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A behavioral theory of alliance portfolio reconfiguration: Evidence from pharmaceutical biotechnology

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Abstract

***Research Summary*:** Extant research suggests that firms rationally evaluate external and/or internal contingencies when deciding how to reconfigure their alliance portfolios. We advance a behavioral perspective which assumes that managers are boundedly rational and thus rely on behavioral heuristics when making alliance portfolio reconfiguration decisions. In panel data on U.S.-listed biotechnology firms, we find that below-aspiration performance motivates a firm to form alliances with novel partners within the resource scope of its existing alliance portfolio. This effect is weakened by equity ties with existing partners and strengthened by firm-specific uncertainty. Conversely, above-aspiration performance leads to new alliances with existing partners but outside the resource scope of the firm's existing alliance portfolio. Finally, as organizational slack increases, a firm forms alliances with novel partners focusing on new-to-the-portfolio resources.

***Managerial Summary*:** We study why and how firms change the configuration of their alliance portfolios over time. We find that actual performance relative to performance objectives, and firms' excess resources, are important drivers of such change. The more firms fail to meet their performance objectives, the more likely they are to form alliances with novel partners focusing on areas in which

they already have one or more alliances with other partners. The more firms exceed their performance objectives, the greater their inclination to form alliances with their existing partners in areas in which they do not yet have alliances. The greater the stock of excess resources, the greater firms' propensities to form alliances with novel partners focusing on areas in which they do not yet have alliances.

KEYWORDS

alliance portfolios, innovation performance, organizational slack, performance aspirations, pharmaceutical biotechnology

1 | INTRODUCTION

The portfolio perspective on interfirm alliances suggests that the benefits firms derive from their alliance portfolios can exceed the sum of the benefits obtained from each individual alliance (Hoehn-Weiss, Karim, & Lee, 2017; Wassmer, 2010). Building on this insight, numerous studies have sought to identify alliance portfolio configurations that enhance firm performance (e.g., Bos, Faems, & Noseleit, 2017; Hoehn-Weiss et al., 2017; Jiang, Tao, & Santoro, 2010; Lavie, 2007; Ozcan & Eisenhardt, 2009; Wassmer & Dussauge, 2012; Wassmer, Li, & Madhok, 2017) and related outcomes such as liquidity events (Hoehn-Weiss & Karim, 2014), knowledge acquisition (Frankort, Hagedoorn, & Letterie, 2012), and product innovation (Wuyts & Dutta, 2014). While these studies contribute to understanding the consequences of portfolio configurations, little research has examined why firms decide to change the configuration of, or "reconfigure," their alliance portfolios over time, and how they implement such decisions.

Besides conceptual suggestions (e.g., Kim, Oh, & Swaminathan, 2006; Koka, Madhavan, & Prescott, 2006), empirical studies show that alliance portfolio reconfiguration may be driven by firm-specific uncertainty (Beckman, Haunschild, & Phillips, 2004), gradual shifts in a firm's strategy in response to external technological changes (Lavie & Singh, 2012), combinations of strategic uncertainty and firm competencies (Hoffmann, 2007), and external contingencies such as technological discontinuities (Asgari, Singh, & Mitchell, 2017) or market competition and uncertainty (Beckman et al., 2004; Ozcan, 2018). While providing valuable insights into the antecedents of alliance portfolio reconfigurations, these studies conceptualize managers as value-maximizing decision makers who make portfolio reconfiguration decisions based on a rational evaluation of external and/or internal contingencies. Yet, managers are more accurately viewed as boundedly rational (Simon, 1955) and so they may rely on behavioral heuristics when making decisions regarding alliance portfolio reconfiguration. Despite broader evidence that behavioral drivers such as performance feedback and a stock of slack resources (Cyert & March, 1963) influence firms' collaborative activities (Baum, Rowley, Shipilov, & Chuang, 2005; Ener & Hoang, 2016; Lungeanu, Stern, & Zajac, 2016; Makarevich, 2018; Tyler & Caner, 2016), we know little about how such factors may affect firms' alliance portfolio reconfigurations.

In this study, we develop a comprehensive model of alliance portfolio reconfiguration based on the behavioral theory of the firm (Cyert & March, 1963), a theory of decision making rooted in the

notion that managers are boundedly rational. Our central line of argument consists of four parts: (a) Performance feedback and slack resources influence firms' preferences regarding value creation and appropriation from their alliance portfolios (Lavie, 2007); (b) portfolio-level value creation and appropriation derive from synergies and conflicts in the alliance portfolio (Hoehn-Weiss et al., 2017); (c) these synergies and conflicts are determined by portfolios' partner and resource characteristics (Gulati, Lavie, & Madhavan, 2011); and thus (d) firms accommodate their evolving value creation and appropriation preferences by reconfiguring their portfolios through simultaneous partner-choice and resource-focus decisions in newly formed alliances.

We propose that below-aspiration performance will motivate a firm to seek greater value appropriation from its alliance portfolio to address performance problems (Cyert & March, 1963). To this end, the firm will reconfigure its portfolio by forming alliances with novel partners, yet focusing on resources already accessible through its alliance portfolio, which may induce competition between new and existing partners, increasing the firm's bargaining power (Lavie, 2007). In contrast, above-aspiration performance and slack resources motivate a firm to seek greater value creation from its alliance portfolio (Chen & Miller, 2007). Therefore, the firm will reconfigure the portfolio by forming alliances focusing on new resources, thus expanding the scope for synergistic resource combinations (Gulati et al., 2011; Wassmer & Dussauge, 2012). While above-aspiration performance motivates firms to form such alliances with existing partners due to the implied satisfaction with these partners (Levinthal & March, 1993), slack motivates and enables simultaneous experimentation with new resources and novel partners (Greve, 2003a). We also uncover some boundary conditions by examining how firms' equity ties to existing partners and firm-specific uncertainty alter the role of performance feedback and slack resources in motivating specific types of alliance portfolio reconfiguration. Empirical analyses of U.S.-listed biotechnology firms from 1981 to 2000 generally support our predictions.

Our first and primary contribution lies in developing and testing a behavioral theory of alliance portfolio reconfiguration. By conceptualizing managers as boundedly rational decision makers, we show evidence that they are guided by behavioral heuristics, thus providing novel insights into the antecedents of observed alliance portfolio configurations. Second, while the behavioral theory has long argued that firms may respond differently to below-aspiration performance, above-aspiration performance, or organizational slack, empirical evidence of such differences is sparse (Posen, Keil, Kim, & Meissner, 2018). By uncovering how the nature of firms' responses to these distinct behavioral drivers differs, we extend the behavioral literature with more fine-grained and discerning evidence of behaviorally motivated organizational decisions. Finally, behavioral research has traditionally focused on the relationships between behavioral drivers and organizational decisions, with limited attention to the boundary conditions of such relationships (Greve & Gaba, 2017; Shinkle, 2012). In the context of alliance portfolio reconfiguration, we extend this nascent understanding of boundary conditions by elucidating how a firm's equity ties and firm-specific uncertainty interact with behavioral mechanisms.

2 | THEORETICAL BACKGROUND

The core premise of the portfolio perspective on alliances is that, in addition to value obtained from individual alliances, firms can also derive value from their alliance portfolios by combining resources accessed through multiple simultaneous alliances (Hoehn-Weiss et al., 2017; Lavie, 2007; Wassmer & Dussauge, 2012). A critical determinant of such additional value is the prevalence of portfolio interdependencies, that is, the synergies and conflicts in the portfolio which result from "the

complex patterns of resource exchanges or flows between a focal firm and one alliance partner as well as the resource flows between a focal firm and other partners within its alliance portfolio" (Hoehn-Weiss et al., 2017, p. 57). Portfolio interdependencies determine a focal firm's value creation and appropriation from its alliance portfolio (Lavie, 2007). Specifically, a firm may create value by exploiting synergies arising from combinations of portfolio resources, meaning alliance partners' tangible and intangible assets and capabilities, such as specialized equipment, expertise in a specific area, or technological know-how, whose services are made available to the firm through collaboration (Gulati et al., 2011).[1] Moreover, the firm can appropriate value from its alliance portfolio by exploiting conflicts among its partners (Lavie, 2007).

As a firm's preferences change regarding value creation and appropriation from its alliance portfolio, a motivation will arise to alter portfolio interdependencies in a way that accommodates these evolving preferences. A firm can accomplish this by reconfiguring portfolio characteristics that give rise to potential portfolio interdependencies. We begin by discussing such characteristics. Subsequently, we identify three distinct portfolio-reconfiguration options that can change portfolio interdependencies, with different implications for value creation and appropriation from a firm's portfolio. Finally, we develop predictions regarding how performance feedback and a stock of slack resources influence a firm's alliance portfolio-reconfiguration decisions, by affecting its preferences regarding value creation and appropriation.

2.1 | Alliance portfolio characteristics and interdependencies

Alliance portfolio research suggests three determinants of synergies and conflicts in an alliance portfolio. First, the resource richness of an alliance portfolio—the breadth of portfolio resources available to a firm through its alliances—determines the scope for portfolio synergies (Gulati et al., 2011). As the breadth of portfolio resources increases, so does the scope for their synergistic combinations, implying greater value creation potential available to the firm (Hoehn-Weiss et al., 2017; Lavie, 2007; Wassmer & Dussauge, 2012). Second, a firm's receptivity to portfolio resources—how effectively a firm can leverage these resources (Gulati et al., 2011)—determines the extent to which the firm can realize potential synergies in the portfolio. A key determinant of receptivity is the quality of a firm's ties to its alliance partners (Gulati et al., 2011), which in turn depends on relational assets, such as shared collaborative routines (Zollo, Reuer, & Singh, 2002) and trust (Gulati, Lavie, & Singh, 2009). Although relational assets are dyadic in nature (Gulati et al., 2009; Zollo et al., 2002), they can also enhance portfolio-level value creation because more effective access to partner resources in individual alliances enhances a firm's ability to combine such resources with other portfolio resources.

Third, the availability to a firm of alternative partners providing access to similar resources determines the degree of potential conflicts within a portfolio and, thus, the firm's relative bargaining power vis-à-vis its partners (Lavie, 2007), that is, its ability to favorably shape the terms of resource exchanges with its partners (Yan & Gray, 1994). A firm's bargaining power is limited to the extent that it depends on specific partners to access a given resource. Multiple alliance partners enabling access to similar resources may induce conflicts in an alliance portfolio in the form of competition among a firm's partners. Such competition enables the firm to negotiate more favorable resource exchange conditions with its partners, enhancing its ability to appropriate value created through the portfolio (Lavie, 2007).

[1] "Portfolio resources" correspond to what Gulati et al. (2011) call "network resources."

This line of reasoning suggests that the richness of portfolio resources, the receptivity of a firm to these resources, and the availability of alternative partners jointly can affect portfolio synergies and conflicts. Therefore, reconfiguring these portfolio characteristics is likely to change such interdependencies, which may in turn change the extent to which the firm can create and appropriate value from its alliance portfolio. Below, we identify and discuss the benefits, costs, and risks of particular portfolio-reconfiguration options in light of their potential impact on portfolio synergies and conflicts.

2.2 | Alliance portfolio reconfiguration

In this study, alliance portfolio reconfiguration refers to the addition of one or more alliances that introduce novel partners and/or new resources to a firm's alliance portfolio in a way that changes the portfolio's resource richness, the firm's receptivity, and/or the availability of alternative partners. A portfolio's resource richness increases when the firm adds to its portfolio an alliance focusing on new resources—that is, resources not currently accessible through the portfolio—which extends the scope for synergistic combinations of portfolio resources (Hoehn-Weiss et al., 2017; Wassmer & Dussauge, 2012). A firm's receptivity depends on the extent to which the firm shares relational assets with its partners. Since such assets are developed over the course of repeated collaborations (Gulati, 1995; Zollo et al., 2002), alliances with novel partners—with which the focal firm does not currently have an alliance—may reduce the firm's effectiveness in combining portfolio resources. However, novel partners may also introduce the firm to innovative ways of combining portfolio resources (Hoang & Rothaermel, 2005), which may enhance value creation from its alliance portfolio.

The availability of alternative partners increases when a firm adds to its portfolio an alliance with a novel partner focusing on resources already accessible through the portfolio (Lavie, 2007). The presence of multiple alliances in a portfolio that provide access to similar resources induces competition between new and existing partners for preferential access to the firm's resources and attention, increasing the firm's bargaining power and enabling it to appropriate a greater share of the value created in the portfolio (Lavie, 2007; Sailer, 1978). However, such an act may also lead to unfavorable outcomes for the focal firm. Specifically, existing partners may perceive the firm's new alliances as cannibalizing the value of their alliances with the firm (Hoehn-Weiss et al., 2017), for example due to possible leakage of their proprietary knowledge to the firm's novel partners. Such perceptions may prompt existing partners to take defensive actions and sever their resource exchanges with the focal firm.

We propose that a firm can reconfigure its alliance portfolio in three ways. Table 1 summarizes our typology of alliance portfolio-reconfiguration options based on partner-choice and resource-focus decisions in a firm's new alliances. First, the firm may form alliances with novel partners focusing on existing resources, that is, resources already accessible through its alliance portfolio. Such alliances may enhance the firm's value appropriation from the portfolio and introduce the firm to innovative ways of combining portfolio resources (Lavie, 2007). At the same time, they can reduce the firm's receptivity due to the lack of relational assets shared with novel partners. Furthermore, this reconfiguration option may trigger defensive actions from existing partners, which will lower the firm's ability to create value from the portfolio (Hoehn-Weiss et al., 2017). Thus, the firm will invoke this portfolio-reconfiguration option to the extent that it anticipates the potential increase in value appropriation to outweigh such costs and risks.

Second, the firm may form alliances with existing partners focusing on new resources. Leaving the firm's value appropriation ability unchanged, this reconfiguration option enables the firm to

TABLE 1 Three types of alliance portfolio reconfiguration through alliance formation

	Resource focus	Partner choice	Potential benefits	Costs	Risks
1	Existing resources	Novel partners	Greater bargaining power through competition between new and existing partners; and access to innovative ways of combining portfolio resources	Reduced receptivity due to lack of relational assets shared with novel partners	Suboptimal value creation from portfolio due to severed resource exchanges with existing partners
2	New resources	Existing partners	Greater resource richness; and enhanced receptivity due to exploitation of existing relational assets	Inability to access innovative ways of combining new resources with other portfolio resources	Suboptimal value creation from portfolio due to exclusive reliance on existing partners to leverage new resources
3	New resources	Novel partners	Greater resource richness; and access to innovative ways of combining portfolio resources	Reduced receptivity due to lack of relational assets shared with novel partners	Suboptimal value creation from portfolio due to simultaneous exposure to severed resource exchanges with existing partners and reduced receptivity

extend the resource richness of its alliance portfolio, which increases the portfolio's value creation potential (Gulati et al., 2011; Wassmer & Dussauge, 2012). This option also allows the firm to exploit the relational assets shared with existing partners, which enhances its receptivity. Notwithstanding these potential benefits, this reconfiguration option may preclude the firm from adopting innovative ways of combining portfolio resources that may be accessible through novel partners, preventing it from realizing the full value creation potential of its portfolio resources. Thus, a firm will be inclined to invoke this portfolio-reconfiguration option to the extent that it is satisfied with the share of the value that it appropriates from its alliance portfolio, and with the outcomes of resource exchanges with its partners.

Third, the firm may form alliances with novel partners focusing on new resources. This reconfiguration option enables the firm to simultaneously extend its portfolio's resource richness and experiment with innovative ways of combining resources accessed through novel partners. However, the lack of relational assets shared with novel partners may reduce the effectiveness of such experimentation and curb value creation from the portfolio. Moreover, although these alliances pose no direct competition to resource exchanges between the firm and its existing partners, the latter may still engage in defensive actions because the inclusion of novel partners in an alliance portfolio is likely to restrict the resources and attention extended by a firm to its existing partners (Singh & Mitchell, 1996). Thus, a firm will be motivated to invoke this portfolio-reconfiguration option to the extent that it can tolerate a reduction in collaboration effectiveness as well as the risk of severed resource exchanges with its existing partners.

To illustrate these three portfolio-reconfiguration options, we provide for each type of alliance formation an example from the pharmaceutical biotechnology industry, our empirical context. The process of developing genetically engineered drugs, which involves identifying potential drug candidates, developing them to have the desired properties, and undertaking clinical trials, requires combinations of resources that even the largest firms do not possess in-house. Therefore, alliance portfolios have been a vital means for firms in this industry to access resources (Baum, Calabrese, & Silverman, 2000; Pisano, 2006). Table 2 provides illustrative examples of alliance formations by Genentech, the first public biotechnology firm, which pioneered the industry by developing the first genetically engineered human therapeutic.

As Genentech's alliances illustrate, firms can also add to their portfolios alliances with existing partners focusing on existing resources, in addition to the three reconfiguration options that we discussed. Such alliances enable a firm to deepen its focus on resource combinations already available in its alliance portfolio. For example, firms may continue the development of promising projects or apply the same resources towards developing products with different commercial purposes. However, since such alliances do not introduce novel partners and/or new resources to a firm's alliance portfolio, in our study they do not imply a portfolio reconfiguration.

Overall, in addition to the costs of forming and managing alliances that are associated with alliance portfolio reconfiguration in general (Asgari et al., 2017), each of these reconfiguration options

TABLE 2 Examples of Genentech's alliances with different combinations of partner choice and resource focus

	Existing resources	**New resources**
Existing partners	Genentech formed an alliance with Stemcells Inc. in 1996 to advance development efforts for specific drug candidates identified as promising through a previous collaboration with the same partner in 1994, which focused on a variety of candidates. In both alliances, the key resource introduced to Genentech's alliance portfolio was Stemcells' expertise in the *oral delivery of central nervous system drugs*	After collaborating with Incyte Inc. to develop and commercialize a human protein called BPI, Genentech formed an alliance with the same partner in 1997 to access Incyte's database on *gene sequencing,* a valuable resource to aid the interpretation of genetic code stored in DNA through gene expression technology
Novel partners	In 1987, Genentech formed an alliance with Genzyme Inc. focusing on *recombinant DNA*, which enables DNA from different sources to be combined to create new DNA forms that are useful to treat diseases but do not exist naturally. Between its inception in 1976 and this alliance, Genentech formed 11 other alliances with different partners to access technological expertise in recombinant DNA technology, a key resource to develop genetically engineered drugs	In 1989, Genentech formed an alliance with Xenova Inc. for the screening of biologically active small molecules to identify promising drug candidates for further development. The partners did not have a prior collaboration and the alliance introduced Xenova's *proprietary screening technology* to Genentech's alliance portfolio. This technology added a critical and new resource to the portfolio since the value of other drug development resources would increase, as new and promising drug candidates can more easily be identified using this new resource

implies a unique combination of potential benefits, costs, and risks. Firms reconfigure their alliance portfolios to the extent they anticipate that the benefits of reconfiguration outweigh the costs and risks (Wassmer, 2010). Although available research provides valuable insights into the antecedents of alliance portfolio reconfigurations, it has tended to conceptualize managers as value-maximizing decision-makers who rationally evaluate external and/or internal contingencies when making portfolio reconfiguration decisions. Yet, managers are more accurately viewed as boundedly rational (Simon, 1955), which implies they may rely on behavioral heuristics when making decisions regarding alliance portfolio reconfiguration. Thus, we next draw on the behavioral theory of the firm (Cyert & March, 1963) and develop and test predictions regarding how boundedly rational managers make alliance portfolio-reconfiguration decisions based on an evaluation of the benefits, costs, and risks of different reconfiguration options.

3 | HYPOTHESES

A key premise of the behavioral theory of the firm (Cyert & March, 1963) is that the extent and nature of organizational search and risk-taking is influenced by a firm's actual performance relative to performance aspirations (Greve, 2003b), and its stock of slack resources (Greve, 2003a; Nohria & Gulati, 1996). Performance aspirations serve as reference points that help distinguish perceived failures and successes, and typically evolve over time as functions of a firm's own historical performance and the performance of comparable others (Bromiley & Harris, 2014; Levinthal & March, 1981). An attainment discrepancy occurs when performance deviates from aspirations, and may serve as an inducement for organizational search and risk-taking.

Negative attainment discrepancies trigger "problemistic search," a goal-oriented behavior focused on raising performance to the firm's aspiration level (Cyert & March, 1963; Levinthal & March, 1981). A firm's stock of slack resources, that is, resources in excess of those necessary for the firm's daily operations, prompts "slack search," which enables the firm to undertake more substantial organizational changes and experiment with risky but potentially rewarding projects (Cyert & March, 1963; Greve, 2003a; Levinthal & March, 1981). Finally, positive attainment discrepancies, while not necessarily generating slack resources, may motivate experimentation with new projects by reducing the cost of accessing new resources, thus mitigating fears of poor performance and motivating firms to loosen managerial controls (Baum et al., 2005). Based on these insights, we develop predictions connecting performance relative to aspirations and slack resources to the three alliance portfolio-reconfiguration options that we identified above.

3.1 | Below-aspiration performance

When performance is below aspirations, firms engage in problemistic search, which typically implies a search for relatively immediate improvements to reduce or eliminate negative attainment discrepancies (Levinthal & March, 1981). Thus, problemistic search tends to be myopic, in that it constitutes efforts to find solutions near the problem symptom or the current activities (Cyert & March, 1963). Because alliance portfolios are important for firm performance (Hoehn-Weiss et al., 2017; Lavie, 2007; Wassmer & Dussauge, 2012), firms performing below their aspirations will initiate actions to obtain greater benefits from their portfolios to address performance shortfalls. Due to its relatively short-term and myopic nature, problemistic search is unlikely to involve exploration of new resource combinations because such exploration typically requires considerable time before contributing to a firm's performance (March, 1991). Thus, speedier performance improvements are more likely

realized through an increased commitment to existing resources. We therefore propose that a negative attainment discrepancy motivates firms to search for ways to appropriate more value from existing portfolio resources.

Firms can more effectively leverage and appropriate value from existing portfolio resources by forming alliances with novel partners, yet replicating the resource focus of existing alliances. Such alliances may offer fresh perspectives on how to use existing portfolio resources more effectively. Moreover, a firm's potential access to innovative ways of utilizing its existing portfolio resources through novel partners is likely to induce competition between the firm's existing and novel partners, enabling the firm to increase its bargaining power vis-à-vis these partners, and appropriate a greater share of the value created through the portfolio (Lavie, 2007). Although this portfolio-reconfiguration option carries the risk of defensive actions from existing partners, a negative attainment discrepancy will motivate firms to tolerate such risks in an effort to meet performance aspirations (Bromiley & Harris, 2014; Greve, 2003a, 2003b).

Hypothesis 1. *The lower a firm's performance relative to aspirations, the greater the firm's number of new alliances with novel partners focusing on existing resources.*

3.2 | Above-aspiration performance

Firm performance exceeding aspirations leads to loosening managerial controls and motivates experimentation with new projects with high potential pay-offs (Baum et al., 2005; Chen & Miller, 2007). Moreover, above-aspiration performance reduces the cost of accessing new resources (Baum et al., 2005), for example by enhancing the attractiveness of a firm to investors. Consequently, firms performing above aspirations will be inclined to explore new value creation opportunities. A viable way in which a firm can achieve this is to extend the scope for synergistic combinations of resources accessed through its alliance portfolio by enhancing the portfolio's resource richness. While such exploration is inherently uncertain and risky (March, 1991), above-aspiration performance motivates firms to tolerate these uncertainties and risks by acting as a buffer between actual performance and aspirations (Baum et al., 2005).

For two reasons, we suggest that firms performing above their aspirations will be motivated to include new resources in their alliance portfolios through alliances with existing rather than novel partners. First, allying with existing partners enables firms to exploit relational assets shared with these partners, which in turn enhances the effectiveness of combining portfolio resources accessed through new and existing alliances. Second, above-aspiration performance acts as an implicit validation of the firm's choice of alliance partners, and induces satisfaction with the value appropriated from the alliance portfolio (Levinthal & March, 1993). Although allying with novel partners may enable a firm to appropriate greater value from its alliance portfolio, or to adopt new ways of combining portfolio resources, for firms performing above aspirations the risk of jeopardizing their relationships with existing partners likely outweighs the potential benefits offered by novel partners (Singh & Mitchell, 1996).

Hypothesis 2. *The higher a firm's performance relative to aspirations, the greater the firm's number of new alliances with existing partners focusing on new resources.*

3.3 | Organizational slack

Our arguments so far imply that when reconfiguring their alliance portfolios in response to performance feedback, firms limit their risk-taking to either the partner-choice or resource-focus decisions. Thus, they avoid excessive risks associated with the formation of alliances with novel partners focusing on new resources (Lavie, Kang, & Rosenkopf, 2011). Yet, when do firms opt for this third reconfiguration option?

The behavioral theory of the firm offers organizational slack as one source enabling firms to experiment with risky but potentially rewarding organizational changes (Cyert & March, 1963; Greve, 2003a). Absorbed slack, a particular form of organizational slack, refers to organizational capacity above and beyond what is required for a firm's day-to-day operations, such as excess facilities and personnel for research and development (R&D) (Greve, 2003a). The deployment of absorbed slack does not directly affect a firm's core operations and so enables relatively more risky explorations of new value creation opportunities (Levinthal & March, 1981; Nohria & Gulati, 1996). While above-aspiration performance also allows firms to experiment with risky projects (e.g., Baum et al., 2005), positive attainment discrepancies are potentially short-lived due to the adaptive nature of performance aspirations. Instead, absorbed slack accumulates and is dispersed over longer periods of time, providing a more permanent buffer between the outcomes of risky actions and their consequences for short-term performance (Greve, 2003a).

We argue that absorbed slack motivates and enables firms to reconfigure their alliance portfolios by forming alliances with novel partners focusing on new resources. This may introduce a firm to superior ways to combine the new resources with existing portfolio resources. Yet, such alliances may restrict the firm's value creation from the portfolio if existing partners sever their resource exchanges with the firm due to the perceived shift of the firm's managerial resources and attention to its novel partners (Singh & Mitchell, 1996). Moreover, alliances with novel partners reduce the firm's receptivity, leading to less effective value creation at the portfolio level. Absorbed slack mitigates the impact of a decline in value creation from the alliance portfolio by acting as a buffer between the outcomes of organizational actions and their short-term performance consequences. Thus, slack mitigates a firm's vulnerability to defensive actions from its partners as well as reduced receptivity, and provides firms the motivation and ability to experiment with novel partners and new resources.

Hypothesis 3. *The higher a firm's level of absorbed slack, the greater the firm's number of new alliances with novel partners focusing on new resources.*

3.4 | The moderating role of equity ties to existing partners

When examining firms' alliance portfolio reconfigurations, one important contingency is a firm's equity ties to its existing alliance partners. Equity ties include joint ventures in which partners share equity in a newly created entity, and minority equity investments in which one or both partners make an investment in the other in exchange for equity (Gulati & Singh, 1998). In contrast to purely contractual alliances, equity ties require alliance partners to make ex-ante investments, which increase their commitment to each other (Gulati & Singh, 1998). First, an investment by a partner in a focal firm's equity provides the partner some control over the firm's activities, deterring the firm from engaging in actions that might undermine the alliance and the partner's investment (Oxley, 1997). Second, an investment by a focal firm in a partner's equity is unlikely to be recovered unless the alliance achieves its intended objectives. Thus, to protect its own investment, the firm will be committed

to maintaining its resource exchanges with the partner towards the realization of alliance goals, and refrain from actions that might jeopardize these exchanges. Finally, reciprocal equity investments, including joint ventures, create a "mutual hostage" situation in which both partners have incentives not to jeopardize their relationship because doing so would put their ex-ante investments at risk (Oxley, 1997; Pisano, 1989).

We argue that, by increasing commitments to their existing partners, equity ties influence firms' alliance portfolio-reconfiguration decisions in response to performance feedback and slack resources. First, in H1 we predicted that below-aspiration performance motivates firms to reconfigure their alliance portfolios by forming alliances with novel partners focusing on existing resources. We expect equity ties to curb this tendency by amplifying the perceived costs and risks relative to the potential benefits associated with this portfolio-reconfiguration option. A firm's new alliances with novel partners focusing on existing resources may be perceived as a form of opportunistic behavior by existing partners that have invested in the firm (Hoehn-Weiss et al., 2017), prompting them to invoke their equity rights to protect their investments in the firm. The risk of retaliation is lower when investing partners do not perceive such alliances as an attempt to behave opportunistically, or when they have a limited ability to retaliate. However, the shift of a firm's attention regarding existing resources from existing to novel partners may signal inconsistency with the commitment expectations implied by equity ties, and harm the firm's reputation as a desirable alliance partner (Dacin, Oliver, & Roy, 2007).

When equity ties are instead formed by a focal firm's investments in its partners, this portfolio-reconfiguration option is tantamount to suggesting that such investments failed to generate the expected returns. Although ex-ante investments in partners' equity are sunk costs for a focal firm, managers tend to avoid acknowledging losses so as not to appear incompetent (Staw, 1981). Thus, firms are likely to maintain a commitment to these investments (Inkpen & Ross, 2001), and refrain from actions implying a decline in their value. In case of reciprocal investments, the desire to avoid retaliation, reputation loss, and an implied loss in value of existing equity investments jointly deter firms from invoking this portfolio-reconfiguration option.

This line of reasoning also extends to our hypothesized effect of absorbed slack on firms' tendencies to reconfigure their alliances portfolios by forming alliances with novel partners focusing on new resources (H3). Although absorbed slack enables firms to tolerate the costs and risks of simultaneous exploration with novel partners and new resources, equity ties to existing partners likely curtail this tendency. While absorbed slack shields a firm's regular operations from the short-term decline of value created from its alliance portfolio, the possible negative performance consequences of partner retaliation, reputation loss, and/or an implied loss in the value of existing equity investments amplify perceived costs and risks associated with this portfolio-reconfiguration option. Thus, equity ties reduce the impact of absorbed slack on alliance portfolio reconfiguration through alliances with novel partners focusing on new resources.

Finally, for firms performing above aspirations, we expect equity ties to reinforce the tendency to reconfigure alliance portfolios by forming alliances with existing partners focusing on new resources (H2). Above-aspiration performance motivates firms to seek greater value creation from their alliance portfolios through exploration of new resource combinations, and implies a commitment to existing partners by acting as an implicit validation of the firm's choice of alliance partners. By imposing additional commitments to existing partners, equity ties heighten the opportunity cost of allying with novel, rather than existing, partners to experiment with new resources, thus increasing the attractiveness of this portfolio-reconfiguration option in response to positive attainment discrepancies.

Hypothesis 4a. *As a firm's equity commitment to existing partners increases, a decrease in performance relative to aspirations is* less *strongly associated with a firm's number of new alliances with novel partners focusing on existing resources.*

Hypothesis 4b. *As a firm's equity commitment to existing partners increases, an increase in performance relative to aspirations is* more *strongly associated with a firm's number of new alliances with existing partners focusing on new resources.*

Hypothesis 4c. *As a firm's equity commitment to existing partners increases, an increase in absorbed slack is* less *strongly associated with a firm's number of new alliances with novel partners focusing on new resources.*

3.5 | The moderating role of firm-specific uncertainty

Another factor that influences firms' alliance portfolio reconfiguration is the degree of firm-specific uncertainty (Beckman et al., 2004; Howard, Withers, Carnes, & Hillman, 2016), which refers to ambiguity stemming from idiosyncratic sources regarding the expected outcomes of organizational actions (Gulati et al., 2009). In order to manage and reduce firm-specific uncertainty, firms search for new information, which can often be accessed through novel alliance partners (Beckman et al., 2004). We extend these insights to develop predictions regarding how firm-specific uncertainty affects firms' alliance portfolio-reconfiguration decisions, by intensifying problemistic search and attenuating slack search.

Problemistic search compels firms performing below aspirations to seek targeted solutions to generate greater performance from their current activities (Greve, 2003a). Reconfiguration of alliance portfolios through the formation of alliances with novel partners focusing on existing resources can be such a solution (H1). We argue that firm-specific uncertainty will strengthen the tendency to invoke this portfolio-reconfiguration option as a response to below-aspiration performance. Uncertainty compounds the need for new information regarding the causes that prevent firms' existing portfolio resources from contributing to a satisfactory level of performance. Firm-specific uncertainty also implies a lowered ability to assess the likelihood that new and useful information will become available through particular novel alliance partners. Increasing the number of alliances with novel partners focusing on existing resources will enable firms to diversify their attempts to access new information to address performance problems, and increase the probability that such information will become available.

In contrast to problemistic search, slack search enables firms to undertake risky but potentially rewarding projects that are more distant from their current activities, such as experimenting with new resources. Absorbed slack, and to a lesser extent above-aspiration performance, allows firms to afford such risk-taking by acting as a buffer between the potential adverse outcomes of risky decisions and firms' core activities. While experimentation with new resources inherently implies uncertain pay-offs, firm-specific uncertainty compounds the difficulty of evaluating the expected outcomes of such experimentation. As a result, whether the anticipated benefits of portfolio configuration options involving a focus on new resources will outweigh their costs and risks becomes more ambiguous. This, in turn, may lead to concerns regarding the extent to which past performance exceeding aspirations and absorbed slack may shield firms' regular operations from the potentially adverse effects of risky portfolio-reconfiguration decisions. Therefore, we expect firm-specific uncertainty to deter firms from engaging in alliance portfolio reconfiguration through alliances focusing on new resources with existing or novel partners as a response to above-aspiration performance and absorbed slack.

Hypothesis 5a. *As firm-specific uncertainty increases, a decrease in performance relative to aspirations is* more *strongly associated with a firm's number of new alliances with novel partners focusing on existing resources.*

Hypothesis 5b. *As firm-specific uncertainty increases, an increase in performance relative to aspirations is* less *strongly associated with a firm's number of new alliances with existing partners focusing on new resources.*

Hypothesis 5c. *As firm-specific uncertainty increases, an increase in absorbed slack is* less *strongly associated with a firm's number of new alliances with novel partners focusing on new resources.*

4 | METHODS

4.1 | Empirical setting

We tested our hypotheses in an empirical study of U.S.-listed dedicated biotechnology firms (DBFs) engaged in alliances during 1985–2000. Although many large pharmaceutical firms and some food and agricultural firms have been involved in biotechnology since its emergence in the 1970s, the central players in this industry are DBFs (Pisano, 2006; Powell, 1996). DBFs are ideal subjects for our study. To share the costs and reduce the risks of drug development, DBFs actively engage in alliances with each other and with other players, such as large pharmaceutical firms (Pisano, 2006). Such alliances play an important role in the innovation performance of DBFs (Baum et al., 2000) and evidence implies that DBFs care deeply about the value creation and appropriation potential of their alliance portfolios (e.g., Asgari et al., 2017). Moreover, a focus on DBFs gives us a relatively homogeneous set of firms, which ensures comparability in the firms' line of business and normal resource requirements, an important condition for isolating performance feedback and slack resource effects (Greve, 2003a, 2003b).

4.2 | Data and sample

Following Gulati and Higgins (2003) and Higgins and Gulati (2006), we obtained our initial sample of 280 public DBFs from the *BioWorld Stock Report for Public Biotechnology Companies* in 2001. This listing excludes large corporations with primary activities outside of biotechnology, thus constituting an appropriate data source for our study. In this initial sample, we were able to match 231 firms to identifiers in both Compustat and the NBER Patent Data Project (Hall, Jaffe, & Trajtenberg, 2002). We then identified all alliances formed by these 231 firms from 1985 to 2000 using the Recombinant Capital (ReCap) database, which is commonly used for alliance research in the biotechnology industry (Schilling, 2009). Of the 231 firms, 196 had one or multiple alliances during the sampling window.

We collected additional data to measure independent and control variables from the NBER Patent Data Project, Compustat, the Center for Research in Security Prices (CRSP) US Stock Databases, the Pharmaprojects® data set of *Informa Pharma Intelligence*, Mergent Online, Mergent Archives, and firms' 10-K filings and initial public offering (IPO) prospectuses. We applied listwise deletion in case of missing data and retained all firms with at least 2 years of available data, reducing the sample from 196 to 165 DBFs, which resulted in a final panel data set of 1,016 firm–year observations involving the formation of 1,340 alliances. This data set formed the basis for our empirical models predicting

alliance portfolio reconfiguration in the years 1985–2000. The panel is unbalanced, reflecting a substantial increase in the number of alliances formed in pharmaceutical biotechnology during the sampling period (Frankort & Hagedoorn, 2019). To address left-censoring, we used information on alliance formation by the sampled firms during 1981–1984, from which we constructed initial alliance portfolios. Subsequently, we constructed the variables related to firms' alliance portfolios based on a rolling 4-year window. Our dependent variables take a 1-year lead in our analyses, meaning that alliances formed from year $t - 3$ to year t (i.e., the firm's "existing alliance portfolio") affected alliance formations in year $t + 1$. This is consistent with the common assumption of a 5-year horizon of alliances in biotechnology (Robinson & Stuart, 2007).

4.3 | Dependent variables

Consistent with our conceptualization of alliance portfolio reconfiguration, we used three dependent variables according to the nature of the partners and resources involved in a firm's newly formed alliances in a given year. We obtained information on partner identities and resources exchanged for each alliance from ReCap. For each newly formed alliance, we established whether the alliance partner was "novel," in the sense that the firm had no active alliance(s) with that partner in its existing alliance portfolio (Beckman et al., 2004; Lavie & Rosenkopf, 2006). Similarly, we established whether a resource provided by a newly formed alliance was "new" to a firm's alliance portfolio, in that it was not already provided by an alliance in the firm's existing portfolio. Following Asgari et al. (2017, p. 1069), we identified and distinguished resources using ReCap's classification of alliances as pertaining to one or multiple of 53 possible technological areas.[2]

We used this information to specify three distinct counts of alliances as our dependent variables. First, *novel partners − existing resources* is the count of alliances formed by a firm in year $t + 1$ involving a novel partner and exclusively focusing on resources already accessible through the firm's existing alliance portfolio. This is the dependent variable to test Hypotheses **1**, **4a**, and **5a**. Second, *existing partners − new resources* is the count of alliances formed by a firm in year $t + 1$ involving at least one new resource, with a partner already in the firm's existing alliance portfolio. This was the dependent variable to test Hypotheses **2**, **4b**, and **5b**. Third, *novel partners − new resources* is the count of alliances formed by a firm in year $t + 1$ involving a novel partner and at least one new resource. This was the dependent variable to test Hypotheses **3**, **4c**, and **5c**.

4.4 | Independent variables and moderators

4.4.1 | Performance relative to aspirations

We constructed our variables for performance relative to aspirations based on the difference between a firm's performance in year t and its historical and social performance aspiration levels, respectively. In many prior studies, performance has been based on accounting or financial measures. Yet, during the emergence of the industry, "biotechnologies" were typically far removed from the product market

[2]We classified each alliance as focused on new or existing resources from a focal firm's point of view. Typically, such resources include alliance partners' proprietary data or expertise in a specified technological area. Unlike Asgari et al. (2017), who record separate alliances for each resource exchanged in a given collaboration, for each firm we recorded each alliance only once, regardless of the number of resources exchanged. Instead, we considered an alliance to focus on new resources when the alliance included at least one technological area that was not included in any alliance in the firm's alliance portfolio. Similarly, we considered an alliance to focus on existing resources when the alliance did not include at least one technological area that was not included in any alliance in the firm's portfolio.

and audiences focused their attention on evidence of promising technologies (Pisano, 2006). Thus, consistent with recent studies assessing performance feedback in technology-intensive industries (Gaba & Bhattacharya, 2012; Lungeanu et al., 2016; Tyler & Caner, 2016), we focused on innovation performance to construct our performance variables.

We relied on the patenting activities of the DBFs in our sample to calculate their innovation performance, and to construct historical and social aspiration levels. Patents have the potential to protect competitive advantage in biotechnology because they offer effective intellectual property protection necessary for firms to bring new technologies to market (Cohen, Nelson, & Walsh, 2000). Some observers even note that "the biotechnology industry would not have emerged but for the existence of predictable patents" (Federal Trade Commission, 2003, p. 17). Moreover, prior studies show that biotechnology firms with more patents attract more financing and go to IPO faster (Baum & Silverman, 2004; Stuart, Hoang, & Hybels, 1999), while they also achieve higher market valuations once they are publicly traded (Hall, Jaffe, & Trajtenberg, 2005). Consistent with these observations, numerous studies examining biotechnology have based measures of innovation performance on counts of patents (e.g., Baum et al., 2000; Rothaermel & Hess, 2007; Whittington, Owen-Smith, & Powell, 2009), and patents are used to construct measures of performance relative to aspirations in recent studies analyzing technology-intensive settings like ours (Gaba & Bhattacharya, 2012; Lungeanu et al., 2016).

We measured innovation performance as a firm's number of successful patent applications in year *t*. Subsequently, we calculated measures of *performance − aspirations* by subtracting historical and social aspiration levels, respectively, from the firm's actual innovation performance in a given year. Following prior research (Greve, 2003b; Levinthal & March, 1981), we calculated historical aspiration levels as exponentially weighted moving averages of historical performance, as follows: $A_{it} = \alpha A_{it-1} + (1 - \alpha)P_{it-1}$, where i is a subscript for firms; t is a time subscript; P is the number of successful patent applications in a given year; and the updating parameter α is the weight attached to the most recent historical aspiration level A_{it-1}. Following Greve (2003b, p. 129), we defined α as the value that provides the best fit of the models to the data (e.g., Bromiley & Harris, 2014; Gaba & Bhattacharya, 2012; Lungeanu et al., 2016). In our case, models predicting *novel partners − existing resources* retained an α of .1, while all other models retained an α of .9.

We obtained social aspiration levels based on the average patenting performance of other DBFs in the panel in a given year (Lungeanu et al., 2016). Specifically, we calculated a firm's social aspiration level as $S_{it} = \sum_{j \neq i} P_{jt}/(N_t - 1)$, where P_{jt} is the number of successful patent applications by a DBF j other than focal firm i in year t, and $N_t - 1$ is the number of DBFs other than i in year t (Greve, 2003b). We used patent applications because DBFs have a reasonable sense of the average rate at which patents are filed. Indeed, while not immediately made public by the United States Patent and Trademark Office (USPTO), information on pending patents is typically reported in the annual reports of DBFs and likely moves extensively through networks of scientists, advisors, investors, and analysts (Powell, 1996). Our measure of social aspirations restricts social comparison to other DBFs because industry peers orient themselves towards the same (investor) audience and so constitute a key reference group.

To summarize, *performance − aspirations* $= P_{it} - A_{it}$ for historical aspirations, while it equals $P_{it} - S_{it}$ for social aspirations. We used spline specifications that are more flexible in allowing *performance − aspirations* to have different slopes above and below the aspiration level (Greve, 2003b, p. 125). Specifically, *performance − aspirations* (<0) equals *performance − aspirations* when performance is below the aspiration level and equals 0 when performance is at or above the aspiration level. Similarly, *performance − aspirations* (>0) equals *performance − aspirations* when

performance is above the aspiration level and equals 0 when performance is at or below the aspiration level. These variables help test Hypotheses **1**, **2**, **4a**, **4b**, **5a**, and **5b**.

4.4.2 | Absorbed slack

To test Hypothesis **3**, we calculated *absorbed slack* as the ratio of a firm's selling, general, and administrative expenses to its sales in year *t*, consistent with prior research (e.g., Greve, 2003a). To test Hypotheses **4c** and **5c**, we interacted this variable with variables capturing equity ties and firm-specific uncertainty, as defined next. We obtained similar results when operationalizing this variable as the ratio of a firm's selling, general, and administrative expenses to its number of employees in a given year.

4.4.3 | Equity ties

We constructed our first moderator, *%equity alliances*, as the share of all alliances in a firm's alliance portfolio in year *t* that include minority equity investments and/or are joint ventures. To test Hypotheses **4a**–**4c**, we interacted this variable with the variables for performance relative to aspirations and absorbed slack.

4.4.4 | Firm-specific uncertainty

We constructed our second moderator, *firm-specific uncertainty*, as the standardized monthly volatility of a firm's stock in year *t*, consistent with Beckman et al. (2004), Gulati et al. (2009), and Howard et al. (2016). Specifically, for each firm in each year, we obtained the coefficient of variation by calculating the standard deviation across the firm's monthly stock closing prices and dividing it by their average. To test Hypotheses **5a**–**5c**, we interacted this variable with the variables for performance relative to aspirations and absorbed slack.

4.5 | Control variables

All models included time fixed-effects to account for broader environmental changes affecting all sampled firms such as fluctuations in the financing environment (e.g., Lerner, Shane, & Tsai, 2003), or technological breakthroughs such as the advances in combinatorial chemistry and high throughput screening in the 1990s (e.g., Asgari et al., 2017). Models predicting *novel partners − existing resources* and *novel partners − new resources* included year fixed-effects. Models predicting *existing partners − new resources* included fixed effects for 2-year periods because we used conditional fixed-effects models that had less statistical power in these specific analyses. Nevertheless, various unconditional estimators with year fixed-effects generated similar results (see section 4.6 below). We also included a number of control variables at the firm level (for year *t*) and the alliance portfolio level (for years $t - 3$ to *t*), which may affect alliance formation in year $t + 1$.

At the firm level, we controlled for two forms of financial slack which may affect a firm's alliance formation (e.g., Patzelt, Shepherd, Deeds, & Bradley, 2008). Following prior research (e.g., Greve, 2003a), we measured *unabsorbed slack* as the ratio of a firm's cash and short-term investments to its liabilities, and *potential slack* as the ratio of a firm's equity to debt. To account for potential changes in the nature of innovation strategies due to organizational aging and experience (e.g., Rothaermel & Boeker, 2008; Sørensen & Stuart, 2000), we controlled for *age* as a firm's age in years since

incorporation. We controlled for a firm's *return on assets* (ROA) to account for the role of financial performance in affecting the attractiveness of the firm as an alliance partner (Beckman et al., 2004). *Headcount* captures the natural logarithm of a firm's number of employees, which accounted for a possible link between the size of a DBF and the scale and nature of its external relationships (Powell, Koput, & Smith-Doerr, 1996). We accounted for the scale of a DBF's involvement in drug discovery, which may affect a firm's resource requirements (Asgari et al., 2017). Specifically, *clinical trials* is the natural logarithm of the number of a firm's drugs that are in clinical trials.

We also included two variables for a DBF's capacity to handle external knowledge (Cohen & Levinthal, 1990). *R&D expenditures* is the natural logarithm of a DBF's R&D expenditures, capturing its R&D capacity. *Technological scope* is the extent to which the patents in a firm's patent stock are distributed across distinct technology classes, which proxies for the scope of exploitable complementarities (Cassiman & Veugelers, 2002). Specifically, it captures $(1 - \sum_1^j p_j^2)*(N_{it}/(N_{it} - 1))$, where p is the proportion of a DBF's patents in patent class j and N_{it} is the DBF's total number of patents (Frankort, 2016).

At the alliance portfolio level, *alliance portfolio size* measures the number of alliances in a firm's alliance portfolio, which may increase or decrease the probability of additional alliance formation (Deeds & Hill, 1996; Powell et al., 1996). It comprises all alliances formed during the 4-year period from $t - 3$ to t. The variable *resources in portfolio* captures the proportion of all 53 technologies listed in the ReCap database covered in a DBF's existing alliance portfolio. The more resources already covered, the less likely a firm would form alliances focusing on new resources. Two additional variables capture the characteristics of the alliances in a firm's existing alliance portfolio, which may incentivize particular types of new alliance formation. *Commercialization alliances* is the share of a firm's alliances that include a commercialization provision for the outcome of the alliance, while *R&D alliances* is the share of a firm's alliances that explicitly designate R&D as a major activity in the alliance.

4.6 | Estimation

Because the three dependent variables are nonnegative count variables, we estimated all models using a Poisson quasi-maximum likelihood (QML) estimator with conditional firm fixed-effects (Wooldridge, 1999). Firm fixed-effects impose a within-firm correlation structure on the data that accounts for stable firm differences in alliance formation, which is important to obtain estimates of alliance formation in response to performance feedback and slack resources that are not confounded by more habitual, institutionalized drivers of alliance formation (Chen & Miller, 2007; Greve, 2003b, pp. 89–90). The Poisson QML estimator accommodates auto-correlated error terms and overdispersion and is robust to conditional heteroscedasticity.

A conditional fixed-effects specification discards firms without nonzero values on the dependent variable but generates unbiased and consistent estimates. Therefore, depending on the specific dependent variable, effective sample sizes vary across the models. To assess the consistency between conditional and unconditional fixed-effects estimations, we separately estimated all models on the full sample of 1,016 firm–years (165 firms) using both unconditional fixed-effects negative binomial regression with robust standard errors (Allison & Waterman, 2002), and ordinary least squares (OLS) fixed-effects regression in log-linear form, with standard errors corrected for autocorrelation (Driscoll & Kraay, 1998). Both alternatives generated essentially identical results across the various hypotheses tests, including models for *existing partners − new resources* that included year rather than 2-year fixed-effects.

5 | RESULTS

Table 3 shows descriptive statistics and pairwise correlations among all the variables. Correlations are generally low to moderate among the explanatory variables (columns 4–23), although a few are somewhat higher. Some of the variables for *performance − aspirations* (>0) are strongly correlated but none of these are used in the same model. Moreover, *alliance portfolio size* and *resources in portfolio* are correlated at $r = .83$. However, this correlation partly reflects differences between firms (i.e., the portfolios of firms with more alliances on average cover more resources), which are absorbed by firm fixed-effects. We examined the variance inflation factors (VIFs) for all explanatory variables to identify possible collinearity problems. The VIFs for all key variables are well below the commonly accepted threshold of 10, suggesting that our estimations are not materially affected by multicollinearity.

5.1 | Hypotheses tests

Table 4 shows the models we used to test Hypotheses **1**–**3**. Consistent with prior studies (e.g., Chen & Miller, 2007; Lungeanu et al., 2016), we show separate models for performance relative to historical and social aspirations. In models 1 and 2, the coefficients for *performance − aspirations* are negative, yet they are precisely estimated only above aspirations ($t = -1.76$ and $t = -2.69$ in models 1 and 2, respectively). Nevertheless, the estimates for below- and above-aspiration performance are statistically indistinguishable ($Chi^2[1df] = 0.05$, $p = .83$ in model 1; $Chi^2[1df] = 1.86$, $p = .17$ in model 2). Thus, the models could be re-estimated more parsimoniously without spline (Greve, 2003a, p. 694). Once this is done, the coefficient for *performance − aspirations* is −0.0028 ($t = -3.38$; $p = .001$) in model 1 and −0.0044 ($t = -3.19$; $p = .001$) in model 2. These estimates imply that, as performance decreases by one standard deviation relative to *historical* aspirations, the firm's estimated rate of alliance formation with novel partners focusing on existing resources increases by 4.4% (exp[−0.0028* − 15.51] = 1.044).[3] As performance decreases by one standard deviation relative to *social* aspirations, the firm's estimated rate of alliance formation with novel partners focusing on existing resources increases by 8.3% (exp[−0.0043* − 18.45] = 1.083). These results are consistent with Hypothesis **1**: The lower a firm's performance relative to aspirations, the greater the number of newly formed alliances with novel partners focusing on existing resources.

In model 3, the coefficients for *performance − aspirations* are positive and precisely determined above aspirations ($t = 2.75$). Nevertheless, the estimates for below- and above-aspiration performance are statistically indistinguishable ($Chi^2[1df] = 0.60$, $p = .44$). We thus re-estimated the model without spline, resulting in a coefficient for *performance − aspirations* of 0.0170 ($t = 2.75$; $p = .006$). Therefore, as performance increases by one standard deviation relative to historical aspirations, the firm's estimated rate of alliance formation with existing partners focusing on new resources increases by about 50% (exp[0.0176*23.19] = 1.504).

In model 4, the coefficients for *performance − aspirations* are positive and precisely determined both below and above aspirations ($t = 2.44$ and $t = 2.95$, respectively), yet here the two slopes appear statistically distinct ($Chi^2[1df] = 5.48$, $p = .02$). Thus, below social aspirations, as performance increases by one standard deviation, the firm's estimated rate of alliance formation with existing partners focusing on new resources increases by almost 160% (exp[0.4220*2.25] = 2.584). And above social aspirations, a one-standard deviation increase in performance instead increases this rate by

[3]We base these and subsequent calculations on descriptive statistics for each individual estimation sample, which varies across the models due to conditional estimation.

TABLE 3 Summary statistics and bivariate correlations

		Mean	*SD*	1	2	3	4	5	6	7	8	9	10	11
Dependent variables														
1	Novel partners − existing resources	0.72	1.44											
2	Existing partners − new resources	0.02	0.16	0.04										
3	Novel partners − new resources	0.58	0.99	0.24	0.08									
Independent variables														
4	Performance − aspirations (<0) (historical, $\alpha = .1$)	−1.60	9.22	−0.28	−0.02	−0.11								
5	Performance − aspirations (<0) (historical, $\alpha = .9$)	−0.06	0.21	0.04	0.04	0.00	0.16							
6	Performance − aspirations (<0) (social)	−2.66	2.64	0.13	0.06	0.14	−0.07	0.25						
7	Performance − aspirations (>0) (historical, $\alpha = .1$)	2.63	9.34	0.16	0.24	0.13	0.05	0.08	0.24					
8	Performance − aspirations (>0) (historical, $\alpha = .9$)	6.00	15.28	0.27	0.21	0.23	0.00	0.11	0.33	0.90				
9	Performance − aspirations (>0) (social)	4.06	15.30	0.30	0.20	0.24	−0.10	0.07	0.28	0.86	0.98			
10	Absorbed slack	3.85	21.21	−0.05	−0.01	0.04	0.01	−0.03	−0.03	−0.02	−0.03	−0.04		
Moderating variables														
11	%equity alliances	0.18	0.26	0.04	0.02	0.06	−0.07	−0.04	0.12	0.06	0.07	0.06	−0.05	
12	Firm-specific uncertainty	0.26	0.15	0.06	−0.05	0.03	−0.01	−0.05	−0.13	−0.05	−0.06	−0.07	0.06	−0.02
Control variables														
13	Unabsorbed slack	5.92	8.96	−0.12	−0.03	−0.11	0.03	−0.01	0.00	−0.04	−0.07	−0.07	0.16	−0.03
14	Potential slack	93.18	563.51	−0.02	0.01	−0.01	0.01	0.00	−0.01	−0.01	−0.02	−0.02	−0.02	0.03
15	Age	10.07	5.49	0.01	−0.03	0.07	−0.06	0.01	−0.12	0.01	0.04	0.06	−0.03	−0.12
16	Return on assets	−0.32	0.43	0.10	0.03	0.04	−0.06	0.01	0.17	0.09	0.13	0.15	−0.28	0.00
17	Headcount (log)	−2.23	1.17	0.38	0.09	0.29	−0.19	0.10	0.40	0.27	0.42	0.43	−0.13	0.08
18	Clinical trials (log)	0.49	0.75	0.12	0.02	0.19	−0.11	0.00	0.19	0.15	0.26	0.26	0.01	0.19
19	R&D expenditures (log)	2.32	1.35	0.36	0.09	0.32	−0.18	0.04	0.35	0.27	0.42	0.41	−0.07	0.23
20	Technological scope	0.57	0.29	0.10	−0.01	0.14	−0.04	0.02	0.15	0.07	0.11	0.10	0.02	0.04

TABLE 3 (Continued)

		Mean	*SD*	1	2	3	4	5	6	7	8	9	10	11
21	Alliance portfolio size	4.57	5.36	0.66	0.15	0.31	−0.22	0.06	0.20	0.29	0.44	0.47	−0.08	0.04
22	Resources in portfolio	0.06	0.06	0.56	0.16	0.35	−0.23	0.04	0.24	0.33	0.48	0.51	−0.08	0.13
23	Commercialization alliances	0.08	0.18	0.01	0.01	0.02	−0.03	−0.05	0.06	0.02	0.03	0.02	−0.06	0.47
24	R&D alliances	0.52	0.39	0.21	0.08	0.13	−0.04	0.01	0.23	0.09	0.12	0.10	−0.05	0.44

		12	13	14	15	16	17	18	19	20	21	22	23
13	Unabsorbed slack	−0.04											
14	Potential slack	−0.03	0.04										
15	Age	−0.01	−0.16	0.02									
16	Return on assets	−0.20	0.07	0.05	0.04								
17	Headcount (log)	−0.16	−0.28	0.04	0.12	0.41							
18	Clinical trials (log)	−0.07	−0.01	0.00	0.14	0.02	0.26						
19	R&D expenditures (log)	−0.03	−0.14	−0.04	−0.02	0.06	0.67	0.41					
20	Technological scope	−0.07	−0.01	0.04	0.18	0.10	0.24	0.04	0.24				
21	Alliance portfolio size	0.01	−0.15	0.01	0.07	0.18	0.55	0.24	0.49	0.14			
22	Resources in portfolio	0.00	−0.17	0.02	0.08	0.16	0.58	0.28	0.57	0.19	0.83		
23	Commercialization alliances	−0.03	−0.01	0.01	−0.03	0.05	0.08	0.15	0.17	0.05	0.04	0.07	
24	R&D alliances	−0.02	0.02	0.01	−0.16	0.02	0.17	0.14	0.31	0.01	0.28	0.33	0.34

Notes: $n = 1{,}016$ for means and standard deviations (*SDs*), except for variables 4, 5, 7, and 8, where $n = 939$. Correlations are based on $n = 939$.

about 68% (exp[0.0219*23.64] = 1.678). Together with the results in model 3, these estimates are consistent with Hypothesis **2**: The higher a firm's performance relative to aspirations, the greater the number of newly formed alliances with existing partners focusing on new resources.

Models 5 and 6 test Hypothesis **3**, predicting that absorbed slack increases a firm's propensity to form alliances with novel partners focusing on new resources. Consistent with Hypothesis **3**, the coefficient for *absorbed slack* is positive and precisely determined in both models 5 and 6 ($t = 2.53$ and $t = 2.60$, respectively). The point estimates are similar between the two models. Based on model 5, a one-standard deviation increase in *absorbed slack* increases the estimated rate of alliance formation with novel partners focusing on new resources by 17.4% (exp[0.0067*23.94] = 1.174).

Table 5 shows models to test Hypotheses **4a**–**4c**. Models 1 and 2 test Hypothesis **4a**, by interacting *performance − aspirations* with *%equity alliances.* Although the estimates are indistinguishable from zero in model 2, in model 1 the coefficient for this interaction term is positive below aspirations and clearly inconsistent with a null effect ($t = 3.49$, $p = .000$). The interaction coefficient is negative and somewhat less precisely determined above aspirations ($t = -1.76$, $p = .078$). To understand these findings, Figure 1 uses the point estimates in model 1 of Table 5 to show the estimated interaction effect at the 10th, 50th, and 90th percentiles of *%equity alliances.* Below the historical aspiration level, a decrease in *performance − aspirations* more strongly stimulates the formation of alliances with novel partners focusing on existing resources when the firm has a smaller proportion of equity ties to existing partners. Interestingly, above the historical aspiration level, an increase in *performance − aspirations* more strongly reduces the formation of alliances with novel partners focusing on existing resources when the firm shares more equity ties with existing partners. Together, these findings partially support Hypothesis **4a**.

Models 3–6 test Hypotheses **4b** and **4c**.[4] In these models, all the interaction coefficients have relatively large standard errors and *t*-statistics consistently below unity, rendering all coefficients indistinguishable from zero at acceptable confidence levels. Thus, our data do not support Hypotheses **4b**–**4c**.

Table 6 shows models to test Hypotheses **5a**–**5c**. Models 1 and 2 test Hypothesis **5a**, by interacting *performance − aspirations* with *firm-specific uncertainty.* Although again the estimates are indistinguishable from zero in the social aspiration model (model 2), in model 1 the interaction coefficient is positive below aspirations and inconsistent with a null effect ($t = -2.51$, $p = .012$). Above aspirations, the interaction coefficient is indistinguishable from zero ($t = 0.74$, $p = .458$). Figure 2 uses the point estimates in model 1 of Table 6 to show the estimated interaction effect at the 10th, 50th, and 90th percentiles of *firm-specific uncertainty.* Below historical aspirations, a decrease in performance more strongly stimulates the formation of alliances with novel partners focusing on existing resources when firm-specific uncertainty is greater. These findings partially support Hypothesis **5a**.

Models 3–6 test Hypotheses **5b** and **5c**. In these models, all the interaction coefficients have large standard errors and *t*-statistics well below unity, again rendering all coefficients indistinguishable from zero at acceptable confidence levels. Thus, our data do not support Hypotheses **5b** and **5c**. Overall, the empirical evidence in Tables 5 and 6 is inconclusive with respect to whether or not the mechanisms underlying Hypotheses **4b**, **4c**, **5b**, and **5c** are operative. In the absence of such evidence, we suggest that perhaps equity ties and firm-specific uncertainty represent more critical contingencies when a firm is engaged in problemistic search.

[4]Due to collinearity, we could not estimate spline interactions in model 3. Instead, we estimated one interaction term for continuous *performance–aspirations* by *%equity alliances.* We did the same in Table 6, when assessing the moderating effects of *firm-specific uncertainty.*

TABLE 4 Poisson quasi-maximum likelihood (QML) conditional fixed-effects estimates: Hypotheses **1–3**

Dependent variable	**Novel partners – existing resources**		**Existing partners – new resources**		**Novel partners – new resources**	
Aspiration level	**Historical** (1)	**Social** (2)	**Historical** (3)	**Social** (4)	**Historical** (5)	**Social** (6)
Performance – aspirations (<0)	−0.0026 [0.0018]	−0.0506 [0.0339]	2.1752 [2.7968]	0.4220 [0.1729]	0.0078 [0.2050]	0.0109 [0.0332]
Performance – aspirations (>0)	−0.0033 [0.0019]	−0.0037 [0.0014]	0.0170 [0.0062]	0.0219 [0.0074]	0.0041 [0.0032]	0.0057 [0.0036]
Absorbed slack	−0.0031 [0.0030]	−0.0014 [0.0029]	0.0635 [0.0279]	0.0530 [0.0245]	0.0067 [0.0026]	0.0059 [0.0023]
%equity alliances	−0.3353 [0.4020]	−0.3737 [0.3579]	−1.0828 [1.3537]	−1.2853 [1.3631]	0.1063 [0.4363]	0.2981 [0.3929]
Firm-specific uncertainty	0.5051 [0.2901]	0.7448 [0.3027]	−7.2047 [3.5041]	−7.0726 [3.4507]	0.2947 [0.3696]	0.1509 [0.3899]
Unabsorbed slack	−0.0142 [0.0124]	−0.0233 [0.0117]	−0.2723 [0.1921]	−0.2560 [0.1244]	−0.0285 [0.0146]	−0.0200 [0.0132]
Potential slack	−0.0001 [0.0001]	−0.0001 [0.0001]	0.0004 [0.0006]	0.0002 [0.0005]	−0.0000 [0.0001]	−0.0000 [0.0001]
Age	0.7555 [0.5787]	−0.2153 [0.3787]	0.5901 [0.4536]	0.8610 [0.4007]	−0.0131 [0.5206]	0.3686 [0.3403]
Return on assets	−0.3508 [0.1374]	−0.2552 [0.1368]	4.7732 [2.5712]	2.6882 [1.9615]	−0.2823 [0.2416]	−0.3717 [0.2263]
Headcount (log)	0.0748 [0.1584]	0.1371 [0.1528]	−1.8467 [1.1730]	−1.9651 [0.9651]	−0.0475 [0.2106]	−0.0509 [0.1896]
Clinical trials (log)	−0.0019 [0.1700]	0.0074 [0.1643]	−0.0650 [1.0691]	0.4695 [1.3305]	−0.0095 [0.1587]	−0.0135 [0.1473]
R&D expenditures (log)	0.0883 [0.1263]	0.1253 [0.1180]	1.3421 [0.7309]	1.3678 [0.6608]	0.2054 [0.1953]	0.1869 [0.1829]
Technological scope	0.1325 [0.3663]	0.3538 [0.3053]	1.1070 [3.0586]	1.3154 [2.9777]	0.8178 [0.6709]	0.3139 [0.4638]
Alliance portfolio size	−0.0226 [0.0111]	−0.0198 [0.0119]	0.1343 [0.0925]	0.1603 [0.0868]	−0.0223 [0.0310]	−0.0279 [0.0301]
Resources in portfolio	4.6296 [1.1175]	4.5785 [1.1286]	−10.1616 [6.3121]	−15.1671 [7.5920]	−3.5644 [2.8783]	−3.3604 [2.6803]
Commercialization alliances	−0.5948 [0.4688]	−0.6468 [0.4336]	−3.0643 [2.7973]	−1.1298 [2.4045]	−0.0719 [0.5048]	−0.1412 [0.4731]
R&D alliances	0.6635 [0.3861]	0.7571 [0.3346]	0.3521 [1.3652]	1.5565 [1.5459]	−0.4868 [0.3210]	−0.4046 [0.2909]
n (firm–years)	675	739	162	171	778	869
n (firms)	103	105	20	20	118	124
Log-likelihood	−547.8	−592.1	−29.81	−29.31	−552.1	−635.7

Notes: Standard errors in brackets. All models include time fixed effects.

TABLE 5 Poisson quasi-maximum likelihood (QML) conditional fixed-effects estimates: Hypotheses **4a–4c**

Dependent variable	**Novel partners – existing resources**		**Existing partners – new resources**		**Novel partners – new resources**	
Aspiration level	**Historical** (1)	**Social** (2)	**Historical** (3)	**Social** (4)	**Historical** (5)	**Social** (6)
Performance – aspirations (<0)	−0.0118 [0.0031]	−0.0451 [0.0399]	2.1761 [2.8038]	0.4514 [0.2295]	0.0088 [0.2046]	0.0108 [0.0332]
Performance – aspirations (>0)	0.0090 [0.0073]	−0.0037 [0.0040]	0.0162 [0.0366]	0.0031 [0.0378]	0.0041 [0.0032]	0.0057 [0.0036]
Absorbed slack	−0.0032 [0.0031]	−0.0014 [0.0029]	0.0636 [0.0279]	0.0513 [0.0258]	0.0066 [0.0025]	0.0059 [0.0022]
Performance – aspirations (<0)*%equity alliances	0.0284 [0.0081]	−0.0319 [0.1296]		−0.1008 [0.4376]		
Performance – aspirations (>0)* %equity alliances	−0.0386 [0.0219]	0.0000 [0.0120]		0.0602 [0.1191]		
Performance – aspirations*%equity alliances			0.0024 [0.1100]			
Absorbed slack*%equity alliances					0.0058 [0.0217]	0.0024 [0.0215]
%equity alliances	−0.1660 [0.4281]	−0.4401 [0.4142]	−1.0950 [1.4568]	−1.6389 [1.7749]	0.0971 [0.4420]	0.2947 [0.3996]
Firm-specific uncertainty	0.4025 [0.3119]	0.7468 [0.3042]	−7.2022 [3.4929]	−7.1401 [3.6443]	0.2956 [0.3696]	0.1513 [0.3901]
Unabsorbed slack	−0.0158 [0.0122]	−0.0233 [0.0116]	−0.2720 [0.1946]	−0.2471 [0.1251]	−0.0286 [0.0147]	−0.0200 [0.0133]
Potential slack	−0.0001 [0.0001]	−0.0001 [0.0001]	0.0004 [0.0006]	0.0003 [0.0005]	−0.0000 [0.0001]	−0.0000 [0.0001]
Age	0.7635 [0.5643]	−0.2195 [0.3744]	0.5931 [0.4841]	0.8904 [0.4599]	−0.0130 [0.5207]	0.3684 [0.3403]
Return on assets	−0.3482 [0.1392]	−0.2533 [0.1376]	4.7645 [2.6227]	2.4812 [2.1547]	−0.2714 [0.2585]	−0.3679 [0.2380]
Headcount (log)	0.0319 [0.1627]	0.1404 [0.1516]	−1.8451 [1.1731]	−1.9070 [0.9967]	−0.0498 [0.2135]	−0.0516 [0.1912]
Clinical trials (log)	0.0275 [0.1648]	0.0046 [0.1666]	−0.0533 [1.0018]	0.6658 [1.2571]	−0.0095 [0.1587]	−0.0135 [0.1473]
R&D expenditures (log)	0.1049 [0.1280]	0.1241 [0.1185]	1.3406 [0.7107]	1.3026 [0.6884]	0.2079 [0.1981]	0.1878 [0.1850]

TABLE 5 (Continued)

Dependent variable	Novel partners – existing resources		Existing partners – new resources		Novel partners – new resources	
Aspiration level	**Historical** (1)	**Social** (2)	**Historical** (3)	**Social** (4)	**Historical** (5)	**Social** (6)
Technological scope	0.1360 [0.3675]	0.3454 [0.3095]	1.1173 [3.1417]	1.5418 [3.0745]	0.8143 [0.6735]	0.3126 [0.4648]
Alliance portfolio size	−0.0200 [0.0114]	−0.0198 [0.0117]	0.1343 [0.0929]	0.1691 [0.0913]	−0.0223 [0.0310]	−0.0279 [0.0301]
Resources in portfolio	4.4332 [1.1579]	4.5636 [1.1298]	−10.1553 [6.4167]	−15.5764 [8.1197]	−3.5665 [2.8804]	−3.3599 [2.6794]
Commercialization alliances	−0.6892 [0.4713]	−0.6706 [0.4363]	−3.0722 [2.8078]	−1.3396 [2.2263]	−0.0741 [0.5064]	−0.1420 [0.4736]
R&D alliances	0.6684 [0.3875]	0.7559 [0.3360]	0.3540 [1.3888]	1.6378 [1.6317]	−0.4880 [0.3210]	−0.4051 [0.2907]
n (firm–years)	675	739	162	171	778	869
n (firms)	103	105	20	20	118	124
Log-likelihood	−545.4	−592	−29.81	−29.22	−552.1	−635.7

Note: Standard errors in brackets. All models include time fixed effects.

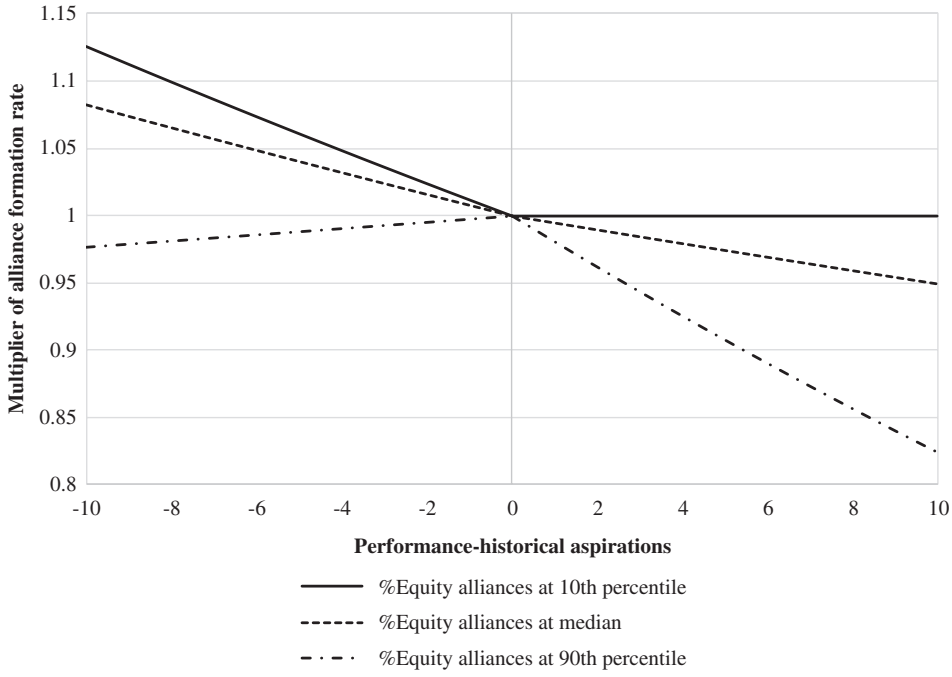

FIGURE 1 Rate multiplier for *novel partners − existing resources* (Hypothesis **4a**)

To summarize, after controlling for a range of time-varying factors at the firm and alliance portfolio levels, and fixed effects for firms and time, we found that the nature of alliance portfolio reconfiguration is affected by performance relative to aspirations and organizational slack. Firms expand the partner base, but not the resource base, of their alliance portfolios as performance decreases relative to aspirations (Hypothesis **1**), albeit at a reduced rate when they share equity ties with existing partners (Hypothesis **4a**), and at an increased rate when they experience firm-specific uncertainty (Hypothesis **5a**). Firms instead expand the resource base of their alliance portfolios, but not the partner base, as performance increases relative to aspirations (Hypothesis **2**). Finally, simultaneous expansion of partner and resource bases occurs as organizational slack increases (Hypothesis **3**).[5]

5.2 | Robustness

We assessed the sensitivity of our findings through several additional tests. First, our focus on firm-specific uncertainty as measured by stock data required that all sample firms were public, although our theory imposed no such requirement. We thus enlarged our sample to incorporate firm–year observations in which the DBFs were still private entities. This way, our estimation sample grew from 165 DBFs and 1,016 firm–year observations to 187 DBFs and 1,099 firm–year observations. While we were unable to test Hypotheses **5a**–**5c** because firm-specific uncertainty was only

[5]It is important to note that the heterogeneity in the effects of different behavioral drivers constitutes a conservative finding because all our empirical specifications allow for the possibility that below-aspiration performance, above-aspiration performance, and organizational slack have entirely identical consequences.

TABLE 6 Poisson quasi-maximum likelihood (QML) conditional fixed-effects estimates: Hypotheses **5a–5c**

Dependent variable	**Novel partners – existing resources**		**Existing partners – new resources**		**Novel partners – new resources**	
Aspiration level	**Historical** (1)	**Social** (2)	**Historical** (3)	**Social** (4)	**Historical** (5)	**Social** (6)
Performance – aspirations (<0)	0.0012 [0.0017]	−0.0682 [0.0520]	2.2040 [2.8226]	0.5253 [0.4219]	0.0111 [0.2049]	0.0114 [0.0333]
Performance – aspirations (>0)	−0.0058 [0.0031]	−0.0047 [0.0020]	0.0076 [0.0175]	0.0138 [0.0289]	0.0042 [0.0032]	0.0057 [0.0036]
Absorbed slack	−0.0032 [0.0030]	−0.0015 [0.0029]	0.0631 [0.0272]	0.0539 [0.0229]	0.0104 [0.0052]	0.0085 [0.0051]
Performance – aspirations (<0)*firm-specific uncertainty	−0.0086 [0.0033]	0.0575 [0.0970]		−0.4537 [1.2323]		
Performance – aspirations (>0)*firm-specific uncertainty	0.0132 [0.0166]	0.0050 [0.0093]		0.0309 [0.1144]		
Performance – aspirations*firm-specific uncertainty			0.0345 [0.0740]			
Absorbed slack*firm-specific uncertainty					−0.0096 [0.0129]	−0.0066 [0.0125]
%equity alliances	−0.3187 [0.4094]	−0.3801 [0.3615]	−1.0586 [1.3379]	−1.3944 [1.4079]	0.1149 [0.4394]	0.3031 [0.3948]
Firm-specific uncertainty	0.3431 [0.3377]	0.8152 [0.4012]	−7.6100 [4.1971]	−8.2134 [5.7694]	0.3188 [0.3712]	0.1663 [0.3931]
Unabsorbed slack	−0.0145 [0.0123]	−0.0228 [0.0115]	−0.2689 [0.1926]	−0.2491 [0.1279]	−0.0292 [0.0147]	−0.0203 [0.0132]
Potential slack	−0.0001 [0.0001]	−0.0001 [0.0001]	0.0004 [0.0006]	0.0003 [0.0006]	−0.0000 [0.0001]	−0.0000 [0.0001]
Age	0.7816 [0.5654]	−0.2113 [0.3809]	0.5813 [0.4635]	0.8692 [0.3985]	−0.0127 [0.5203]	0.3686 [0.3397]
Return on assets	−0.3434 [0.1380]	−0.2603 [0.1380]	4.7231 [2.5125]	2.7073 [1.9616]	−0.2969 [0.2445]	−0.3803 [0.2278]
Headcount (log)	0.0126 [0.1662]	0.1230 [0.1481]	−1.8391 [1.1735]	−1.9156 [0.9366]	−0.0479 [0.2095]	−0.0512 [0.1890]
Clinical trials (log)	0.0140 [0.1662]	0.0126 [0.1661]	0.0059 [1.0841]	0.4742 [1.3184]	−0.0072 [0.1589]	−0.0122 [0.1475]
R&D expenditures (log)	0.1129 [0.1259]	0.1243 [0.1159]	1.3395 [0.7363]	1.3402 [0.6444]	0.2078 [0.1949]	0.1879 [0.1827]
Technological scope	0.1521 [0.3641]	0.3837 [0.3105]	1.1946 [3.1058]	1.4285 [2.9840]	0.8217 [0.6682]	0.3142 [0.4636]
Alliance portfolio size	−0.0188 [0.0120]	−0.0198 [0.0112]	0.1353 [0.0940]	0.1628 [0.0920]	−0.0224 [0.0310]	−0.0280 [0.0301]
Resources in portfolio	4.4320 [1.1702]	4.6341 [1.1235]	−10.5448 [6.5961]	−15.7471 [7.8844]	−3.5887 [2.8834]	−3.3751 [2.6860]
Commercialization alliances	−0.6702 [0.4910]	−0.6927 [0.4409]	−3.0686 [2.8090]	−1.0415 [2.5058]	−0.0694 [0.5067]	−0.1376 [0.4740]
R&D alliances	0.6767 [0.3879]	0.7816 [0.3339]	0.3247 [1.3841]	1.5928 [1.6664]	−0.4907 [0.3211]	−0.4074 [0.2911]
n (firm–years)	675	739	162	171	778	869
n (firms)	103	105	20	20	118	124
Log-likelihood	−546.7	−591.7	−29.77	−29.26	−551.9	−635.6

Note: Standard errors in brackets. All models include time fixed effects.

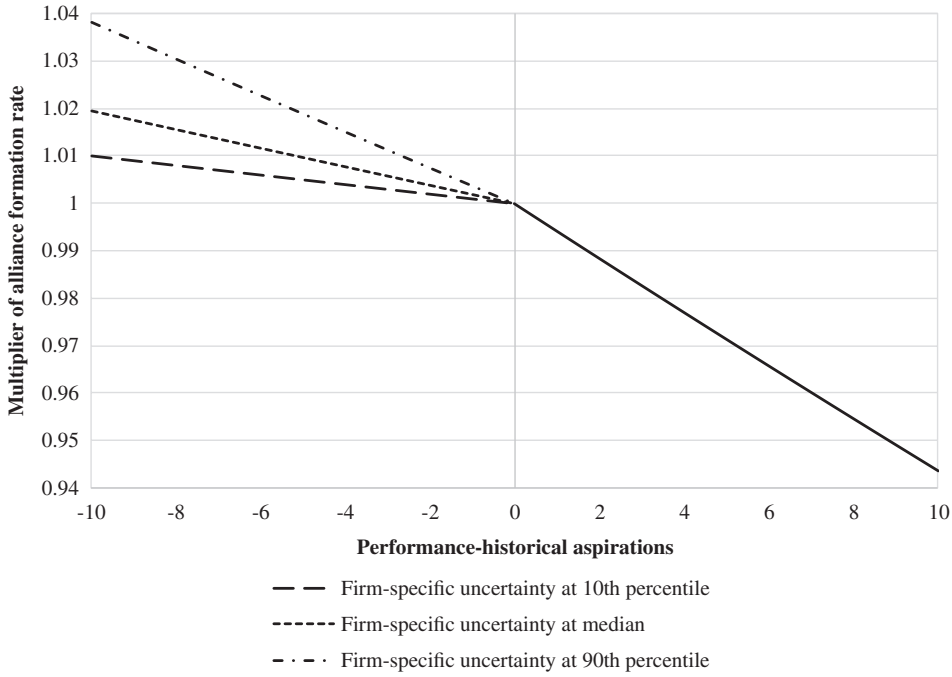

FIGURE 2 Rate multiplier for *novel partners − existing resources* (Hypothesis **5a**)

identifiable for public DBFs, we found results for Hypotheses **1–3** and **4a–4c** that were essentially identical to those shown in Tables 4 and 5.[6]

Second, our results remained similar once we excluded from the estimation sample one DBF offering contract research services, and five DBFs headquartered outside the United States, all in Europe.[7] These restrictions gave even greater comparability in the line of business and normal resource requirements of the sampled firms, enhancing the validity of the performance feedback and slack resource effects (Greve, 2003a, 2003b).

Third, in models predicting *novel partners − new resources*, we excluded firm–year observations corresponding to years in which firms formed their first alliance(s) (Lavie & Rosenkopf, 2006, p. 808). By disregarding novice collaborators, this criterion restricts *novel partners − new resources* to only those alliances formed by firms already managing an active alliance portfolio, allowing us to interpret all instances of alliance formation in the restricted sample as genuine acts of alliance portfolio *re*configuration. Alternatively, we included in the full sample a dummy variable capturing whether or not a firm's alliance portfolio had a size of zero in a given year. Across both approaches, we found results fully consistent with those shown in models 5 and 6 in Tables 4–6, although the coefficient for *absorbed slack* was larger (roughly 0.011) and more precisely determined ($t > 3$) in the restricted sample.

Fourth, we examined the possibility that our *performance − aspirations* measures absorb a categorical rather than continuous classification, where performance below aspirations is considered a

[6]In all models, we included a fixed effect for whether an observation concerned a private firm. We found that, all else constant, private firms were less likely than public firms to expand either the partner or the resource base of their alliance portfolios.

[7]Embrex Inc. was excluded from the sample because it offered contract research services, and the excluded European DBFs were Alkermes PLC (Ireland), Flamel Technologies SA and Genset SA (France), Qiagen NV (Netherlands), and Xenova Group PLC (UK).

failure, and above aspirations a success, regardless of how far performance is away from the aspiration level (Greve, 2003b, pp. 59–61). We checked for this possibility by incorporating dummy variables for whether or not performance was below aspirations (Baum et al., 2005, p. 551). The results for the direct and interactive effects of *performance − aspirations* were identical. Thus, the sign and magnitude of performance relative to aspirations, rather than its sign alone, affect the nature of alliance portfolio reconfiguration.

Finally, rather than estimating separate models for the three dependent variables, we also estimated least-squares simultaneous equations models, each in log-linear form, that jointly predict the three outcomes for all sampled firm–years. This approach explicitly treats the three alliance portfolio-reconfiguration decisions as interrelated and simultaneously determined (Zellner, 1962). For both performance relative to historical and social aspirations, we estimated one system of equations to jointly test Hypotheses **1**–**3**; one to jointly test Hypotheses **4a**–**4c**; and one to jointly test Hypotheses **5a**–**5c**. Across the six systems of simultaneous equations, we found evidence strongly consistent with that in Tables 4–6, while some of the coefficients testing Hypotheses **4b** and **5b** were more precisely determined. However, such precision must be treated cautiously because multiple testing (e.g., more than a dozen tests across alternative specifications alone) progressively increases the probability of false positives (Romano, Shaikh, & Wolf, 2010).

6 | DISCUSSION

While the consequences of alliance portfolio configurations have received considerable scholarly attention, less is known about how and why firms reconfigure their alliance portfolios over time. In this study, we complement the literature on alliance portfolio reconfiguration by developing and testing a comprehensive behavioral perspective. We found that as performance decreases relative to aspirations, firms form alliances with novel partners within the resource scope of their existing alliance portfolios. Such problemistic search is attenuated by equity ties with existing partners but intensified by firm-specific uncertainty. Conversely, as performance increases relative to aspirations, firms form alliances with existing partners but outside the resource scope of their existing alliance portfolios. Finally, firms accumulating organizational slack most radically reconfigure their alliance portfolios by forming alliances with novel partners focusing on new-to-the-portfolio resources.

This study's primary contribution is to research examining the antecedents of alliance portfolio reconfiguration. Available studies point at external contingencies, such as gradual or discontinuous technological changes (Asgari et al., 2017; Lavie & Singh, 2012) and market competition and uncertainty (Beckman et al., 2004; Ozcan, 2018), as drivers of alliance portfolio reconfiguration. Internal contingencies, such as firm-specific uncertainty, competencies, and business strategy, have also been identified as important because they can mediate the ways in which external contingencies influence portfolio reconfiguration (Beckman et al., 2004; Hoffmann, 2007; Lavie & Singh, 2012). We contribute to this emerging body of research by explicitly considering how alliance portfolio-reconfiguration decisions may also derive from behavioral heuristics as a consequence of managers' bounded rationality (Cyert & March, 1963). While firms may proactively or reactively engage in alliance portfolio reconfigurations through a rational evaluation of external and/or internal contingencies, we argue and show that reconfiguration decisions are also shaped in predictable ways by performance feedback and organizational slack, thus making portfolio reconfiguration responsive to behavioral antecedents.

One implication of this evidence is that behavioral drivers can help explain why firms may deviate from longer-term portfolio strategies (e.g., Hoffmann, 2007), which may lead their portfolios to look like apparently incoherent sets of individual alliances. Awareness of the fact that behavioral

factors may drive portfolio reconfiguration may assist managers and investors when interpreting and responding to the portfolio-reconfiguration choices of their (potential) partners, competitors, and/or investees. Indeed, an act of alliance portfolio reconfiguration might require different responses depending on whether such changes are driven by fundamental shifts in business strategy, external contingencies, or behavioral factors.

Our behavioral theory extends research on alliance portfolio reconfiguration also by proposing that behavioral drivers lead firms to form alliances in an attempt to alter the synergies and conflicts arising from their portfolios' partner and resource characteristics. Thus, it incorporates the multi-dimensionality of alliance portfolio (re)configuration (Wassmer, 2010), by underlining the need to simultaneously consider partner choice and resource focus in firms' newly formed alliances. While of course practitioners are faced with multiple concurrent considerations when forming alliances to reconfigure their portfolios, available theory and evidence have mostly focused on individual considerations of partner choice (Beckman et al., 2004; Howard et al., 2016) or the nature of accessed resources (Asgari et al., 2017). Our theory clarifies how a concurrent focus on partner-choice and resource-focus decisions is a necessary consequence of the value creation and appropriation preferences formed by firms with respect to their alliance portfolios in response to behavioral antecedents.

By drawing attention to the importance of concurrent partner-choice and resource-focus decisions, our theory also contributes to behavioral theory. Studies in the behavioral tradition have typically examined how performance feedback and organizational slack affect the intensity of search along one dimension. For example, evidence shows higher R&D intensities in firms performing below aspirations, but also in firms with higher levels of slack (Chen & Miller, 2007; Greve, 2003a). And Baum et al. (2005) find that Canadian investment banks facing attainment discrepancies, whether negative or positive, are more likely to accept the risk and uncertainty of underwriting syndicate ties with partners with which they have no existing direct or third-party ties. Our study departs from and extends such evidence by uncovering meaningful heterogeneity in the consequences of different behavioral drivers: Not only do positive and negative attainment discrepancies predict distinct types of alliance portfolio reconfiguration, but also slack predicts a reconfiguration type not predicted by performance above or below aspirations. Thus, we show how behavioral drivers determine not only the intensity of search in an individual dimension of an organizational activity, but also heterogeneity in the distribution of search across multiple dimensions of that same activity.

These findings underscore the importance, for behavioral research, of more rigorously examining the nature of distinct search processes. Behavioral theory has long typified the nature of problemistic search as more short-term, myopic, and somewhat exploitative, but that of slack search as relatively exploratory. Yet, by focusing on the intensity of search along one dimension, empirical studies have not explored the possible implications of this fundamental conceptual distinction (an exception is Xu, Zhou, & Du, 2018), nor have they examined possible differences in the nature of slack search derived from positive attainment discrepancies versus organizational slack. Thus, it has proven difficult to disentangle the various search processes responsible for observed search intensities (Posen et al., 2018). By predicting and uncovering how the *nature* of search differs with its origin in below-aspiration performance, above-aspiration performance, or organizational slack, our study extends the behavioral literature with more fine-grained and discerning evidence of behaviorally motivated organizational search.

A final set of contributions emerge from elucidating how actor-specific contingencies interacted with the behavioral mechanisms shaping alliance portfolio reconfiguration. By uncovering how a firm's equity ties and firm-specific uncertainty moderated the intensity of problemistic search in response to performance feedback, we extend a nascent understanding in the behavioral theory of the

factors that explain heterogeneity in firms' responsiveness to performance feedback (Greve & Gaba, 2017; Shinkle, 2012). First, we found that firms performing below aspirations are progressively more likely to form alliances with novel partners in existing resources, yet equity ties to existing partners reduced this tendency. Thus, consistent with Williamson's (1991) intuition that cooperative and autonomous adaptation potential are inversely related, the possible advantages of equity-based commitments, such as incentive alignment with existing partners (Oxley, 1997), may come at the cost of limiting a firm's ability to bring conflicting partners into its alliance portfolio. By implication, firms must consider whether the anticipated benefits of equity in a focal alliance outweigh the reduced ability to adapt the broader portfolio beyond that alliance. Second, we found that below aspirations, firm-specific uncertainty intensifies the formation of alliances with novel partners in existing resources. This finding extends evidence that firm-specific uncertainty motivates alliance formation (Beckman et al., 2004) because it reveals that, by intensifying firms' responses to negative attainment discrepancies, such uncertainty also interacts with the process of problemistic search.

7 | LIMITATIONS AND FUTURE RESEARCH

Opportunities exist to extend our research and address some of its limitations. First, whether or not particular alliance portfolio reconfiguration decisions will achieve their intended outcomes is inherently uncertain, and firms' greatest control over portfolio synergies and conflicts is through decisions that influence the *potential* for desired interdependencies. These are the decisions we considered. Nevertheless, questions remain regarding the eventual effectiveness of alliance portfolio reconfiguration decisions. Future research can complement our work by directly capturing portfolio synergies and conflicts, and by exploring how firms can influence such interdependencies towards realizing their value creation and appropriation preferences.

Second, firms reconfigure alliance portfolios through alliance formations and terminations (e.g., Asgari et al., 2017; Ozcan, 2018). We have focused on alliance formations, although we accounted for terminations by assuming a 5-year lifespan for each alliance, consistent with relevant prior literature (e.g., Robinson & Stuart, 2007). Future studies might extend our behavioral perspective on alliance portfolio reconfiguration by focusing on alliance terminations. We believe such efforts are worthwhile yet challenging: They require data on alliance termination dates and, crucially, a sharp distinction between termination due to project or contract completion on the one hand, and premature termination on the other (e.g., Greve, Baum, Mitsuhashi, & Rowley, 2010).

Third, DBFs are often limited in scope, yet interesting questions emerge regarding the role of horizontal and vertical diversification in shaping links between behavioral drivers and alliance portfolio reconfiguration. We examined the role of behavioral antecedents in shaping firms' alliance portfolio configurations, yet in firms with larger scale and scope such antecedents might simultaneously influence multiple organizational activities, including acquisitions, divestitures, and venture capital investments. We believe that an extension such as this is valuable yet scholars must take care to consider contextually important resources and performance outcomes when examining predictions in other empirical settings. For example, we focused our empirics on technological resources because these permeate all the activities of DBFs, including their alliances, regardless of whether they are alliances with other DBFs, public sector research institutions, or pharmaceutical firms (Powell et al., 1996). In settings where other resources are (also) a prevalent component of firms' external relationships, the empirical analysis must reflect such resources. Relatedly, we based measures of performance relative to aspirations on innovation performance, an outcome that DBFs' alliance portfolios are expected to generate (e.g., Baum et al., 2000), and so one that should direct firms' search efforts to their alliance

portfolios. Tests of the implications of our theory in other settings similarly require the identification of contextually important performance outcomes.

8 | CONCLUSION

Our study introduces a comprehensive behavioral perspective to research on alliance portfolio reconfiguration, which to date has mostly assumed value-maximizing managers while frequently focusing on external antecedents. Assuming that managers are boundedly rational and reliant on behavioral heuristics, we have focused on the internal factors of performance feedback and organizational slack as drivers of alliance portfolio reconfiguration, and we have offered evidence of some contingencies affecting the behavioral mechanisms. We hope our theory and analyses will stimulate further research on the evolution of portfolios of corporate development activities, and on the nature and contingencies of distinct behaviorally driven search processes.

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