretical frameworks provides the required structure to the study of product innovativeness, as it considers the benefits and the costs of new product alliances under both different partnership types, and different stages of the NPD process. Relying on these complementary theoretical frameworks, I can better advance a contingency model (alliance partnership type/alliance

stage) in which a firm's product innovativeness depends on the benefits accrued by each partner, their individual motivations, and absorptive capacity considerations alter the transaction costs involved in different alliance partnership types formed at different NPD stage.

### **Research questions and empirical context**

In accordance with TCE, I argue that firms initiating new product alliances with other organizations face varying degrees of transaction costs involved at each stage of the NPD process. Two main sources of transaction costs during the NPD process are performance uncertainty and product specificity (Heide & John, 1990; Rindfleisch & Heide, 1997; Santoro & McGill, 2005). New product alliances which commence at earlier stages of the NPD process result in higher product specificity and larger performance uncertainty due to the costs associated with the extensive search needed for discovering new knowledge (Rothaermel & Deeds, 2004). However, the magnitude of these costs for the focal firm varies according to the type of partnership (Baum et al., 2000). In other words, for a given partnership type with certain benefits, the transaction costs vary based on the stage during which the new product alliance is formed. Although a firm's new product alliance with its partner may be considered beneficial, such benefit is contingent on the variant transaction costs on the stage (timing) such alliance is formed. For example, the alliance formed during the discovery stage of a drug between a focal biotechnology (biotech) firm and its pharmaceutical (pharma) partner, involves significantly higher transaction costs than an alliance formed during the prelaunch stage. In this case, the insight offered by RBV regarding the benefits of a particular partnership

type will be complemented (mitigated) by the insight from TCE regarding the variant levels of transaction costs at different stages of NPD process. To address how the change in transaction costs embedded in each stage of the NPD process affects the product innovativeness for each partnership type, I aim to answer the following research question:

i) How does the innovativeness of a new drug launched in the market by a biotech firm relate to the focal firm's decision to form alliances at the discovery, development, and prelaunch stages of the new drug development process when the partnership type is a) universities, b) other biotech firms, and c) pharma firms?

In accordance with the interorganizational (cooperative) aspect of RBV, firms can obtain some important resources through collaborative alliances from external sources, as these are heterogeneously distributed among organizations (Hitt et al., 2000; Wernerfelt, 1984). This theoretical aspect relies on the benefits of different organizations in providing the focal firm with competitive advantage in the market. During each stage of its NPD process, a firm can form alliances with different organizations. In this case, although the transaction costs regarding the NPD stage is the same (product specificity and performance uncertainty), the benefits involved in each partnership type may vary. In other words, each partnership type offers a specific benefit at a given level of transaction costs. Having considered that benefits related to each specific partnership type at a given stage of the NPD process, a firm can increase the chance of its product innovativeness. For example, during the discovery stage of the new drug development process with a substantial amount of transaction costs, a focal biotech firm's choice of the alliance partnership with pharma, other biotech, or universities affects the drug radicalness of the

focal firm in different ways. In this case, the insight from TCE regarding the transaction costs involved for each specific stage of the NPD process can be complemented by insights from RBV regarding the variant benefits involved in alliance partnerships with different partners. Aside from the RBV premises which allow us to better understand the benefits and the primary motivations in entering new product alliances of each partnership type, firms also need to consider their ability to absorb the relevant technological knowledge (Cohen & Levinthal, 1990) of their partners, irrespective of the main motivation (Schildt, Keil, & Maula, 2012) for alliance formation. This conceptualization reflects how relative absorptive capacity influences a focal firm's ability to absorb knowledge from different partners at various stages of the NPD process. To address how the change in benefits involved in each alliance partnership type affects the product innovativeness for each stage (timing) of the NPD process, I aim to answer the following research question:

ii) How does the innovativeness of a new drug launched in the market by a biotech firm relate to the biotech firm's decision to form alliances with universities, other biotech firms, and pharma firms when the stage of the new drug development is a) discovery stage, b) development stage, and c) pre-launch?

In summary (also shown visually in Graph 1), the first question relies mainly on RBV as the theoretical perspective setting the constraint (partnership type is constant) and TCE as the conditional variable (different stages of the NPD process incur different transaction costs). However, the second question is posed based on TCE as the theoretical

perspective setting the constraint (transaction cost is constant in each NPD stage) and RBV as the conditional variable (Different partnership types offer different benefits).

The industrial context of this thesis is the biopharmaceutical (biopharma) industry as this sector offers abundant variations regarding partnership types formed at different stages of the NPD process. These attributes make this industry an appropriate context for testing the hypotheses of this study (presented in Chapter 3). In this study, I focus on biotech firms forming new product alliances from discovery through development and prelaunch stages of a new drug development process with research institutes and universities, other biotech firms, and pharma firms. This natural setting provides an opportunity to study how new product alliances that focal biotech firms initiate with their partners at different stages of the NPD process lead to increased innovativeness of focal firms' new products. Considering the potential variance that exists across new product alliances, initiated under different motivations, with various partners at different NPD stages, provides important insights that can help biotech firms (as relatively small firms) better manage their new product alliances to advance the innovativeness of their new products. In Chapter 3, I develop two sets of testable hypotheses in this empirical context in line with the research questions stated earlier.

These guiding research questions, and in line with the theoretical conceptualization in this study, I examine factors at alliance, firm, and drug levels. First, at the alliance level, consistent with previous studies (e.g. Baum et al., 2001; Fang et al., 2015), I emphasize the use of three partnership types formed at three stages of the new drug development process. According to this conceptualization, focal biotech firms

coordinate interactions with their partners to maximize the benefits and minimize opportunistic behaviours of partners associated with product specificity and performance uncertainty at different stages of the new drug development process. Second, at the firm level, I specify focal firm capabilities by considering its size and capacity to conduct activities related to research and development (R&D) (Dutta, Narasimhan, & Rajiv, 1999), as a method of controlling for heterogeneity among the focal biotech firm's ability in generating more innovative drugs. Third, I also identify therapeutic areas and approval dates of drugs as a method of controlling for economic and competitive factors in a market over time (Hoang & Rothaermel, 2010), as these factors can explain some of the variations in the innovativeness of drugs.

I collected archival (historical) data from multiple sources, including the Food and Drug Administration (FDA), Deloitte Recombinant Capital (Recap), Compustat, and LexisNexis. As mentioned earlier, the empirical setting in this thesis is the biopharma industry, a technologically-intensive sector consisting of a heterogeneous population of organizations. I examine product innovativeness from the perspective of biotech firms because they are normally under more pressure than industry incumbents (large pharma firms) to leverage their unique technological resources by configuring new product alliances with other entities (Haeussler, Patzelt, & Zahra, 2012).

Relying on a hypothesis-testing methodology for 230 approved drugs developed by 85 focal biotech firms from 1982-2016, I find that the alliances that biotech firms form with universities, other biotech firms, and pharma firms during the discovery, development, and prelaunch stages of their new drug development process, relate

inconsistently with the radicalness of new drugs. This finding primarily demonstrates the importance of distinguishing new product alliances into partnership type and partnership stage.

Relying primarily on RBV and absorptive capacity, and secondarily on TCE, our results demonstrate that setting alliances with universities during both the discovery and development stages has positive impact on radicalness of new drugs. It indicates the higher benefits of university partnerships during early stages of the new product development process. However, the results failed to support the negative association between university alliances and drug radicalness during the prelaunch stage of the new product development process. I find comprehensive support for the positive effect of alliances with other biotech firms and drug radicalness during discovery and development stages. The results also support the posited negative association between such partnership types and drug radicalness during the prelaunch stage. In addition, the results show a negative association between pharma alliance and drug radicalness during the discovery stage. However, the results failed to support the positive association between this partnership type and the radicalness of drug.

Relying primarily on TCE, and secondarily on RBV and absorptive capacity, the results demonstrate that during the discovery stage, the likelihood of radical new drugs decreases when the focal firm forms alliances with pharma firms, whereas this likelihood increases in partnerships with universities and other biotech firms. Also, during the development stage, the likelihood of radical new drugs increases when the focal firm forms alliances with universities and other biotech firms. However, contrary to



expectation, this likelihood decreases as the likelihood of allying with pharma firms increases. Finally, during the prelaunch stage, unsurprisingly, the effect of alliances with other biotech firms on the likelihood of drug radicalness is negative.

## **Contributions**

### **Offering a New Typology of ‘Alliance Timing-Type’**

Although prior studies have acknowledged the complexity of interorganizational (alliance) relationships and the wide dispersion of resources in a technologically intensive industry (e.g. Powell et al., 1996), current empirical research has largely oversimplified such interactions and the consequences of their performance. This oversimplification of alliances used in prior studies (e.g. using the number of alliances a firm forms), increases the risk of aggregation bias and can lead to spurious results. In this study, I extend the alliance literature by introducing a new alliance typology and examining its application to the innovativeness of new products. The Alliance Timing-Type typology categorizes alliance relationships which focal firms form in an industry, by the timing and the type of alliance partnerships. Regarding the alliance timing, a firm can initiate alliances at different stages of the new drug development process. While partnership timing determines the stage of the NPD process during which the focal firm forms alliances, partnership type is the position occupied by the focal firm’s partner in the industry. In terms of partnership timing, I delineate the stages of the NPD process to discovery stage, development stage, and prelaunch stage. Regarding partnership type, I disintegrate alliances under three categories: universities and research institutes, alliances with competitors, and alliances with incumbent large firms. The application of this typology is

important in providing the opportunity to relatively small and underfunded firms (with a considerable failure rate in NPD) to track the success path of developing radical new products through alliance formations with different partners during various stages of the NPD process.

The core idea behind forming collaborative alliances in innovation and NPD contexts is for organizations to share the risks and costs of new product development and access resources unavailable within their organizational boundaries. Using the biopharma industry as the research setting, I argue that considering the variance that exists across alliance relationships contributes to the existing body of literature by extending the implications of previous studies (Fang et al., 2015). Although prior studies have highlighted the importance of Partnership timing (e.g. Hoang & Rothaermel, 2010; Fang et al., 2015) as well as partnership type (Baum et al., 2000; Powell et al., 1996), the interaction of these two factors on the innovativeness of new products have not been studied previously. Thus, a more complex dynamic, considering the different types of alliance partnerships and the timings of such alliances, is more applicable, accurate, and provides more valuable insights.

For example, I propose that a biotech firm's decision to enter a collaborative alliance with a university or research institute has different implications on product innovativeness when this alliance is formed at the discovery stage, compared with when such an alliance is formed at the prelaunch stage of the drug development process. Extending this example, I disintegrate the alliance types which a focal biotech firm can choose in the biopharma sector into university and research institutes, other biotech firms

(competitors), and pharmaceutical firms (firms with chemically-oriented technologies). By the same token, I disintegrate alliances based on the timing (stage) of its formation, e.g. the stage at which a focal biotech firm initiates an alliance with different partners. These stages consist of discovery, development, and prelaunch during the new drug development process.

The interaction between three types of alliance partnership and three stages of alliance timing provides nine mutually exclusive NPD strategies for biotech firms (in line with theoretical perspectives of RBV and TCE displayed in Graph 1) to enhance their product innovativeness. Despite the existence of potential synergies and dis-synergies among these nine strategies, this study focuses only on developing these nine mutually exclusive strategies affecting product innovativeness. As this research is pioneer in introducing timing-type typology, considering interactions (in any formats of causality or correlation) between these nine mutually exclusive strategic options (synergies or dis-synergies) provides a promising agenda for future research. From the empirical standpoint, I checked whether there are any significant correlations between these nine strategic choices. The results, tabulated in the Table 4, show that this is not an issue in this study.

### **Product as the Level of Analysis and a Unique Methodological Design**

Different degrees of product innovation have been explored according to industry-, firm-, and product-specific variables (e.g. Kotabe & Swan, 1995). However, the innovativeness of new products has never been explored as a function of the alliances

formed with various partners to develop the new product at different stages of the new product development process. Applying a new typology of alliance partnership in the biopharma sector, I determine the interaction effects of alliance timing and type on the innovativeness of drugs approved by the FDA. To undertake these complex analyses and test hypotheses regarding the linkages between the innovativeness of drugs developed by focal biotech firm and the alliances specifically formed for a specific drug, I employed a unique method of data collection. This was done by, integrating product level data on drug innovativeness as an outcome variable, with specific interfirm level alliances formed, as explanatory variables.

This method of integrating products to their associated alliances necessitated tracking the history of each FDA-approved drug and linking this to the alliances that the focal biotech firm formed specifically for the purpose of the drug in question. To this end, I combined data from different data sources such as Deloitte Recombinant Capital (Recap), FDA drug sources, LexisNexis, and Compustat. Unlike this drug specific methodological design for data collection, prior studies generally focused on outcome variables at the firm level of analysis. However, this method of conceptualization and the subsequent data collection is theoretically distant from the performance at the collaborative level of alliances. Therefore, I argue that a subtle understanding of how alliances influence product innovativeness necessitates changing the unit of analysis to the product level, and that this is a more appropriate method of investigating product innovativeness in an alliance context.

### **Measurement of product innovativeness**

While early researchers in marketing focused on behavioral adoption models that considered the changes in customer receptiveness and diffusion rates of innovations as a measure of product innovativeness, these changes may also be a result of technological advancements. Thus, studying the antecedents of inherent product innovativeness, which integrates the technological as well as customer adoption aspects of the innovation, provides updated implications. Considering product innovativeness along two dimensions, being the core technology integrated into the new product and the value it adds to customers, compared with existing products in the market, is a more exhaustive and comprehensive proxy. Measuring these two dimensions significantly reduces the measurement bias of using perceptual variation of the characteristics of the new product as a proxy for product innovativeness.

Using this measure (accounting for the significance of both technological change and customer benefits) as a proxy for product innovativeness, the majority of prior studies have focused on organizational variables as determinants of product innovativeness. For example, a study by Chandy and Tellis (1998) demonstrates how the willingness of large firms to cannibalize their own products affects the innovativeness of their new products in terms of radical versus incremental innovations. Even though a few previous studies have used this operationalization of product innovativeness (considering both core technological and customer benefit dimensions), as a cumulative outcome of a firm's cumulative alliances (e.g. Lee, 2011; Wuyts et al., 2004), this study explicitly and systematically links the innovativeness of a product to the alliances that the focal firm (as

the developer of the product) formed during the new product development process in terms of timing and type. Using this operationalization for product innovativeness and linking it to the product-related alliances formed by the focal firm, provides unique and valuable insights overlooked by prior studies.

### **Product innovativeness of relatively small firms in technologically intensive sectors**

Prior alliance studies have largely examined product performance from the perspective of large firms. However, in this study, I apply the typology of alliance timing and type, as a new conceptualization of the alliance relationships, to the product innovativeness performance of relatively small firms (e.g. biotech). Whereas large firms have options to develop their new products in-house or in alliance with other organizations, small firms often have no choice but to form alliances due to a lack of internal resources required to develop a new product (Yli-Renko & Janakiraman, 2008). Additionally, Baum et al. (2000) imply that the failure rate of new products is significantly higher in small firms than in large firms, due to the liability of “smallness” and a lack of effective relationships and a proven track record with outside organizations. The authors also suggest that small firms vary substantially in their access to resources and relationships, and, subsequently, these variations may well lead to differences in their innovation performance. Building on this reasoning, I argue that it is extremely important to investigate and better understand how variations in the composition of the alliances formed by small firms influence the innovativeness of their new drugs, regardless of their inherent disadvantages compared to large and established firms. As a result, examining

the new product innovativeness effects of alliances taking the perspective of small firms is critically important as prior studies have left a gap by focusing on large firms.

With the emergence of biotechnology as a disruptive force for established pharmaceutical players in this sector, the convergence of many biotechnology fields within biotech firms, and the upsurge in collaborative alliances that biotech firms initiate, it is imperative to study how the collaborative alliances that biotech firms form affect the innovativeness of their drugs. Since biotech firms have been active in the biopharma sector since the 1980s, understanding the innovation performance of the alliances of such firms, without the necessary resources to undertake a full cycle of the NPD process in this highly regulated industry, provides extremely important implications to biotechnology firms. This research deals exclusively with dedicated biotechnology firms whose predominant activity is dedicated to the application of their research in biotechnology to the life sciences.

#### **Theoretical implications (integration of cost and benefit perspectives)**

Combining alliance timing and type with their underlying components provides nine strategic options (as a result of multiplication of three partnership types and three partnership timing) to focal biotech firms when making decisions to form alliances for developing their new drugs. The interactions between timing and type of alliance permits analysis of the effects of each option on product innovativeness. While all nine of these alliance options are formed by firms, there has been no empirical research investigating whether, and how, these options result in enhanced product innovativeness. I argue that

each of these nine mutually exclusive strategic options (created as an interaction between alliance timing and type) involves a unique set of benefits and costs. Due to consideration of alliances as a cumulative measure, prior studies mainly focus on the cost or benefit perspective of collaborative alliances in general, to develop testable hypotheses.

However, in this study, I use both TCE and RBV to encompass benefits, costs, and risks involved in each mutually exclusive type of alliance timing-type combination.

Regarding alliance partnership costs and risks and in accordance with the underlying premises of TCE, I argue that the transaction costs vary according to the timing (stage) of the alliance, as well as the type (partner choice) of alliances that the focal firm forms for developing its new drug. With regards to the benefits of alliance partnerships, I rely on RBV and absorptive capacity to argue that each stage of the NPD process and each alliance partner are bound with certain benefits. In other words, alliance timing and type provide conditions under which the focal biotech firm can receive different benefits from entering into alliance partnerships.

The proposed typology for alliance relationships in this study provides an opportunity to integrate insights from TCE with its cost-oriented view, and RBV and absorptive capacity with their benefit-oriented theoretical perspective. Prior studies with a focus on a cumulative view of alliances mainly used one or the other of these views. This thesis contributes to TCE theory by studying the dynamic conditions (nine alliance timing and type combinations) under which transaction costs vary. This dynamic view provides fine-grained theoretical implications to studies in the alliance field of research, which has primarily taken a static view of transaction costs. Similarly, this study extends the



theoretical implications of RBV and absorptive capacity by shedding light on the previous static view of synergistic benefits that alliance partners may gain through alliance relationships. This thesis proposes and provides empirical evidence that benefits obtained through alliances offer differential performance outcomes, conditional on both the timing and the type of alliance that the focal firm initiates.

### **Practical implications (Dealing with partners)**

This study also offers practical implications for practitioners with empirical evidence to support decision making with regards to the timing and type of alliance to enter into to enhance the innovativeness of their new products. It is critical for small firms operating in technologically intensive sectors to exploit opportunities by developing innovative new products to grow and keep the pace with dynamic changes in the market. Focal firms in the sample are relatively small biotech firms. Due to their lack of internal resources and the costly and time-consuming nature of the NPD process, it is important for biotech firms to enter into alliances with other organizations. However, the need to access novel basic research and scientific knowledge, R&D capabilities, as well as financial and complementary resources of other firms, may cause some biotech firms to join alliances with different organizations under unfavourable conditions, which make these alliances prone to failure.

Driven to develop and launch new products to the market and reduce costs during the NPD cycle, managers of small and underfunded firms sometimes overestimate the benefits and underestimate the risks involved in joining alliances. By applying the

typology of alliance timing and type, small firms can better understand the risks and rewards of the nine choices of alliances, as both the timing and type of alliances formed at different stages of the NPD process moderates the effects of said alliances on the innovativeness of its new product. For example, while prior research shows that alliances with competitors positively affect product innovativeness (e.g. Oxley & Sampson, 2004), this study concludes that this effect is only positive during the discovery and development stages. The results show that this alliance type negatively influences the innovativeness of new products when formed during the prelaunch stage of the NPD process. This finding suggests that managers of small firms should avoid forming alliances with their competitors during late stages of the NPD process and keep the scope of alliance relationships to R&D when it comes to partnerships with their business rivals.

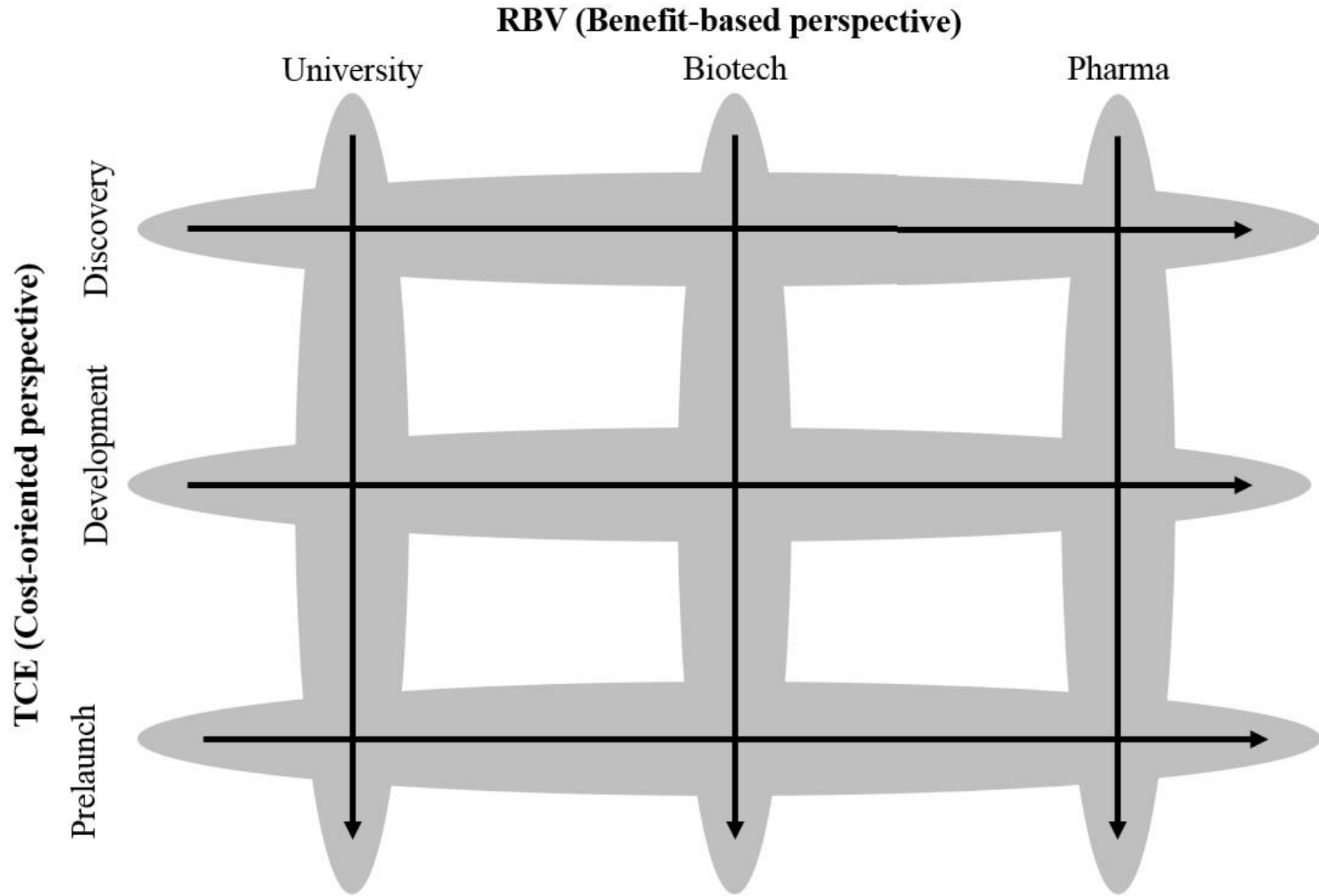
The results also indicate that alliances between high-tech small firms and large established firms negatively affect product innovativeness during all stages of the NPD process. While prior studies taking the perspective of large firms show that the product performance of large firms (frequency of product launch) benefits from alliance partnerships with small firms, especially at the commercialization stage, this study demonstrates that such partnerships do not help the innovativeness of new products originated by small firms. Therefore, the results indicate that managers of small firms need to be extra cautious when considering an alliance partner. Large firms, on the other hand, should strive to create an atmosphere of trust and commitment using normative governance or equity-based joint venture options to encourage more collaboration towards sharing proprietary knowledge. This knowledge is required to enhance the

innovativeness of the new product being jointly developed within alliance partnerships. Additionally, even though alliances with universities and research institutes are considered to have a positive influence on product innovativeness, the results in this study indicate that this partnership type results in enhanced product innovativeness when such partnerships are formed in the discovery or development stage of the NPD process. However, the results further indicate that this partnership type has no effect when formed in the prelaunch stage. This finding suggests that the benefits of alliance partnership with universities and research institutes diminish while their transaction costs increases during the prelaunch stage of the NPD process.

The results of this study also provide managerial implications for firms which have predetermined the stage during which they need to form alliances, even though they question what partnership type will result in enhanced product innovativeness. For example, when a small firm decides to form an alliance during the discovery stage, the results show that alliances with an established and financially rich firm results in negative product innovativeness, even though small firms may think that they can benefit from legitimacy and additional resources to expedite their NPD process. Therefore, the managers of small firms should pursue other partnership types which are indicated to increase the likelihood of product innovativeness. In this study, biotech alliances with other biotech firms (rivals) or universities during the discovery stage, increase the probability of drug innovativeness while alliances with pharma firms reduce this likelihood. As different alliance partnership timings and types are bound with different costs, benefits, and risks, alliances have differential effects on the outcome variable.

Thus, matching the timing and type of alliances that small firms initiate can influence their gains regarding product innovativeness. Given these factors, this study provides novel practical implications for managers to better understand the complexity and dynamic of alliance relationships in technologically intensive industries to assist them to make better partnership decisions to enhance the likelihood of innovative new products.

**Graph 1: Underlying theoretical perspectives in formulating the research questions**



**Table 1: Research examining the role of alliance composition on firm and product level performance**

Empirical research	Research question	Empirical Context	Focal firm perspective	Alliance type	Alliance timing	Relevant outcome variable(s)	Level of analysis	Relevant empirical findings
Kotabe and Swan (1995)	The role of firm and industry characteristics on product innovativeness of firms in the context of alliances	Alliance portfolio, multiple industries	Mixed	No	No	Innovativeness – measured as newness to the firm and the market	Firm level	New products developed in alliances are less innovative than those developed by single firms.
Powell et al. (1996)	The role of firm R&D alliances, prior alliance experience, and network centrality on subsequent alliances	Alliance network of Biotech firms	Relatively small	Yes	No	Alliance structure – measured as formation of R&D versus marketing alliances	Firm level	The locus of learning and innovativeness is found in the network of interorganizational networks.
Baum et al. (2000)	The role of startup alliance network composition at founding on early performance	Alliance network, startup firms	Relatively small	Yes	No	Focal firm innovativeness – measured as focal firm growth in the number of patents	Firm level	At founding, startup alliances with university and pharma firm increase innovativeness. Alliance with rivals decreases innovativeness.
Sivadas and Dwyer (2000)	The influence of organizational factors on new product success in alliance-based processes	Alliance dyads, semiconductor and healthcare sectors	Large	No	No	NPD success – measured as speed to market, market share, quality, and meeting target costs	Product level	Clarity of alliance agreement and lack of resistance is positively associated with NPD success.

Stuart (2000)	The role of alliance partner characteristics on the innovation and growth rate of focal firms	Alliance portfolio, Semiconductor industry	Mixed	No	No	Firm innovation rate and revenue – measured as the number of patents and sales respectively	Firm level	A firm's rate of innovation and sales growth is a function of its partners' innovation capabilities and revenue.
Rothaermel (2001)	The effects of alliance exploration and exploitation on focal firm's product performance	Alliance portfolio, Biopharma sector	Large	No	Yes	New product development – measured as the number of new products launched to the market	Firm level	Exploitation alliances of an incumbent firm have a greater impact than exploitation alliances on its new product development.
George et al. (2002)	The impact of university partnership on innovation and financial performance	Alliance portfolio, Publicly traded biotech firms	Relatively small	No	No	Innovative output – measured by the number of patents	Firm level	Firms with university ties have significantly more patents (more innovative) and spend significantly less on R&D than firms without such alliance ties.
Wuyts et al. (2004)	The role of technological diversity and repeated partnership in a firm's alliance portfolio on product innovativeness	Alliance portfolio, biopharma sector	Large	No	No	Product innovativeness – measured as radicalness from both technology and customer value perspectives	Firm level	Greater technological diversity and repeated partnership in a firm's portfolio of R&D alliances, increases the radicalness of the new products.
Swaminathan and Moorman (2009)	The impact of a firm's network characteristics on firm value	Alliance network, software industry	Mixed	No	No	Firm value – measured as the firm's abnormal return	Firm level	A firm's alliance capability, network efficiency, and network density affect the firm's abnormal return.

Hoang and Rothaermel (2010)	The role of a firm's prior alliance experience on product performance	Alliance portfolio, pharma companies	Large	No	Yes	Product performance – measured as the time between project initiation to prelaunch	Product level	A firm's prior alliance-based exploitation experience has a greater impact on product performance than its exploration experience.
Cui and O'Connor (2012)	The innovation performance of a firm's alliance portfolio diversity and other contingent factors	Alliance portfolio, multiple industries	Mixed	No	No	Firm innovation – industry experts to rate firms within their industries	Firm level	The contribution of a firm's alliance portfolio to firm innovation is subject to various conditions such as alliance management and the market environment.
Fang et al. (2015)	The role of alliance timing on firm value of alliance partners	Alliance dyads, biopharma industry	Mixed	No	Yes	Firm value – measured as abnormal returns from upstream and downstream firms	Firm level	Abnormal returns for partners involved in an alliance vary based on the timing partners initiate the alliance.
This study	The role of the type and timing of alliances that a small firm forms to develop a new product on the innovativeness of the new product	Alliance dyads, biopharma industry	Relatively small	Yes	Yes	Product innovativeness – measured as radicalness from both technology and customer value perspectives	Product level	Alliances formed by a focal firm have different effects on product innovativeness subject to differences in timing (discovery, development, or prelaunch stage) and type of the alliances (university, direct competitor, or large firm).



## CHAPTER II

### LITERATURE REVIEW

#### Introduction

This chapter draws from the fields of marketing, innovation, and strategy to provide a review of existing research in innovation and NPD. The specific attention in this review will be on extant literature in NPD management through interorganizational relationships. This review will highlight key gaps emerging from the interface of research in innovation and new product alliances. Relying on transaction cost economics (TCE), resource-based view (RBV), and relative absorptive capacity, I will introduce key interorganizational constructs that could help in effective management of alliances and, therefore, addressing the gaps in the literature.

To this end, this chapter is organized as follows. The first section will cover the existing research in innovation and innovativeness, focusing on their impact, benefits, and measurement issues. I will specifically draw attention on radical and incremental innovations as indicators (outcome variable) of a firm's new product innovativeness.

In the second section, I will review the streams of research on internal and external NPD strategies and the evolution of the NPD landscape, with interorganizational research as the focus of this study. Third, I build on suggestions from prior research to direct attention towards partner selection and partnership timing. These variables are considered in this review as the two main interorganizational variables in better management of alliances towards more innovative new products.

As the focus of the thesis is on product innovativeness from the perspective of relatively small firms, the fourth section will cover the few studies conducted on small firm innovations and NPD, the importance of acknowledging this perspective, and the need for further research. Finally, the chapter ends with a summary and analyses of gaps in existing literature.

### **Innovation and innovativeness**

Innovation and NPD success are among the main drivers of a firm's profitability, increased revenue, and, above all, competitive strengths over otherwise comparable firms (Sivadas & Dwyer, 2000). An early study by Booz et al. (1982) shows that out of Fortune 1000 firms, 700 companies indicate that one-third of their profits over the course of five years came from new products they introduced to the market. In addition to providing benefits to organizations, technological innovations have been considered as an influential force for improved productivity as well as industrial development (Abernathy & Clark, 1985).

However, Garcia and Calantone (2002) draw attention on an ambiguity in the operationalization of 'innovation' and 'innovativeness' in the NPD literature due to a wide variety of definitions used for new product innovation. Researchers have utilized a number of terms to describe innovation. Therefore, even though previous research provides support regarding the benefits of innovation (Abernathy & Clark, 1985; Booz et al., 1982; Sivadas & Dwyer, 2000), it is important to consider the different definitions of innovation used in the NPD literature before looking at the underlying process of developing innovations.

The following two sections of literature review will demonstrate the inconsistencies in labeling innovations in response to the call from innovation research (e.g. Garcia & Calantone, 2002; Kotabe & Swan, 1995) who argue that NPD researchers' utilization of various innovation terms and types on an ad hoc basis has resulted in research myopia.

### **Innovation**

Since innovation and NPD provide organizations with competitive benefits (Booz et al., 1982), firms need to frequently introduce new products to the market (Sivadas & Dwyer, 2000). Researchers have highlighted the importance of focusing on the number of new products launched to the market as an important dimension of a firm's innovation strategy (e.g. Ali, 1994; Zahra, 1996).

Greenhalgh and Longland (2005) argue that in an environment characterized by intense competition, the profits that one innovation generates may be short term, and therefore firms need to continually innovate to maintain their competitiveness. Building on this line of reasoning, in which firms need to develop new products steadily due to competitive pressure, researchers (e.g. Barczak, 1995; McDermott & O'Conneor, 2002) have argued that introducing multiple innovations to the market over time may maintain a high level of profitability for the firms. Additionally, Acs and Audretsch's (1990) work shows that rapid introduction of products improves a firm's ability in the market to differentiate itself from competitors.

Such studies conclusively recommend that effective management of the NPD process is critically important for firms (Hagedoorn, 1993; Marsh & Stock, 2003), as it enables them to increase the rate of their successfully launched products to the market. This stream of research considers NPD success as the rate of successfully launching innovations to the market and considers the number of new products as the main source of a firm's profitability and growth (Hagedoorn, 1993). The apparent underlying premise used in these studies has been the linear effectiveness of new product counts on firm profitability and as a remedy to address intense competition.

The second stream of research in the NPD literature, however, considers innovation to have differential effects on a firm's competitive advantage. As a first step, Abernathy and Clark (1985) suggest that innovations do not have a unified effect because some of them disrupt and destroy existing technologies rendering established competences obsolete, while others only refine and improve. This stream of literature considers the role of technological change and recognizes its effect on increased competitive forces and rivalries among firms (Porter, 1990).

Abernathy and Clark (1985) further focus on defining innovation as the technological development along the NPD process starting from the invention and culminating to commercialization (introduction) of the product to consumers for adoption. Yet, using a slightly different view, Ali, Krapfel, and LaBahn (1995) define innovation as an iterative process in which technological innovation will be launched to the market after going through the NPD process, followed by a reintroduction of an improved version of the innovation to the market. While the former definition does not

overtly indicate the degree of product innovativeness, the latter implies that there are different levels of innovativeness (different types of innovations) (Garcia & Calantone, 2002).

Either way, technology-based innovations have a common attribute of embodying inventions from both pure and applied science to develop a new product, examples of which include innovations from pharmaceuticals, electronics, information systems, and aerospace industries. In addition to basic and applied science, technological innovations need to go through the whole NPD process before being termed an “innovation” (Rothaermel, 2001; Garcia & Calantone, 2002). Rothaermel (2001) borrows arguments from Schumpeter’s (1942) work to discuss the importance of defining innovations as new products that have passed through the NPD process from discovery and development (exploration) to prelaunch and commercialization (exploitation) stages. Finding a solution to a basic scientific problem or the invention of a new product in the laboratory would make little to no economic contribution and should not be considered as an innovation (Garcia & Calantone, 2002).

Researchers (e.g. Utterback, 1994) have used the central premise in the topic of the S-shaped curve of technological evolution that a new product starts underneath an existing innovation, crosses the performance of the old technology, and ends at a higher level. They also provided empirical support regarding the S-shaped curve of technological evolution, which demonstrated the performance of existing technological innovations can be exceeded by the emergence of new technological innovations. The S-shaped technological evolution warns that even though firms might be able to launch multiple

innovations relying on a mature technology to improve their performance (at the top of its S curve), such products would be incremental advancements that typically provide short-term benefits to their developers (Sood & Tellis, 2005).

Other researchers (e.g. Rothaermel, 2001) argue that the passage of time renders the technological advantage of a firm obsolete due to intensification of the competition, competitive imitation, and the emergence of new technologies. These studies also emphasize the inherent differences among innovations and the importance of gauging the degree of innovativeness of new products rather than simply count the number of new products introduced by firms.

#### **Innovativeness (innovation type)**

Different types of product innovations may require different investments of resources and impose different risks and offer different benefits to their developers (Wuyts et al., 2004). Thus, an aggregate number of new products introduced to the market may not necessarily capture the benefits and costs associated with various innovation types, rendering prior aggregate findings and implications biased and ineffective (Garcia & Calantone, 2002). Kotabe and Swan (1995) highlight the importance of new product innovativeness of products (innovation type) building on dynamic models of competition.

The rapid technological change adds additional pressure on firms to develop radical innovations to stay ahead of the competition, much more so than in the past (D'Aveni, 1994; Dickson, 1992). Radicalness of products signifies the “newness” of products introduced to the market (Hauser et al., 2006), enabling the firm to significantly

grow by creating a new market or capturing existing market share. This demonstrates that the degree of product innovativeness is more important than the number of innovations for the firm.

Identifying the distinction between innovation types and their impact on firm performance, as well as the market, is as old as Schumpeterian economics (Schumpeter, 1939) in that the emphasis has been on the role of innovation type on a firm's success. Garcia and Calantone (2002) discuss that ignoring new product innovativeness (innovation type) is comparable to turning down more than seven decades of research on innovation and NPD processes.

Even though there has been a long history of inquiry (e.g. Schumpeter, 1939; Barnett, 1953) into types of innovation (degree of innovativeness), one of the chief problems in the innovation literature has been the deficiency of meaningful measures (Capon et al., 1992; Kuznets, 1962; Utterback, 1987). Popular proxies used in innovation research have involved R&D expenditure as well as unweighted or weighted patents, all of which have been criticized as biased (Kotabe & Swan, 1995). Griliches (1994) argues how using such measures can create problems affecting both within and between-industry comparisons.

Previous studies show that participating in alliance relationships can translate into firm's innovative outcomes such as higher patent count or new products (Ahuja 2000; Baum et al., 2000; Wuyts et al., 2004), creativity (Im & Workman, 2004), innovation speed (Rindfleisch & Moorman, 2001), and profitability (Wuyts et al., 2004). However, using the raw number of patents (e.g. Baum et al., 2000) and number of products introduced to the

market (e.g. Rothaermel, 2001; Lee, 2011) may not be an appropriate index for innovation and might not fully capture a firm's superior NPD performance over potential competitors in the market.

In the domain of product innovativeness research in marketing, a wide variety of studies (e.g. Ettlie & Rubenstein, 1987; Robertson, 1967; Utterback, 1974) have focused on the adoption and diffusion of innovations and have mainly defined product innovativeness in light of the extent to which the innovations change the usage patterns or habits of customers. Hirschman (1980), on the other hand, argues how variation in consumer perception of a product's innovativeness (as a subjective measure) can obscure the inherent 'newness' of an innovation. Kotabe and Swan (1995) recommend that innovativeness of new products should be examined considering inherent product attributes through three views: "newness to the market", "newness to the firm", or a combination thereof.

Chandy and Tellis (2000) state that when a radical innovation gets to the market, it leads to the decline or demise of the existing technology and the cycle repeats itself again with the next wave of radical innovation. Sood and Tellis (2005) argue that moving to a whole new technological platform is the only possible way to limit the problems associated with the maturity of existing technologies and to develop radical innovations. This argument highlights the critical importance of radical innovations for a firm in providing the competitive advantage over its potential competitors in the market. The continuity of the technological evolution cycle (Sood & Tellis, 2005) has increased the challenges associated with NPD especially in technologically intensive industries (Oxley



& Sampson, 2004) and for small and young entrepreneurial firms (Haeussler et al., 2012; Yli-Renko & Janakiraman, 2008).

Considering both the ‘degree of technological change’ embedded in an innovation and the ‘benefits it provides to customers’ compared to previous technological innovations, Chandy and Tellis (1998) define product innovativeness based on a more objective measure. Focusing on technological improvement as well as customer-related benefits may reduce the measurement issue (relying solely on perceptual factors) associated with previous studies (e.g. Acs & Audretsch, 1988; Mahajan, Muller, & Bass, 1995).

In this thesis following the same reasoning, I use the terms ‘product innovativeness,’ ‘degree of innovativeness,’ and ‘innovation type’ interchangeably to capture the radicalness level of innovations by drawing from Chandy and Tellis’s (1998) work on “organizing for radical product innovation”.

Consequently, a radical innovation is defined as a new product that incorporates a substantially different core technology and offers significantly higher benefits to customer relative to existing products in an industry. These radical innovations can be the source of competitive advantage to their innovators (e.g. Wind & Mahajan, 1997). Conversely, an incremental innovation involves insignificant changes in an existing technology and provides relatively incremental benefits to customers. Due to differential effects of incremental versus radical innovations (Chandy & Tellis, 1998; Kotabe & Swan, 1995; Wuyts et al., 2004) on viability and competitiveness of firms, it is critical to understand NPD strategies and related factors which lead to enhanced product innovativeness.

Even though different terms are used in the innovation literature to capture the radicalness of innovations (such as "disruptive," "breakthrough," "revolutionary," or "discontinuous") these terminologies mainly focus on effects rather than sources of radical innovations (e.g. Garcia & Calantone, 2002; Tushman & Anderson, 1986). To contribute to our understanding of innovation and NPD, I argue that firms need to use strategies (antecedents) that accommodate their need for developing radical innovations while keeping NPD risks at a tolerable level.

### **Innovation and NPD strategies**

In general, the ability to develop resources and capabilities and successfully exploit them is generally considered as a key determinant of a firm's competitive advantage and performance (Bettis & Hitt, 1995; Helfat & Peteraf, 2003). To achieve a sustainable competitive advantage, as highlighted in the resource-based view (RBV), a firm needs to have the ability to assemble valuable, rare, and inimitable resources or capabilities (Barney, 1986; Wernerfelt, 1984). In the context of NPD, understanding the effectiveness of strategies that explain variations in a firm's innovation success under various conditions have also been the subject of extensive research and empirical testing (Dickson, 1992; Hirschman, 1980; Rogers, 1962).

Organizational aspects of the RBV highlight the internal (in-house) management of resources to achieve competitive advantages (Barney, 1991; Peteraf, 1993). However, the interorganizational (cooperative) aspect of RBV relates to obtaining some important resources through collaborative alliances from external sources, as these are heterogeneously distributed among organizations (Hitt et al., 2000; Wernerfelt, 1984).

In recent years, despite their many drawbacks, new product alliances have become popular (Rindfleisch & Moorman, 2001), and are widely considered as an alternative strategic choice to in-house NPD strategies (Geyskens, Steenkamp, & Kumar, 2006). Research in marketing and strategy has identified rapid technological change and competitive pressures as two main reasons responsible for shifting from using organizational to interorganizational NPD (Kotabe & Swan, 1995; Sivadas & Dwyer, 2000; Webster, 1992), resulting in increasingly costly and time-consuming process of internally developing and accumulating required technological capabilities (Haeussler et al., 2012). However, for these same reasons, the performance outcome of developing innovations has also become substantially uncertain in markets characterized by dynamic environments (Rice et al., 1998).

In the following sections, I first review marketing and strategy research on reasons for a technological change in the market and reasons why organizational strategies are not as effective and relevant as they were previously in NPD. Second, I review the literature on underlying motivations of organizations to join interorganizational strategies, the resulting challenges of such strategies, and their implications for NPD research. Finally, I outline gaps in the frontiers of the literature by drawing attention to the dearth of literature on topics such as partner selection (partnership type) and timing of partnerships (NPD stage) in interorganizational NPD strategies.

### **Technological changes: A paradigm shift in NPD strategies**

Technological change has been perhaps the most influential source of growth for firms (Chandy & Tellis, 1998; Christensen, 2013; Sood & Tellis, 2005) as well as the

improved welfare for society as a whole (Abernathy & Clark, 1985). Accelerated *technological change* requires firms to sustain their competitiveness by developing major innovations (D'Aveni, 1994; Dickson, 1992), characterized by significantly improved technological innovations and significantly higher value to customers relative to existing technological innovations currently in the industry. Embedded in differentiated technological capabilities and resources, radical innovations meet these characteristics (Chandy & Tellis, 1998) in addressing increased dynamism in the market.

Despite all these benefits, radical innovations have the capacity to make existing technologies obsolete and destroy the costly investment on technological resources of incumbents made over the years (Sood & Tellis, 2005). As a result, the effects of rapid technological change (demanding development of radical innovations) have accelerated competitive forces in a given industry (Gold, 1981). These hypercompetitions emphasize the need for competitive urgency (D'Aveni, 1994), implying that developing radical products is needed as a result of a technological change on an industrial level.

One of the main by-products of radical innovations is a significant increase in competition among firms in the market by disrupting established technologies and suddenly making existing technologies useless (Chandy & Tellis, 2000; Tushman & Anderson, 1986). Since technological capabilities are no exception in facing erosion over time, firms need to constantly improve and update their technological capabilities to not only prevent them from being out-of-date but also provide the firm with competitive strengths in the market (Teece, 1992).

As a major source of performance heterogeneity among firms, technological capital is defined as firm-specific activities regarding past successful technology development (Ahuja & Katila, 2004). Oxley and Sampson (2004) also consider specialized technological capabilities as a typical example of firm-specific resources causing differences among firms in terms of innovation and NPD success.

As more companies started to increase investment on their internal R&D and embark on developing in-house expertise (Lane & Lubatkin, 1998), the more competitive the market became. Technological change and increased competitive forces along with increased global competition and standardization of products have resulted in shorter product life-cycle, rising costs of internal R&D activities, and rapid reduction in the profit margin of firms (Teece, Pisano, & Shuen, 1999). In addition to upfront costs to build technological capabilities as well as increasing R&D expenses to keep them updated, the performance outcomes of such activities may be very uncertain for firms (Mitchell & Singh, 1992). Consequently, in-house innovation and NPD have become increasingly challenging for companies.

### **Organizational strategies**

The competitive landscape has changed significantly over time due to globalization, constant technological changes, and standardization of products (Rindfleisch & Moorman, 2001). These factors have made the in-house creation of such innovations even more challenging than before (Dickson, 1992; Kotabe & Swan, 1995; Sivadas & Dwyer, 2000). Additionally, it is difficult to develop radical innovations using

the stage-gate process, in which development of product occurs in-house in explicitly defined and officially approved stages (Wind & Mahajan, 1997).

In this way, internal innovation strategies have contributed to the innovation literature by examining firms' NPD success within a firm-specific (organizational) context (e.g. Katila & Ahuja, 2002; Leiponen & Helfat, 2010). Since the seminal work by Schumpeter (1942), various studies have recognized a firm's NPD success as a function of firm-level factors such as firm size (Scherer, 1984), willingness to cannibalize existing technologies in the firm (Chandy & Tellis, 1998), organizational structures and internal capabilities (e.g., Moorman & Slotegraaf, 1999; Olson, Walker, & Ruekert, 1995), and dominance in the market (Sorescu, Chandy, & Prabhu, 2003). In addition to firm-specific factors, the focus of prior studies has also been on industry and product-specific attributes (Ettlie & Rubenstein, 1987; Robertson, 1967).

Radical new product innovations require a wide variety of technological resources (Kotabe & Swan, 1995), while in-house development and reconfiguration of technological knowledge and competencies to create value (Zahra & Covin, 1993) is costly and time-consuming and is fraught with substantial uncertainties (Teece et al., 1999). A firm rarely has the full range of resources and expertise required in-house to offer cost-effective and timely new product innovations (Kotabe & Swan, 1995) while the competitive environment and the rules of rivalry constantly change (D'Aveni, 1994).

Building on accelerated technological change and intense competitive pressure, in-house NPD strategies may be ineffective or even irrelevant in some contexts. Drawing attention to cooperative strategies for innovation and NPD is nowhere more valid than in

technologically intensive industries (Bingham & Davis, 2012; Steensma & Corley, 2000) such as biopharma in which most biotechnology firms operating do not possess all necessary capabilities to go through the full cycle of the NPD process.

The next section covers extant literature on interorganizational strategies and provides a more in-depth review of the literature on the major motivations of firms to enter alliance partnerships as well as the main challenges they might face in such relationships. Reviewing these factors will result in a better understanding of the connection between new product alliances (as a strategic option for NPD) and the product innovativeness of such strategies. The dominant theories used in the literature to discuss the motivations and challenges regarding alliance partnerships include RBV, TCE, and relative absorptive capacity.

### **Interorganizational strategies**

Technological and industrial changes have triggered a strategic shift in the development of new products, causing a dramatic increase in the popularity of interorganizational partnerships (Kotabe & Swan, 1995; Sivadas & Dwyer, 2000). The rate of interorganizational partnerships, such as R&D alliances, has significantly increased in recent years (Dyer, Kale, & Singh, 2001; Simonin, 1997). Gulati (1998) identifies alliance as a ubiquitous phenomenon due to the increase in its popularity in both domestic and global markets. The flexibility and relatively low risks of alliances rather than other strategic options, (e.g. in-house and acquisitions) have sometimes made them a preferred strategic alternative for growth (Harrison, Hitt, Hoskisson, & Ireland, 2001).

The interorganizational aspect of the RBV holds that, if effectively deployed, a firm can use external resources in ways that result in superior innovation performance (Zahra & Nielsen, 2002). To better understand how interorganizational strategies can create value for firms, it is important to identify the motivations behind joining these relationships and the potential challenges they can arise for participants.

### **Motivations to enter collaborative alliances**

It is normally time-consuming for firms to internally develop the knowledge and capabilities required to respond effectively to a problem and keep pace with competitors in the market (Dierickx & Cool, 1989; Huber, 1991). Interorganizational alliances are widely recognized in the literature as a strategic option in which participating firms can share resources to improve their performance and competitive position in the market (Hitt et al., 2000; Jarillo, 1988). Such collaborative partnerships have been recognized in the literature as having a high potential for value creation (Barringer & Harrison, 2000).

As implied in this broad view, alliance partners can gain value (though synergy between resources), which can be disproportionate to what they could have received using alternative organizational arrangements (Madhok & Tallman, 1998). Thus, to gain a disproportionately higher rent than that achieved in using alternative organizational strategies is considered as one of the key motives (reasons) behind entering such relationships (Dyer & Singh, 1998).

Alliances can potentially contribute to value creation by providing opportunities including economies of scale, learning from partners, the effective management of risk, and



the efficient market entries (Alvarez & Barney, 2001; Kogut, 1988). The RBV has been helpful in providing an explanation for the formation of alliance relationships in general. Many researchers have considered resource interdependency as well as gaining access to complementary resources resource, as among the main motivating factors for firms to join alliances and the reasons for the rise in the number of technological alliances (e.g. Ireland, Hitt, & Vaidyanath, 2002; Nohria & Garcia-Pont, 1991; Nooteboom, Vanhaverbeke, Duysters, Gilsing, & van den Oord, 2007).

Hagedoorn (2002) recognized the underlying motives of organizations to join different interorganizational partnerships as *economic* and *strategic*. First, the economic (cost-saving) motivation applies when at least one of the alliance partners joins the partnership mainly to reduce the cost of its NPD activities by spreading out the increasing R&D costs with partner companies. This cost-saving logic is specifically relevant and plays a key role in technologically intensive industries where the R&D costs of a single project (e.g. developing a bio-based drug) may be far beyond the internal resources of many organizations (Hagedoorn, 1993).

Second, strategic motivations become important when a firm, for example, selectively initiates partnerships with organizations possessing the complementary expertise and core activities that are not related to their own, leaving the firm to focus on its own R&D activities within its own boundary (Teece, 1986). For example, findings of a study by Stuart (2000) indicate smaller and resource-constrained firms benefit more than larger counterparts in alliance partnership with firms possessing leading technologies. In addition to pulling a partner organizations' complementary resources, the strategic

motivation of interorganizational partnerships also occurs when companies jointly undertake novel and risky R&D projects for which the required technological capabilities are unclear.

However, in many partnership cases, both cost-saving and strategic intents are apparent. Most studies in this domain stress a combination of strategic and cost-economizing motivations for interorganizational partnerships (see amongst others, Das & Teng, 1998; Eisenhardt & Schoonhoven, 1996; Hagedoorn, 1993; Lorenzoni & Lipparini, 1999; Mowery, Oxley, & Silverman, 1998). However, it is imperative to consider the dynamic aspect inherent in these relationships, because the motivations of an organization can vary over time as a result of both changes and development within the organization itself and changes within the partnership relationship (Harrigan, 1988).

### **Challenges in collaborative alliances**

Although alliance partnerships have become recognized in the literature as a potential strategic option in creating value, many of these relationships fail (MacAvoy, Robert, Theodore, Lynn, & Thomas, 1998). The cost of an alliance failure can be considerable, and a number of factors have been identified to explain such substantial rates of failure, including the conflict among partners (lack of goal congruency), partners' opportunistic behaviours, and coordination costs (Doz, 1996; Kale, Singh, & Perlmutter, 2000). Thus, even with the promising potential of providing synergies among partners' resource, the success of alliance partnerships is questionable (Madhok & Tallman, 1998).

For example, partner opportunism can occur since it is difficult to detect a priori due to lack of control and performance measures over the intentions of partners in the relationship, which is an impediment to alliance success when the effects surface (Das & Teng, 2000). Thus, firms are required to use an effective process for the formation and management of their alliances to realize the prospective benefits of alliance partnership including survival, profitability, and growth in the market.

Ill-intentioned incentives such as learning races (Hamel, 1991) and deploying the acquired knowledge outside the realm of the alliance arrangement often lead to these opportunistic behaviors surfacing. Considered as a moral hazard, learning races happen when a partner's primary motive is to rapidly learn the other partner's know-how and skills and subsequently reduce its commitment in the relationship after reaching its own learning goals (Alvarez & Barney, 2001; Hamel, 1991; Khanna, Gulati, & Nohria, 1998). As a result, TCE theory (Williamson, 1996) suggests that organizations are somewhat dubious to join partnerships with others due to their reduced control in the collaboration, lack of trust towards companies with different motives and the specificity of resources being shared in such relationships.

Organizations form alliances to take advantage of their partners' knowledge and resources, but most interorganizational alliances are characterized by transaction costs (Lorange et al., 1992). These costs limit the flow of information essential for new product success (e.g., Barclay 1992). Finding a balance between partner flexibility and keeping transaction costs at a tolerable level is challenging but critical to NPD success within the context of alliances (Bidault & Cummings 1994).

In their study, Gulati and Singh (1998) draw attention to the coordination costs in alliance partnerships arising from inherent interdependence and complexity of activities across organizational boundaries to be accomplished jointly or individually. Even though strategic alliances work as a conduit through which partners' knowledge can flow, (Madhavan, Koka, & Prescott, 1998) the interdependence and complexity of tasks in the relationship can produce a substantial level of uncertainty in the alliance (Gulati & Singh, 1998). Mutual interdependency and complexity of tasks in alliances arise from decomposition and coordination of tasks in alliances, resulting in difficult knowledge integration and the vulnerability of each partner with regards to the other party (Ireland et al., 2002).

Each partner asks for a relatively strong commitment of the other partners and an interorganizational interdependence during the joint project development (Hagedoorn, 1993). The mutual interdependence of partners brings about shared control and management of the collaborative arrangement (Parkhe, 1993), giving rise to additional complexity involving simultaneous cooperation and conflicts (competition) between them. This coordination-related uncertainty requires partners to mutually adjust and adapt changes in alliance tasks and (activities) along the way. As a result, it is necessary for partners to effectively manage alliances to realize the potential benefits of such partnership relationships (Hagedoorn, 2002). While alliances have the potential to significantly improve the performance a firm, managing them is often challenging.

### **New product alliance: a specific form of collaborative alliances**

New product alliances are mainly viewed as a conduit through which firms can gain access to technological know-how that is internally unavailable to them, mitigate the risk of product failure after introduction, and share the enormous costs of development (Hamel, Doz, & Prahalad, 1989; Kogut, 1988; Ohmae, 1989; Webster, 1992).

As noted earlier, the primary motives for firms in adopting interorganizational strategies are considered to be embedded in external factors (e.g. an accelerated change in technological and the NPD landscape) (Rindfleisch & Moorman, 2001). Employing such strategies for developing new products is no exception in the NPD context. These changes are characterized by the increased level of complexity of technological development, the rise in performance uncertainty of R&D activities, and the significant upsurge in costs of R&D projects (see Contractor & Lorange, 1988; Dussauge, Garette, & Mitchell, 2000; Hagedoorn, 1993; Hagedoorn, 1996).

Firms need to develop radical innovations to stay ahead of the competition in the market, while the creation of such innovations is substantially challenging (Sivadas & Dwyer, 2000) as a result of technological change, competitive pressures, and lack of internal resources. Radically different technological innovations (radical innovations) demand significantly diverse resources (Sivadas & Dwyer, 2000) which may not be available within the boundaries of a single firm.

Additionally, an individual firm rarely has all capabilities and expertise needed for innovation and NPD (Kotabe & Swan, 1995; Teece, 1987) in a market characterized by

rapid technological change as well as competitive forces (D'Aveni, 1994). While incremental advancements are normally rooted in the recombination of existing technological capabilities and offer short-term benefits to firms (Chandy & Tellis, 2000), radical innovations demand a great deal of learning and unlearning and offer long-term benefits (Sivadas & Dwyer, 2000).

As a solution to this double bind, interorganizational relationships (cooperative strategies) such as alliances, mergers, and acquisitions play critical roles in providing access to important resources (Lin et al., 2009). Given that resources are heterogeneously dispersed among organizations (Hitt et al., 2000), using cooperative (interorganizational) strategies is considered as a promising conduit through which firms can gain access to complementary resources (Das & Teng, 2000; Gulati et al., 2000) and develop new competitive advantages (March, 1991; Stuart, 2000). Oxley and Sampson (2004) state that R&D alliances seem necessary in acquiring and leveraging technological capabilities in dynamic and technologically-intensive environments.

Hagedoorn (2002) defines alliances in terms of R&D agreements as a specific form of a relatively large set of interfirm partnerships, where two or more economically independent firms share some of their R&D activities such as joint development agreements. More specifically, new product alliances are defined as a cooperative agreement between two or more firms to develop and commercialize an innovation by sharing resources (Deeds & Hill, 1996; Rindfleisch & Moorman, 2001; Sivadas & Dwyer, 2000). Thus, it seems to be a win-win situation for firms involved in a new product alliance (Rindfleisch & Moorman, 2001) as such relationships provide partners

with access to complementary resources (Oxley & Sampson, 2004; Stuart, 2000) enabling them to develop radical innovations. More specifically, alliance relationships provide access to technology, resources, information, and markets (Hitt, Ireland, Camp, & Sexton, 2001).

Despite all these advantages, nearly 70% of alliances fail to reach their objectives (Parkhe, 1993). By some account, more than 50% of alliances terminate one year after formation (Greve et al., 2010), creating a stream of research in alliance literature investigating factors affecting alliance termination (Cui, 2013; Cui and Kumar, 2012; Cui, Kalantone, and Griffith, 2011). Bidault and Cummings (1994) suggest that many of the prescriptions for successful management of cooperative alliances clash with effective management of innovations. Alliance relationships succeed when partners follow their responsibilities clearly detailed in the agreement (Hausler, Hohn, & Lutz, 1994; Lorange et al., 1992). Nevertheless, innovation and NPD success require firms directly involved in a new product alliance to be flexible in the relationship. Due to the transaction costs involved in most interorganizational relationships (Heide, 1994), partners try to avoid any renegotiations that may happen due to departures from prior agreements. This may, however, negatively impact the effective development of innovations that demand flexibility.

If managed effectively, alliance partnerships help firms in minimizing transaction costs, coping with environmental uncertainty, reducing their dependency on resources readily unavailable to them, and successfully repositioning themselves in increasingly dynamic markets (Das & Teng, 1996, 2000; Spekman et al., 1998). However, to date,

most researchers have provided theoretical and practical insights to alliance research by concentrating on requisites for the formation of alliance partnerships (a content issue). For example, the emphasis on the content of alliances has mainly tried to shed light on the reasons why firms choose to join particular alliances, instead of other types, and why certain governance structures are chosen over other forms (Gulati, 1998).

Many researchers in strategy and marketing alike have stated that managing collaborative alliances is an important issue warranting further study as effectively managing them would be a game changer for firms in achieving and maintaining competitive advantage and performance (Arino, 2001). In particular, Sivadas and Dwyer (2000) call for further research in partner selection mechanisms and on the ways firms can improve their performance by finding right partners. Additionally, Ireland et al. (2002) argue that, in the study of alliance partnerships, the focus has been on the reasons (why) alliances are formed and relatively less attention has been paid on the process of managing such partnerships to achieve competitive advantage.

Thus, developing new products achieving innovation success require firms to find partners that maximize their goals (Lorange, Roos, & Bronn, 1992) while keeping the transaction costs at a tolerable level (Oxley & Sampson, 2004). In line with hypotheses in this thesis (presented in Chapter 3), appropriate partner selection and partnership timing may explain variations in products innovativeness of firms using alliance partnerships.



### **Effective management of collaborative alliances**

Focusing on management of collaborative alliances concerns the dynamic (instead of static) aspects of collaborative arrangements (Arino & de la Torre, 1998). An effective management of alliance relationships is an important, yet challenging, issue which has been an underestimated phenomenon in this domain (Hutt, Stafford, Walker, & Reingen, 2000; MacAvoy et al., 1998). Advancing our knowledge regarding factors that lead to successful alliance relationships (effective alliance management) contributes to a reduction in alliance substantial rate of failures and improving managerial insights (Barringer & Harrison, 2000).

An effective management of alliances can create substantial value (rent) (Doz & Hamel, 1998; Eisenhardt & Schoonhoven, 1996; Parkhe, 1993). Relatively little research has systematically and empirically analyzed how (the process) a specific alliance is formed and managed to result in favourable outcomes (Ireland et al., 2002). Instead of understanding the reasons alliances are formed, it is necessary to study processes utilized for effectively managing alliances (Barringer & Harrison, 2000; Doz, 1996; Gulati, 1998).

With the increasing popularity of alliance partnership between firms, the lack of research in how arrangements of new product alliances affect product innovativeness is surprising (see Kotabe & Swan, 1995 for an exception). Focusing on the process side of alliance relationships, I particularly consider partner selection and partnership timing as two main factors that have been overlooked in the literature in relation to their impact on the innovativeness of new products.

Effective alliance management diminishes opportunistic acts and the subsequent adverse outcomes of partnerships with certain partners (Sivadas & Dwyer, 2000). In this thesis, building on existing research, I recognize that partner selection and partnership timing play critical roles in realizing the potential benefits of alliance partnerships. To this end, in the following sections, I provide a review of related research (embedded mostly in the RBV and TCE theories) as stepping stones for developing the hypotheses presented in the next chapter.

### **Partner selection in collaborative alliances**

*Static perspective:* Firms frequently look for alliance partners with resources they cannot readily access internally (Gulati et al., 2000). For that reason, resource profiles of firms play a pivotal role in the formation of alliance partnership (Stuart, 2000). Firms normally search for partners with specialized resources which are not readily available from other firms (Doh, 2000). These resources can involve unique technological know-how and capabilities (Nagarajan & Mitchell, 1998).

Building on the RBV literature, Hitt and colleagues (2000) show how firms use ‘gaining access to complementary capabilities’ as a primary criterion for partner selection. Accessing complementary resources is considered as a means for developing new competitive advantages and as an important partner-selection criterion for both larger firms with rich resources and smaller underfunded firms (Hitt et al., 2001; March, 1991).

The probability of creating value is highest in alliance partnerships in which the potential for creating synergy is high between partners (Madhok & Tallman, 1998). On

the other hand, Harrison et al. (2001) conclude that acquiring other firms with similar resources would result in lower performance relative to acquiring firms with complementary resources. While similar resources offer partners a gain in economies of scale and exploiting their existing competitive advantages (Miller & Ireland, 2005), complementary resources provide partners with an opportunity to create synergies, achieve economies of scope, and develop novel resources (Harrison et al., 2001).

The main premise of RBV is that capabilities from different internal and external sources can be integrated and deployed (Teece et al., 1999) to create new products and commercialize them to the market. For example, Zahra and Nielsen (2002) demonstrate that possessing technological knowledge without developing and commercializing them may not result in any value, implying that complementary sources (e.g. manufacturing capabilities) from other firms are required to help a firm realize its internal capabilities.

*Dynamic perspective:* Although RBV provides a reasonable rationale about the selection of appropriate alliance partners, it mostly views partner selection from an economic perspective, emphasizing the potential synergy of pooling complementary resources (Lin, Yang, & Arya, 2009). Hitt et al., (2000) argue that a firm's gain from an alliance is a function of its partner's willingness to share knowledge and resources. Additionally, evidence suggests that alliance success is a function of the quality of relationships between partners (Glaister & Buckley, 1999).

Firms can lose their competitiveness if their existing resources and capabilities (e.g. technological know-how) become outdated by the emergence of new technological innovations (Afuah, 2000). As internal resources face erosion over time due to

technological evolutions, the main motivation of a firm can be to learn newer technological know-how by gaining accessing and using partner resources (Hite & Hesterly, 2001). Thus, the changing needs of firms for resources have incentivized alliance partners to constantly learn new capabilities to stay competitive (Lei, Hitt, & Bettis, 1996; Teece et al., 1999).

Cooper (2000) states that a successful commercialization of a new technology is critical for survival and growth in today's competitive market. These capabilities can be collected and integrated from various partners (Teece et al., 1999) and then applied to create and introduce new products (innovations) to the market timely. Even though research has increasingly suggested the importance of partner selection relying on theoretical arguments (e.g. Ireland et al., 2002), there is a lack of adequate attention and empirical investigations on how the selection of different alliance partners can realize the potential benefits of alliance partnership. I argue that a critical component of effective alliance management for alliances' benefits to be realized is considering the 'partnership type'.

Scholars have mentioned that various kinds of alliance relationships enable firms to access resources and learn knowledge from other organizations (Jarillo, 1988; Varadarajan & Cunningham, 1995) and have argued that such access can stimulate fusion (Dewar & Dutton, 1986), and mitigate the costs and risks associated with innovation (Sivadas & Dwyer 2000). As a result, failure in acknowledging different alliance partners and recognizing differences in their potential benefits for the focal firm may impose serious theoretical problems.

In practice, firms are increasingly gaining access to resources from various partners (Powell et al., 1996) due to dynamic change in their needs towards resources to stay

competitive (Hite & Hesterly, 2001). Thus, I argue that this gap may be better filled by incorporating ‘partnership type’ into the alliance literature and by empirically testing related hypotheses that clarify the innovation output effects of various partners.

### **Partnership timing in collaborative alliances**

*Absorptive capacity view:* Each organization may be a source (repository) of competitive knowledge (Tsai, 2001). Thus, a firm’s specialized resources are important for its sustainable competitive advantage. An effective interorganizational transfer of these specialized resources facilitates mutual learning and partner cooperation which is necessary for achieving alliance objectives (Ireland et al., 2002). In other words, reaching the objective for both partners in an alliance is a function of an effective incorporation of different specific resources owned by different partners. To this end, firms must make sure that they have an adequate absorptive capacity to understand and apply the incoming knowledge (Cohen & Levinthal, 1990). Tsai’s (2001) work suggests that a large absorptive capacity of a firm in an alliance relationship is associated with successful applications of acquired knowledge towards new product ends. Dyer and Singh (1998) also point out that alliance partners must have knowledge-absorbing capacities that facilitate sharing of information for the joint NPD.

*TCE view:* In addition to having an absorptive capacity, firms’ sharing of their proprietary resources is a function of perceived transaction costs (partners’ opportunistic behaviours) in an alliance (Williamson, 1991). Alliance partners must have compatible motives to share their proprietary resources (Hitt, Hoskisson, & Kim, 1997). In short, the challenge for the firm is to manage the outflow of competitively relevant information to its

partner to support the alliance and facilitate inter-partner learning, while simultaneously protecting proprietary knowledge (Hutt et al., 2000). Thus, firms need to understand each other's motives, or the extent to which a firm's objective is to outlearn its partners (Hamel, 1991). Effective management of information flows facilitate necessary knowledge sharing while preventing partner appropriation of knowledge (Baughn, Stevens, Denekamp & Osborn, 1997).

*Agreement scope:* Oxley and Sampson (2004) posit that determining *relationship scope* is critical in limiting alliances the opportunistic behaviours of partners. The authors argue that alliance scope can work as an alternative method to governance structure, which may not be effective even if it is a joint venture. Categorizing alliance scope under exploration versus exploitation has been identified in the literature of alliance by a few researchers (e.g. Oxley & Sampson, 2004; Rothaermel, 2001). Also, Kalaignanam, Shankar, and Varadarajan (2007) argue that alliance scope (broad versus narrow) influences the financial gains of alliance partners. This highlights the importance of considering an alternative method for governing alliance partnerships. Within the determined alliance scope characterized by reduced transaction costs, it is important for both partners to have equal opportunity to benefit from the partnership (Douma, Bilderbeek, Idenburg, & Looise, 2000; Hitt et al., 2000). Cui and Kumar (2012) argue that alliance scope is related to the termination of joint venture alliances, suggesting the importance of alliance scope for the success of an alliance partnership. All of these imply that alliance scope can satisfy both knowledge protection and absorptive capacity, both

critical for the free flow of information which is critical to the success of the alliance and its performance outcome.

*Implications for NPD research:* In the NPD context, firms are conducting new product activities during the NPD process from discovery to commercialization (Rothaermel, 2001). In terms of uncertainty, regardless of their stage in the NPD process, the majority of innovations being developed jointly in new product alliances will not result in marketable products (Lerner, Shane, & Tsai, 2003). However, uncertainty declines as a project moves along through the NPD process (Rothaermel & Deeds, 2004), indicating that early-stage new product alliances generally involve higher uncertainty than late-stage alliances. Thus, decomposing the NPD process to different stages would provide firms with different alliance timing which can be comparable to agreement scope by reducing the partners' transaction cost and enhancing control and monitoring.

Firms enter alliances at early stages of the NPD process (exploration alliances) to discover something novel cooperatively with a partner, while alliances initiated at later stages (exploitation alliances) are done to increase the efficiency of existing resources and technologies (Fang et al., 2015; Koza & Lewin, 1998). Mitchell and Singh (1996) emphasize the augmentation of technological capabilities using complementary external resources, *throughout* the development and manufacturing process. This signifies the importance of considering the changing dynamics in each stage of the NPD process.

A more recent study in marketing by Fang et al. (2015) illustrates how transaction costs vary as a new product moves along the NPD process from early stages (e.g. discovery) to late stages (e.g. pre-launch). The authors mainly rely on TCE as a

theoretical framework, (e.g. Heide, 1994; Rindfleisch & Heide, 1997; Santoro & McGill, 2005) to indicate varying degrees of transactions cost in codevelopment alliances (product specificity and performance uncertainty) during the NPD process.

Building on the logic of varying transaction costs through different stages of the NPD process, I argue that ignoring alliance timing (NPD stage) may impose serious theoretical problems, therefore negatively affecting an effective management of alliance partnerships. Thus, this gap may be better filled by taking into account ‘partnership timing’ (NPD stage) in the alliance literature and by empirically testing related hypotheses that clarify its innovation output effects.

Because the focus of this thesis is on the innovation success of biotech firms, as relatively small firms, the final section of the literature review summarizes research in this domain with a particular focus on small firms.

### **Innovation and NPD for small firms**

The rules of competition have changed over time and, with them, the strategies firms use in interorganizational alliances. Due to dynamic environments and hypercompetition, companies strive to learn from other organizations through alliances in contrast to the traditional view of using alliances as access points to resources only (Prahalad & Hamel, 2000; D’Aveni, 1994; Teece & Pisano, 1994). However, relevant studies in this field focus mainly on one type of interorganizational alliances (between large and small firms) while measuring alliance outcome mostly from the perspective of large firms (e.g. Rothaermel, 2001).



Doing so, the innovation effects of alliance partnerships from the perspective of small firms have mainly been ignored in the literature (see Baum et al., 2000 for an exception). In reality, small firms can choose from a wide variety of partners (e.g. university and research institutions; competitors; incumbents) to develop new products (Lane & Lubaktin, 1998; Powell et al., 1996) at different stages of the NPD process (Fang et al., 2015). Not only does the innovation performance from the view of small firms require more research, but also other types of alliances need to be considered to avoid biases in the results.

As mentioned earlier, in-house NPD and firm-specific factors are of restricted relevance for small firms (Yli-Renko & Janakiraman, 2008). Such firms are normally small and underfunded (Kotabe & Swan, 1995) with financial constraints or enough resources to conduct acquisitions. However, Katila and Shane (2005) argue that small firms can successfully develop and introduce innovations. The main question here would be what are the factors explaining a small firm's capability to innovate? Since capability development is extremely time-consuming, costly, complex, and uncertain (Teece et al., 1999; DiMasi Hansen, & Grabowski, 2003), many small firms rely on interorganizational partners to develop and launch new products.

On the other hand, firms that introduced radical innovations have typically been small and new entrants into the market (Utterback, 1994). The radical innovations introduced by small firms can disrupt the market as powerful incumbents decline and might even spark incumbent demise (Chandy & Tellis, 1998). Findings of an empirical study by Scherer (1984) indicate how small firms can play a significant role in the

development of radical industrial products. Prior studies outlined reasons for the myopic view of large incumbents resulting in their unwillingness to cannibalize their existing technological innovations (Chandy & Tellis, 1998) and failure to launch radical innovations (Ghemawat, 1991). As firms grow, they become bureaucratic and involve multiple levels of screening and decision making, and incentives to develop radical innovations diminish (Cohen & Levin, 1989).

Additionally, the performance of relatively small firms in an industry has normally been overlooked while these innovative firms heavily rely on interorganizational partnerships to overcome competitor patent fight as well as large downstream incumbents' advantages to attract customers (Utterback & Abernathy, 1975). By forming strategic alliances, small firms can thus potentially access technological and competitive product development resources that normally involve years of experience to obtain internally (Ahuja, 2000; Nohria, & Garcia-Pont, 1991).

Cohen and Levinthal (1990) discuss technological knowledge opportunities available in relationships with universities or competitors that complement and leverage the firm's internal knowledge. The significant need of small firms for external resources to maintain their technological knowledge updated, develop their technologies, and commercialize their technological knowledge, has motivated them to partner up with a variety of organizations (Baum et al., 2000; Powell et al., 1996).

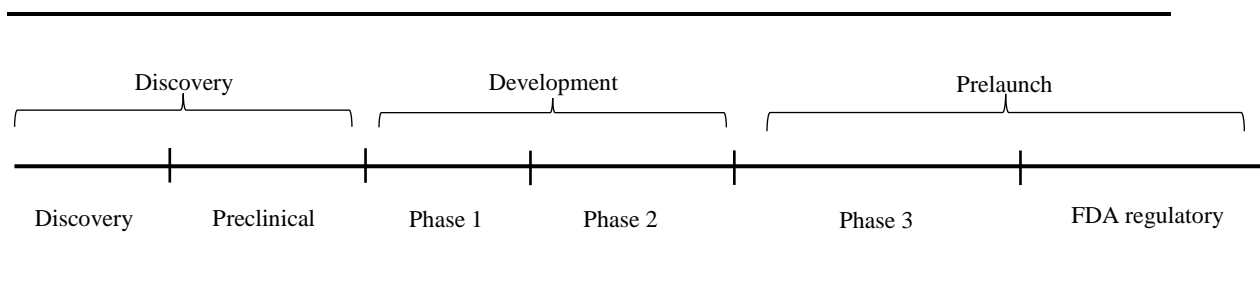
New product development generally requires the integration of different functions from discovery and research to development, design, and marketing activities (Kotler & Rath, 1984). Empirical work suggest that firms have a tendency to vertically integrate when

the transaction costs in the market and in alliance relationships exceed the costs of vertical integration (Klein, Crawford, & Alchian, 1978; Monteverde & Teece, 1982; Pisano, 1990). However, implications from these studies may be relatively less relevant for small firms operating in technologically intensive industries such as biotechnology, software, and semiconductors. (Haeussler et al., 2012).

These firms may not have the skills or time to acquire the required expertise to complete a full cycle of NPD in-house (Lerner et al., 2003). In the biopharma industry, for example, a full cycle of NPD takes an average of 12 years (DiMasi et al., 2003). Additionally, small firms join cooperative strategies for NPD because forward integration is costly and risky and external funding through capital markets may not be a viable option (Rothaermel & Deeds, 2004). Thus, small firms may have no choice but to form alliances to turn their research discoveries into marketable products (Lerner et al., 2003; Rothaermel & Deeds, 2004).

Alvarez and Barney (2001) argue that although alliances between large and small firms can create value, the latter is normally more vulnerable than the former in such relationships. Small firms may, consequently, face the challenge of being overlearned and exploited by their large downstream partners (Hamel, 1991). On the one hand, small firms have less power earlier in the NPD process and thus are more willing to participate in an alliance initiated by the established technology partner (Rothaermel & Boeker, 2008). Drug development process is presented in figure 1.

Figure 1. The Drug Development Process



Source: Adapted from FDA (1999)

### **Small firms' new product innovativeness in a technologically-intensive context**

This thesis specifically focuses on small firms and the biopharma industry, as a technologically intensive industry. I draw attention to how biotechnology firms operating in the biopharma industry (with comparable internal resource constraints) have used and configured their new product alliances with universities, competitors, and incumbents in order to introduce radical innovations to the market. I argue that this is of critical importance as incremental innovations are even less valuable than radical innovations in technologically intensive sectors (e.g. biotechnology and semi-conductor), and additionally vital for small firms.

Firms operating in technologically intensive industries (e.g. the biotechnology industry) must increase their chance of introducing innovative products to the market (Hagedoorn, 1993) due to shortened product life cycles, shrinking profit margins, and competitive pressures, inherent in such industries. In technologically intensive industries, relentless advancement of technologies requires firms to generate radical innovations

(Dickson, 1992). On the other hand, the dynamic competitive environment and imitation products erode almost all internal advantages over time (Kotabe & Swan, 1995).

Organizations cannot solely rely on their internal NPD strategies to maintain their competitive advantages (Hagedoorn, 1993). Thus, accelerated competition, along with associated technological uncertainties, in technologically intensive industries increasingly require firms to develop radical innovations (D'Aveni, 1994; Dickson, 1992).

In the Schumpeterian tradition, the success of small firms is subject to discontinuous (radical) innovations and breaking into the market. They need to generate innovative products more than large firms, in order to survive and to gain the competitive lead (Haeussler et al., 2012). However, developing innovations is challenging for small firms. On the one hand, small firms must be highly innovative to attract the attention of investors, keep pace with market competitiveness forces, and more notably, overcome advantages of industry incumbents in attracting customers (Utterback & Abernathy, 1975). On the other hand, such firms normally lack the required internal resources to conduct a full cycle of the NPD process on their own, since such companies often lack the required financial resources (Heide & John, 1990; Haeussler et al., 2012). Also, using vertical integration strategies (e.g. forward integration of bigger firms) might not be an option for them.

Table 2 outlines the benefits and costs associated with organizational and interorganizational forms of new product development. I draw mainly from arguments in transaction cost economic (TCE) (Heide, 1994) and dynamic models of competition (Hagedoorn, 1993). I describe the inherent transaction costs and the benefits of exchanging

resources in interorganizational strategies against the cost of scarcity of resources and benefits of safeguarding resources, specificity related to internal NPD strategies.

Competitive environment pressures and constant technological advancements amplify the benefits and mitigate the costs associated with interorganizational strategies. Also, a lack of internal resources renders internal NPD strategies nearly useless for small firms. This view suggests a paradigm shift from organizational to interorganizational strategies.

**Table2: The benefits and costs of internal versus external NPD**

NPD strategies	Benefits / Costs	Logic	Tech-intensive context	Small firms	Notes
Bureaucratic and market-based NPD strategies	Benefits	High chance of predictable outcome. Low transaction costs regarding product specificity and performance uncertainty.	-	-	Internal NPD often results in incremental form of new product success (Dickson, 1992; Utterback, 1987).
Bureaucratic and market-based NPD strategies	Costs	Lack of access to the full range of know-how and other resource required to offer timely and cost-effective new product innovations (Teece, 1987).	+	+	Internal NPD often results in incremental form of new product success (Dickson, 1992; Utterback, 1987). Products of a single firm tend to be more innovative than products of cooperating firms (Kotabe & Swan, 1995).
Cooperative NPD strategies	Benefits	Access to various complementary technological know-how and other resources unavailable internally.	+	+	Organizations cannot solely rely on their internal NPD strategies to maintain their competitive advantages (Hagedoorn, 1993).
Cooperative NPD strategies	Costs	Low chance of predictable outcome. High transaction costs regarding product specificity and performance uncertainty.	-	-	Creating radical innovations is often a function of the external knowledge that a firm can access (Ahuja & Lampert, 2001; Rosenkopf & Nerkar 2001).

Notes: + = increase in the benefits/ costs of NPD strategies; - = decrease in the benefits/ costs of NPD strategies

### **Gap analysis**

To summarize, this chapter provides a review of the literature on innovation and NPD research, internal versus external NPD strategies, and effective management of alliance (interorganizational) partnerships. As pointed out below, a number of gaps surfaced in the process of reviewing the literature in this domain:

- There is a lack of attention on product innovativeness, and researchers have mainly focused on the count variables as representative for NPD success (Baum et al., 2000). This review provides reasons why there is bias involved in measuring innovation as an outcome variable. Removing this bias requires a more objective operationalization of product innovativeness. I draw from Wyuts et al. (2004) to measure product innovativeness as a function of both technology integrated in the product and the benefits it adds to customers. Additionally, effective management of the NPD process has also been towards increasing the number of new products rather than their innovativeness. Therefore, addressing this gap requires revisiting the research in NPD processes and providing recommendations that satisfy the need for developing and introducing radically innovative new products.
- Despite the suggestions in the literature regarding the benefits of interorganizational (alliance) relations as an alternate to organizational (in-house) NPD strategy, there is a lack of systematic and empirical examination of the alliances on product innovativeness. The research in



this domain has mostly linked the count number of alliances to innovation performance of firms. The substantial rate of failure signifies the need for understanding variations in alliance partnerships instead of relying on anecdotal premise of benefits these relationships have to offer. This is a gap in the literature, which needs to be filled by drawing attention on effective management of new product alliances.

- Building on theoretical arguments from TCE, RBV and insights from the absorptive capacity concept, an effective management of dyadic alliance partnerships requires both partners to possess: compatible motives, equal opportunity to benefit from the partnership, and a relatively adequate capacity to learn in the partnership. There is a gap in the literature regarding incorporating the abovementioned theoretical lenses to provide new insights in effective management of alliances and, more specifically, developing new products.
- To understand the product innovativeness effect of alliance partnerships, using the incorporated theoretical lenses above would lead to considering “partnership type” and “partnership timing”. While the former is concerned with acknowledging the importance of appropriate partner selection in alliance success, the latter acknowledge the differential transaction costs of alliances formed at different stages of the NPD process. These factors would be analogous to agreement scope in the alliance literature. These factors enable firms to have more manageable

partnerships that maximize the resource benefits of partners and minimize the costs and risks associate with partners.

- Finally, the performance effects of interorganizational partnerships have been mainly considered from the perspective of large (incumbent) firms. Relatively little research in this domain has focused on small firms, even though such firms are more vulnerable in the relationship and developing innovations is critically important for their survival and growth. Not only will small and underfunded firms normally find organizational NPD strategies ineffective, they also find that acquiring other firms is not an option due to the substantial costs associated with such strategies. Therefore, in practice, most small firms employ interorganizational alliances to develop new products. This underscores the importance of examining the innovation success or small firms using alliance relationships with other organizations. This thesis intends to fill this gap by switching the perspective from large to small firms.

*Assumption:* Literature suggests that the same factors explaining alliance relationships can be used as requisites for NPD success (e.g. Sivadas & Dwyer, 2000). However, substantial failure rate reported for alliances (70%) (Barringer & Harrison, 2000) is mainly due to differences in the logic of alliance management and that of innovation management. While the success of an alliance is a function of detailed goals and partner responsibilities (Hausler et al., 1994), innovation demands flexibility between the partners involved with a given project. Thus, an effective management of

interorganizational relationships for developing NPD requires a setting that minimizes transaction costs without compromising the flexibility of partners. To reach this balance, a theoretical model is needed that conceptualizes and incorporates partnership type and partnership timing. In the next chapter, I will develop testable hypotheses by the conceptualization of these factors in a parsimonious theoretical framework linking alliances to product innovativeness.

## **CHAPTER III**

### **THEORETICAL BACKGROUND AND HYPOTHESES**

#### **Introduction**

The underlying theoretical framework in this thesis includes resource-based view (RBV) and transaction cost economics (TCE). These theories encompass the main two streams of research in this thesis: management of alliances and management of innovations and new products. Given that the main purpose of this thesis is to integrate these research streams and provide new insight into new product innovativeness through alliance management, it is important to understand the underlying theoretical bases in this regard.

In linking alliance to firm performance, RBV suggests that firms need to look for appropriate partners with resources that maximize the economic value for the firm. However, TCE proposes that firms can enhance their performance through alliances by using appropriate governance mechanism (e.g. joint ventures) that minimizes transaction costs. Even though both theories aim to enhance the performance of firms through alliances, the premises behind each theory may not be aligned.

As stated in Sivadas and Dwyer's (2000) work, the logic behind alliance management may be in clash with the basis behind successful innovation management. The logic of alliance management is to define alliance goals and partners' responsibilities in detail to avoid conflict of interest between partners (TCE logic). However, successful

innovation requires from alliance partners to have flexibility and be open to renegotiation. In the case of radical innovations, a diverse outlay of resources is needed that may not be available internally, and alliance partnerships with appropriate partners may provide the firm with access to such resources (RBV logic). Thus, to solve this tension, it seems necessary to develop a theoretical framework (linking product innovativeness with alliance research) that satisfies premises of both RBV and TCE perspectives.

This chapter intends to contribute to both alliance and innovation research by introducing a new typology for alliance management and its application to product innovativeness. Integrating theoretical arguments from RBV and TCE, this typology contributes to alliance management by distinguishing new product alliances along the dimensions of 1) alliance partnership type (alliance partners that create synergy enhance product innovativeness) and 2) alliance partnership timing (alliances during the NPD process with lower transaction costs enhance product innovativeness). I employ this typology to develop testable hypotheses by determining interactive effects of partnership type and partnership timing on the innovativeness of a project— being developed through alliances with different partners during the process of NPD.

### **Theoretical background**

In the following sections, I provide related theoretical background for RBV and TCE. In doing so, I suggest that these two theoretical perspectives are complementary, though with different premises, in their ability to provide insights on how to enhance product innovativeness through effective management of alliance partnerships. Finally, I

develop related hypotheses using the integrated view as well as related middle-range theories and concepts such as relative absorptive capacity.

### **Resource-based view on alliances**

The resource-based view (RBV) of the firm theory suggests that a firm's competitive advantage is embedded in its management of internal resources (Barney, 1991; Wernerfelt, 1984). However, due to the heterogeneity of resources across firms (Das & Teng, 2000), the interorganizational perspective of RBV later recognized that some important resources can be obtained from other firms (Hitt et al., 2000).

Building on interorganizational RBV, researchers suggest that firms should seek out alliance partners with whom they can leverage resources and create synergy (e.g. Das et al., 1998; Lin et al., 2007). Thus, the purpose of alliance partnerships, from the RBV view, revolves around gaining access to resources not available within the boundaries of firms, as well as learning and assimilating resources from alliance partners (e.g. technological know-how) (Stuart, 2000). However, it is necessary that both alliance partners be willing to share resources to ensure that the gain is mutually beneficial from the alliance (Hitt et al., 2000).

Developing innovations requires a recombination of various resource and skills as well as an interplay of various functions including R&D, marketing, and manufacturing (Kotler & Rath, 1984; Ouchi, 1980). A single firm rarely has all of these requirements to this end (Teece, 1987), and constraints require firms to focus on internal resources (Prahalad & Hamel, 2000). The need to enter into alliances is more prominent when firms

face rapid technological change and a new competitive environment. Thus, a firm joins alliances to source technology and knowledge from alliance partners and leverage them to maximize its relative competitive advantage (Dickson, 1992).

This theoretical perspective relates to partner selection as different partners may provide resources either complementary or similar to those a firm might have internally. A study by Harrison et al. (2001) shows that companies acquiring other firms with complementary resources would outperform those acquiring targets with highly similar resources.

Accessing dissimilar but complementary resources, firms can create synergies, learn how to develop new resources and skills, and gain economies of scope (Harrison et al., 2001).

However, highly similar resources also provide firms with the opportunity to better exploit their internal resources and existing competitive advantages and, sometimes, gain economies of scale (Miller & Ireland, 2005).

According to Lin et al. (2009), the rationale for alliance partnership from the RBV perspective is different from the theory of resource dependence, because alliances are conduits for not only gaining access to valuable resources of other firms, but also providing firms with an opportunity to leverage partner resources to maximize rents. Adopting RBV, researchers can better understand alliance partners in terms of their resource characteristics (similarity vs. complementary) (Das & Teng, 2000). The assumption of RBV is rooted in the potential value creation of the pooled resources of alliance partners.

Findings of a study by Hitt et al. (2000) provide support for the resource-based reasoning behind partner selection in alliance partnerships. For example, established firms looked

for partners possessing complementary resources such as distribution channels and market knowledge, thus offering potential synergies. Similarly, emerging firms sought partners to help them gain access to the resources that they needed, namely technical and financial resources, and strategic status in the market.

Consequently, there is a lack of sufficient attention to transaction cost influences. Failure to acknowledge transaction cost embeddedness in alliance partnerships may impose a serious partner selection issue during the NPD process, leading to an increase in alliance and innovation failures (Sivadas & Dwyer, 2000). Incorporating the TCE perspective into RBV reasoning may better align the conflictual logics of alliance management and NPD management.

In summary, alliance partnerships enable pooling of resources among organizations, making the creation of synergies possible. RBV places a strong emphasis on economic rationality of accessing and developing resources through alliance partnerships. However, this tends to disregard the potential costs associated with alliance partnerships, imposing the problem of protecting proprietary resources from unintended leakage to partners. Thus, even though RBV provides a solid rationale for alliance partner selection, it largely examines the process of partner selection from an economic perspective, emphasizing the efficiency of combining resources.

### **Transaction cost economics view on alliances**

Relying on TCE for the purpose of minimizing the transaction costs, empirical research has provided support for the concept of vertical integrations as a remedy where



the transaction costs associated with the market or alliance arrangements exceed those offered by vertical integration (Klein et al., 1978; Pisano, 1990). Vertical integration will be used when a transaction is characterized by complexity of the task, specificity of assets (resources) involved, and difficulty of measuring and monitoring the other party's performance. In this view, the focus of research from the TCE perspective has been on alliance formation as an alternative strategy to markets or vertical integration for addressing the specific needs of firms (Stuart, 2000).

Alliance partnerships are prone to substantial transaction costs due to lack of trust in, and the fear of, being overlearned between partners (Hamel, 1991), making firms reluctant to share their proprietary knowledge necessary for developing highly innovative new products. Previous research in TCE suggests that firms choose an appropriate governance structure in an alliance to improve knowledge sharing and to enhance protection of specialized internal resources (e.g., Pisano, 1989; Oxley, 1997; Kale et al., 2000; Sampson, 2004). From the TCE perspective, a successful management of alliances is a function of boundary-spanning activities of a firm while minimizing the sum of its production and transaction costs (Barringer & Harrison, 2000). This suggests that firms consider partner selection and relationship characteristics that minimize transaction costs.

Transaction cost economics focus largely on the manifestation of behavioural and environmental uncertainties that a firm may face in its transaction with other organizations, which enhances the firm's appropriation concerns and makes designing and drafting a potentially complete contract difficult and costly (Williamson, 1985). TCE considers these factors (uncertainties and asset specificity) to rationalize the appropriate

use of governance structure (contractual vs. joint venture) in minimizing transaction costs (Williamson, 1991).

In terms of alliance outcome, TCE also suggests that alliance partnerships that better safeguard the scarce and valuable resources exchanged during the course of relationship will result in a firm's survival and higher knowledge transfer (Mowery, Oxley, & Silverman, 1996). Also, essential to TCE arguments is the firm's ability to control coordination costs in the alliance which result from decomposing tasks among partners and coordinating actions (Gulati, 1998; Gulati & Singh, 1998). Frictions between alliance partners can arise due to poorly specified and insufficiently protected intellectual property rights (Teece, 1986) or by transfer of tacit knowledge and related to complex projects across boundaries of organizations (Lane & Lubatkin, 1998).

From the TCE perspective, relative to contractual governance, a joint venture is considered a protective mechanism or alliance governance structure that minimizes transaction costs and maximizes the free flow of knowledge between alliance partners (Mowery et al., 1996). However, researchers (e.g. Dyer, 1997; Oxley & Sampson, 2004) state that using joint ventures, despite their many benefits, are expensive and may not necessarily be effective to avoid transaction costs. Even if activities are embedded in an equity joint venture, the residual opportunism hazards may be large enough to prevent required knowledge sharing between alliance partners (Inkpen, 2000).

Although TCE considers partnership characteristics as explanatory factors for choosing appropriate governance mechanism and, subsequently, alliance outcomes, the path to achieve the alliance objective passes through cost minimization. This may cause

foregoing the partner that maximizes the potential value creation. Additionally, research (e.g. Oxley & Sampson, 2004) shows that despite the effectiveness of using appropriate governance structure in reducing the transaction costs, there may be situations where even the most ‘protective’ governance structure (e.g. the equity joint venture) does not sufficiently prevent unintended leakage of specialized resources. Thus, it seems that the incorporation of RBV to traditional transaction cost analysis (Hill, 1990) will complement the TCE with its concentration on costs by capturing the nature of resource being exchanged, creating a balance between costs and benefits in such relationships.

In summary, theoretical arguments built on TCE theory suggest that firms must consider transaction attributes and conditions under which alliance partnerships are formed, and subsequently apply appropriate governance mechanism to minimize costs associated with the transactions in alliances. As a part of transaction attributes, TCE highlights the importance of appropriate partner selection in reducing such costs. Thus, the main criterion of partner selection is transaction cost minimization, which may cause firms to forego choosing partners that could provide higher benefits. In such situations, firms must either relinquish the benefits of alliance partnerships completely or find alternative solutions to reduce the hazards of such collaborations. Thus, a complementary perspective of RBV is required to help companies select firms that maximize the value creation benefits, while transaction costs are held to a tolerable level.

**A theoretical integration: effective management of alliances for NPD success**

Both RBV and TCE perspectives offer insights for value creation through alliances; however, each has a different emphasis. Alliance, from the perspective of RBV, is a means for exchanging resources and learning that enables firms to create sustainable competitive advantages (Hitt et al., 2000). In this way, developing unique resource bundles is the main focus in RBV. Additionally, according to the TCE, an alliance is associated with potential transaction costs and value creation happens when such costs are minimized using appropriate governance structures (Ireland et al., 2002).

In contrast, RBV focuses on the importance of alliance partnership type and considers it as a means for gaining and maintaining competitive advantage through accessing to technological knowledge, resources, and markets (Das & Teng, 2000). TCE focuses on transaction costs involved in alliances and suggests that alliances can create value when transaction costs involved in them is less than those in alternative organizational or the market strategies (Jarillo, 1988). TCE places emphasis on managing alliances by choosing appropriate governance structure (e.g. joint venture) to promote knowledge sharing and protect valuable resources (Mowery et al., 1996).

Both RBV and TCE emphasize the importance of partner selection (Hitt et al., 2000; Ireland et al., 2002), as a key factor in the effective management of alliances. However, in addition to partner selection, TCE highlights the importance of considering varying transaction costs during the NPD process. Recent research shows that there are in fact varying transaction costs during the process of NPD (e.g. Fang et al., 2015), where

alliances formed in early stages of the NPD are prone to significantly greater transaction costs than late stages. Thus, TCE is capable of providing insights regarding not only the partnership type but also the partnership timing (NPD stage at which the alliance is formed). However, TCE suggestions regarding partnership type and timing are cost-oriented, and this transaction cost view in selecting partners at a different timing (NPD stages), though effective in reducing friction between partners, is in direct contrast with the flexibility requirements inherent in the perspective of innovation management.

Given that the objective in this thesis is to provide insight as to how firms can enhance product innovativeness through an effective alliance and innovation management, I argue that RBV complements the TCE view on partnership type and timing. By suggesting the partnership type that could potentially provide the highest resource benefits under different alliance timings, RBV looks at creating and maintaining a sustained competitive advantage (product innovativeness in this thesis). Thus, despite the contradictory logics of these views at first glance, it seems that these two perspectives are not mutually exclusive. TCE and RBV are rather complementary and can be incorporated to shed new light on a more effective management of alliances to achieve highly innovative new products.

Taken together, while RBV has a strong emphasis on the economic value of gaining access and developing resources through alliances, it bypasses the interaction process between alliance partners. Even though TCE highlights the effective management of alliances by focusing on minimizing transaction costs in the process of alliance partner interaction, it fails, for the most part, to provide insight in determining whether the

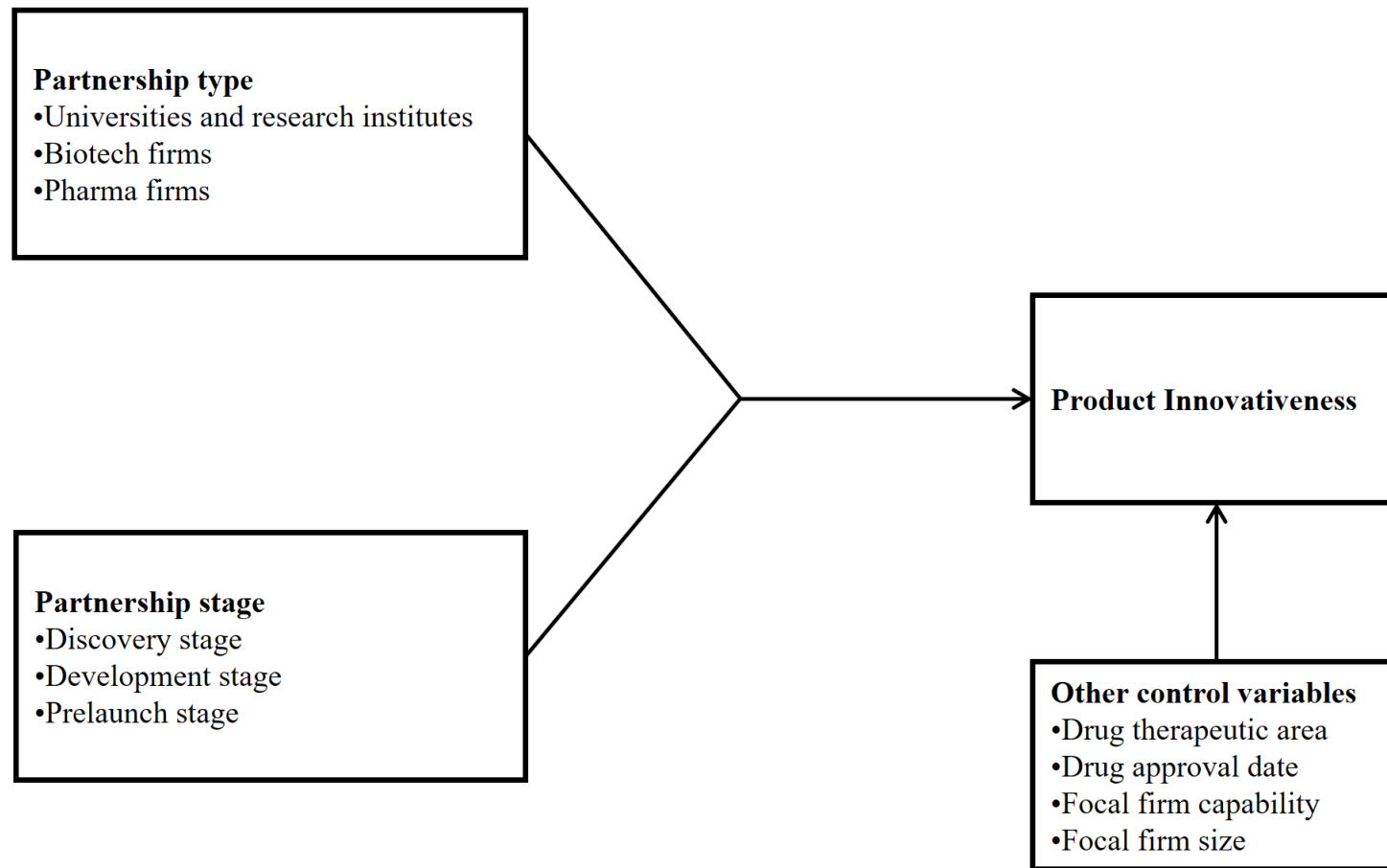
combination of resources that firms have incorporated through alliance will lead to highest possible innovation outcome.

In summary, building on these theoretical reasonings, I propose an integrative theoretical framework (Figure 2) and develop related hypotheses. Given that both TCE and RBV emphasize the importance of “partnership type” and “partnership timing”, focusing on each of the two without considering the other may not result in an effective alliance management (Ireland et al., 2002) for achieving the best possible innovation outcome. Thus, instead of hypothesizing the respective role of each variable, I develop hypotheses examining their interactive effects in order to be in line with the conceptualization outlined earlier (theoretical integration of RBV and TCE). This conceptualization intends to compromise conflicting logics between alliance management success (rigidity) and innovation management success (flexibility).

### **Hypotheses development**

Firms normally face the challenge of managing different alliances as they are likely to impose different costs and provide different benefits. I argue that these differences in potential costs and benefits stem mainly from two factors: the different types of partners (Rothaermel & Deeds, 2006) and different alliance timing during the NPD process (Fang et al., 2015). Additionally, Lane and Lubatkin (1998) identified substantial differences among different types of partners. Different partnership types and partnership timings impose differential transaction costs, provide differential benefits, and make differential demands on the firm’s alliance management capability. Given the existence of potential variations among alliances along two dimensions of

**Figure 2: Conceptual framework**



alliance type and timing, it is necessary to further categorize (split) these dimensions to examine potential order within each dimension in enhancing the product innovativeness.

Thus, in the following sections, I develop a typology capturing partnership type and timing and their respective levels. Since I intend to use the biopharma industry as my empirical setting, I then briefly discuss a biotechnology firm's different partnership types and timing along the industry value chain before applying the typology and discussing its implications.

### **Typology development**

I address a potential aggregation bias in the alliance research by proposing a disaggregation of alliances along two dimensions: the *type* and the *timing* of the alliance partnership. While alliance partnership type focuses on the type of alliances the small firm initiates for the purpose of its project in the process of NPD. Alliance partnership timing is related to the timing, or the NPD stage, in which the focal firm form the alliance for the same purpose. More specifically, the first dimension separates alliances, which the focal firm has formed, into three partnership type choices:

- i. upstream research institutes,
- ii. horizontal competitors, and
- iii. downstream incumbents.

On the other hand, the second dimension splits alliances, which the focal firm has formed, into three partnership timing choices:



- i. discovery stage,
- ii. development stage, and
- iii. prelaunch stage.

Taking together potential differences in alliances in terms of partnership type and timing, I argue that the interaction between these two factors affects the product innovativeness of the focal firm. More specifically, the product innovativeness effect of alliance(s) formed by the focal firm with each partnership type is conditional on the alliance timing. Likewise, the product innovativeness effect of alliance(s) formed by the focal firm in each timing (stage) of the NPD process is conditional on the pecking order of alliance partnership type.

### **Alliance type and timing in the biopharma industry**

As mentioned earlier, entering into alliances is a critically important NPD strategy for small firms, since other NPD strategies may be ineffective or even irrelevant for them. A biotechnology firm is normally underfunded with a lack of financial and complementary resources to turn their technological capabilities and know-how into marketable products (Haeussler et al., 2012). Thus, the innovation success of such firms is highly dependent on alliance strategies they make, as they normally initiate alliance partnerships with different partners at different timings (NPD stages). Building on this reasoning, biotechnology firms with FDA-approved drugs are denoted as focal firms in this thesis, and I argue that the innovativeness of their drugs is related to alliance decisions they have made during the NPD process of their drugs.

Understanding the role of biotech firms entering into alliances along the entire NPD process is particularly prominent given the fact that most innovation projects will either fail before they reach the market (Griffin, 1997; Stevens & Burley, 1997), or if they are successful and launch a marketable product, results are likely not to meet expectations (Booz et al., 1982).

I develop hypotheses by applying the typology (developed in the previous section) to the biopharma industry. Biotechnology firms generally face three different partnership types (Baum et al., 2000), and they also face three different partnership timings (Fang et al., 2015). Biotechnology partnership types are research universities or research institutions, partnerships with other biotechnology firms, and partnership with established pharmaceutical companies. In terms of partnership timing, biotech firms can enter into alliances anytime during the NPD process. However, recent research by Fang et al. (2015) has divided the NPD process into three stages (alliance timing): the discovery stage, where the goal is to conduct research and explore potential solutions to a problem, the development stage, where the objective is to conduct preliminary and medium-level clinical trials, and the prelaunch stage (regulatory), where the goal is to conduct large-scale clinical trials and regulatory activities.

In the biopharma industry, biotech firms are considered by some researchers (e.g. Rothaermel & Deeds, 2004) as intermediaries which take on the responsibilities of both knowledge transformation and commercialization. The tenet in this conceptualization of the partner roles in the industry value chain is that biotech firms initiate upstream alliances with universities where they can assimilate basic knowledge, and then form

downstream alliances with pharma firms to apply and commercialize the obtained knowledge through regulatory processes and distribution. Even though such conceptualization of partnership type in biopharma has provided insights, other researchers (e.g. Rothaermel, 2001; Yang, Zheng, & Zhao, 2014) have not limited their conceptualization of the value chain in the biopharma industry as a consecutive process that starts from universities and ends with pharma firms. Building on the latter, I argue that biotech firms can enter into alliances with such partners at different foci of the value chain (Hoang & Rothaermel, 2010). This conceptualization provides more comprehensive implications to firms without relying on a priori assumptions.

Given these delineations along two dimensions, and in line with theoretical the integration of RBV and TCE, I develop nine mutually exclusive NPD strategies for biotech firms to enhance their product innovativeness (as shown in Figure 2). Despite the existence of potential synergies and dis-synergies among these nine strategies, this study focuses on developing these nine mutually exclusive strategies affecting product innovativeness.

On the one hand, the first set of three hypotheses deals with the differential effects of alliance timing on the product innovativeness of firms, given a constant type of partnership. Thus, hypotheses 1, 2, and 3 intend to provide answers to the question: given the partnership type, how does shifting from discovery to development to prelaunch stages of the NPD process affect the product innovativeness of new drugs developed by the focal firm? On the other hand, the second set of three hypotheses concerns with differential effects of alliance partners (partnership type) on the product innovativeness of

firms, given constant partnership stage. Thus, hypotheses 4, 5, and 6 intend to provide answers to the question: given the partnership stage, how does shifting partnership type from university to biotechnology to pharmaceutical type affect the focal firm's product innovativeness?

In summary, if variation exists among alliances regarding both partnership type and partnership stage, it seems necessary to examine the effect of varying partnership stage on innovation outcome (innovativeness) for each partnership type. By the same token, it is critical to examine the effect of the variation of partnership type on innovation outcomes for each partnership timing (NPD stage). As a result, ignoring these potential variations leads to spurious findings. The product innovativeness of biotechnology firms (and potentially other small firms operating in technologically intensive industries) as a result of these choices provide updated insights in managing alliance partnerships geared towards enhancing their product innovativeness.

### **Biotech firms' partnership timing strategies for each partnership type**

Recent research has started to recognize variations among new product alliances in terms of the alliance timing (NPD stage) at which firms join alliances (Fang et al., 2015; Rothaermel, 2001). In their study, Hoang and Rothaermel (2010) systematically considered R&D alliances under exploration (research) and exploitation (development) stages and concluded that these variations among alliances affect outcomes. Thus, if variations exist among alliances with regards to partnership stage, it seems necessary to examine the effect of different partnership timing on innovation outcomes for each partnership type.

I build on these arguments to develop the following three hypotheses (first set of hypotheses), where I propose that the effect of biotech firms' alliances initiated with each partnership type on their product innovativeness varies subject to differential costs, benefits, and motivations involved in each stage of the NPD process. To this end, for each partnership type that the focal biotechnology firm initiates, I will provide theoretical reasoning that demonstrates which stage of the NPD process leads to greatest product innovativeness.

### **Partnership timing strategies with universities and product innovativeness**

The success of firms operating in science-based industries (such as biotechnology) is a function of diverse technological capabilities (Zahra, 1996). Companies need to develop beneficial relationships with research universities and other non-profit research organizations, as the suppliers of basic scientific resources (Bstieler, Hemmert, and Barczak, 2015, 2017; Oliver & Liebeskind, 1997). These alliances provide the biotech firm with access to diverse resources at a price normally lower than market rates, enabling the firm to lower costs and attain superior performance outcome (Geisler, 1995; Matkin, 1990).

More specifically, Rothaermel and Deeds (2004) argue that the innovation success of biotech firms depends heavily on commercialization of the uncertain and tacit knowledge obtained through alliances with research universities and other non-profit research institutes. Thus, forming alliances with universities provides biotech firms an opportunity to convert basic scientific knowledge into viable products. McMillan, Narin,

& Deeds (2000) also argue that biotech firms are highly dependent on basic knowledge created by research institutes, and this is evident by the number of citations to scientific journals they use in their patent applications.

Benefits of alliances with universities for the biotech firm notwithstanding, such partnerships can pose substantial costs to biotech firms (Rothaermel & Deeds, 2006). Research universities are normally large public institutions and with bureaucratic structures with a primary obligation of knowledge creation and dissemination (George, Zahra, & Wood, 2002). On the other hand, biotech firms are, for the most part, technologically entrepreneurial firms and are often underfunded with resource constraints (Baum et al., 2000). Thus, even though the focus of biotech companies is largely on R&D, they are for-profit organizations with a goal of turning proprietary knowledge to commercialized products for a profit, making biotech firms substantially different from universities in terms of structure and compensation plans (e.g. stock options).

Extending the concept of relative absorptive capacity (Lane & Lubatkin, 1998) to the biopharma context suggest that a biotech firm has a lower relative absorptive capacity in assimilating knowledge from universities than all other organizations. The authors argue that the ability of alliance partners to learn from each other depends on the similarity of both organizations in terms of (1) knowledge bases and (2) organizational structures. Since the knowledge base and organizational structure of university and biotech firms are relatively different, then biotech firms should have difficulty in learning from universities.

Thus, on the one hand, a biotech firm's success is a function of its alliances with universities (benefiting from universities' basic scientific knowledge), on the other hand, these two partners are substantially different both in terms of structure and internal resources (cost imposed by lack of relative absorptive capacity). As a result of these benefits and costs associated with such alliances, biotech firms must either forego the benefits of such alliances or find a way to maximize the benefits while keeping costs at a tolerable level. I argue that the effect of alliances between universities and biotech firms on the product innovativeness of the latter is a function of the alliance timing (NPD stage) at which such alliances are formed.

The TCE perspective on alliance timing suggests that early stages of the NPD (e.g. research and discovery) are fraught with a substantial product specificity and performance uncertainty (Heide, 1994). As the project moves along the NPD process and reaches later stages (e.g. development and prelaunch), the specificity of product and the uncertainty of product performance will diminish (Fang et al., 2015). This implies that transaction costs involved in alliances between biotech firms and research universities are relatively lower at later stages than earlier stages of the NPD process. However, research suggests that research institutions, including universities, are less motivated than other business partners to act opportunistically, and they also normally lack complementary resources to commercialize intellectual property generated in an alliance (Bercovitz & Feldman, 2007; Martinez-Noya, Garcia-Canal, & Guillen, 2013). These arguments suggest that despite a higher transaction cost in earlier stages of than NPD than in later stages, these transaction costs are insignificantly variant across different NPD stages.

Even though biotech-university alliances seem to be homogenous across the discovery, development, and prelaunch stages of NPD in terms of transaction costs, building on RBV, I argue that there is a significant difference across discovery, development, and prelaunch stages of NPD in terms of effectiveness (benefits). In general, developing close alliances with universities has been considered as a widely used strategy by firms operating in science-based industries (Bowie, 1994; Peters, Groenewegen, & Fiebelkorn, 1998) that can give companies flexibility in conducting research and development (R&D). Such linkages with research universities provide the firm with scientific discoveries and emerging technologies (George et al., 2002). Therefore, biotech–university alliances can be a win-win for both partners provided that objectives of both the university and the firm are realized.

Since universities are recognized as the supplier (source) of basic scientific knowledge, then their effectiveness in early stages of NPD is greater than in later stages. This reasoning lies in the complementarity of resources in creating synergy and NPD success (Sivadas & Dwyer, 2000). This implies that there is a substantial difference in each stage in creating synergies between university and biotech resources, with discovery stage creating the highest potential synergy followed by development. Rothaermel and Deeds (2006) argue that universities mostly have bureaucratic structures, and their primary objective is knowledge creation and dissemination. However, as the alliance timing moves from discovery to development to prelaunch stages, the level of potential synergies substantially diminishes. Relying on these foundations, I can argue that, in the



product prelaunch stage, alliances formed with universities relate negatively to the innovativeness of the product. These arguments suggest the following hypothesis:

*H1 The likelihood of drug radicalness increases when biotech firms form alliance partnerships with universities during (a) discovery and (b) development stages, while this likelihood decreases during (c) prelaunch stage.*

### **Partnership timing strategies with biotech firms and product innovativeness**

A biotech firm can improve its innovation output by entering into alliances with other biotech firms (competitors) as the focal biotech firm can access relatively similar resources, technologies, and skills required to better exploit its internal resources (Debackere, Clarysse, & Rappa, 1996). In such alliances, partners have a high degree of overlap due to the redundancy of their knowledge bases. However, because of their high degree of structural similarity, alliances between competitors are characterized with more redundant knowledge than all other types of alliance partners (Rindfleisch & Moorman, 2001). Thus, these studies suggest that biotech-biotech alliances can enhance the focal biotech firm's innovation due to similar organizational routines, a shared base of tacit knowledge, and similar structure and beliefs which are building blocks for innovation success (Dougherty, 1992).

From the viewpoint of relative absorptive capacity (Lane & Lubatkin, 1998), alliances between two biotech firms enhance innovation by capitalizing on the absorptive capacity of partners. Hutt, Reingen, and Rochetto (1988) also find that shared knowledge

and value structures raise the level of product innovativeness. Indeed, the similarity in terms of knowledge base and organizational structures are likely to provide a foundation for better communications and actions even in uncertain environments. For example, early research in innovation benefits of alliance partnerships between competitors (Allen, 1983) concludes that a radical innovation is effectively diffused through the exchange of know-how among competitors.

Despite the benefits that knowledge redundancy and structural similarity offer to the biotech firm in forming alliances with other biotech firms, such relationships are fraught with substantial transaction costs (Oxley & Sampson, 2004). These similarities between competing firms may not only result in the effective voluntary transfer of knowledge (Dyer & Singh, 1998), but also involuntary (unintended) spillover of knowledge (Emden et al., 2006). Given that alliances, per se, are complex and are organized under incomplete contracts, assimilating knowledge from other biotech firms can impose significant costs on the focal biotech firm. Instead of foraging the benefits of such alliances, I argue that a risk/benefit analyses based on different theoretical perspectives can provide insights as to which stage of NPD can provide the maximum benefits, while keeping transaction costs to a tolerable level.

In this respect, Oxley and Sampson (2004) argue that partnership with competitors on the commercialization of a joint project would have the highest transaction costs since competitors normally share the same market in which they introduce their products. Thus, alliances formed closer to the commercialization stage of NPD create a substantial conflict of interest between partners. By the same token,

alliances formed during the discovery stage would incur relatively the lowest transaction costs followed by the development stage. Thus, TCE suggests that biotech-biotech alliances formed at discovery and development stages pose significantly lower transaction costs than those formed during the prelaunch stage of the NPD process.

Even though TCE suggests that transaction costs in the discovery stage are higher than during the development stage, there are no significant variations in biotech-biotech alliances at discovery and development stages in terms of transaction cost (due to high product specificity and performance uncertainty). Assuming that there are no significant differences in terms of transaction costs between discovery and development stages, RBV and relative absorptive capacity (Barney, 1991; Lane & Lubatkin, 1998) suggest the development stage is the optimal stage in providing the highest product innovativeness effect. In other words, although the discovery stage has marginally less transaction costs than the development stage in such alliances, the synergy between two biotech companies is positively related to innovation outcome. However, partnerships with biotech firms negatively associate with product innovativeness. Taken together, these arguments suggest the following hypothesis:

*H2 The likelihood of drug radicalness increases when biotech firms form alliance partnerships with other biotech firms during (a) discovery and (b) development stages, while this likelihood decreases during (c) prelaunch stage.*

### **Partnership timing strategies with pharma firms and product innovativeness**

The alliances of biotech firms with large firms are vital to the survival and growth of small firms (Baum et al., 2000). A biotech company generally forms an alliance with a pharmaceutical firm for its FDA regulatory know-how, manufacturing capabilities, as well as market access and knowledge (Rothaermel & Deeds, 2006). Thus, the focus on these types of alliances is mostly on resource complementarities between the two allied partners in creating a synergy by exchanging explicit (codifiable) knowledge (Teece, 1992). Complementary motives of the biotech firms form the basic tenet in such alliances, in that the biotech firm is normally responsible for drug discovery and development, and the pharma company leverages their expertise in clinical trials, regulatory management, and drug distribution (Rothaermel, 2001).

In addition to motives regarding complementarity of resources, empirical evidence (Saxton, 1997; Stuart, Hoang, & Hybels, 1999) indicates that biotech companies are seeking the legitimacy and reputation of their pharma partners (required to absorb the attention of external stakeholders to interact with them). Alliance with pharma firms can reflect biotech quality, and financial position of focal firms (Dollinger, Golden, & Saxton, 1997). According to the RBV theory, a legitimacy that a biotech firm can gain from alliance partnership with pharma firms is a valuable intangible resource that may allow the biotech firm to establish a sustainable competitive advantage (Barney, 1991; Hall, 1992). Additionally, small firms, including biotech companies, are generally underfunded

and lack a track record, and, therefore, external endorsement and legitimacy can reduce their liabilities of small size.

Despite the benefits of such relationships (regarding resource complementarity and legitimacy), biotech firms can suffer significantly from partnerships with pharma firms since the latter can potentially exploit or outlearn the former and then take the lion's share of the created value in the alliance (Alvarez & Barney, 2001). Therefore, biotech firms often face the challenge of managing their alliances with large firms. I argue that considering these benefits and costs in light of the NPD process can help clarify at what point in the NPD process would the transaction costs of such alliances reach a tolerable level without compromising the synergistic benefits.

Biotech alliances with pharma firms at early stages of the NPD process reflect the biotech firm's desire to receive financial resources, legitimacy, as well as discover new opportunities and build new competencies to better adapt to the environment (Koza & Lewin, 1998). In contrast, biotech alliances with pharma firms at later stages of the NPD process help the former to leverage their existing capabilities and incorporate competencies across firm boundaries (Rothaermel & Deeds, 2004). Although both early and late stage alliances may create value, they may significantly differ in terms of transaction costs. Recent studies (e.g. Fang et al., 2015; Yang et al., 2014) indicate that the transaction costs associated with such alliances are highest in the discovery stage and they will diminish as the project moves from discovery to development and prelaunch. Given the fact that pharma firms have the downstream facilities to commercialize a new product (e.g. distribution channels), this makes the biotech-pharma alliance initiation at

the discovery stage prone to more opportunistic acts by the pharma firm than the development and prelaunch stages.

From an RBV perspective, biotech-pharma alliances are beneficial in both discovery, development, and prelaunch stages, and there is not a significant difference in the biotech-pharma firms during different stages of the NPD process in terms of value creation benefits. RBV, in this case, considers synergies from gaining access to complementary resources in later stages, and financial resources and legitimacy in earlier stages of the NPD process. This view suggests that synergy is not from the nature of learning as there may be a significant difference between the knowledge base of biotech and pharma firms. As a complementary view to this suggestion, relative absorptive capacity perspective (Lane & Lubatkin, 1998), also suggests that biotech-pharma alliances may not learn much, even if the alliance is formed during the discovery stage, since the knowledge base of pharma firms is chemical while that of biotech firms is biological.

Therefore, RBV and absorptive capacity arguments may not suggest which NPD stage leads to the highest product innovativeness of the biotech firm in biotech-pharma alliances. However, theoretical arguments from TCE suggest that the prelaunch stage provides the highest level product innovativeness effect (due to the lowest transaction costs), followed marginally by the development stage of the NPD process. However, such partnership type is negatively related to product innovativeness. Taken together, these arguments suggest the following hypothesis:

*H<sub>3</sub> The likelihood of drug radicalness increases when biotech firms form alliance partnerships with pharma firms during (a) development and (b) prelaunch stages, while this likelihood decreases during (c) discovery stage.*

### **Biotech firms' partnership type strategies for each NPD stage**

The popular work of Koza and Lewin (1998) distinguishes alliances as those motivated by the need to explore novel opportunities and those motivated by the need to exploit and leverage existing opportunities. In biopharma industry, the characterization of exploratory alliances is highly consistent with the drug discovery (early) stage of the NPD process; and exploitative alliances are analogous to alliances initiated at development (mid) and prelaunch (late) stages of the NPD process respectively. In addition to alliance timing, prior studies also suggest that there exists variance across alliances in terms of the alliance partners (Powell et al., 1996). In their study, Baum et al. (2000) considered small firm alliance partnership as universities, competitors, and industry incumbents. Rothaermel and Deeds' (2006) study on alliance management capability also relied on the same categorization as Baum et al. (2000). Thus, if there are variations among alliances regarding partnership type, it is critical to examine the effect of partnership type on innovation outcomes for each partnership timing (stage of the NPD process).

I build on these arguments to develop the following three hypotheses (second set of hypotheses), where I propose that the effect biotech firm alliances, initiated at each partnership timing (NPD stage) on their product innovativeness, varies subject to differential costs, benefits, and motivations involved in each type of partnership. To this end, for each partnership timing at which the focal biotechnology firm initiate alliances, I

provide theoretical reasoning that demonstrates which partnership type leads to the highest level of product innovativeness.

### **Partnership types at discovery stage and product innovativeness**

Biotech firms enter into alliances during the discovery stage with different motivations. Prior research shows that these alliances are normally motivated by long-term strategic horizons and are unpredictable—with a high variance regarding returns (Hoang & Rothaermel, 2010). The high variance in returns at this stage suggests that there may exist variations between alliances that biotech firms form in terms of partnership type (George et al., 2002), as different alliance partners are associated with different benefits, costs, and motivations.

Thus, biotech firms need not only consider their own motives in joining alliances in light of achieving their product innovativeness goals but, likewise, take into account the different motivations of partners and their associated costs and benefits. I argue that the first step in a biotech firm's innovation success derived from its alliances at discovery stage is to compare partners considering their benefits and costs. Doing so, biotech firms can then enhance their product innovativeness by selecting the appropriate partner that maximizes the benefits of alliance and keep the costs of partnership at a tolerable level.

Biotech alliances at the discovery stage of the NPD is beneficial in providing the firm with gaining access to and learning from partner's new knowledge (Lubatkin, Florin, & Lane, 2001). In other cases, biotech firms seek out partner reputation, endorsement, and legitimacy to reflect the quality and absorb shareholder investments (Baum et al.,



2000). Either motivation (endorsement or learning), these benefits are believed in the literature to offer the firm an opportunity for creating a sustainable competitive advantage (Yang et al., 2014).

Despite these benefits, biotech firms face substantial risks and costs while initiating alliances during the discovery stage. There is a potential risk of a learning race (Hamel, 1991) in such alliances in which each partner tries to recognize, transfer, and absorb the other partner's valuable (specialized) resources first. Under such circumstances, biotech firms may suffer substantially from alliance partners, especially large firms since they can potentially outlearn and exploit the smaller firm (biotech in this case) and take home the lion's share of the created value (Alvarez & Barney, 2001). The costs incurred at this stage are associated with high product specificity and performance uncertainty (Fang et al., 2015) and lack of relative absorptive capacity (Lane & Lubatkin, 1998), making biotech firms vulnerable to their partners' potential opportunistic acts.

From the TCE perspective (Heide, 1994), alliances in the discovery stage have a relatively higher level of transaction costs than other stages of the NPD. In this regard, alliances with universities would impose the lowest transaction cost compared to business partners (Gesing et al., 2015), as they have little intention or means for commercialization and thus exploit the biotech firm. However, the transaction costs in alliances with pharma firms are the highest as the latter has the required means to commercialize the created value in the alliance, thus appropriating the lion's share of the value. Following pharma partners, biotech partners impose the second highest transaction costs (lower than universities but higher than pharma firms). As mentioned by Oxley and Sampson (2004),

alliances between competitors (coopetition) are common at early stages of the NPD process.

Therefore, TCE suggests that both biotech-university as well as biotech-biotech alliances formed, during the discovery stage, would have tolerable transaction costs, even though, these costs are more in biotech-biotech than biotech-university alliances. Taken together, I argue that alliances with universities provide the focal biotech firm with the highest product innovativeness benefits (due to the lowest transaction costs), followed marginally by partnerships with biotech firms. However, this effect significantly diminishes if the alliance partner is the pharma firm at the discovery stage (due to considerable transaction costs).

From the RBV perspective (Ireland et al., 2002), biotech firms can create synergies with universities as the latter can offer basic scientific knowledge, and biotech firms can turn them into viable products. Biotech firms can also rely on alliances with pharma firms since pharma firms can offer biotech firms financial resources and legitimacy (Yang et al., 2014).

In biotech-biotech alliances, partners generally have similar resources and technologies, and the legitimacy that pharma firms have to offer biotech firms are normally higher than the endorsement that a biotech firm could offer to another biotech firm. Thus, from the RBV perspective, biotech-biotech alliances provide the focal biotech firm with significantly lower product innovativeness benefits than universities and pharma firms as partners. However, the superiority of benefits that pharma firms and

universities is unclear, and, thus, it seems fair to argue that their benefits are only marginally different from this viewpoint.

Finally, drawing from relative absorptive capacity (Lane & Lubatkin, 1998), biotech partners have the highest similarity to the focal biotech firm in terms of both knowledge base and organizational structure. By the same reasoning, pharma firms are also relatively similar to biotech firms in terms of organizational structure. Even though both biotech-pharma and biotech-university lack relative absorptive capacity in terms of knowledge base, biotech-pharma alliances are relatively more similar than biotech-university alliances in terms of organizational structure (Rothaermel & Deeds, 2006). This suggests that universities are the least effective partners from the relative absorptive capacity view. Drawing from these theoretical arguments, I argue that biotech partners are the most favourable partners followed by pharma and then biotech partners respectively.

Taken together, universities seem to impose the lowest costs on biotech firms followed by biotech and then pharma firms. In terms of benefit, universities are again the most preferred partners in creating synergies, followed by pharma and then biotech partners. Finally, in terms of relative absorptive capacity, biotech is the best partner, followed by pharma and then university partners. I argue that due to the vulnerability of the biotech firm during the discovery stage, despite the benefits that pharma firms have to offer, universities and other biotech firms are relatively less risky partners (even though focal biotech firms may not fully absorb university know-how), and thus, the more preferred option. However, partnerships with pharma partners are least preferred as they result in negative product innovativeness. Therefore, I specifically hypothesize:

*H4 The likelihood of drug radicalness increases when biotech firms form alliance partnerships during the discovery stage with (a) universities and (b) other biotech firms, while this likelihood decreases with (c) pharma firms.*

### **Partnership types at the development stage and product**

#### **innovativeness**

Biotech firms join alliances during the development stage of the NPD to turn their internal knowledge to a commercially viable product. Extending Koza and Lewin's (1998) work, the decision of biotech firms to enter alliances during this stage is mainly motivated by exploiting an existing capability. Rothaermel and Deeds (2004) argue that biotech firms initiate alliances during the development stage to exploit their novel molecular entities which are normally codified through patenting, moreover, this newly obtained knowledge is normally a result of activities performed during the exploration stage of the NPD process. Whether motivated by leveraging existing internal resources or triggered by newly obtained technological capabilities, I argue that, the effectiveness of alliances formed by a biotech firm at this stage on its product innovativeness varies subject to the type of alliance partnership.

From the TCE perspective, even though alliances formed during the development stage involve projects with relatively lower product specificity and performance uncertainty (Heide, 1994), a substantial failure rate of innovation projects at this stage still demonstrates substantial transaction costs (Rothaermel, 2001). However, different partners may impose different transaction costs to the biotech firm. At this stage, biotech-university partnerships incur the lowest transaction costs as universities normally lack the

downstream facilities to commercialize the potential value created in alliance with biotech firms. Even though the knowledge being transferred at this stage of alliances is more tangible and codifiable, there is still a substantial level of product specificity and performance uncertainty, making biotech-pharma alliances more costly to the biotech firm than biotech-biotech alliances. Therefore, drawing from this view, I argue that alliances with universities provide the focal biotech firm with the highest product innovativeness benefits (due to lowest transaction costs), followed by partnerships with biotech firms. However, this effect drops where the alliance partner is the pharma firm during the development stage (due to considerable transaction costs).

Drawing from interorganizational RBV (Tsang, 2000), I argue that alliances form a basis for firms to *gain access* to internally unavailable resources (Hitt et al., 2001). These resources can be technology, information, and special access to a marketplace. In addition to the chief motivation of gaining access to partner resources, RBV also considers alliances as a conduit to *learn new knowledge* from partners (Zahra, Nielsen, & Bogner, 1999). Taking a broader view, Das and Teng (2000) consider alliances as a means that firms use to find the optimal resource, whether similar or complementary, that substantially leverages the value of their internal resources relative to other possible resource combinations. As a result, given that the motivation of a biotech firm in joining alliances during the development stage is to exploit their existing technological capabilities, relatively less learning occurs during the development than during the discovery stage. This makes biotech-university alliances the least effective partnership

type in enhancing the biotech firm's product innovativeness. In other words, universities possess intangible and basic scientific resources that are of less value at this stage.

In contrast, biotech firms can leverage their existing technological capabilities and achieve the greatest alliance outcome in alliances with other biotech firms. In other words, pooling a relatively similar knowledge base (biotechnology), can create the highest synergy at this stage. Additionally, prior research has provided evidence in that small biotechnology firms and large pharmaceutical companies initiate alliances at the development stage, where the biotech firm's new drug candidate is ready to enter clinical trials (Lane & Lubatkin, 1998). This suggests that pharma firms can be beneficial partners to biotech firms due to the enhanced tangibility of knowledge at this stage of the NPD process. Thus, drawing from RBV, I argue that biotech alliances with university partners create little to no synergies. However, partnerships with both biotech and pharma partners create synergies by pooling similar and complementary resources respectively. From the RBV perspective, it seems unclear, however, whether biotech or pharma partners are more beneficial in enhancing the focal biotech firm's product innovativeness.

Finally, drawing from the relative absorptive capacity literature (Lane & Lubatkin, 1998), biotech partners have the highest similarity to the focal biotech firm in terms of both knowledge base and organizational structure. On the other hand, pharma firms are the second-best partners for biotech firms in terms of absorptive capacity, as the two partners are relatively similar in terms of organizational structure. Even though both biotech-pharma and biotech-university lack relative absorptive capacity in terms of shared knowledge base, biotech-pharma alliances are relatively more similar than biotech-

university in terms of organizational structure (Rothaermel & Deeds, 2006). This suggests that universities are the least effective partners from the relative absorptive capacity point of view. Drawing from these theoretical foundations, I argue that biotech partners are the most favourable partners followed by pharma and then university partners respectively.

Taken together, during the development stage, universities seem to impose the lowest transaction costs on biotech firms followed by university and then pharma partners. In terms of resource-synergy creation, biotech partners are the most preferred partners in creating synergies, followed by pharma and then university partners. Finally, in terms of relative absorptive capacity, biotech is the best partner, followed by pharma and then university partners. I argue that due to a biotech firm's need to exploit their existing technological capabilities during the development stage, despite the benefits that pharma firms have to offer, biotech partners are relatively more beneficial and less risky partners, and thus, the more preferred option. Also, pharma firms and university partners are also positively associated with drug radicalness. Therefore, I specifically hypothesize:

*H5 The likelihood of drug radicalness increases when biotech firms form alliance partnerships during the development stage with (a) universities and (b) other biotech firms, and (c) pharma firms.*

#### **Partnership types at discovery stage and product innovativeness**

Biotech firms join alliances during the prelaunch stage of the NPD to conduct large-scale complementary clinical trials (clinical trial 3) and undertake regulatory activities, required by governments (e.g. FDA), prior to introducing products to the

market (Rothaermel & Deeds, 2006; Powell et al., 1996). Both product specificity and performance uncertainty (Fang et al., 2015) are significantly lower during the prelaunch stage than the discovery and development stages of the NPD process. However, Rothaermel (2001) argues that there are uncertainties (including obtaining FDA approval) even at this stage. The still substantial rate of failure of innovation projects in the “post-technological completion stage” Rothaermel (2001: 690) provides evidence indicating that prelaunch alliances bear residual uncertainties and may be viewed as antecedents of NPD success. Building on these arguments, and the definition of innovation by Schumpeter (1934), that an innovation as a commercialized invention with approval granted to the firms, I argue that the effectiveness of alliances formed by a biotech firm during the prelaunch stage on product innovativeness is a function of the variations between alliance partnership types.

From the TCE perspective, the hazards of alliances at this stage are most prominent between partner firms that are direct competitors in end product markets (Oxley & Sampson, 2004), suggesting that biotech-biotech alliances formed during the prelaunch stage of the NPD process will be prone to unintended market-related knowledge leakage. From this viewpoint, universities seem to incur the lowest transaction costs for biotech firms. Even though pharma partners have the downstream facilities to potentially commercialize biotech firms’ innovations, biotech-pharma alliances are associated with substantially lower transaction costs at this stage than during the discovery and development stages of the NPD process—due to a mitigated specificity of the product and its performance uncertainty. This suggests that there are no significant



differences between biotech-university and biotech-pharma at this stage in terms of transaction costs. Thus, drawing from TCE, I argue that alliances with universities provide the focal biotech firm with the highest product innovativeness benefits (due to lowest transaction costs), followed marginally by partnerships with pharma firms. However, this effect significantly drops biotech-biotech alliances at the prelaunch stage (due to considerable transaction costs).

Extending interorganizational RBV (Ireland et al., 2002; Tsang, 2000), I argue that pharma firms are the most effective partners for biotech firms during the prelaunch stage, as they offer complementary resources. In contrast, universities have little resources that could create synergies with biotech firm resources. This makes biotech-university alliances the least effective partnership type in enhancing the biotech firm's product innovativeness. In other words, universities possess intangible and basic scientific resources that are of least value at this stage. In terms of biotech-biotech alliances, focal biotech firms can still leverage their existing technological capabilities through partnerships with biotech partners to increase their alliance outcomes. However, given that the motivation of a biotech firm in joining alliances at prelaunch stage is to commercialize their own innovations, biotech partners create relatively less synergy at this stage than pharma partners. Thus, drawing from RBV, I argue that alliances with pharma partners provide the focal biotech firm with the highest product innovativeness benefits (due to the greatest synergy), followed marginally by partnerships with biotech firms. However, this effect significantly drops in alliances with universities (due to lack of potential synergy).

Finally, drawing from relative absorptive capacity (Lane & Lubatkin, 1998), biotech partners have the highest similarity to the focal biotech firm in terms of both knowledge base and organizational structure. By the same reasoning, pharma firms are the second-best partners for biotech firms as the two partners are relatively similar in terms of organizational structure. Additionally, the relative absorptive capacity between pharma and biotech firms are highest during the prelaunch stage due to an enhanced tangibility of knowledge. From this view, universities are the least effective partners from the relative absorptive capacity view as university partners and biotech firms have huge differences in terms of both knowledge base and organizational structure, particularly at this level. Drawing from these theoretical arguments, I posit that biotech and pharma partners are the most favourable partners, and universities are the least favourable partners for biotech firms during the prelaunch stage.

Taken together, during the prelaunch stage, even though universities seem to impose the lowest transaction costs, they are the least favourable partners for biotech firms since there is little to no synergy and relative absorptive capacity in biotech-university alliances. Building on the same reasoning, biotech partners are not favourable partners since there is a substantial conflict of interest in biotech-biotech alliances. I argue that, even though this hazard is considerable in biotech-biotech alliances, the benefits of synergy and relative absorptive capacity make biotech partners a more favourable partner than university partners at this stage. Finally, since transaction costs are lowest at this stage than other stages, and because pharma partners offer complementary resources and have the high relative absorptive capacity with biotech firms at this stage, pharma firms

are the most effective partners to enhance the product innovativeness of the focal biotech firm. Therefore, I specifically hypothesize:

*H6 The likelihood of drug radicalness increases when biotech firms form alliance partnerships during the prelaunch stage with (a) pharma firms, while this likelihood decreases with (b) universities and other biotech firms.*

In the development of the above hypotheses, I borrowed insights from the theoretical optics of TCE, RBV, and absorptive capacity. For the first three hypotheses, TCE provides conditions because the stage of development is changing along the new drug development process, given the partnership type is constant. In developing these hypotheses, I used arguments from RBV and absorptive capacity to complement the mainstream arguments underlying TCE. However, for the second set of hypotheses (H<sub>4</sub>-H<sub>6</sub>), I used RBV and absorptive capacity insights to argue which partnership type(s) increase the likelihood of radical innovations when the partnership stage is considered constant. In the next chapter, I outline the methodology design used to test these hypotheses and the tests developed for each. Moreover, details on the empirical setting (context) are provided, along with the data collection process, sample size, the operationalization of variables, and the construction of empirical models that fit the data.

## CHAPTER IV

### METHODS

#### **Empirical setting**

Today, companies in a wide range of industries are employing some form of external collaboration in nearly every step of the production process—from discovery to distribution (Powell et al., 1996). As evidence of one of the substantial technological advancements, biotechnology has been built on significantly different scientific foundations of molecular biology as an alternate to traditional drug development knowledge embedded in organic chemistry. This major technological change has since caused technological discontinuities for incumbent chemical and pharmaceutical firms, restructured the pharmaceutical industry, and given rise to the biopharma industry (Rothaermel, 2001).

The empirical setting in this thesis is the biopharma industry. In particular, I examine the effect of partnership types that biotech firms (focal firms in this study) form at different partnership stages of their new drug development on the radicalness of such drugs. I chose this context for several reasons. First, the biopharma is a technologically-intensive industry in which basic-scientific knowledge from universities and biotechnology firms plays a pivotal role. Second, interorganizational collaborations in this sector have dramatically increased after the emergence of biotechnology, particularly since the 1980s. Alliance agreements between biotech firms and other organizations, including research institutes and research universities, established pharmaceutical firms,

and other biotech firms have restructured the traditional pharmaceutical industry. Third, access to secondary (archival) data is available on alliance agreements in this industry since the 1980s.

Since its emergence, biotechnology has been characterized as a “regime of rapid technological development” (Powell et al., 1996: P117), in which no single firm internally owns all the essential capabilities needed to succeed. Along with, and as a response to, the emergence of biotechnology (as a disruptive technology), alliances of different kinds have been formed between organizations for the purpose of exploiting developments in this novel technology. As a result of these alliances, there has been an upsurge in technology thus further advancing biotechnology. This implies that, in the biopharma sector, biotechnology has triggered a loop in which collaborative alliances play the role as effects, as well as causes for, advances in biotechnology.

All organizations related to the process of drug development have been affected by biotechnology. More specifically, biotechnology has motivated biotech firms, as the originator of biotechnology, pharma firms, as disrupted industry incumbents, and universities and other research institutes, as suppliers of scientific biological knowledge, to exploit these novel developments. The focus in this thesis is on the alliances that biotech firms form with universities, other biotech firms, and pharma firms during the discovery, development, and prelaunch (commercialization) stages of the new biological drug development process. In this thesis, alliances that biotech firms form with other organizations in the biopharma sector are categorized under two dimensions of partnership type and partnership timing (new drug development stages). Therefore, the

myriad of alliances formed in the biopharma industry at different stages of the drug development process offers a rich empirical setting to test the hypotheses developed in chapter three.

However, since the main objective in this thesis is to examine the resulting innovativeness of biotech drugs in their designated alliance partnerships, it is primarily important to operationalize the alliance relationships that the biotech firms form with other organizations. However, to apply previously developed measures, it seems critical to review relevant studies to ensure that assumptions used in this thesis are in line with those used in other studies regarding rationales for categorization of alliances in this industry. Given that each of these partners may enter into an alliance with biotech firms trying to exploit the latter's biotech capabilities and potentially deploy the joint value creation outside the scope of the alliance for their own benefits, it seems critical to take into account the motivations of each partner in joining alliances as part of the operationalization of explanatory variables. This research deals exclusively with dedicated biotechnology firms whose predominant activity is dedicated to the application of their research in biotechnology to the life sciences.

*Relaxing previous assumptions:* In the process of the operationalization of alliances in the biopharma industry, prior studies have primarily taken two approaches built on two different assumptions. In the first view, the alliances are means for sharing risks, gaining access to new markets and technologies, speeding time to market, and pooling complementary resources. Relying on this assumption, scholars have fixated alliance partners to their role in the value chain (e.g. Baum et al., 2000; Rothaermel &

Deeds, 2006). In the biopharma context, this view has considered three types of alliances namely, upstream, horizontal, and downstream to be the territories of universities, other biotech firms, and pharma firms respectively. In other words, biotech alliances with aforementioned partners are assumed *a priori* designated to specific stages of the new drug development process.

Conversely, the second view tries to provide an alternative argument based on a different set of underlying assumptions in which alliances are means not only for sharing risks and pooling resources, but also for enhancing organizational learning (Hamel, 1991; Lane & Lubatkin, 1998). This view considers learning as a social phenomenon which can take place in alliances and learning is fluid and dynamic rather than static and tightly bound. It implies that learning can occur in different types of partnerships under different alliance timings. In the first view, alliances can be framed largely as a make-or-buy argument, and the formation of alliances is a function of acquiring resources where the hazards of collaboration are tolerable. The second view considers alliances as learning mechanisms in which what is learned is a function of the conditions under which it is learned.

Given that both alliance-related resource complementarity, as well as organizational learning, give rise to the radicalness of a drug, I relax the assumption used in the first view that partnership timing of biotech alliances with each partnership type is predetermined. In other words, I argue that each form of partnership type could potentially occur at each stage of the new drug development process— which cannot be explained by assumptions used in the first view. Rather than focusing on either of these

views, I draw on a combination of them which enclose the motives behind each partnership type at different stages of the new product development. Doing so, the empirical effects of partnership type and timing on the innovativeness of biotech firms' drugs would indicate a true representative of theoretical conceptualizations.

For example, prior research shows that, in addition to the prelaunch stage, alliances between pharma and biotech firms can happen at discovery and development stages of a new drug development for the purpose of learning for pharma firms and endorsement and financial needs of biotech firms (Yang et al., 2014). Moreover, despite being considered competitors (Oxley & Sampson, 2004), the alliances between two biotech firms can occur at each stage of the new drug development. The main reason for this could be because two biotech firms may not be direct competitors, due to working on different therapeutic areas, allowing them to collaborate not only in discovery and development stages but also at prelaunch stages without facing considerable conflicts of interest.

Lastly, even biotech firms could potentially initiate alliances with universities during the clinical trial and prelaunch stages to receive related drug development and commercialization consultations from the latter. Therefore, I argue that in line with common practice in real life, biotech alliances with each partnership type (universities, other biotech firms, and pharma firms), can occur at different stages of the new drug development stages (discovery, development, and prelaunch).



### **Data description**

*Data collection procedure.* I followed a multistage approach in collecting data from five different data sources to test theoretical hypotheses developed in the previous chapter. I primarily relied on the Deloitte Recombinant Capital (Recap) database used in prior marketing studies (e.g. Lee, 2011; Rothaermel & Deeds 2004; Fang et al., 2015; Wuyts et al., 2004) to initiate the process of collecting data on drug and alliance agreements.

This database provides relevant and detailed alliance information from the biopharma sector since 1980 until the present. The identity of partners in each dyadic alliance partnership is recognized which helped in coding the alliances formed between biotech firms and other organizations (universities, other biotech firms, and pharma firms). In addition, the partnership stages at which such alliances are formed are also available. Even though there are records of more than 48,000 alliances available in the database, formed at different stages of drug development, information about the drugs being developed in these alliances is not available.

This database also provides a list of some 454 FDA-approved drugs and devices for a variety of disease indications. However, the records of drugs and alliances are not incorporated, as it requires historical content analyses to link each drug to its designated alliances formed at different stages of the development process. Thus, to link these approved drugs to their development history in terms of alliances, I used LexisNexis, FDA data sources, Compustat, and USPTO to integrate the data regarding drugs and

alliances and to collect related data on control variables prior to finalizing the sample and running analyses. Specifically, I used the following systematic steps:

- i. Conduct keyword search on trade and generic names of each of 454 drugs to ensure the information on drugs are available in the FDA data sources.
- ii. Retrieve the drugs with complete information on variables of interests (developer, radicalness, the technology used, disease indication, and approval date).
- iii. Search LexisNexis for news items published on the shortlisted drugs on related alliances at different stages of the drug development.
- iv. Match the list of alliances formed for each drug with alliances in the Recap database to ensure the validity and finding alliance-level variables of interests (partnership type, partnership stage, agreement type, and governance structure).
- v. Search Compustat IQ database to collect focal firm-level variables of interests (SIC code, firm size, R&D expenditure).

*Sample profile.* The developers (originators) of these drugs are considered in Recap database as biotech firms. This is in line with the conceptualization used in this thesis. In the first step, I used FDA data sources to validate the primary sample of 454 drugs. Since the focus in this study is on the radicalness of drugs from the focal perspective of biotech firms, I used the FDA Orange Book database to confirm the name of the developer for each drug and to collect additional drug-related information.

Undertaking keyword search of drug trade and generic names (in some cases) in the FDA databases (e.g. Product Approvals; The Center for Drug Evaluation and Research (CDER)), it became clear that out of this sample of 454 drugs, 6 observations were registered with FDA under category of devices and not drugs. Next, I removed 16 more observations on the basis of: 1) drug was registered with the FDA, but there was no approval information available (4 drugs), 2) drug had not been registered in the FDA database (10 drugs), and, thus, approval information could not be acquired. This reduced the sample size to 432 FDA-approved drugs.

Out of these 432 remaining drugs, 221 drugs have been registered in FDA database only once, as they have been approved for the treatment of one disease only, while 211 drugs have been recorded more than one time (minimum of 2 and maximum of 7 times) for the treatment of multiple diseases. For example, Abraxane is approved by the FDA for treatment of three different cancer subcategories: lung cancer, breast cancer, and pancreatic cancer. In this case, Abraxane has duplicate records in the sample. Since companies use the *same molecule* for developing drugs with a potential treatment of other diseases, I removed secondary indications (124 secondary indications) and retrieved 87 records of such drugs approved by the FDA for the first time (recorded as primary disease indication). Undertaking this systematic process reduces the sample to 308 drugs.

In the second stage, I undertook a detailed content analysis, to connect alliances that were formed by the focal developers of these 308 drugs with other organizations at different stages of the new drug development process. To this end, I used LexisNexis to look up published news items regarding alliances formed on each drug, using both trade

and generic names. This process revealed that out of the sample of 308 drugs, 18 drugs have been developed in-house, and thus, there were no records of alliances for them in LexisNexis data sources. The remaining 290 drugs accounted for 1131 alliances formed between the focal developers (biotech firms) and other organizations.

Next, I used the Recap Deloitte database to confirm the date of each alliance and to identify the partnership types and timings (stages) of such alliances. However, alliances formed for each drug after the drug received the approval from the FDA must be removed. To this end, prior to confirming the date for each alliance, I collected data on the approval date of these 290 drugs from the FDA database to benchmark against the data on alliance dates for each drug and ensure that all alliances formed after the approval date of each drug were not included in the sample.

Finally, I identified and removed from the sample 475 alliances dated after the FDA-approval dates of designated drugs. This reduced the sample of drugs and related alliances to 257 drugs and 615 alliances respectively. Since there are duplicate records of the same type of alliances in each stage, the final sample size with no duplicates was 230 drugs linked to 384 alliances developed by 85 biotech firms.

### **Operationalizations and Measures**

*Dependent variables.* When a product incorporates a significantly improved core technology, as well as substantially superior benefits to customers, than existing new products in the market, the product is called “*radical*” (Chandy & Tellis, 1998). When these conditions are not present, the product is called “*incremental*”.

Given that a radical drug must incorporate a significantly different core technology and provide a significantly greater benefit to patient than existing drugs in the market (Chandy & Tellis, 2000), I used the drug radicalness distinction used by the FDA (also used in marketing studies: Lee, 2011; Wuyts et al., 2004). The FDA categorizes all new drugs according to their potential efficacy in treating diseases and distinguishes between standard ("therapeutic qualities similar to those of an already marketed drug") and high-potential ("an advance over available therapy") drugs. In particular, following previous studies (e.g. Wuyts, et al., 2004), I distinguish between high-potential (priority review process: "for drugs that are expected to have a particularly great impact on the treatment of a disease"), and low-potential (standard review: "therapeutic qualities similar to those of an already marketed drug"). Second, I distinguished between technologies used in drugs based on FDA-designated chemical types. In this regard, only drugs with Chemical Type 1 represent a new technology (i.e., significantly different from the established technologies). The drug was coded as radical when it met both of these conditions. The drug was deemed an incremental innovation when it did not take any of these designations after the FDA review process.

*Independent variables.* I categorize alliances related to each drug in the dataset under two sub categories of partnership type and partnership timing (stage). For each drug in the sample developed (originated) by a biotech firm, there may be multiple alliances that the biotech firm formed with other organizations at different stages of the new drug development process. In the sample, there is no less than one alliance formed for each

drug, providing a setting through which I could examine the effectiveness of the alliance on the radicalness of the drug.

However, as the biotech firm may enter into multiple alliances during the process of developing its new drug, I categorize alliances based on their partnership type and partnership timing (stage) to better test the effectiveness of the interactions between each alliance partnership type and timing on the radicalness of drug. To this end, I built on previously used measures (Baum et al., 2000; Rothaermel & Deeds, 2006) and disintegrated alliance partnership into biotech firms alliances with: “*university and research institutes*”, “*other biotech firms*”, and “*incumbent pharma firms*”. In terms of alliance stage, I employ “*discovery*”, “*development*”, and “*prelaunch*” as proxies for the stages during which alliances were formed.

*Control variables.* I control for multiple other variables affecting drug radicalness which are outside the scope of this study. Specifically, I control for organizational and drug-related factors. In terms of organizational factors, I control for “*firm size*”, as prior research in marketing and economics alike have addressed the link between firm size and innovation outcome, relying mainly on the seminal work of Schumpeter (1942). Findings of research examining this relationship have found insignificant, negative, and positive effects (e.g. Ali, 1994; Chandy & Tellis, 2000). Thus, it seems critical to control for firm size. The radicalness of drugs may also vary with the expertise that biotech firms have at the time they start developing new drugs. To this end, I also control for “*R&D expenditure*”, defined as the firm expenditure on Research and Development in million dollars.

In terms of drug-level factors, I controlled for therapeutic (e.g., cancer, cardiovascular). In this way, I control for the potential differences between the effects of drugs being developed for the treatment of cancer and those being developed for other diseases (Rothaermel & Deeds, 2004). The idea is that cancer drugs may have more potential to turn into radical drugs in comparison with other drugs. Thus, I use a dummy variable to capture any potential variations in this regard: (1=cancer patient drugs, 0=other). Lastly, I use year dummy variables to control for drug approval date (Wuyts et al., 2004). This controls for unobserved time-related factors, such as GDP, that might affect the drug development of focal firms in the sample. I present the measures for these constructs and data sources in Table 3.

## **Empirical Model**

Because drug radicalness is a binary (dummy) variable (e.g. Wuyts et al., 2004), regular regression based on ordinary least squares estimation is not appropriate. Instead, I used a logit model for model estimation:

### **The first set of equations**

The estimation model regarding the effect of different alliance stages when a particular partnership type is formed for developing a new drug, features three equations, accounting for the second set of hypotheses developed in the last chapter. The first equation considers the radicalness of drugs at the time “t” as a result of alliances that focal biotech firms form with universities “u” at discovery stage “t-3”, development stage “t-2”, and development stage “t-1”.

Equation 2 and 3 follow the same denotation for the radicalness of drugs, except for partnership type. More specifically, equation 2 represents a model for the radicalness of drugs as a result of alliances that focal biotech firms form with other biotech firms, while equation 3 represents a model for radicalness of drugs as a result of alliances that focal biotech firms form with pharma firms. In summary, the following models try to capture



**Table 3: Constructs, Measurements, and Data Sources**

<b>Constructs</b>	<b>Measurements</b>	<b>Data Source</b>
Partnership type	1 = universities and research institutes, 2 = other biotech firms, 3 = pharma firms	Recap, LexisNexis
Partnership stage	1 = discovery stage, 2 = clinical trial stage, 3 = prelaunch stage	Recap, LexisNexis
Product innovativeness	1= radical drug, 0= incremental drug (using the chemical type of compounds and review process assigned to drugs by FDA)	FDA approved drug products (Drugs@FDA)
Drug therapeutic area	0= non-oncology therapeutics, 1= oncology therapeutics	Recap, FDA drug database
Focal firm size	Number of employees (thousands)	Compustat
Focal firm capability	R&D expense (million dollars)	Compustat
Prior partnership experience	1 = prior alliances with universities and research institutes, 2 = prior alliances with other biotech firms, 3 = prior alliances with pharma firms	Recap, LexisNexis

how the different drug development stages (variation in alliance timing) moderate the effectiveness of each partnership type in explaining the radicalness of a drug.

(1) Radicalness of a drug at time  $t$ , as a logit function of alliances the focal biotech forms with **research institutes and universities  $u$**  at different stages of the drug development process (1 = drug is approved by FDA with radical designation, 0 = incremental designation)  $t-3, t-2, t-1$

$$= \beta_0 + \beta_1 \text{Alliance at discovery stage}_{u,t-3} + \beta_2 \text{Alliances at development stage}_{u,t-2} + \beta_3 \text{Alliances at prelaunch stage}_{u,t-1} + \text{Control variables}_{p,b,t} + \varepsilon_{p,b,u,t-3,t-2,t-1,t}$$

(2) Radicalness of a drug at time  $t$ , as a logit function of alliances the focal biotech forms with **other biotech firms  $b$**  formed at different stages of the drug development process (1 = drug is approved by FDA with radical designation, 0 = incremental designation)  $t-3, t-2, t-1$

$$= \beta_0 + \beta_1 \text{Alliances at discovery stage}_{b,t-3} + \beta_2 \text{Alliances at development stage}_{b,t-2} + \beta_3 \text{Alliances at prelaunch stage}_{b,t-1} + \text{Control variables}_{p,u,t} + \varepsilon_{p,b,u,t-3,t-2,t-1,t}$$

(3) Radicalness of a drug at time  $t$ , as a logit function of alliances that the focal biotech forms with **pharma firms  $p$**  at different stages of the drug development process (1 = drug is approved by FDA with radical designation, 0 = incremental designation)  $t-3, t-2, t-1$

$$= \beta_0 + \beta_1 \text{Alliances at discovery stage}_{p,t-3} + \beta_2 \text{Alliances at development stage}_{p,t-2} + \beta_3 \text{Alliances at prelaunch stage}_{p,t-1} + \text{Control variables}_{b,u,t} + \varepsilon_{p,b,u,t-3,t-2,t-1,t}$$

### Second set of equations

The estimation model regarding the effect of alliance types formed at different stages of the new drug development process features three equations, accounting for the first set of three hypotheses developed in the last chapter. The first equation considers the radicalness of drugs at the time “t” as a result of alliances that focal biotech firms form with pharma firms “p”, other biotech firms “b”, and universities and research institutes “u” at discovery stage “t-3” stage of the drug development.

By the same token, equations 2 and 3 follow the same denotation for radicalness of drugs, except for the stage at which such alliances have been formed. Equation 2 represents a model for radicalness of drugs as a result of alliances that focal biotech firms form at development stage “t-2”, while equation 3 represents a model for radicalness of drugs as a result of alliances that focal biotech firms form at development stage “t-1”. In summary, the following models try to capture how variations in partnership type moderates the effectiveness of alliances formed at each stage of the drug development process.

- (1) Radicalness of a drug at time t, as a logit function of different alliance types (p, b, and u) that the focal biotech firm forms at **discovery stage t-3** (1 = drug is approved by FDA with radical designation, 0 = incremental designation)  $p, b, u$
- $$= \beta_0 + \beta_1 \text{Alliance with pharmaceutical firm}_{p,t-3} + \beta_2 \text{Alliances with other biotech firm}_{b,t-3} + \beta_3 \text{Alliances with university}_{u,t-3} + \text{Control variable}_{t-2,t-1,t} + \varepsilon_{p,b,u,t-3,t-2,t-1,t}$$

(2) Radicalness of a drug at time  $t$ , as a logit function of different alliance types ( $p$ ,  $b$ , and  $u$ ) that the focal biotech firm forms at **development stage  $t-2$**  (1 = drug is approved by FDA with radical designation, 0 = incremental designation)  $p, b, u$

$$= \beta_0 + \beta_1 \text{Alliances with pharmaceutical firm}_{p,t-2} + \beta_2 \text{Alliances with other biotech firm}_{b,t-2} + \beta_3 \text{Alliances with university}_{u,t-2} + \text{Control variables}_{t-3,t-1,t} + \varepsilon_{p,b,u,t-3,t-2,t-1,t}$$

(3) Radicalness of a drug at time  $t$ , as a logit function of different alliance types ( $p$ ,  $b$ , and  $u$ ) that the focal biotech firm forms at **prelaunch stage  $t-1$**  (1 = drug is approved by FDA with radical designation, 0 = incremental designation)  $p, b, u$

$$= \beta_0 + \beta_1 \text{Alliance with pharmaceutical firm}_{p,t-1} + \beta_2 \text{Alliances with other biotech firm}_{b,t-1} + \beta_3 \text{Alliances with university}_{u,t-1} + \text{Control variables}_{t-3,t-2,t} + \varepsilon_{p,b,u,t-3,t-2,t-1,t}$$

The following chapter presents the results of the above equations. In addition to undertaking analyses to provide support for hypothesized effects, I will demonstrate the robustness checks and related post hoc analyses.

## CHAPTER V

### ANALYSIS AND RESULTS

#### Analysis

The analyses of this study are accomplished using logistic regression to test the hypotheses developed in chapter 3. Since the outcome variable (product innovativeness) is measured with a dichotomous variable (1=radical drug; 0=incremental drug), logistic regression is an appropriate specification in view of the binary character of the dependent variable product innovativeness (INNOVNESS) with two possible outcomes. In line with the conceptualization in prior chapters, I distinguish alliances formed for the different drugs in the sample (a total of 384 alliances formed on 230 drugs developed by 85 focal biotechnology firms during 1982-2016) on the basis of partnership type and development stages at which alliances were formed. Subsequently, as explanatory variables, I include the focal biotech firm's alliances formed with pharma firms (P) (n=51), other biotech firms (B) (n=120), and universities (U) (n=213) at the discovery stage (S1) (n=121), development stage (S2) (140), and prelaunch stage (S3) (n=123) of the drug development process, creating nine possibilities in a partnership type/partnership stage matrix of three by three. In particular, I can examine how the likelihood (probability) of product innovativeness changes with alliances formed at partnership stages S1, S2, and S3 with each partnership type (hypotheses 1 to 3) as well as with alliances formed with partnership types P, B, and U at each partnership stage (hypotheses 4 to 6). I control for APPROVDTE, the year dummy variable of drug approval date, THRPUTIC, the

therapeutic area of approved drugs, and focal firms' R&D expenditure, and FIRMSIZE that may explain variations in the dependent variable INNOVNESS.

Table 4 presents a correlation matrix of the variables used in this study. Both the signs and the values of correlations among variables are important. Meyers, Gamst, and Guarino (2006) argue that if the absolute value of correlation between two independent variables are greater than 0.7, then concerns for multicollinearity might arise. In this study, correlation values between the main independent variables range from  $|-0.149|$  and  $|-0.149|$ , ensuring that multicollinearity is not an issue. The highest correlation between two variables is between firm size and firm R&D expenditure with a value of 0.865 (at  $p < .001$ ), which is expected given the nature of these variables that both measure firm capabilities.

To solve this issue, I tested the model with firm size only, with firm R&D expenditure only, and with both firm size and R&D expenditure and verified if the results differed. This treatment demonstrates that including both firm size and R&D expenditure in the model does not change the results compared with inclusion of either firm size or firm R&D expenditure in the model. Thus, following prior studies (e.g. Wuyts et al., 2004) and for the purpose of comprehensiveness, I included both of these variables in the model.

## **Results**

Table 5 presents the estimation results of analyses for the product innovativeness equation providing evidence to support hypotheses 1 to 3. For the purpose of increased

**Table 4: Descriptive Statistics and Correlations between Variables (Sample size = 230)**

Variables	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Drug radicalness	0.587	N.A.	0	1	1												
2 Therapeutic area	0.239	N.A.	0	1	0.35	1											
3 Focal firm size	2.353	3.914	0.009	20	0.14	0.22	1										
4 Focal firm R&D expense	499.792	876.195	0.243	4297	0.16	0.23	0.87	1									
5 Discovery-Pharma	0.27	N.A.	0	1	-0.11	-0.11	-0.07	-0.05	1								
6 Discovery-Biotech	0.148	N.A.	0	1	0.13	0.08	0.23	0.2	0.02	1							
7 Discovery-University	0.109	N.A.	0	1	0.09	0	-0.05	-0.04	0.04	-0.11	1						
8 Development-Pharma	0.313	N.A.	0	1	-0.1	-0.05	-0.1	-0.03	-0.05	-0.15	0.04	1					
9 Development-Biotech	0.235	N.A.	0	1	0.07	-0.05	0.02	-0.05	-0.08	-0.03	0.04	-0.04	1				
10 Development-University	0.061	N.A.	0	1	0.14	0.16	0.1	0.14	-0.11	0.1	-0.09	-0.05	-0.1	1			
11 Prelaunch-Pharma	0.339	N.A.	0	1	0.04	0.07	0.02	0	-0.1	-0.07	-0.04	-0.13	-0.07	-0.11	1		
12 Prelaunch-Biotech	0.139	N.A.	0	1	-0.17	-0.08	-0.1	-0.13	-0.13	-0.13	-0.1	-0.03	0.01	-0.05	0.08	1	
13 Prelaunch-University	0.057	N.A.	0	1	0.01	0.08	0.08	0.07	-0.02	-0.05	-0.02	-0.08	-0.05	0.02	0.1	-0.04	1

Note: N.A. = not applicable

insight and more complete interpretations of results, Table 6 provides evidence to support hypotheses 4 to 6. The results indicate that the interaction between partnership types of alliances and the stage at which such alliances are formed relates differently with the radicalness (innovativeness) of drugs. This inconsistency supports the importance of considering both partnership type and stage of the NPD process in this study, which have been largely overlooked in previous research. The details of results follow.

*Partnership with universities formed at different stages and product innovativeness*

The empirical results partially support H<sub>1</sub>. I hypothesized that the likelihood of drug radicalness increases when the partnership of focal biotech firms with universities happen during the discovery and development stages. In support of H<sub>1a</sub>, the results of focal biotech firm alliance partnerships with universities at the discovery stage indicate a positive association with the radicalness of drugs ( $\beta=1.40, p<.02$ ). This type of partnership at the development stage is also positively associated with drug radicalness ( $\beta=1.28, p<.08$ ), providing support for H<sub>2a</sub>.

I further hypothesized that the likelihood of drug radicalness decreases as the partnership of focal biotech firms with universities occurs during the prelaunch stage of drug development process. For this part of the hypothesis, I find only directional support for H<sub>1c</sub>—the effect of partnerships with universities on the radicalness of drugs is not significant during the prelaunch stage of the drug development process, which causes me to reject H<sub>1c</sub> ( $\beta=-.14, p=.43$ ). This finding seems to indicate that the effects of transaction costs and the potential benefits involved in the partnership with universities cancel each



other out, resulting in a non-significant result for this partnership type during the prelaunch stage. Although universities are important partners for biotech firms, their effect on product innovativeness significantly diminishes at later stages of the NPD process, due mainly to a lack of relative absorptive capacity from both parties at this stage.

*Partnership with other biotech firms formed at different stages and product innovativeness*

I find comprehensive support for H<sub>2</sub>. I hypothesized how the likelihood of drug radicalness changes when focal biotech firms initiate alliance partnerships with other biotech firms during the discovery and development stages and decreases during the prelaunch stage of new drug development. In line with this hypothesis, the regression results show that as the likelihood of forming alliances with other biotech firms at the discovery stage increases, the likelihood of radicalness for the drug also increases ( $\beta=1.04$ ,  $p<.05$ ), supporting H<sub>2a</sub>. Similarly, supporting H<sub>2b</sub>, when the likelihood of forming this type of partnership increases during the development stage, the likelihood of drug radicalness also positively increases ( $\beta=.62$ ,  $p<.06$ ), indicating a positive association between biotech alliance partnership type at the development stage and product innovativeness. Finally, the results show that there is a negative association between biotech-biotech alliance partnership types formed at the prelaunch stage and radicalness of the drug ( $\beta=-1.01$ ,  $p<.03$ ) which supports H<sub>1c</sub>. These findings are in line with prior studies (e.g. Oxley & Sampson, 2004) arguing that as the scope of competitors cooperating together in an alliance deviates from R&D to commercialization and marketing, the effectiveness of their collaboration reduces due to the conflict of interest that competitors face operating in the same market.

*Partnership with pharma firms formed at different stages and product innovativeness*

I also find partial support for H<sub>3</sub> in the empirical results. In this hypothesis, I proposed that alliance partnerships with pharma firms formed during the discovery stage will relate negatively to drug radicalness. I further posited that this association is positive between drug radicalness and alliance partnerships formed with pharma firms during the development and prelaunch stages of the drug development process. In accordance with H<sub>3a</sub>, as the likelihood of alliance with pharma firms formed at discovery stage increases, the likelihood of drug radicalness decreases ( $\beta = -.81, p < .04$ ). I also find a statistically significant association between alliance partnership types during the development stage and drug radicalness but in a negative direction ( $\beta = -.53, p < .09$ ), providing a counter-intuitive finding for H<sub>3b</sub>. The negative direction of the finding seems to suggest that the partnership with pharma firms during the development stage is not beneficial to increase product innovativeness. It seems to demonstrate a lack of biotech firm's trust towards pharma firms, as there is still an element of intellectual property in the development stage of the NPD process. I may also indicate a lack of absorptive capacity between these biotech and pharma firms. Regarding the effect of this partnership type alliance on drug radicalness, I find no significant effect ( $\beta = -.20, p < .33$ ) which fails to provide support for H<sub>3c</sub>.

**Table 5: Results of logistic regression analyses**

Variables	Hypothesis	Product innovativeness			
		Parameter Estimate	Standard Error	z-Value	p-Value
<b>Control Variables</b>					
Firm size		-0.06	0.08	-0.80	0.21
Firm R&D expense		0.00	0.00	1.36	0.09
Drug therapeutic area		2.42	0.59	4.12	0.00
<b>Main Variables</b>					
University partnership x discovery stage	H <sub>1a</sub> : (+)	1.40	0.67	2.09	0.02
University partnership x development stage	H <sub>1b</sub> : (+)	1.28	0.93	1.38	0.08
University partnership x prelaunch stage	H <sub>1c</sub> : (-)	-0.14	0.79	-0.17	0.43
Biotech partnership x discovery stage	H <sub>2a</sub> : (+)	1.04	0.63	1.65	0.05
Biotech partnership x development stage	H <sub>2b</sub> : (+)	0.62	0.40	1.56	0.06
Biotech partnership x prelaunch stage	H <sub>2c</sub> : (-)	-1.01	0.55	-1.83	0.03
Pharma partnership x discovery stage	H <sub>3a</sub> : (-)	-0.81	0.46	-1.76	0.04
Pharma partnership x development stage	H <sub>3b</sub> : (+)	-0.53	0.39	-1.36	0.09
Pharma partnership x prelaunch stage	H <sub>3c</sub> : (+)	-0.20	0.46	-0.44	0.33
Fit	Pseudo R <sup>2</sup> = .26 Likelihood ratio $\chi^2$ (31): 77.85; p < .001				
N	230				

Note: Coefficients are unstandardized beta values. For brevity, the results of the year dummies (approval date) are not presented. Standard errors adjusted for 85 focal firms. *p*-value is one tailed.

*Partnership at discovery stage with different partners and product innovativeness*

The empirical results in this study comprehensively support H<sub>4</sub>. In general, hypothesis 4 states that the effect of alliances formed during the discovery stage on drug radicalness change subject to the type of alliance partnership. In particular, I posited that the likelihood of drug innovativeness increases as the likelihood of alliances that focal biotech firms initiate during the discovery stage with universities ( $\beta=1.40$ ,  $p<.02$ ) and other biotech firms ( $\beta=1.04$ ,  $p<.05$ ) increases. However, as the likelihood of the focal firm's partnership with pharma firms formed during the discovery stage increases, the likelihood of drug radicalness decreases ( $\beta=-.81$ ,  $p<.04$ ) in support of H<sub>4c</sub>. In the discovery stage, as argued in Chapter 3 and in accordance with TCE, both the product specificity and performance uncertainty is high. However, the findings of empirical results show that the transaction cost is variant subject to the partnership type. As indicated by the results, at the discovery stage, a new drug development partnership with pharma firms reduces the chance of drug radicalness in spite of the financial capabilities that the latter has to offer. Consistent with TCE arguments, the high transaction costs that large pharma firms impose to relatively small biotech firms may outweigh the benefits they offer. Whereas, the partnership with universities (as providers of basic knowledge), as well as other biotech firms (as the provider of similar capabilities for better exploitation of existing resources), increases the probability of drug radicalness.

*Partnership at development stage with different partners and product innovativeness*

The empirical results also reflect substantial support regarding H<sub>5</sub>. This hypothesis states that the effect of alliances that focal biotech firms initiate at the development stage of the

drug radicalness is positive for all partnership types—universities, other biotech firms, and pharma firms. As posited, the likelihood of drug innovativeness increases with an increase in the likelihood of alliances formed during the discovery stage by focal biotech firms with universities ( $\beta=1.28$ ,  $p<.08$ ), and other biotech firms ( $\beta=.62$ ,  $p<.06$ ). However, the results show that the effect of alliances formed during the development stage with pharma firms ( $\beta=-.53$ ,  $p<.09$ ) is statistically significant but in a negative direction. This finding implies that in spite of a moderate transaction cost involved in the development stage (regarding product specificity and performance uncertainty), these costs outweighed the benefits of sharing product development and financial resources that pharma firms have to offer biotech firms. On the other hand, a focal biotech firm's alliance partnerships with universities and other biotech firms seem to provide more benefits than costs, maintaining transaction costs involved in these types of partnership at a tolerable level.

*Partnership at the prelaunch stage with different partners and product innovativeness*

I observed partial support for H<sub>6</sub> in the empirical results. I hypothesized that the effect of alliances formed by the focal biotech firms during the prelaunch stage of the drug development process is positive when alliances partners are pharma firms and decreases when alliance partners are universities and other biotech firms. I find no support for the hypothesized effect of alliances formed during the prelaunch stage when the partnership type is the university ( $\beta=-.14$ ,  $p<.43$ ), failing to provide support for H<sub>6a</sub>. As hypothesized, I find a negative association between alliances formed during the prelaunch stage of the drug development process with other biotech firms and drug radicalness ( $\beta=-1.01$ ,  $p<.03$ ), in accordance to H<sub>6b</sub>. However, the empirical results fail to provide support for the

hypothesized effect of alliances formed during the prelaunch stage with pharma firms on drug radicalness ( $\beta = -.13$ ,  $p < .33$ ).

In addition to the main explanatory variables, the results show that the effect of drugs in the oncology therapeutic area is positively associated with the likelihood of radical new drugs ( $\beta = 2.41$ ,  $p < .001$ ). Also, I observe that when R&D expenditure of focal firms increases, the likelihood of radical new drugs increases ( $\beta = .0005$ ,  $p < .09$ ). However, the regression results show that size of focal firms is not associated with the likelihood of drug radicalness. However, this association is in a negative direction ( $\beta = -.06$ ,  $p < .22$ ).

## **Post hoc analyses and robustness checks**

### *Regression with clustered data*

Since the dataset consists of 230 drugs across 85 firms, this may raise the issue of the regression with clustered data. To correct for this issue, following prior studies (e.g. Liu & Ravichandran, 2015), I ran a logistic regression, with standard errors clustered by focal firms, to attain robust estimations. This procedure relaxes the assumption of interdependence within repeated observations of the same firm in the sample, and has been recommended and employed in prior studies (e.g., Wang & Zajac, 2007). This corrects for standard errors given the incidence of correlations in error terms within the cluster (Wooldridge, 2002). Thus, although undertaking the regression with clustered data does not change the original results, I reported the regression with clustered data, producing a robust estimation of standard errors.

### *Analyses for endogeneity issue*

I must address the fact that the phenomenon under study in this thesis, like all other organizational design problems (e.g. Hoang & Rothaermel, 2010; Oxley & Wada, 2009), may be embedded within a broader endogenous system of strategic choices. In the biopharma context, for example, I know that biotech firms may selectively enter into different alliance partnerships, in part to increase their chance of launching a radical new drug at the end of the new drug development process. Systematic but unobserved differences in characteristics of biotech firms, regarding their choice of alliance partnerships formed at different stages of the new drug development process, could lead to bias in the regression results. Unobserved factors that impact both the formation of such alliances during the drug development process, and subsequent performance (radicalness of the drug) could otherwise lead to spurious or biased results (Argyres & Liebeskind, 2002; Hamilton & Nickerson, 2003).

In terms of observable characteristics, the inclusion of a set of control variables in the logistic regressions allows us to account for some of many obvious sources of heterogeneity. However, it is almost impossible to include an exhaustive set of control variables, and, therefore, the potential for unobserved heterogeneity and omitted variables bias arise inevitably. To address this issue, an ideal solution is to identify an exogenous system that impacts the explanatory variables of interest (partnerships formed at different stages), but does not influence the radicalness of drugs (as an outcome variable). This process would allow me to account for the endogenous strategic (organizational) choice and effectively correct for potential bias raised by omitted variables. Unfortunately,

finding statistically valid and conceptually sound instruments regarding the research setting of this study has not been possible in the extant literature.

Given the availability of data, I searched and identified three variables that satisfy the conceptually motivated requirement of valid instruments to assess potential bias in regression results raised by endogeneity issue. These three instrumental variables that I found are the count number of '*prior alliance experience*' (also used in prior studies; e.g. Lavie, Kang, & Rosenkopf, 2011) regarding biotech firm's alliances with universities, other biotech firms, and pharma firms respectively. These count variables exclude alliances that the focal biotech firm has formed when developing the drug under study in the sample. In this way, I can check whether the alliances that focal biotech firms formed with such partners on other projects (outside the sample scope in this study), can assist in ruling out possible bias in results. I found three instrumental variables for nine endogenous variables in the estimation model (three partnership types formed at three stages), and because there need to be at least one instrumental variables for each endogenous variable in the regression, I ran three separate two-stage regressions.

The results of the Durbin–Wu–Hausman endogeneity (Caner & Tyler, 2015) test for all regressions were not significant, indicating that endogeneity is not an issue in this study (i.e., I failed to reject the null hypotheses that interaction between alliance partnership type and partnership stage are exogenous; p-values of the tests of endogeneity for partnership with universities, other biotech firms, and pharma firms are .369, .396, and .438 at discovery, development, and prelaunch stage respectively).



**Table 6: Results of logistic regression analyses**

Variables	Hypothesis	Product innovativeness			
		Parameter Estimate	Standard Error	z-Value	p-Value
<b>Control Variables</b>					
Firm size		-0.06	0.08	-0.80	0.21
Firm R&D expense		0.00	0.00	1.36	0.09
Drug therapeutic area		2.42	0.59	4.12	0.00
<b>Main Variables</b>					
Partnership during discovery stage with university	H <sub>4a</sub> : (+)	1.40	0.67	2.09	0.02
Partnership during discovery stage with biotech firms	H <sub>4b</sub> : (+)	1.04	0.63	1.65	0.05
Partnership during discovery stage with pharma firms	H <sub>4c</sub> : (-)	-0.81	0.46	-1.76	0.04
Partnership during development stage with university	H <sub>5a</sub> : (+)	1.28	0.93	1.38	0.08
Partnership during development stage with biotech firms	H <sub>5b</sub> : (+)	0.62	0.40	1.56	0.06
Partnership during development stage with pharma firms	H <sub>5c</sub> : (+)	-0.53	0.39	-1.36	0.09
Partnership during prelaunch stage with university	H <sub>6a</sub> : (-)	-0.14	0.79	-0.17	0.43
Partnership during prelaunch stage with biotech firms	H <sub>6b</sub> : (-)	-1.01	0.55	-1.83	0.03
Partnership during prelaunch stage with pharma firms	H <sub>6c</sub> : (+)	-0.20	0.46	-0.44	0.33
Fit	Pseudo R <sup>2</sup> = .26 Likelihood ratio $\chi^2$ (31): 77.85; p < .001				
N	230				

Note: Coefficients are unstandardized beta values. For brevity, the results of the year dummies (approval date) are not presented. Standard errors adjusted for 85 focal firms. *p*-value is one tailed.

## **CHAPTER VI**

### **CONCLUSION, DISCUSSION, AND LIMITATIONS**

In this thesis, I explored the impacts of alliance collaboration agreements that biotech firms form to develop their new drugs on product innovativeness. I introduced alliance partnership type and alliance partnership stage variables and empirically examined their interactive effects between these two variables (resulting in nine mutually exclusive NPD strategies) in the biopharma industry on the innovativeness of drugs that biotech firms introduce to the market. In this way, I contribute to the literature in product innovation and NPD, as well as marketing strategy, by refining and extending the current understanding for the impacts of cooperative strategies on new product performance (e.g. Kotabe & Swan, 1995). This thesis is driven and motivated by multiple gaps in the product innovation and marketing strategy literature, described as follows.

Having recognized the paradigm shift in developing new products from bureaucratic and market-based to interorganizational arrangements (Webster, 1992), researchers in marketing and strategy have studied the effects of alliance on product innovation from different views. For example, Sivadas and Dwyer (2000) focus on alliance management view and show that cooperative competency (trust, commitment, and coordination between partners) in a dyadic alliance between a focal firm and its partner positively affect a focal firm's NPD success. Others have focused on the effect a focal firm's alliance portfolio and alliance network characteristics on the firm's number of patents (e.g. Stuart, 2000) and product innovation and revenue and profitability growth

(e.g. Wuyts et al., 2004). However, studies under both dyadic and portfolio level of alliance have largely ignored the importance and effects of partnership type as well as the stage or timing of the partnership during the NPD process on innovation performance.

Few prior studies have conceptualized alliance partnership type and their effects on focal firm performance (Baum et al., 2000; Rothaermel & Deeds, 2006). For example, Baum et al. (2000) investigated the effect of a young firm's network partnership composition on early performance. However, in spite of each partner's differential effects on a focal firm's performance, the position of partners has been ignored and conceptualized as fixed (universities as upstream, other biotech as horizontal, and pharma firms as downstream partners). However, for example, Fang et al. (2015) argue that the locus of codevelopment alliance between biotech and pharma firms can be in early versus late stages of new drug development. Previous research has also examined the alliances formed at different foci of the value chain and NPD process (e.g. Fang et al., 2015; Rothaermel & Deeds, 2006; Hoang & Rothaermel, 2010) of the focal firm's performance. However, such studies have, by and large, focused on one partnership type (mostly between small upstream and large downstream firms).

In this thesis, I argue that, in an interorganizational context, each alliance partnership can be formed at different stages of the NPD process. In their influential work, Powell et al. (1996) highlight the importance of considering various forms of alliance partnership type in industries with a complex knowledge base and a rapid regime of technological advancements (e.g. biopharmaceutical and electronics). They argue that the complexity of managing a joint project, with difficulties to relinquish control, brings

about confusion to relatively young and small firms as to whom to ally with. Powell et al. (1996) also emphasize the importance of the stage of alliance collaborations along the value chain and show that the locus of innovation is dispersed among organizations operating in the industry.

The importance of considering both partnership type and partnership stage during the NPD process is further reinforced due to controversial results of previous studies regarding performance effects of alliances. Controversial results seem to indicate an oversimplification of a complex system of interorganizational alliances (Powell, et al., 1996). Previous research focusing on the effectiveness of NPD strategies by comparing interorganizational with in-house strategies in product innovation suggest contradictory findings. For example, Kotabe and Swan (1995) conclude that products developed through interorganizational collaborations are less innovative than those developed by single firms. On the other hand, a more recent study by Stuart (2000) suggests that the innovation performance of alliance collaborations is significantly higher than comparable in-house arrangements. Even results of studies where the primary focus is solely comparison of on alliance-performance relation offer controversial conclusions. For example, in their seminal work, Dyer and Singh (1998) provide evidence that external R&D collaborations (relational view) enhance performance (relational rents), while more recent studies (e.g. Salge et al., 2013) cast doubt on the use of external R&D resources as a panacea for NPD success. Such alliance-performance inconsistencies suggest that important contingencies affecting the link between different firm alliances and performance have been overlooked (Gesing et al., 2015).

With few notable exceptions (e.g. Baum et al., 2000), prior studies have largely focused on product performance effects of alliances from the perspective of large firms (e.g. Rothaermel, 2001; Wuyts et al., 2004). This thesis joins the growing research interest in performance effects of alliances in the entrepreneurial settings of small firms. For example, Yang et al. (2014) examine the relative performance impacts of exploration versus exploitation alliances with large firms from the perspective of small firms. However, current studies focusing on the alliance performance effects on relatively smaller firms, largely focus on value appropriation concerns of small firms in relation to capturing the value created in alliance agreements with large firms (Rothaermel & Deeds, 2004). This view has been formed assuming the differential performance outcomes between small and large firms due to their negotiation power to appropriate a larger portion of value jointly created in alliances. However, this view has largely failed to recognize and examine the differential outcome variations among small firms in terms of value creation in such alliances. This study extends insights from prior studies, which mostly focused on one type of alliance partnerships (between focal upstream and downstream firms; see Fang et al., 2015, for example) by the inclusion of universities, other biotech firms, and pharma firms.

Another critical challenge in understanding the innovation effects of alliances has been the lack of using meaningful measures (proxy) to represent innovation performance. Kotabe and Swan (1995) argue that prior studies largely relied on aggregate measures of R&D expenditure and patents, and ignored investigating product innovativeness

employing the inherent attributes and features of the product itself. As a result, findings from prior studies may not reflect a true account of advantages, disadvantages, and innovation performance effects of alliances. Given the popularity and complexity of new product alliances among different organizations (Powell et al., 1996), and the convergence of many cutting-edge technologies (Kotabe & Swan, 1995), a lack of empirical studies in response to these gaps in product innovation and NPD research is surprising. To address this gap, I use product innovativeness using a binary variable to capture the difference between radical and incremental product innovations. Following the definition of radical innovation by Chandy and Tellis (1998) and following the recommendations in Wuyts et al. (2004) to operationalize radicalness of drugs in the biopharma sector, I use chemical type as well as the therapeutic potential of approved drugs to measure the technological and customer benefit aspects of a product innovation. If a drug is approved by FDA designations of ‘Chemical Type 1’ and ‘Priority Review’, I consider the drug as radical. Otherwise, the drug is considered as incremental. This objective approach provides a significant advantage to measure product innovativeness using inherent attributes and features of the product itself.

Finally, in this thesis, I used ‘product’ as the level of analysis. The change from the firm- to the project-level of analysis enables me to explore the innovativeness of product by relating it to alliances that the focal firm forms along the process of the NPD process with various partners. With an exception of a study by Hoang and Rothaermel (2010) which focus on time to market of projects, this study is among the first to focus on the innovativeness of projects. I collected secondary data on 384 alliance formed on 230

drugs developed by 85 biotechnology firms along the process of the new drug development, linking each drug to its designated alliances initiated by the focal firm. This design of data collection offers significant insights on challenging decisions that biotech firms face to leverage different partnership types (*with whom*) at different partnership stages of the NPD (*when*) in enhancing the innovativeness of their project (drug) outcomes.

In summary, this thesis is driven by a) inconclusive results in prior studies investigating alliance-performance link; b) a paucity of research taking the perspective of relatively smaller firms in alliance-performance domain; c) lack of attention to both partnership type and partnership stage, as the insights from prior studies may be misleading due to oversimplification of alliance relationships and the subsequent aggregate bias raised as a result of using aggregate measures for alliance as well as product innovation performance; d) considering product rather than the firm as the unit of analysis (product-driven alliance decision), which may reduce the theoretical and statistical power of association between alliances and product performance.

Motivated by these gaps in, and building on, the current body of literature, this thesis has provided me with an opportunity to explore how radicalness of a drugs is determined by decisions of biotechnology firms to ally with universities, other biotech firms and pharma firms at discovery, development, and prelaunch stage of new drug development process.

I relied on premises and insights from TCE (Williamson, 1985), RBV (Barney, 1991; Wernerfelt, 1984), and the concept of absorptive capacity (Cohen & Levinthal,

1990) to understand how different alliance partnership types initiated by focal firms at different stages of the NPD process affect the product innovativeness. While the insights from TCE is embedded in transaction costs and potential opportunistic behaviours occurring in dealing with partners, RBV takes the benefit-oriented perspective relying on the competitive advantage that firms can obtain by accessing to and sharing resources with partners through interorganizational relationships. In addition, interorganizational learning and absorptive capacity concepts (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998) complement insights from to TCE and RBV theories. Aside from their costs and benefits in entering new product alliances, partners also need to have abilities to absorb the relevant technological knowledge of their partners, irrespective of the main motivation (Schildt et al., 2012).

In accordance with TCE arguments regarding differential costs imposed by different product specificity and performance uncertainty along the process of new drug development (Fang et al., 2015), I developed the first set of hypotheses. I posited and empirically tested how the effects of each partnership type (universities, other biotech firms, and pharma firms) on drug radicalness change, subject to the new drug development stage during which the partnership was formed. In developing these hypotheses, I also borrowed insights from RBV and absorptive capacity to argue that potential benefits associated with each partnership type as well as the focal firm's absorptive capacity to learn from each partnership type, also changes during each stage of the new drug development process and moderates the changing transaction costs from discovery through development and prelaunch stages. To develop the second set of



hypotheses, I mainly relied on the insights from RBV and absorptive capacity to hypothesize and empirically test how the effects of alliances formed at each stage (discovery, development, and prelaunch) on drug radicalness change, subject to the type of partnership.

The results show that the likelihood of drug radicalness increases through increases in the likelihood of alliance partnerships with other biotech firms when such alliances are formed during the discovery and development stages. However, the increase in the likelihood of alliance partnerships with other biotech firms decreases the likelihood of drug radicalness when these alliances are formed during the prelaunch stage of the drug development process. In the case of alliance partnerships with universities, the results show a positive association between these alliance partnerships and drug radicalness during the discovery and development stages. Finally, the empirical results indicate that alliances with pharma firms during discovery stage of the drug development process decrease drug radicalness. A surprising highlight of the finding is that, contrary to hypothesized effects, alliance partnerships with pharma firms during the development stage are negatively associated with drug radicalness. This effect is neither directional nor statistically significant during the prelaunch stage.

In the case of alliances formed during the discovery stage of the new drug development process, the results show that the increase in the likelihood of drug radicalness is determined by an increase in the likelihood of alliance partnerships with universities and other biotech firms. However, an increase in the likelihood of alliance partnerships with pharma firms decreases the likelihood of drug radicalness. The effects

of alliances with universities and other biotech firms on drug radicalness during the development stage is same as the discovery stage, indicating the higher benefits than transaction costs involved in these types of alliance partners during the discovery and development stages. However, alliances formed with universities and pharma firms at this stage are not related to drug radicalness even though the costs of product specificity and performance uncertainty are minimal. This finding could suggest that given the minimal transaction costs during the prelaunch stage, universities and pharma firms offer little benefits related to the radicalness of drugs. This may also indicate that drug radicalness is already determined at earlier stages and the commercialization specialties of pharma firms would not be related to drug radicalness.

### **Theoretical and Managerial Implications**

First, this thesis contributes to studies of product innovation effects of alliances. Whereas prior studies have examined either partnership type or partnership effects (Rothaermel & Deeds, 2006), this study extends our understanding of alliance dyads by considering both partnership types and partnership stages. The joint creation of value has been assumed in prior studies (e.g. Dyer & Singh, 1998) from partners' sharing of capabilities and complementary resources through interorganizational collaborations. More specifically, the argument in creating value through alliances centers around expanding the alliance partners' potential performance by combining resources in the alliance dyad. However, this line of reasoning has largely taken for granted the differential value creation due to differences in terms of alliance-partnership types and stages. For instance, in his work regarding alliance between upstream and downstream

partners, Fang (2008) shows that partner coordination and sharing information are among critical determinants of new product performance. Moreover, previous research (e.g. Adegbesan & Higgins, 2010; Fang et al., 2015; Lavie, 2007) has mostly focused on the intra-alliance division (appropriation) of created value by alliance partners. Whereas, this view cannot reflect the unique nature of alliances in creating values due to different costs and benefits involved in different types of partnerships formed during different stages of the NPD process. This thesis is among the first studies to challenge the value creation assumption by arguing that the value created (drug radicalness in this study), through each specific alliance partnership type, varies subject to the differential transaction costs in different stages of the drug development process. By the same token, I also argue that the product innovativeness effect of each alliance formed at each partnership stage of the NPD process changes depending on the differential benefits that different types of alliance partnership have to offer.

Second, the inter-alliance view of dyadic alliances provides an opportunity to examine the changing transaction costs regarding product specificity and performance uncertainty along the process of new product development. For example, I examined how the effects of alliances between the focal biotech firm and other biotech firms on drug radicalness can change from discovery stage through development and prelaunch stages. The results show an inconsistent effect on drug radicalness at different stages, indicating the different transaction costs during each stage of the NPD process. This inconsistency, keeping the partnership type constant, extends TCE by identifying and empirically testing different sources of transaction costs along the NPD process. In addition to TCE, this

study also extends insights from RBV theory (Barney, 1991) and the absorptive capacity concept (Cohen & Levinthal, 1990), by identifying and examining how the benefits of alliances formed with different partners change subject to the stage that these alliances are initiated. For example, results show how alliances formed during discovery stages, with the same level of product specificity and performance uncertainty, lead to differential drug radicalness for partnerships with pharma firms compared to other biotech firms and universities. This could suggest that at the same level of transaction costs, the type of partnership poses a condition which makes the benefits and absorptive capacity in alliance dyads vary with the type of alliance partnership.

Third, this thesis provides a more subtle and accurate understanding of alliance partnership effects on product performance. Prior studies in alliance focus on product innovation outcomes at the firm level of analysis (e.g. Lee, 2011; Wuyts et al., 2004) which are theoretically distant from product innovation at alliance level (Hoang & Rothaermel, 2010). This thesis links each drug to its alliances to offer a more accurate conceptualization of alliance-performance relations. Linking a sample of 230 FDA-approved drugs (developed by 85 focal biotech firms), to their 384 associated alliances enabled me to provide more accurate insights, as for how variations in alliance dyad attributes (partnership type and partnership stage) relate to variations in drug radicalness.

Fourth, this study draws attention to different benefits and costs that relatively small firms face during their alliance partnerships along the NPD process with different types of partners. By noting the complexity of alliance network (Powell et al., 1996), and the inconsistent effects of different alliance partnerships formed along the new drug

development process, this study helps clarify the conditions that help focal firms increase the radicalness of their drugs. In a firm's effort to create value with its partners (Dyer & Singh, 1998), the inter-alliance perspective used in this thesis leads to firm's better partner selection at each stage of NPD process. This study offers a systematic approach for aligning alliance partnership types with alliance partnership stages, contributing to the highest likelihood of product innovativeness for focal firms. A combination of cost-oriented TCE, with a focus on reducing the risk of opportunism, as well as the benefit-oriented RBV and interorganizational learning, provides the required implications for the product innovativeness of firms.

### **Limitations and future research**

The limitations of this thesis suggest promising research opportunities. First, given the availability of data and due to the nature of the research question in this thesis, the failure rate of drugs after introducing to market was not determined in this study. This offers an opportunity for future research, as previous research reports a substantial failure rate, even after market introduction. The dependent variable, product radicalness, is a means to an end, and it would be interesting to relate this variable to actual market outcomes.

While this is beyond the initial scope of the thesis, it could be worthwhile to examine this additional relationship in the future. Furthermore, the alliances studied do not happen in isolation. Another possible extension of this study could be the examination of the composition of alliance portfolios at the same development stage.

For example, a more recent study by Castellion and Markham (2013) shows that almost 50% of new product innovations launched to the market fail. Although the innovativeness

of new product could be a critical determinant of product success in the market, further empirical research is needed to provide updated understanding on how product innovativeness is related to new product success in the market after launch. Since, by some account, seventy percent of resources spend on new product leads to no product success in the market (Booz et al., 1982; Sivadas & Dwyer, 2000), a follow up study investigating the link between determinants of new product product-innovativeness success in this study (e.g. alliance partnership type and stage) help firms better align their internal and external resources to new product product-market success.

Second, this study draws attention to differential product innovativeness from an inter-alliance perspective. By changing the focus from the firm level of analysis to the product level of analysis, I examined how drug radicalness, measured by the drug attributes, can be determined by variations among associated attributes of alliances, regarding their types and stages of partnerships. In this study, given the availability of data, I have controlled for heterogeneity among the capabilities of focal biotech firms only; differences among focal biotech firms regarding their capabilities may relate to variations in the radicalness of their drugs.

Further studies can illuminate this area by also considering the capabilities of different partners (universities, other biotech, and pharma firms). The firm-level measure from the perspective of partners (e.g. size, age, and capabilities) may also play a role in predicting drug radicalness. Thus, future studies need to consider firm-level technological capabilities (Rothaermel & Deeds, 2004) of partners or intra-alliance technological diversity (Schildt et al., 2012) and then examine how the inter-alliance differences of

alliances can relate to the product innovativeness. Ignoring variations among partners may raise the issue to insignificant or controversial results. For example, I found a directional but not statistically significant relation between alliances with universities and the drug radicalness, when these alliances are formed during the prelaunch stage. Also, the results show that alliances with pharma firms during all stages of the drug development process lead to negative drug radicalness. These findings could imply that even though the transaction costs associated with this type of partnership are low, the benefits are even lower, as universities are traditionally inexperienced during prelaunch stages. However, an alternative explanation could be due to considering homogeneity in each partnership type. Considering partner measures can provide an answer to this confusion and shed more light on the surprising results. Continued research efforts are required to verify results in this thesis and to further consider the unique characteristics of each partnership type.

Third, I focused on the biopharmaceutical industry, a specific context in which the process of NPD is lengthy and highly regulated, as well as alliance partnerships among organizations are highly pertinent (Wuyts et al., 2004). Additional investigation into the innovation and NPD effects of alliance partnerships in other contexts, such as low- or other high-tech industries, could provide more implications and updated insights into the nature and effects of different alliance attributes (e.g. partnership types and stages) on product performance. In addition to verifying results in other contexts, it is important to study other aspects of alliance-product relations. Whereas this thesis has started a research effort regarding alliances formed during the NPD process, additional research

efforts are needed to investigate more aspects of alliances as well as new product performance. For example, research could examine how different types of alliance governance moderate the effectiveness of alliance partnership types on the product innovativeness along the NPD process. Further studies can also examine how variations in attributes of alliances can affect the time to market of new products.

Finally, despite the existence of potential synergies and dis-synergies among these nine strategies, this study focuses only on developing these nine mutually exclusive strategies affecting product innovativeness. As this research is pioneer in introducing timing-type typology, considering interactions (in any formats of causality or correlation) between these nine mutually exclusive strategic options (synergies or dis-synergies) provides a promising agenda for future research.



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