Uncertainty, Adaptation, and Alliance Performance

Xu Jiang, Feifei Jiang, Africa Ariño, and Mike W. Peng

***Abstract*—We conceptualize alliance adaptation as a bundle of governance-based change practices in ongoing alliances, including contractual alterations, ownership change, board change, monitoring mechanism change, and key personnel turnover. Leveraging a transaction cost perspective, we investigate how changing environmental conditions (i.e., demand uncertainty and technological uncertainty) and unpredictable partner actions (i.e., behavioral uncertainty) trigger *ex post* governance adaptations in alliances, and how these adaptations in turn affect alliance performance. Using data collected from 178 partner firms in China, we find that the partner firms will undertake more extensive alliance adaptations as demand uncertainty and behavioral uncertainty increase. However, while the extent of alliance adaptations increases as technological uncertainty increases, there is a threshold level of technological uncertainty beyond which the extent of alliance adaptations decreases. The results also suggest that although alliance adaptations enhance alliance performance, this positive impact may diminish after alliance adaptations reach a certain threshold level. Overall, we contribute to the alliance evolution literature by focusing on why partner firms undertake alliance adaptations and how they benefit from these *ex post* governance adaptations.**

***Index Terms*—Alliance adaptations, alliance performance, transaction cost theory, uncertainty.**

I. Introduction

As STRATEGIC alliances evolve, governance-related or management-related problems are likely to occur. Such problems may emerge as a consequence of governance misalignments [1] or of a misfit between the initial alliance design and ongoing conditions [2]. For example, the structures of alliance contracts may become inappropriate as partner firms learn more about how to work together [3]. To cope with these problems, partner firms may need to reevaluate their alliances and adjust the alliances' governance structures accordingly. Alliance adaptations denote the extent to which a set of governance-based adjustments is made by partner firms in ongoing alliances. These *ex post* adjustments may include alterations in the alliance contract, changes in the ownership structure, changes in the joint board or committee overseeing the alliance, the introduction or formalization of monitoring mechanisms, and key personnel turnover.[1]

Focusing on alliance adaptations, previous studies have often taken a transaction cost economics (TCE) perspective to investigate the occurrence and determinants of particular adaptation practices [2], [4]–[6]. Others have addressed the performance implications and outcomes of such practices [7], [8]. Despite the insights from the literature, for three reasons we still lack a fine-grained understanding of the nature, role, and value of alliance adaptations. First, the prevailing focus on the occurrence of isolated adaptation practices such as contractual alterations, board changes, or monitoring mechanism changes [5] limits our ability to understand the scope and magnitude of alliance adaptations, which often entail simultaneous changes of varying degrees in multiple governance mechanisms. Second, the role of uncertainty both within and outside the scope of an alliance in triggering *ex post* governance adaptations remains only partially understood [2], [5]. Third, Ness [9] and Reuer *et al*. [5] call for more attention on the performance implications of *ex post* governance adaptations in alliances. Thus, our purpose in this study is to achieve a more complete understanding of the antecedents and consequences of alliance adaptations by addressing the following questions.

1) How do various environmental conditions (technological uncertainty and demand uncertainty) and partner-specific behavior factors (behavioral uncertainty) influence the extent of alliance adaptations?
2) How do alliance adaptations influence alliance performance?

In addressing these questions, we conceptualize alliance adaptations as the extent to which a bundle of governance-based change practices is undertaken within a given alliance, including contractual alterations, ownership change, board change, monitoring mechanism change, and key personnel turnover, extending our understanding of adaptations regarding this important aspect of alliance postformation dynamics. This constitutes the first of three contributions to the literature made by this study. Our second contribution lies in extending the TCE perspective to analyze the differential impact of various types of uncertainty on *ex post* alliance adaptations. In this way, we extend the TCE perspective to the alliance postformation stage. Our third contribution stems from establishing a curvilinear relationship between alliance adaptations and performance, based on the balance between the benefits and costs of adaptation practices. By doing so, we show that the association between alliance

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[1] In line with the sole theoretical perspective used in this study—transaction cost economics (TCE), we emphasize the formal and structural mechanisms of alliance adaptations.

postformation dynamics and performance is more complex than it may appear at face.

II. Literature Review

A. Research Context: Strategic Alliances

A strategic alliance is a voluntary arrangement in exchanging or sharing resources between two or more independent firms to engage in the codevelopment or provision of products, services, or technologies [10]. Nowadays, strategic alliances have been increasingly applied across industries such as the construction industry [11], [12]; the metal, mechanical, and engineering industry [13]; and the high-tech industry [14]. Partners in such alliances work cooperatively on the basis of sharing project risk and reward [15]. Strategic alliances take different forms, including joint ventures, collaborative research and development (R&D), coproduction, and joint marketing. Firms enter into different types of alliances depending on the type of knowledge that they are seeking to acquire, such as R&D alliances, manufacturing alliances, and marketing alliances. Strategic alliances can be classified in terms of different features. For example, the classification of equity alliances and nonequity alliances is based on the use of equity ownership [16]. The classification of upstream alliances and downstream alliances is based on the position of an alliance along the value chain [17].

B. Prior Research on Alliance Adaptations

Alliance evolution has received increasing research attention, and conceptual and case-based models have made important contributions to our understanding [18]–[20]. In spite of their diverse theoretical underpinnings, these models share a comprehensive approach to alliance dynamics that includes both pre- and postformation stages, as well as alliance outcomes.

In contrast, most empirical studies on alliance evolution focus either on the alliance preformation stage or on alliance outcomes. For instance, studies focusing on the preformation stage have explored how an alliance is optimally structured and examined issues such as how to select appropriate partners [21], [22]; how to choose an effective alliance type [23], [24]; and how to determine the scope of activities [25]. In contrast to this stream of research, studies on governance flexibility at the preformation stage of alliances are recent, arguing that the choice of alliance structure is less consequential to firms with more alliance experience because they are better able to protect their interests under any given alliance structure [26]. At the same time, those centered on alliance outcomes have analyzed how alliance performance is assessed [8], [27], and how alliances achieve success [28]–[30].

Despite being recognized as an aspect that is at least as important as alliance preformation stage and alliance outcomes [19], alliance postformation dynamics have received relatively little empirical attention other than in case-based research [18], [19], [31]. In particular, research on alliance adaptations at the postformation stage remains rather sparse, and is limited in three ways. First, researchers have selectively analyzed particular mechanisms of alliance adaptations such as

1) contractual alterations (i.e., modifying some specific terms in the contract or even renegotiating the contract to a mutually agreed degree);
2) board changes (i.e., changing the size or composition of the joint board or committee overseeing the alliance);
3) monitoring mechanism changes (i.e., introducing a new monitoring mechanism or changing the current control mechanism in the alliance) [2].

However, some important adaptation practices have been underexplored. One is ownership change—change in the alliance's ownership structure such as increasing or decreasing one party's share. As well documented in prior research, ownership change represents a major source of adaptation activities [32], providing the basis for governance changes in alliances. Another key component that should be comprised in the alliance adaptations construct is key personnel turnover, such as reappointing new chief engineer, accountants, or internal auditors. Key personnel turnover is a relatively informal and less costly tool [2], but the common use of this activity is equivalent to the other activities mentioned above among different alliances [19], [33]. Therefore, prior research has not offered a relatively comprehensive understanding of alliance adaptations that captures the complexity of this phenomenon.

A second shortcoming is that individual adaptation practices have been studied in isolation. Yet, it is problematic when divorcing these specific practices from each other because it ignores the possibility that diverse adaptation practices may take place at the same time. Indeed, in practice several adaptation practices are often undertaken simultaneously. For instance, FAW–Volkswagen is a joint venture between China-based FAW and Germany-based Volkswagen located in Jilin Province of China. Its postformation alliance adaptations included both ownership changes (FAW's holding decreased from 60 percent of the equity to 51 percent) and contractual alterations (adding details about jointly developing new energy automobiles). China Tianjin Otis Elevator Company, a joint venture owned by China Tianjin Elevator Company and U.S.-based Otis Company, experienced key personnel turnover (implementing some layoffs), contractual alterations (changing related provisions on the joint venture's managerial systems), and ownership changes (Otis Elevator's stake increased from 30 percent to 44 percent, and then to 51 percent). Thus, limiting the scope of alliance adaptations or isolating these practices from one another provides only a piecemeal understanding of alliance adaptations. There is a dearth of research regarding the whole-picture effects of these often concurrent practices.

A third limitation is that past studies examine only whether or not a specific adaptation practice occurs in a given alliance. While these studies focus on the likelihood of an isolated adaptation practice, they often do not investigate the magnitude of these multifaceted practices, limiting our knowledge of the nature and role of alliance adaptations.

As an initial step to address these drawbacks, we examine alliance adaptations based on an integrated conceptualization, whereby various types of governance-based change practices are bundled together to capture alliance adaptations.

III. Hypothesis Development

A central tenet of TCE is "discriminating alignment": aligning transactions with effective governance structures leads to more efficient outcomes by reducing transaction costs [34]. Based on this proposition, numerous studies apply TCE to investigate the alliance preformation stage [23]–[25]. Also, this theory has been used to study the alliance postformation stage [2]. Applied to alliance adaptations, the TCE "discriminating alignment" proposition implies that the efficiency of alliance adaptations will be enhanced when the new, adapted governance structure is aligned with the fundamental attributes of the transaction. In theory, discriminating alignment in alliance adaptations aims at both reducing transaction costs and enhancing alliance performance.

Leveraging TCE reasoning, we examine the effects of uncertainty—one important attribute of alliance transactions [35]—on alliance adaptations. Our basic argument is that partner firms will weigh the benefits of undertaking alliance adaptations with the losses they experience from hazards arising from various types of uncertainty. Specifically, we focus on the respective effects of environmental (technological and demand) uncertainty and behavioral uncertainty on alliance adaptations.

A. Environmental Uncertainty and Alliance Adaptations

Environmental uncertainty refers to uncertainty about future states of nature. It stems from exogenous factors that rest outside an organization's control and are hard to anticipate [23], [36]. Technological uncertainty and demand uncertainty are two fundamental types of environmental uncertainty. Technological uncertainty refers to the perceived unpredictability of technological change in a specific industry [37]. Firms with alliances in uncertain technological environments may experience a need to adapt their alliances so as to better reflect the new technology conditions. Demand uncertainty refers to the unpredictability of customer preferences [37]. This type of uncertainty may pressure partner firms to solve potential governance problems in their alliances so as to meet the new market demand. The dramatic changes in both technologies and consumer preferences are more likely to affect their alliances' development and operating efficiency, and thus create incentives for partners to adapt their alliances to address the environment pressures surrounding the alliances. We argue that the influence of environmental—both technological and demand—uncertainty on alliance adaptations is curvilinear in an inverted U-shape. This deviates from previous work that suggests a linear relationship between environmental change and governance adaptations in alliances [2], [18], [19]. We suggest that at low levels of environmental uncertainty, the alliance design choices that partner firms make at the preformation stage are likely to remain aligned with the environment at a later time. Similarly, an environment with low demand uncertainty is characterized by predictable changes in customer preferences. Thus, partner firms may be able to make the right alliance design decisions from the outset. Under these conditions, partner firms may rely on their existing governance structures, and they may not experience a need to undertake complex and costly adaptation activities.

At higher levels of environmental uncertainty, the unanticipated changes in the environment may make the initial alliance design choices unlikely to be aligned with future environmental conditions. As uncertainty increases, partner firms may face the need to adapt the current alliance structure to the new conditions, and according to TCE reasoning, they may do so to the extent that the benefits of adaptations exceed the costs. In the face of technological uncertainty, it may be more difficult for an alliance to survive if it persists in its existing structure, with old solutions to new governance problems. A narrow range of alliance adaptations can solve only a limited number of problems caused by technological uncertainty. Thus, partner firms adopting only isolated adaptation practices may find it difficult to respond to important changes in the technological environment. Given these challenges, partner firms may have to undertake more extensive alliance adaptations.

Similarly, in the face of increasing demand uncertainty, it becomes harder to predict customer preferences. An alliance's internal operating efficiency may decline if its governance design fitting to past customer preferences no longer matches the new customer preferences, which may cause high mismatch costs [38]. This provides incentives for partner firms to undertake costly alliance adaptations that are needed for the alliance to identify and benefit from those new market opportunities. In contrast, limited changes in the alliance may not work well in breaking established cooperative routines and procedures [39], in turn bringing the alliance back to the original track and failing to respond to changing customer demand. Thus, in the presence of environmental uncertainty, partner firms may rely on "self-help," and experience the need to make important adaptations to their preexisting alliance structure. At the same time, as implied by TCE, the benefits from re-aligning the alliance to the new environmental conditions justify the costs of undertaking complex adaptations.

However, there is a threshold level of uncertainty, beyond which the costs of adaptations may surpass the benefits. Partner firms that face an extremely high level of uncertainty have a greater desire to adapting alliances due to their need to aligning with the current environment. Specifically, a very high level of technological uncertainty implies that only a few well-developed technological alternatives are available, and that the criteria to evaluate them are not clear. Thus, partner firms seeking to analyze the environment face an ambiguous and difficult situation [40], [41]. In addition, in the face of rapid technological change, partner firms are uncertain about which adaptation practices will be appropriate for future conditions. As such, partner firms that face an extremely high level of technological uncertainty are most in need of alliance adaptations, but may have the fewest choices to do so. Thus, they may lower the extent of alliance adaptations to address problems caused by technological uncertainty.

Similarly, in the face of extremely frequent customer preference changes, making *ex post* adaptations in alliance governance may not help because partner firms may not know what the right alliance design is for the new demand conditions. Furthermore, even if partner firms plan to invest substantially in major alliance adaptations to manage rapidly changing customer demand, the

effects of such adaptations are far less certain. Thus, partner firms may be reluctant to devote the time and resources needed to cover the costs of initiating changes that may be counterproductive. Hence, the high costs associated with developing social ties as well as conducting complex adaptation activities will make partner firms rationally lower the frequency and extent of their alliance adaptations.

Overall, we expect the extent of alliance adaptations to increase with the level of environmental (both technological and demand) uncertainty. However, there is a threshold level of uncertainty beyond which the extent of alliance adaptations decreases.

H1: The level of technological uncertainty has an inverted U-shaped relationship with the extent of alliance adaptations, such that the extent of alliance adaptations will increase and then decrease as the level of technological uncertainty increases.

H2: The level of demand uncertainty has an inverted U-shaped relationship with the extent of alliance adaptations, such that the extent of alliance adaptations will increase and then decrease as the level of demand uncertainty increases.

B. Behavioral Uncertainty and Alliance Adaptations

Behavioral uncertainty refers to the difficulty in anticipating and understanding another party's actions [34], [35]. It is endogenous to the transacting parties, and is reduced by their actions [23]. TCE suggests that behavioral uncertainty entails costs derived from monitoring partner activities [42]. When behavioral uncertainty is low, alliance activities may be conducted in an open and transparent atmosphere, and partner firms may enjoy a high degree of mutual understanding and trust. Thus, partner firms may rely on their existing governance mechanisms to develop the alliance. They do not need to undertake substantial alliance adaptations, because the costs are not justified.

However, when a focal partner's behavior is subtle and unpredictable, other partners may have difficulties in assessing the focal partner's contributions to the alliance [23]. As implied by TCE, this gives the focal partner potential opportunities to behave opportunistically by engaging in misinformation, technology theft, or default on commitments [43]. With time, other partners' expectations of the focal partner's behavior are increasingly shaped by perceptions of that behavior [44]. As the relationship unfolds, the alliance partners' mutual knowledge improves. As their behavior becomes more predictable, they have a better understanding of the type of structural arrangements that may align their incentives so as to elicit the desired behaviors. Thus, in the presence of behavioral uncertainty, partner firms are more likely to undertake complex alliance adaptations. In sum, the greater the problems arising from behavioral uncertainty, the greater the partners' incentives to bear the costs of undertaking more complex alliance adaptations.

H3: The level of behavioral uncertainty has a positive relationship with the extent of alliance adaptations.

C. Alliance Adaptations and Alliance Performance

Firms enter into alliances intending to achieve superior performance. The majority of past studies examining alliance performance focus on static, preformation stage factors such as level of specific investments [8] and similarities between partners and partner reputation [29]. However, recent studies have also begun to recognize the importance of dynamic changes at the postformation stage to understand alliance performance [8]. We argue that alliance adaptations may affect alliance performance in an adaptive way, that is, alliance adaptations can first have a positive effect on alliance performance. Partner firms undertake alliance adaptations with the purpose of re-aligning the alliance's initial design to the new conditions. From a TCE perspective, the cooperative efficiency of an alliance will be enhanced to the extent that the new structure in the adapted alliance is aligned with the surrounding collaborative environment [2], suggesting that such an adapted alliance has the potential to generate higher performance. In addition, when partner firms undertake adaptations, they must continuously contribute valuable resources and assets to the alliance [4]. These investments create a "mutual hostage" situation that helps in aligning their interests [43]. Thus, partner firms may have a greater incentive to commit to the adapted alliance, and to put forth their best effort to ensure the alliance's success.

However, for two reasons the positive impact of alliance adaptations on alliance performance may diminish and generate disruptive effect after adaptations reach a certain threshold level. First, overly drastic alliance adaptations imply that significant governance changes are needed. The existing cooperative routines that coordinate strategies, knowledge flows, roles, and responsibilities in task execution across partners [39] may create strong internal resistance against overly drastic adaptation activities. To the extent that partner firms must invest additional time, resources, and effort to overcome such resistance, alliance adaptations yield only limited benefits to partner firms. Performance may be lowered when the costs of adaptations exceed the expected gains from the adapted operations [45]. In this case, the benefits derived from the adapted alliance may be lower in value than the costs.

Second, when the level of alliance adaptations is too high, the new pattern of governance deviates significantly from the firm's historical pattern so that partner firms are less able to manage the adapted alliance effectively. Failing to manage the adapted alliance as expected will burden partner firms with more losses than gains from their efforts in the adaptation process. Thus, more costs and efforts would be spent in determining acceptable managerial behavior, and subsequently lower alliance performance following extensive adaptations. Therefore, when multiple governance mechanisms experience significant changes, the disruption caused by these changes may reinforce each other and lead to an amplified disruptive effect.

H4: The extent of alliance adaptations has an inverted U-shaped relationship with alliance performance, such that alliance performance will increase and then decrease as the extent of alliance adaptations increases.

IV. Methods

A. Sample and Data Collection

We use data collected from a survey of 178 Chinese firms engaged in strategic alliances, some of which are formed to

carry out complex projects. China provides a rich setting to test our model. First, in this highly complex and dynamic transition economy, strategic alliances have grown rapidly and became an important strategic choice [46]. Despite the prominence of strategic alliances in China, little is known about how Chinese firms manage their alliances to maximize the potential collaborative benefits [41]. Second, China is undergoing unprecedented institutional transitions, which raise serious misalignment problems and adaptation needs for Chinese partner firms [47]. Obviously, once alliances are beset by unanticipated uncertainties, misalignment problems may occur. Thus, how to adapt alliances to align with the changing environment becomes an important and inevitable decision that each Chinese partner firm has to make. Therefore, China's rapid institutional changes accompanied by relatively underdeveloped factor and product markets yield a very suitable context for exploring the role of external environment [48]. Furthermore, the low-trust nature of Chinese society provides a special context for exploring the role of behavioral uncertainty [49]. Taking all the above-mentioned factors together, China is an ideal setting to examine the uncertainty antecedents and performance consequence of alliance adaptations.

Based on prior studies and in-depth interviews with five alliance managers, we first developed the questionnaire in English. Two scholars in the alliance research field translated it into Chinese, and then two other scholars back-translated it into English to ensure accuracy [50]. Next, we conducted a pilot test of the Chinese questionnaire to check its interpretability and usefulness. A total of 20 top managers from 10 local alliance firms volunteered to review the Chinese version. Based on their feedback, we finalized the instrument.

We randomly selected 1500 firms from a list of high-tech and manufacturing firms located in the four-digit Chinese Standard Industrial Classification codes 1311-4290, where alliances were more prevalent than in other sectors. The sample frame involves industries such as mechanical, electrical, chemical, computer, IT, and others. We collected the data through on-site interviews from 2010 to 2011. This face-to-face procedure allowed us to assess respondents' suitability for the study, and to increase the overall response rate.

To minimize common method bias, we collected data for the variables from two informants in each firm. Specifically, our interviewers would call a manager to set up an appointment and also asked him or her to invite another manager (such as Chairman, CEO, General Manager, or Vice General Manager responsible for alliance affairs) to complete the questionnaire. The interviewers presented the same questionnaire at the scheduled time in each manager's office and collected the survey after its completion. Before interviewing, both informants were asked to choose the same partner that had been an ally for at least one year. Although they jointly identified the same partner and the same alliance, they completed their surveys separately.

After matching key informants and deleting surveys with missing data, we further dropped responses from those in wholly foreign-owned enterprises, as such firms would not be consistent with the rest of the sample. In addition, partner firms that were involved in solo marketing alliances were also excluded from our sample [51]. Finally, we obtained a sample of 178 partner firms (356 respondents). Inter-rater reliability was checked to ascertain that the two respondents in each pair shared similar views of key constructs. ICC (1) is used in this study. Matched pairs of the first and second respondents are built, and each indicator is analyzed separately. The values of ICC (1) for technological uncertainty were between 0.31 and 0.49, for demand uncertainty were between 0.46 and 0.63, for behavioral uncertainty were between 0.38 and 0.49, for alliance adaptations were between 0.33 and 0.52, and for alliance performance were between 0.69 and 0.86. All ICCs (1) are above the threshold of 0.25 and can be considered large [52].

We assessed nonresponse bias by testing for possible differences between respondents and nonrespondents after the data were collected [53]. We found little statistically significant differences between respondents and nonrespondents across firm age ($F = 0.596$, $p > 0.10$), size ($F = 1.416$, $p > 0.10$), or ownership ($F = 1.042$, $p > 0.10$), suggesting that nonresponse bias was not a significant concern.

B. Variables Measurement

The dependent, independent, and moderator variables were all measured with multi-item, seven-point Likert-type scales ranging from 1 = "strongly disagree" to 7 = "strongly agree." The Appendix provides all scale items. Information about three uncertainty variables, alliance performance, and control variables was chosen from the first informant. Information about alliance adaptations was chosen from the second informant.

Alliance adaptations are a formative measurement scale that captures the extent to which partner firms undertake a range of adjustments or revisions of their ongoing alliance. As suggested by MacKenzie *et al*. [54], if the indicators are viewed as defining characteristics, the focal construct is a function of its indicators, and a change in only one of the indicators is expected to cause a change in the focal construct, then the indicators are best thought of as formative indicators of the focal construct. In this study, we asked about partner firms' agreement with the extent to which each of the following adjustments to the initial alliance conditions had been made: alterations in the alliance contract, changes in the ownership structure, changes in the composition of the joint board or committee overseeing the alliance, the introduction or formalization of monitoring mechanisms, and key personnel turnover in the alliance. These are viewed as formative indicators, rather than as reflective indicators, because of the theoretical expectations [54]. It seems reasonable that an increase in the level of, say, alterations in the alliance contract might be associated with an increase in alliance adaptations, without necessarily being associated with changes in any other dimensions of the construct.

Technological uncertainty is a three-item scale that captures the magnitude of changes in technology. The items were adapted from Atuahene-Gima and Li [40].

Demand uncertainty is a 3-item scale that reflects the level of variability in customers' preferences. The items were also adapted from Atuahene-Gima and Li [40].

Behavioral uncertainty was developed as a four-item scale that depicts the difficulty of assessing the partner's actions. It was based on Geyskens *et al*. [55].

Adapted from Kale *et al*. [28], alliance performance was measured with five items capturing the focal firm's perceptual assessment of alliance outcomes.

1) Control Variables: Nine controls are included. Focal firm age is measured as the number of years since the firm formed in a log form. Focal firm ownership is a dummy variable with "1" representing a state-owned enterprise (SOE) and "0" representing a non-SOE. Focal firm size and partner firm size are the logarithm of the number of the focal firm's employees and of the partner's employees, respectively. Alliance structure is a dummy variable with "1" representing an equity-based alliance and "0" representing a nonequity-based alliance. Alliance duration is the logarithm of the number of years an alliance had been in existence at the time the survey was administered. Competitive regime is a dummy which is coded "1" for competitive alliances in which partner firms have their primary operations in the same industry, and "0" for noncompetitive alliances in which partner firms operate in different industries. Alliance scope is an ordinal variable set to "1" when the alliance involves only one collaborative activity (R&D or manufacturing), "2" for two activities (between R&D, manufacturing, and marketing), and "3" for all the three activities. Adapted from Schreiner *et al.* [56], asset specificity was constructed with a three-item scale that reflects the focal firm's transaction-specific investments in the alliance.

C. Construct Validity

We employed LISREL 8.5 to assess the construct validity of the measures. First, alliance adaptations are a five-indicator formative scale, and we followed Diamantopoulos and Winklhofer's [57] process to test the validity of this type of construct. First, we checked for multicollinearity among the indicators to assess the suitability of the formative scale. The maximum variance inflation factor (VIF) is 3.21, far below the threshold of 10.0. This suggests that multicollinearity among these five indicators does not pose a problem. Second, we assessed external validity by means of a multiple indicator multiple causes model through structural equation modeling. The effects of alliance adaptations were represented by two items: 1) the difficulty of undertaking alliance adaptations; and 2) the costs associated with it, as perceived by the respondents. The estimated model showed good fit ($\chi^2/\mathrm{df} = 2.17, \mathrm{CFI} = 0.98, \mathrm{NNFI} = 0.96, \mathrm{SRMR} = 0.024, \mathrm{RMSEA} = 0.078$), and the loadings of all five indicators were significant, suggesting good external validity. Following prior research [37], we employed the simple average of the five items to measure alliance adaptations.

Next, we assessed the construct validity of reflective variables as follows. First, we evaluated their convergent validity using confirmatory factor analysis. Each measurement item was linked to its corresponding construct, and the covariance among the constructs was freely estimated. The model fit indices ($\chi^2/\mathrm{df} = 1.808$, $\mathrm{CFI} = 0.96$, $\mathrm{NNFI} = 0.95$, $\mathrm{SRMR} = 0.052$, $\mathrm{RMSEA} = 0.079$) suggest that the model was acceptable, indicating its convergent validity. All factor loadings were greater than 0.50 and the *t*-values were greater than 2.0 (see the Appendix), further suggesting that our constructs have convergent validity [58]. Second, we used Cronbach's alpha to evaluate reliability in SPSS 13.0. All alpha values exceeded the threshold value of 0.80, providing evidence for the reliability of measures [59].

Second, we assessed discriminant validity by performing a series of chi-square difference tests. For each pair of latent variables, we compared the value obtained from a constrained model in which the correlation between the paired constructs was fixed to 1.0 with the value obtained from an unconstrained model in which the correlation between the paired constructs was set to be free. Results indicate that all chi-square difference tests were significant ($p < 0.001$), demonstrating sufficient discriminant validity [60].

V. Results

Table I provides descriptive statistics and correlations, and Table II shows the results for all multiple regression models. We used SPSS 13.0 to test the hypotheses. To minimize multicollinearity, we mean-centered each scale that constitutes an interaction or a squared term [61]. The largest VIF was 2.45, well below the 10.0 benchmark. Thus, multicollinearity was not a significant concern in our analysis.

The results support H1, which predicts an inverted-U shaped relationship between technological uncertainty and alliance adaptations (Model 1b: $\beta = -0.155$, $p < 0.05$; Model 1e: $\beta = -0.140$, $p < 0.1$). H2 posits that an inverted-U shaped relationship exists between demand uncertainty and alliance adaptations. The first-order term is significant (Model 1c: $\beta = 0.195$, $p < 0.05$; Model 1e: $\beta = 0.136$, $p < 0.1$), but the coefficient for the squared term of demand uncertainty is nonsignificant (Model 1c: $\beta = -0.014$, $p > 0.1$; Model 1e: $\beta = -0.021$, $p > 0.1$). This indicates that demand uncertainty has a positive effect on alliance adaptations, thus, providing no support for H2. H3 hypothesizes a linearly positive relationship between behavioral uncertainty and alliance adaptations. The results lend support to it, as the coefficient of behavioral uncertainty is positive and significant (Model 1d: $\beta = 0.185$, $p < 0.05$; Model 1e: $\beta = 0.138$, $p < 0.5$).

To further evaluate and compare the effects, we graphed the estimated relationships using the mean-centered scale for the actual range of data from our sample for each measure of uncertainty and the mean values for other variables in models lb, 1c, and 1d. Fig. 1 shows the estimated relationships between each uncertainty and alliance adaptations.

H4 posits an inverted-U shaped relationship between alliance adaptations and alliance performance. The negative and

TABLE I
DESCRIPTIVE STATISTICS AND CORRELATIONS

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Technological Uncertainty	4.835	1.104													
2 Demand Uncertainty	4.796	1.203	0.249**												
3 Behavioral Uncertainty	3.986	1.260	0.164*	0.085											
4 Alliance Adaptations	4.827	0.843	0.255**	0.181*	0.176*										
5 Alliance Performance	5.087	1.101	0.066	0.105	–0.054	0.274**									
6 Focal Firm Age[a]	2.793	0.786	0.091	0.050	0.164*	0.005	–0.020								
7 Focal Firm Ownership	0.365	0.482	–0.024	–0.040	0.069	0.028	–0.094	0.272**							
8 Focal Firm Size[a]	6.545	2.105	0.067	0.042	0.203**	0.149*	0.098	0.486**	0.109						
9 Partner Firm Size[a]	5.842	2.307	0.001	–0.002	0.031	0.033	0.102	0.085	0.018	0.294**					
10 Alliance Structure	0.517	0.501	0.040	–0.043	0.012	0.141	0.131	0.001	–0.154	0.087	0.084				
11 Alliance Duration[a]	1.524	0.734	0.140	0.086	0.005	0.082	0.151**	0.234**	0.134	0.180*	0.148*	0.044			
12 Competitive Regime	0.478	0.501	–0.030	0.041	–0.039	–0.041	–0.018	0.089	–0.001	0.116	0.114	0.047	0.030		
13 Alliance Scope	1.702	0.701	0.150*	–0.046	0.043	0.105	0.120	0.047	–0.094	0.029	0.123	0.247**	0.101	0.150*	
14 Asset Specificity	5.309	1.030	0.052	–0.013	–0.083	0.329**	0.365**	–0.022	0.007	0.108	0.124	0.035	0.148*	0.019	0.071

[a] Ln-transformed; $^{*}p < 0.05$; $^{**}p < 0.01$; $n = 178$.

TABLE II
RESULTS OF HIERARCHICAL REGRESSION ANALYSIS

Variables	Alliance adaptations (Model 1)					Alliance performance (Model 2)	
	Model 1a	Model 1b	Model 1c	Model 1d	Model 1e	Model 2a	Model 2b
Direct effects							
Focal Firm Age	–0.075 (–0.874)	–0.120 (–1.424)	–0.082 (–0.974)	–0.088 (–1.040)	–0.128 (–1.542)	–0.046 (–0.535)	–0.053 (–0.641)
Focal Firm Ownership	0.053 (0.701)	0.086 (1.165)	0.067 (0.905)	0.045 (0.613)	0.085 (1.170)	–0.076 (–1.020)	–0.104 (–1.433)
Focal Firm Size	0.157^{+} (1.825)	0.154^{+} (1.860)	0.151^{+} (1.786)	0.121 (1.415)	0.124 (1.497)	0.071 (0.826)	0.039 (0.463)
Partner Firm Size	–0.059 (–0.774)	–0.032 (–0.441)	–0.055 (–0.732)	–0.056 (–0.754)	–0.031 (–0.429)	0.024 (0.317)	0.049 (0.679)
Alliance Structure	0.113 (1.518)	0.118 (1.646)	0.121 (1.632)	0.114 (1.555)	0.122^{+} (1.711)	0.086 (1.168)	0.070 (0.982)
Alliance Duration	0.017 (0.227)	–0.001 (–0.013)	–0.003 (–0.037)	0.024 (0.327)	–0.005 (–0.065)	0.088 (1.179)	0.079 (1.087)
Competitive Regime	–0.069 (–0.951)	–0.063 (–0.904)	–0.079 (–1.099)	–0.056 (–0.779)	–0.063 (–0.912)	–0.055 (–0.762)	–0.033 (–0.467)
Alliance Scope	0.075 (1.004)	0.059 (0.805)	0.088 (1.182)	0.064 (0.862)	0.067 (0.913)	0.072 (0.950)	0.057 (0.789)
Asset Specificity	0.307*** (4.210)	0.290*** (4.126)	0.311*** (4.343)	0.325*** (4.511)	0.310*** (4.441)	0.332*** (4.581)	0.307*** (4.128)
Technological Uncertainty		0.186* (2.547)			0.134^{+} (1.797)	–0.002 (–0.027)	–0.021 (–0.286)
Technological Uncertainty^2		–0.155* (–2.099)			–0.140^{+} (–1.927)		
Demand Uncertainty			0.195* (2.719)		0.136^{+} (1.892)	0.111 (1.518)	0.108 (1.501)
Demand Uncertainty^2			–0.014 (–0.197)		–0.021 (–0.305)		
Behavioral Uncertainty				0.185* (2.557)	0.138* (1.948)	–0.045 (–0.607)	–0.068 (–0.951)
Alliance adaptations							0.159* (2.047)
Alliance adaptations^2							–0.228** (–3.268)
Model summary							
R^2	0.152	0.222	0.190	0.184	0.259	0.187	0.253
$\triangle R^2$		0.019	0.016	0.023	0.088		0.175
Model *F*-value	3.336**	4.297***	3.546***	3.755***	4.066***	3.159***	3.945***

$^{+}p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; $n = 178$.

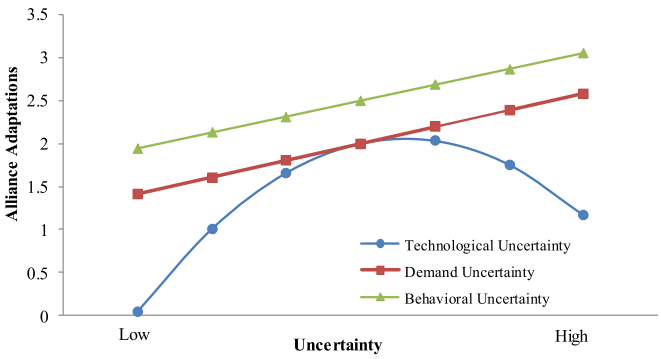

Fig. 1. Effects of uncertainty on alliance adaptations.

significant coefficient of the squared term of alliance adaptations supports H4 (Model 2b: $\beta = -0.228$, $p < 0.01$).

A. Robustness Check

To ensure greater confidence in our findings, we conducted three robustness tests. First, we checked whether our results are sensitive to the alliance type (domestic alliances versus international alliances). We ran regressions using two subsamples of the total sample, 88 international alliances and 90 domestic alliances. We found that these two samples generate highly consistent results, which are also similar to the results of the total sample. Second, we ran regressions using three randomly selected subsamples (90%, 80%, and 70%) of the total observations, and found that our results were consistent with those found using the full sample. Third, we also measured alliance performance by the focal firm's return on assets (ROA). Results have remained consistent with the original results.[2]

[2] All additional robustness test results are available upon request.

VI. Discussion

A. Contributions

Overall, three contributions emerge. First, our findings reveal the variety and complexity of *ex post* governance adaptations in ongoing alliances. Previous alliance governance research generally views alliance adaptations in terms of a single mechanism concerning different aspects of adaptations (e.g., alterations in the alliance contract, changes in the composition of the joint board or committee overseeing the alliance, and changes in the monitoring mechanism). Despite its importance, this single mechanism generally focuses on the likelihood of adaptation practices [5], and fails to reflect the extent of alliance adaptations. Therefore, by incorporating two other important adaptation practices (i.e., changes in the ownership structure and key personnel turnover in the alliance) and bundling these distinct adaptation practices together, this study collectively provides a more complete profile of alliance adaptations. This measure of alliance adaptations allows us to shift from examining the likelihood of adaptations to studying the extent to which partner firms undertake adaptations, thus enriching our current understanding of the conceptualization of alliance adaptations. Concerning the broader literature on the postformation dynamics of alliances, our analysis drawing on several key mechanisms of alliance adaptations is responsive to Reuer *et al*. [5], who call for research to assess the scope and magnitude of alliance adaptations. It is our sincere hope that our research will simulate more advancement in the construction and testing of alliance adaptations theory.

Second, previous alliance governance studies pursuing questions based on TCE generally provide explanations for alliance formation issues, such as which governance mechanism partner firms should adopt for a transaction [23]–[25]. While TCE literature suggests adopting the hierarchical structure when the likelihood for unintended appropriation is high, it does not "provide explanations for adjustments in governance form in response to changes in the environment, partner strategies, and learning differentials" [62]. We extend the existing TCE literature that focuses on the *ex ante* design of alliance governance to highlight the need for effective *ex post* adaptations to fit the changing environment and safeguard against opportunism in alliance relationships. It thus contributes to our understanding of the dynamics of alliance evolution. In addition, we also enrich TCE by showing the effect of uncertainty on alliance e*x post* governance adaptations. We find that this effect is heterogeneous across both types of environmental as well as behavioral uncertainty. Thus, a fine-grained treatment of uncertainty types is necessary to draw valid conclusions about their impact. Overall, this study supports recent calls for the need to understand both external conditions and internal situations in explaining alliance governance dynamics [5].

Third, we contribute to the well-established research on performance implications of alliance governance. Beyond the traditional focus on static governance selection, this study identifies postformation governance dynamics—alliance adaptations—as another key antecedent to alliance performance. Indeed, the relationship between alliance adaptations and alliance performance has been considered to be linear, positive in previous research [7], [8]. However, our analysis offers a novel finding that alliance adaptations have an inverted U-shaped effect on alliance performance. We reveal that overly complex or drastic governance adaptations may bring increased costs that are detrimental to alliance performance. Our study thus indicates that partner firms must be cautious about excessive adaptations and weigh the benefits of undertaking alliance adaptations against the costs. The examination of outcome that occurs after alliance adaptations also will importantly complement our understanding of the value creation with static explanations, responding to prior alliance governance studies that call for fuller explanations of alliance postformation dynamics associated with alliance outcomes [5], [9].

B. Managerial Implications

Our study yields a number of implications for firms regarding the use of alliance adaptations. First, when the external environment of the alliance has changed and existing alliance governance no longer fits into the environmental direction, adapting the alliance could be a reasonable decision. However, managers need to take into account that the optimal level of alliance adaptations depends on the type of uncertainty they face—technological or demand uncertainty. When technological uncertainty is high, firms need to fit by adapting their alliances in multiple facets. However, when technological uncertainty is already very strong, firms should avoid complex governance adaptations. When demand uncertainty is high, firms need to fit by complex adaptations in order to keep track with customer demand.

Second, firms also face the need for adaptations when partners' behaviors are uncertain. Our findings show that firms may use costly governance adaptations to control higher levels of uncertainty about partners' intentions or capabilities. In China, to avoid such costly alliance adaptations, allying with a party with good reputations, which are considered valuable and rare resources in emerging economies characterized by market inefficiency, appears to be helpful. For example, Huawei, China's largest information and communications technology solutions provider, has become the most popular partner to ally with. With improved reputation, the two parties may face very little behavioral uncertainty, which decreases the need for governance adaptations. Or else, contributions and performance measures could be more clearly defined among partners at the early stage of alliances.

Furthermore, alliance adaptations, to some extent, could bring benefits to alliances. For example, after changing the ownership structure, contract, and board members, China Tower, an alliance among China Mobile, China Union, and China Telecom, achieved greater profits. However, firms should be aware of the benefits and downsides associated with alliance adaptations. That is, alliance adaptations do not always improve alliance performance. Alliance managers should be cautious when entertaining any overly drastic governance adaptations.

C. Limitations and Future Research Directions

This study has several limitations, which suggest fruitful areas for further research. First, we measure alliance adaptations on a formative scale. A formative scale requires a comprehensive set of indicators [63]. However, we cannot exhaust all the possible adaptation practices. Therefore, future research should develop more refined measures such as having reflective indicators. Future research can also decompose the construct of alliance adaptations and examine potential synergies among its different mechanisms, such as exploring any complementary or substitute relationship among the practices. Especially, our operationalization of alliance adaptations mainly emphasizes the formal and structural mechanisms of alliance governance, future research should focus more on changes in relational mechanisms. In addition, our arguments on the relationship between adaptations and alliance performance are based on the analysis of adaptation costs. Future research could be done in terms of measuring alliance performance through cost effectiveness [64].

Second, in common with most alliance studies, we use surveyed cross-sectional data to measure our main variables, thus subjecting our study to the limitations of survey studies regarding their effectiveness for testing causal inferences. Future research can use longitudinal data to probe into causal relationships.

Third, we test our hypotheses using data collected from China, which may limit the generalizability of our findings to other economies. Since Chinese firms have a long tradition of using *guanxi* to coordinate transactions [65], alliance adaptations in China may have their own peculiarities. Replications of this study in other national contexts will help establish the generalizability of its results. Fourth, other avenues for research emerge. For instance, this study highlights the antecedents and consequences of alliance postformation dynamics. It will be useful to explore several analyses that reflect such dynamics, such as a mediation analysis or a moderation analysis.

Finally, while we develop a model of alliance adaptations from a TCE perspective, other theoretical perspectives—such as real options theory and organizational inertia—may also be appropriate for understanding alliance adaptations. Future research may incorporate in-depth discussion using these perspectives, and perhaps even compare them with TCE.

VII. Conclusion

Our conclusion is twofold. First, uncertainty may trigger adaptations in strategic alliances. Second, although some adaptations may enhance alliance performance, this positive impact may diminish after adaptations exceed a threshold level. Therefore, our advice to managers is: be flexible to adjust strategic alliances when facing uncertainty, but do not be too flexible.

Appendix: Measurement Scales

Construct	Description	Loadings
Technological uncertainty	1. The technology in our industry is changing quite rapidly.	0.65
(CR = 0.82, alpha = 0.80, AVE = 0.61)	2. There have been major technological developments in our industry.	0.80
	3. A large number of new product ideas have been made possible through technological breakthroughs in our industry.	0.87
Demand uncertainty	1. Customer demand and product preferences are changing quite rapidly.	0.72
(CR = 0.84, alpha = 0.84, AVE = 0.63)	2. We are witnessing demand for our products from customers who never bought from us before.	0.78
	3. Our customers tend to look for new products all the time.	0.88
Behavioral uncertainty	1. The difficulty in assessing the partner's activities in the alliance is high.	0.74
(CR = 0.90, alpha = 0.90, AVE = 0.69)	2. The difficulty in assessing the partner's contribution to the alliance is high.	0.90
	3. The difficulty in monitoring whether the partner follows our recommended operating procedures is high.	0.89
	4. The difficulty in verifying whether the partner behaves opportunistically is high.	0.79
Alliance adaptations	During the collaboration process, we and the partner together undertook the following adjustments or revisions due to the changing initial alliance conditions:	
(Formative scale)	1. Renegotiate the contract to a mutually agreed degree.	
	2. Change the alliance's ownership such as increasing or decreasing one party's share.	
	3. Change the alliance's board or oversight committee such as reelecting board or committee representatives.	
	4. Change the alliance's monitoring mechanisms such as formalizing the internal control system or introducing the third-party audit.	
	5. Replace key personnel from the alliance, such as reappointing new chief engineer, accountants, or internal auditors.	
Alliance performance	1. The alliance is characterized by a strong and harmonious relationship between the partners.	0.90
(CR = 0.95, alpha = 0.95, AVE = 0.79)	2. Our company has achieved the primary objectives(s) in forming this alliance.	0.90
	3. Our company's competitive position has been greatly enhanced due to entering the alliance.	0.93
	4. Our company has been successful in learning some critical skills or capabilities from the partner.	0.88
	5. Our company is satisfied with the overall performance of the alliance.	0.83
Asset specificity	If the alliance were to dissolve:	
(CR = 0.92, alpha = 0.92, AVE = 0.79)	1. It would be difficult for us to recoup investments made in this alliance.	0.85
	2. We would have a lot of trouble redeploying our equipment and facilities presently serving the alliance.	0.96
	3. We would be wasting a lot of knowledge that is tailored to this alliance.	0.85

Note: Respondents answered these questions with reference to the previous three years.

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