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By: **David R. Williams**, Carlton C. Young, and **Betty S. Coffey**

Abstract

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Acquisitions in the biopharmaceutical IPO market: Collaboration, competition and co-opetition

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The present paper explores the little studied area concerning the acquisition of recent biopharmaceutical initial public offering firms. We examine the nature of the relationship between the acquiring firm and the acquired initial public offering firm prior to the acquisition and from the perspective of the resource-based view. We find to some extent that firm specific-resources affect the prospect that the firm will be acquired. Furthermore, our findings show that firms with more of these types of resources are likely to be acquired by firms engaged in co-opetition rather than by firms engaged solely in collaboration, competition, or (to a limited extent) with no prior relationship.

1 | INTRODUCTION

The present paper examines the understudied area of how the resources associated with a firm that has recently gone public affects the likelihood of that firm being acquired and who is acquiring it. Firm mergers and acquisitions (herein after acquisitions) are commonplace in many fragmented markets (Brau, Francis, & Kohers, 2003; Jain & Kini, 2006). Low interest rates, rising stock prices, and an abundance of cash is fueling recent acquisition activity, especially in markets driven by innovation and transformation (KPMG, 2015). Firms acquire other firms for a multitude of reasons including increasing market share to raise prices or lower costs (Henderson, 1979), to acquire the reputation of a firm (Klein, Crawford, & Alchian, 1978), as a defensive measure (Haleblian, Devers, McNamara, Carpenter, & Davison, 2009), to integrate markets (Sawler, 2005), and to acquire research and development (R&D) competencies or other resources that the acquiring firm lacks (Demirbag, Ng, & Tatoglu, 2007; Hirshleifer, 1980). Competitors, collaborators, and firms engaging in both competition and collaboration (e.g., co-opetition or co-opetitors) are all involved with acquisitions. This is particularly true in the biopharmaceutical market sector where newer firms are subject to being acquired for their resources in exchange for capital (LaMattina, 2011; Mazzola, Perrone, & Kamuriwo, 2016), with this market sector being viewed as the most likely to be engaged in near term future acquisition activity in the United States (KPMG, 2015).

Another commonplace activity for firms in fragmented markets is the initial public offering (IPO) process. An IPO represents a different means of raising capital for investors to that of being acquired and is one of the most consequential events in the life of a firm (Celikyurt, Sevilir, & Shivdasani, 2010a). In an IPO, the firm sells a portion of its stock to the general public for the first time. In addition to providing an infusion of capital, firms undertake an IPO for various reasons. These reasons include increasing public awareness of the firm and its products, creating a market value for the firm, increasing financial transparency, minimizing the cost of capital, lessening dependence on other investors, and as an exit vehicle for founders and other early investors (Celikyurt, Sevilir, & Shivdasani, 2010b; Kim & Weisbach, 2008; Pagano, Panetta, & Zingales, 1998). Despite raising capital in an IPO, many biopharmaceutical firms that have gone public eventually end up being acquired by other firms (Mazzola et al., 2016; Williams, 2013) or acquiring other firms (Celikyurt et al., 2010a). Yet we know little about firms that go public and then later are acquired (Brau et al., 2003; Celikyurt et al., 2010b; Certo, Holcomb, & Holmes, 2009).

The present study examines the acquisition of recent biopharmaceutical IPOs and their relationships prior to the acquisition from a resource-based view. Specifically, the study seeks to determine (a) the likelihood of firms with greater resources being acquired, (b) if certain types of resources are more likely to lead to acquisition, and (c) given their resources, if those firms acquired are more likely to be acquired by collaborators, competitors, or co-opetitors.

By addressing these questions, this study contributes to the extant literature in three important ways. First, this study adds to the resource-based view as applied to acquisitions by operationalizing, empirically testing, and comparing different resources within this context. Second, we examine the understudied area of IPO acquisitions (e.g., Gopalakrishnan, Scillitoe, & Santoro, 2008; Williams,

2013). Much of this literature focuses on the financial aspects of the acquired firm (e.g., Ragozzino & Reuer, 2007; Reuer, Tong, & Wu, 2012; Zambuto, Nigro, & O'Brien, 2017); whereas, we examine the acquired firm's other resources. Third, we focus on the collaborative/competitive/co-operative nature of who is acquiring biopharmaceutical IPOs relative to the resources within the acquired firm and region, of which there is insufficient research. The study's overarching premise is that firms with greater resources are more likely to be acquired, with different types of resources leading to being acquired by different types of firms (e.g. collaborators, competitors).

The biopharmaceutical market sector presents an appropriate context for this study for several reasons. The sector is a growing and significant portion of recent IPOs (Ernst & Young, 2014) and acquisitions are prevalent (Danzon, Epstein, & Nicholson, 2007; Hoffman & Plumridge, 2014; Po, 1998). Also, the sector is fragmented, being more likely to have acquisitions than a consolidated market sector (Brau et al., 2003). Part of the reason for acquisitions in this market sector is due to the decrease in internal drug development of large biopharmaceutical firms (Pammolli, Magazzini, & Riccaboni, 2011), which are increasingly seeking external sources of replenishment for their clinical pipelines (Banerjee & Martin, 2015; Kneller, 2010). Acquisitions of new firms in this market sector also may be viewed as less risky compared with internal discovery and development efforts (Curtin, 2014). Regardless of industry, IPOs are frequently subject to acquisitions (Celikyurt et al., 2010a).

New biopharmaceutical firms also rely heavily on other biopharmaceutical firms to fund their innovations (Lerner & Merges, 1998). In addition to acquiring the entire firm, these funding arrangements often take the form of equity alliances, joint ventures, or in-licensing agreements—what we collectively term collaborations. These collaborations are multidirectional as both established and new biopharmaceutical firms are seeking to secure mutually complementary assets (Hagedoorn, 1993; Zambuto et al., 2017). Given this, Billitteri, Lo Nigro, and Perrone (2013:110) observe that the resource-based view underscores how partners bring into collaborative arrangements "their valuable resources and through the alliance they are interested both in acquiring their partners' valuable resources and in protecting their own resources during the alliance-making process." From this perspective investors and collaborators act as resources for the firm or as Lavie (2006: 638) notes "alliance partners play a significant role in shaping the resource-based competitive advantage of the firm." With the exception of trade press announcements, we know very little about the acquisition of biopharmaceutical IPOs. The present study should add to our understanding related to the nature of mergers and acquisitions associated with biopharmaceutical IPOs with it being of interest to both scholars and practitioners.

2 | THEORY DEVELOPMENT

The resource-based view (RBV) of the firm (e.g., Barney, 1991; Penrose, 1959) suggests that competitive advantage for a firm stems from the resources it controls. From this perspective, the firm is a collection of its resources (Penrose, 1959). Firms engage in both collaborations and acquisitions to amass resources. These resources may include technologies of the biotechnology firm, the managerial competencies of both collaborating firms, social capital of its stakeholders, and the financial capital needed to fund the enterprise (Gopalakrishnan et al., 2008). These resources, however, must be valuable, rare, imperfectly imitable, and imperfectly substitutable (Barney, 1991) in order to generate above normal rents. For U.S. biopharmaceutical firms, patents, for one, grant resources the conditions of rare, imperfectly imitable, and imperfectly substitutable (Williams, 2013), with the market determining their value. Hence, prior research on patents suggests that they can be a valuable resource for competitive advantage and predictive of overall firm performance (Powers & McDougall, 2005).

Other factors may be viewed as valuable resources, which lead to competitive advantage and/or acquisition. In rapidly evolving market sectors, collaborations have emerged as a critical facilitator of knowledge acquisition (Zambuto et al., 2017). Due to the high cost of R&D (DiMasi & Grabowski, 2007), new biopharmaceutical firms frequently collaborate with other firms for the development and market approval of new patentable drugs (Banerjee & Martin, 2015). Collaborations occur both before and after the IPO and can act as a *firm-specific resource*. The biopharmaceutical industry exhibits the highest collaboration activity of any industry previously studied by scholars (Rothaermel, 2001). Although acquisitions and collaborations can be viewed as strategic substitutes for one another (Sawler, 2005), these initial collaborative arrangements often lead to the investing firm later acquiring the other firm. Collaborations are attractive as they provide a high degree of flexibility for the firm while limiting resource commitments (Klossek, Meyer, & Nippa, 2015) and may also signal resource quality (Mazzola et al., 2016). Collaborations can take various forms with the form of in-licensing of patents or technology being among the most common for biopharmaceutical firms.

In-licensing is where the owner of the rights (i.e., the licensor) of a patent grants permission to use (i.e., a license) technology to another (i.e., the licensee) and receives compensation in return for granting this right. In other words, in in-licensing, the resources or assets of one firm are appropriable to another firm (Grant, 1996). The initial owner of the rights may retain certain rights such as the ability to exploit the technology itself (i.e., a sole license), for a specific application (e.g., human, plant, and animal), or for a geographic area. For this transfer of rights, the licensor is either compensated at the beginning of the granting of permission to use the technology, during development (e.g., milestone payment), or once the product reaches the market (e.g., royalty payment). Combinations of payment mechanisms frequently occur. Firms are sometimes acquired to gain access to the other rights associated with a patent that they do not control. Thus, a collaborating firm may wish to later acquire an additional right associated with one or more patents with the acquisition of the firm itself being the most efficacious method.

Technologies such as patents represent codified knowledge (Ter Wal, 2014). Codified knowledge is a resource that can be readily tradable. Noncodifiable knowledge resides with the personnel or other resources (such as owners) of the firm (Howells, 2012) and is not readily tradable. Noncodifiable knowledge can be individual specific, industry specific, and general (Williams, 2013). Knowledge has long been viewed as a resource that may lead to competitive

advantage for firms (Tallman, Jenkins, Henry, & Pinch, 2004). In this sense, it is the nontradable resources that are of value. The desire to acquire nontradable resources is another reason that leads many firms to acquire other firms in their entirety, as they cannot gain access to this knowledge or resource by way of collaboration. RBV suggests that mergers and acquisitions can be an effective means of transferring nontradable resources and capabilities between firms (James, 2002).

Additionally, as noncodified knowledge exists in individuals, it is not very mobile in space (Breschi & Lissoni, 2009). Thus, knowledge tends to cluster in certain regions where knowledge workers reside. Scholars for some time (e.g., Ewers & Wettmann, 1980; Porter, 1998) have noted that knowledge has clustered in various market sectors such as biotechnology (e.g., Zaheer & George, 2004), opto-electronics (e.g., Hendry & Brown, 2006), and telecommunications (e.g., Ibrahim, Fallah, & Reilly, 2009), among others.

This clustering of like firms in regional markets furthers the development of social networks (Cohen & Fields, 1999; Eisingerich, Bell, & Tracey, 2010). These social networks facilitate the transfer of knowledge within clusters (Eisingerich et al., 2010). Much of the clustering literature supposes that geographic closeness enables the exchange of knowledge (Zaheer & George, 2004), especially noncodified knowledge among firms (Bell & Zaheer, 2007). Clusters also benefit from regional institutions that assist in the coordination and management of network knowledge and support interaction and learning (Zaheer & George, 2004). Knowledge transfers can occur through the labor market, social networks, and collegial collaborations and through contractual agreements such as formal collaboration arrangements, in-licensing agreements, and product or technology acquisition (Breschi & Lissoni, 2009). Elements associated with clusters we call *regional resources*. By residing in a cluster, firms may gain knowledge and, thus, access in terms of acquisition of other firms.

Early investors in a firm may have more knowledge of the firm than others. Early investors of biopharmaceutical IPOs include other biopharmaceutical firms and venture capitalists (Diestre & Rajagopalan, 2012; Williams, 2013). Venture capitalists initially may be attracted to firms with greater resources, but they also are a resource as they act as a key component in the development of new firms, social networks, and clusters (Gilding, 2008; Kato & Odagiri, 2012). Through investment in the firm, external investors gain firm-specific knowledge. This allows them to assess the value of the varied resources that the firm may possess and may give them an elevated position for firm acquisition. These two types of investors, however, may have different investment objectives and timeframes. For the venture capitalists, the objective is to maximize the value of their investment with either an acquisition or IPO representing a means to liquidate their investment. For a biopharmaceutical firm, in addition to capital appreciation, an investment in another firm may allow them access to knowledge by way of in-licensing of additional patents, learning new techniques, or the opportunity for firm acquisition.

The investment also oftentimes grants the investing firm the ability to participate on the governing body of the firm (Jain & Kini, 1995; Williams, Duncan, & Ginter, 2010). By participating on the board, the IPO firm itself gains additional *firm-specific resources* in the knowledge brought to the firm by these two types of investors. Firm-specific knowledge bearers (e.g., biopharmaceutical firms and venture capitalists) also may assist the IPO with understanding industry-specific issues (i.e., the patent process, FDA approval process, and aspects related to being a publicly traded firm). Both biopharmaceutical and venture capitalists owners may bring in other biopharmaceutical firms as either owners or collaborators. Venture capitalists, for one, prefer to invest with other venture capitalists in what is known as syndication (Williams et al., 2010). For the biopharmaceutical IPO, these firm-specific resources also may create the opportunity for acquisitions as venture capitalists seek to "cash-out" whereas biopharmaceutical firms seek to "cash-in" on new resources. Given the above, we hypothesize

> **H1** *Biopharmaceutical IPOs with greater firm-specific resources and regional resources are more likely to be acquired than biopharmaceutical IPOs with lesser firm-specific and regional resources.*

As mentioned earlier, biopharmaceutical firms make capital commitments in other firms by multiple means. We have identified collaboration as both an investment in a technology (e.g., in-licensing) and equity ownership in the firm. Here, we delineate further and note that equity ownership in the firm may grant the owner additional knowledge of the firm, with this being a prime motivation for the investing firm to do such as opposed to in-licensing. Firms with equity ownership may be seeking R&D competencies that they currently do not have and, thus, invest in the firm to gain such knowledge. Established firms at first do not have to invest large amounts to gain such knowledge. The investment of small amounts in multiple vehicles (i.e., firms), known as real options, is related in the literature to the resource-based view of the firm.

The real option literature "marries the resource-based view with industry positioning by disciplining the analysis of the value of capabilities by a market test" (Kogut & Kulatilaka, 2001: 745). This allows firms to invest in several firms simultaneously searching for new capabilities and technologies (Vassolo, Anand, & Folta, 2004). Or as McGrath and Nerkar (2004: 3) note "by investing relatively small amounts in learning about several promising technical directions simultaneously, a firm can broaden the range of alternatives it can apprehend, generating conceptual variety with parsimony."

Furthermore, with equity ownership of new firms often comes board participation. For an equity investor, board participation allows the participant to gain insight and also potentially the ability to influence firm commitments. From this board position, a firm may be able to learn further from (and reduce uncertainty related to) the invested firm (Janney & Dess, 2004) without initially making a major capital commitment. A firm may engage in such activity to not only learn new knowledge and develop new technologies but also to improve its core business (McGrath, 1997). Given this, an investing biopharmaceutical firm may not wish other firms to collaborate or acquire the firm. Hence, equity ownership may give a favored status position to the owner of the equity to other types of relationships. Thus, we hypothesize

H2 *Biopharmaceutical IPOs with a greater percentage of equity ownership by other biopharmaceutical firms are more likely to be acquired than firms with a greater number of biopharmaceutical firm collaborators.*

As collaborators, competitors, and co-opetitors acquire IPOs, it would be reasonable to assume that the firm specific and regional resources would favor or be associated with different types of acquirers. This is to say that biopharmaceutical firms investing in other firms (i.e., the IPO firm) would be more amenable to selling to a firm that is collaborating with the IPO as opposed to a firm having no relationship with the IPO or is competing with the IPO.

Gnyawali and Park (2009) note that short product life cycle, technological convergence and high R&D costs lead to co-opetition among firms, which are all present in the biopharmaceutical market sector. Co-opetition is oftentimes considered extremely risky as competitors have separate business incentives that might lead to opportunistic behavior (Ritala & Hurmelinna-Laukkanen, 2009). For example, Rothaermel and Deeds (2004) suggest that due to their initially weak bargaining position, smaller firms tend to cede a disproportional amount of control rights to the financier of the R&D arrangement. Moreover, as firms engaged in co-opetition seek to leverage resources and as the nature of the arrangement changes over time (Morris, Kocak, & Özer, 2007), the co-opetitive nature of the relationship may also create additional defensive (Haleblian et al., 2009) and integrative (Sawler, 2005) incentives to acquire the IPO compared to a firm with no relationship or one that is collaborating. Thus, we hypothesize

H3 *For biopharmaceutical IPOs that are acquired, firms with greater firm-specific and regional resources will more likely be acquired by firms engaged in co-opetition than being acquired by collaborators or competitors.*

3 | METHODS

We collected names of biopharmaceutical firms going public in the United States from January 1996 through December 2012 from several Internet sources including biospace.com, hoovers.com, and SEC.gov (Securities and Exchange Commission). We selected biopharmaceutical firms with standard industrial classification (SIC) codes 2833 (Medicinal Chemicals and Botanical Products), 2834 (Pharmaceutical Preparations), 2835 (In Vitro and In Vivo Diagnostic Substances), 2836 (Biological Products), 3829 (Measuring and Controlling Devices), 3841 (Surgical and Medical Instruments and Apparatus), 5122 (Wholesale Drugs), 7371 (Computer Programming Services), 7389 (Business Services), and 8731 (Commercial Physical and Biological Research). For the non-2000 level SIC codes, we verify via their SEC forms that they are primarily engaged in the biopharmaceutical market sector. We found 253 firms went public during this time. We then used the various stock exchanges (NASDAQ, NYSE) to determine which firms were still trading as of the end of 2014. For the firms that we identified as stopping trading, we examined their SEC registration termination filings and other SEC filings to determine the reason for termination or de-listing. Firms de-list as a result of financial distress or being merged or acquired. Of the 253 firms, 116 or 46% were acquired.

We perform both binomial logistic regression and multinomial logistic regression analyses to test our hypotheses. We use time-series–cross-section data. For both tests, the control and independent variables used data from the firm's prospectus and last annual report (10 K) prior to its registration termination. In all of our models, we use natural logs of the total assets and age of the IPO just prior to the acquisition as control variables. We use a natural log of the number of patents and a natural log of the amount of research and development spent, both in the year prior to the IPO. We also control for when the firm went public (Date) by dividing the date into four equal time periods, noting earlier IPOs are more likely to be acquired.

For our independent variables, we use several different measures found in the firms' prospectus. We use Pratt's Guide to Venture Capital (1999) to determine if an investor is a venture capital firm and the percentage of that ownership. We also note the percentage ownership by other biopharmaceutical firms. We note the number of collaborators at the time of the IPO. Venture capital ownership, biopharmaceutical ownership, and number of collaborators are log transformed after adding a small quantity to the variables. Venture capital, biopharmaceutical, and collaborators are proxies for *firm-specific resources*. For *regional resources*, we use Powell, Koput, Bowie, and Smith-Doerr's (2002) nine biopharmaceutical regions or clusters. This is a binary variable noting if the transferring firm is in a geographic region (1) or not (0).

Our dependent variable for the binomial logistic regression model is coded one (1) for the firm being acquired and a zero (0) if not. For the multinomial regression model, we code there being no named relationship as one (1), the acquiring firm as a named collaborator as two (2), the acquiring firm as a named competitor as three (3), and the acquiring firm as both a named collaborator and competitor as four (4). To determine collaborators and competitors, we searched the firm's annual report in the year prior to the acquisition. Annual reports have both a "competition" section and a "collaboration" section. We search these two sections specifically and perform a word search of the entire document seeking to verify if the acquiring firm is either a named collaborator or competitor. We note that the definition of co-opetition is ambiguous in the literature (Bengtsson & Kock, 2014). For this study where the acquiring firm was listed both as a collaborator and competitor, we coded the acquiring firm as a co-opetitor.

4 | RESULTS

For the 253 IPOs, the average IPO reported $49.8 million in total assets and was 7.8 years old as reported in its annual report just prior to the acquisition. At the time of the IPO, the average firm had 1.9 collaborators and was owned 43.1% by venture capitalists and 8.3% by biopharmaceutical firms. At the time of the IPO, the average firm had 26.2 patents and spent about $14.7 million on R&D. Over 15% (15.5%) of the IPOs were acquired by named collaborators. Nineteen percent (19.0%) of the IPOs were acquired by named competitors. Six percent (6.0%) of the IPOs were acquired by firms that were both named collaborators and competitors. Overall, 81% were in clusters.

Table 1 shows the correlations and descriptive statistics of the variables associated with our 253 firms. We show these data without the natural log transformations. As we would expect, firms that went public earlier and had greater biopharmaceutical ownership interest are all significantly correlated with being acquired. Firms that spent less on R&D prior to the IPO also were correlated with being acquired.

Table 2 shows the results of our binomial logistic regression model related to the IPO being acquired. The results indicate a good fit of the model to the data (model χ^2 = 25.852 [p = .002] and Nagelkerke R^2 = .138). In addition to the control variable (Date), our results show that two firm-specific variables have statistical significance: the percentage ownership by both venture capitalists (Venture Capital) and other biopharmaceutical firms (Biopharma). The first significant variable indicates that firms that have greater venture capital ownership are more likely to be acquired than firms having less venture capital ownership. Given greater venture capital ownership, the odds of being acquired are 1.341 times larger than the odds of not being acquired. The second significant variable indicates that firms having a greater percentage of other biopharmaceutical firm ownership are more likely to be acquired than firms that have less other biopharmaceutical firm ownership. Given greater biopharmaceutical firm ownership interest, the odds of being acquired by other firms are 1.451 times larger than the odds of not being acquired. This result modestly supports the first part of our first hypothesis that biopharmaceutical IPOs with greater firm-specific resources are more likely to be acquired than biopharmaceutical IPOs with lesser firm-specific, but not the aspect of the hypothesis related to regional resources. The results support our second hypothesis that biopharmaceutical IPOs with a greater percentage of equity ownership by other biopharmaceutical firms are more likely to be acquired than firms with a greater number of biopharmaceutical firm collaborators.

Table 3 shows the results of our multinomial logistic regression analysis. In this model, we are testing the differences among IPOs that are acquired by firms that either were named as collaborators, competitors, both, or not named at all. The results indicate a good fit of the model to the data (Model χ^2 = 62.369 [p = .000] and Nagelkerke R^2 = .476).

TABLE 2 Binary logistic regression results comparing IPOs that are acquired to IPOs that are not acquired

	B	*SE*	*p* value	Exp(B)
Age (LN)	.414	.285	.145	1.513
Total assets (LN)	.134	.111	.228	1.143
Date	−.338	.164	.040*	.713
Patents (LN)	−.137	.211	.516	.872
R&D (LN)	−.139	.093	.135	.870
Venture capital (LN)	.293	.125	.019*	1.341
Biopharma (LN)	.372	.124	.003**	1.451
Collaborators (LN)	.101	.300	.736	1.107
Region	−.142	.374	.705	.868
Max likelihood	25.852			
p value	.002			
Pseudo R^2 (Nagelkerke)	.138			

Note. IPO = initial public offering. N = 253.

*Data significant at .05.

**Data significant at .01.

Our first three panels compare IPOs acquired by collaborators, IPOs acquired by competitors, IPOs acquired by those engaged in co-opetition to IPOs acquired by firms with no named relationship in the annual report prior to the acquisition. These first three panels do not directly test our hypotheses, but are provided for informational purposes as individuals may wish to know how our dependent variables compare with firms that are acquired by those with no relationships. Our fourth panel compares IPOs acquired by collaborators to IPOs acquired by competitors. Our fifth panel compares IPOs acquired by collaborators to IPOs acquired by those engaged in co-opetition. The sixth panel compares IPOs acquired by competitors to those engaged in co-opetition.

The first panel, for example, Log ($P_{COL/N}$), shows two variables with statistically significant relationships between IPOs acquired by collaborators compared with IPOs acquired by firms with no relationship with the IPO. Our findings show that if IPOs were to increase the percentage of ownership held by venture capitalists at the time of the IPO by one, the multinomial log-odd of being acquired by a

TABLE 1 Descriptive statistics and correlations

		Mean	*SD*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	Acquisition	.460	.499	—									
(2)	Age	7.830	5.174	.020									
(3)	Total assets	16.740	1.430	−.037	.426**								
(4)	Date	2.37	1.033	−.224**	.025	−.053							
(5)	Patents	26.244	195.358	.058	.157*	.501**	.003						
(6)	R&D	14689880	196055690	−.153*	.152*	.226**	.403**	.170**					
(7)	Venture capital	43.057	28.999	.071	−.062	−.104	.278**	−.091	.145*				
(8)	Biopharma	8.254	17.604	.166**	−.038	.006	−.056	−.026	.054	−245**			
(9)	Collaborators	1.900	2.258	.070	.052	.035	−.133*	.088	.055	.023	.003		
(10)	Cluster or region	.810	.396	−.031	−.068	−.114	.060	.027	.131*	.184**	−.005	.120	—

Note. All data shown without natural log transformations. N = 253.

*Data significant at .05.

**Data significant at .01.

TABLE 3 Multinomial logistic regression results comparing collaborators, competitors, co-opetitors, and no relationships

	Dependent variables																	
	Log ($P_{COL/N}$)			Log ($P_{COM/N}$)			Log ($P_{COO/N}$)			Log ($P_{COL/COM}$)			Log ($P_{COL/COO}$)			Log ($P_{COM/COO}$)		
Independent variables	B	*p* value	Exp(B)	B	*p* value	Exp(B)	B	*p* value	Exp(B)	B	*p* value	Exp(B)	B	*p* value	Exp(B)	B	*p* value	Exp(B)
Age (LN)	−.092	.905	.912	−.620	.252	.538	2.078	.202	7.991	.528	.544	1.695	−2.170	.216	.114	−2.698	.109	.067
Total assets (LN)	.085	.777	1.089	−.181	.333	.835	.598	.537	1.819	.266	.420	1.305	−.513	.607	.599	−.779	.427	.459
Date	.287	.476	1.333	.799	.019*	2.223	.539	.543	1.715	−.512	.285	.600	−.252	.787	.777	.260	.779	1.296
Patents (LN)	.551	.295	1.734	−.736	.223	.479	−2.257	.160	.105	1.286	.083	3.620	2.807	.092	16.564	1.521	.366	4.576
R&D (LN)	.069	.778	1.071	.011	.941	1.012	−.042	.926	.959	.057	.830	1.059	.111	.822	1.117	.053	.909	1.055
Venture capital (LN)	−.785	.025*	.456	−.170	.530	.844	1.256	.193	3.511	−.615	.117	.541	−2.041	.042*	.130	−1.426	.147	.240
Biopharma (LN)	.087	.754	1.091	.186	.440	1.204	2.503	.028*	12.217	−.099	.767	.906	−2.416	.038*	.089	−2.317	.045*	.099
Collaborators (LN)	1.944	.007**	6.988	−.231	.737	.794	3.413	.042*	30.364	2.175	.018*	8.803	−1.469	.393	.230	−3.644	.038*	.026
Region	−1.918	.143	.147	.246	.744	1.279	2.947	.055	19.058	−2.164	.133	.115	−4.866	.012*	.008	−2.702	.100	.067
Max likelihood	62.369																	
p value	.000																	
Pseudo R^2 (Nagelkerke)	.476																	

Note. COL = collaborators; COM = competitors; COO = co-opetition; N = no relationship. Where appropriate, data are log transformed per Section 3. *N* = 116.

*Data significant at .05.

**Data significant at .01.

collaborator compared with being acquired by a firm without a relationship with the IPO would be expected to decrease by .456 units while holding all other variables in the model constant. In other words, firms with greater amounts of venture capital ownership at the time of the IPO are less likely to be acquired by collaborating firms than firms with no named relationships. Our findings also show that if IPOs were to increase the number of collaborators at the time of the IPO by one, the multinomial log-odd of being acquired by a collaborator compared with being acquired by a firm without a relationship with the IPO would be expected to increase by 6.988 units while holding all other variables in the model constant. In other words, firms with larger numbers of collaborators at the time of the IPO are more likely to be acquired by collaborating firms than firms with no named relationships.

The second panel, for example, Log ($P_{COM/N}$), shows one variable with statistically significant relationships between IPOs acquired by competitors and IPOs acquired by firms with no relationship with the IPO. Our findings show that if the date increased by one, the multinomial log-odd of being acquired by a competitor compared with being acquired by a firm without a relationship with the IPO would be expected to increase by 2.223 units while holding all other variables in the model constant. In other words, firms that are further away from the IPO in terms of time are more likely to be acquired by competitor firms than firms with no named relationships.

The third panel, for example, Log ($P_{COO/N}$), shows two variables with statistically significant relationships between IPOs acquired by co-opetitors and IPOs acquired by firms with no relationship with the IPO. Our findings show that if IPOs were to increase the percentage ownership by other biopharmaceutical firms by one, the multinomial log-odd of being acquired by a co-opetitor compared with being acquired by a firm with no relationship would be expected to increase by 12.217 units while holding all other variables in the model constant. In other words, firms with greater biopharmaceutical ownership are more likely to be acquired by a co-opetitor than a firm with no relationship. Our findings also show that if IPOs were to increase the number of collaborators by one, the multinomial log-odd of being acquired by a co-opetitor compared with being acquired by a firm with no relationship would be expected to increase by 30.364 units while holding all other variables in the model constant. In other words, firms with greater number of collaborators are more likely to be acquired by a co-opetitor than a firm with no relationship.

The fourth panel, for example, Log ($P_{COL/COM}$), shows one variable with a statistically significant relationship between IPOs acquired by collaborators and IPOs acquired by competitors. Our findings show that if IPOs were to increase the percentage ownership by collaborator firms by one, the multinomial log-odd of being acquired by a collaborator compared with being acquired by a competitor would be expected to increase by 8.803 units while holding all other variables in the model constant. In other words, firms with collaborators at the time of the IPO are more likely to be acquired by a collaborator than a competing firm.

The fifth panel, for example, Log ($P_{COL/COO}$), shows three variables with statistically significant relationships between IPOs acquired by collaborators and IPOs acquired by co-opetitors. Our findings show that if IPOs were to increase the percentage ownership by venture capitalists, other biopharmaceutical firms, or firms in a biopharmaceutical region by one, the multinomial log-odd of being acquired by a collaborator compared with being acquired by a co-opetitor would be expected to decrease respectively by .130, .089, and .008 units while holding all other variables in the model constant. In other words, firms with greater venture capital and biopharmaceutical ownership and those located in a biopharmaceutical region are less likely to be acquired by a collaborator than a firm acquired by a co-opetitor. This supports our third hypothesis that for biopharmaceutical IPOs that are acquired, firms with greater firm-specific and regional resources will more likely be acquired by firms engaged in co-opetition than being acquired by collaborators or competitors.

The sixth panel, for example, Log ($P_{COM/COO}$), shows two variables with statistically significant relationships between IPOs acquired by competitors and IPOs acquired by co-opetitors. Our findings show that if IPOs were to increase the percentage ownership by other biopharmaceutical firms by one, the multinomial log-odd of being acquired by a competitor compared with being acquired by a co-opetitor would be expected to decrease by .099 units while holding all other variables in the model constant. Our findings also show that if IPOs were to increase the number of collaborating firms by one, the multinomial log-odd of being acquired by a collaborator compared with being acquired by a competitor would be expected to decrease by .026 units while holding all other variables in the model constant. In other words, firms with greater biopharmaceutical ownership interests and a greater number of collaborators at the time of the IPO are less likely to be acquired by a competing firm than a firm engaged in co-opetition. This partially supports our third hypothesis that for biopharmaceutical IPOs that are acquired, firms with greater firm-specific and regional resources will more likely be acquired by firms engaged in co-opetition than being acquired by collaborators or competitors.

5 | DISCUSSION

The competitive pressures within the biopharmaceutical market sector continue to drive the urge to merge (Curtin, 2014; Demirbag et al., 2007; Heracleous & Murray, 2001). Yet we know little about mergers and acquisitions in this market sector in general (James, 2002) and less about firms that have recently gone public (McCracken, 2009). The present study has sought to increase our knowledge in this area.

Similar to Mazzola et al. (2016), we found tremendous acquisition activity within this market sector with 46% of the firms being acquired. Collaborators, competitors, and those engaged in co-opetition all were involved in acquiring firms. IPOs with firm-specific resources were more likely to be acquired than firms with less firm-specific resources. The number of collaborators at the time of IPO is not significantly indicative of which firms will be acquired. This suggests that firm specific owners (e.g., venture capitalists and biopharmaceutical firms) are more important than nonequity owner collaborators that do not have an equity position in terms of leading to firm acquisition. IPOs within a regional cluster were just as likely as not to being acquired. Our findings suggested that for biopharmaceutical firms interested in

acquiring nontradable knowledge by way of firm acquisition, being an equity owner in the firm is indeed superior to being a collaborator in terms of being able to later acquire the firm and nontradable knowledge.

We found that the firm-specific and regional-specific attributes affected who or which types of firms were acquiring the IPOs. Reasonably, the more collaborators the acquired firm had at the time of the IPO led to a greater likelihood of being acquired by a collaborator as opposed to a firm with no relationship or a competitor. This is interesting as one may wonder why firms with multiple collaborators would undergo the process of the IPO with all its hurdles, disclosures, costs, and distractions (Certo et al., 2009; Lee, Bach, & Baik, 2011) only to be acquired later by a named collaborator. Williams (2013) found that firms with founders as CEOs were more likely to be acquired after the IPO, speculating that the founder was using the IPO as a valuation vehicle. It could be that collaborators are doing likewise—using the IPO to determine the value of the firm given the multiple parties (e.g., founders, venture capitalists, and other biopharmaceutical owners) with interests. Research (e.g., Ibbotson & Ritter, 1995; Ravasi & Marchisio, 2003) suggests IPOs often obtain higher values as acquisition targets compared to private firms. So in this sense, the noncollaborative owners (e.g., venture capitalists) may know this and use the IPO to increase the value of their shares compared to if they had remained private.

Additionally, we hypothesized that for biopharmaceutical IPOs that are acquired, firms with greater firm-specific and regional resources will more likely be acquired by firms engaged in co-opetition than being acquired by firms solely identified as collaborators or competitors. Our findings support this hypothesis. This may be the most interesting of our findings as it is indicative of the turbulent dynamics occurring in both the biopharmaceutical and IPO markets. Although the number of firms identified as co-opetitors is small, it may suggest for those firms acquired that venture capitalists and other biopharmaceutical firm owners prefer their interests being acquired by co-opetitors. If we extrapolate from the previous paragraphs that the owners are going public to establish a price for the IPO and co-opetitors are doubly incentivized, then perhaps, they are paying a premium for the firm—we do not know, and more research is needed.

Acquisitions may also be the only way that firms engaged in co-opetition can fully realize the benefits of collaboration. Within all types of collaborations, firms construct contractual mechanisms to limit the opportunism of knowledge flows beyond those intended (Williamson, 1985). The strength of the varying protection mechanisms is especially pronounced in collaborations with competitors (Ritala & Hurmelinna-Laukkanen, 2013), perhaps beyond those constructs for noncompetitor collaborators. Thus, acquisitions may be the only way for co-opetitors to gain access to additional knowledge or technologies. Again, we do not know, and more research is needed.

Our study has several managerial implications. For the owner-manager of a new firm, venture capital investment may mean not only loss of control to the venture capitalists prior to the IPO (Williams, 2013), but also loss of control after the IPO via acquisition. Thus, the owner-manager's ownership interest (and control) may be diluted at three points in time: (a) with venture capital involvement, (b) at the IPO itself, and (c) after the IPO by way of an acquisition. The owner-manager should consider this prior to receiving venture capital investment, especially if s/he is expecting the venture capitalist to "cash-out" shortly after the IPO with the owner-manager believing that the owner-manager will maintain some control afterward. For the owner-manager seeking to have some modicum of control, it may be more advantageous to receive funding from other biopharmaceutical firms by way of collaborations than equity acquisition prior to the IPO as ownership by others is more likely to lead to acquisition than collaboration.

For most industries, the IPO represents a means to lessen dependence on other investors, but for biopharmaceutical IPOs other (biopharmaceutical) investors may increase the firm's dependence on them via acquisition. Firms with biopharmaceutical owners should be aware that they are more likely to be acquired by co-opetitors than collaborators. Similarly, for external biopharmaceutical firms seeking to acquire firms, our results suggest that acquiring an ownership interest in the firm may be a more effective means of achieving this rather than collaboration. Venture capitalists may also wish to contemplate these results as they typically exit the firm after the IPO. For them, further research is needed to know (a) at what point (i.e., prior to IPO, post IPO), (b) with what mix (i.e., biopharmaceutical collaborators or owners), and (c) by whom (e.g., collaborators, competitors, and co-opetitors) they maximized their wealth. Our study assists them with the second and third areas with respect to showing who is acquiring these firms post IPO.

Our paper has several limitations. First, our sample size is modest due to the limited time frame and focus on the biopharmaceutical market sector—our sample related to firms engaged in co-opetition is especially small. Second, because of the size of the data we are unable to include several other control variables that we would have liked to include, such as products, expense, net income, working capital, and accumulated deficits. Third, we did not distinguish between firms that are merging and surviving from firms that are acquired and become subsidiaries of larger firms. Fourth, it should be acknowledged that we used "named competitors," with perhaps some acquired firms being reluctant to name an acquiring firm as a competitor. Fifth, we did not study the effects that merger waves of acquisitions or IPO hot markets would have on our study. Finally, we study only IPOs within the United States, noting that the public biopharmaceutical market is increasingly becoming global in scope (Lawrence & Lahteenmaki, 2014).

6 | CONCLUSION

The present paper explores the little studied area related to the nature of relationships between newly acquired biopharmaceutical IPOs and the acquiring firm prior to the acquisition. We find great collaborative and acquisition activities in the sector. We also find that IPOs are acquired by collaborators, competitors, and co-opetitors. We find to some extent, firm-specific resources affect the prospect that the firm will be acquired. Furthermore, our findings also show that firms with more of these resources are likely to be acquired by those firms engaged in co-opetition rather than by those solely engaged in collaboration, competition, or (to a limited extent) with no prior relationship. The present study should be of interest to practitioners in the

biopharmaceutical market sector and researchers of bio-pharmaceuticals, IPOs, mergers and acquisitions, among others.

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