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THE RELATIONSHIP BETWEEN VARIETY AND NEW PRODUCT DEVELOPMENT IN MULTI PARTNER ALLIANCES: THE MODERATING EFFECT OF POWER ASYMMETRY

ABSTRACT
Power asymmetry exists in almost all multi-partner alliances. Literature on interpersonal teams suggests that these power differences influence the degree to which variety in partners’ functional purpose and characteristics results in successful new product development. However, little is known about power asymmetry in multi-partner alliances in general, and its effect on the relationship between variety and new product development in specific. Therefore, we investigate the moderation effect of power asymmetry on the relationship between functional, organizational, and industry variety and new product development in multi-partner alliances. For this purpose, we use a database of 409 alliances with multiple partners granted funding from the Netherlands Technology Foundation STW between 2000 and 2004. We find that the negative and positive effects of functional and organizational variety on new product development success in multi-partner alliances are amplified, if power asymmetry is high rather than low. Furthermore, we show that high industry variety increases the chance that a multi-partner alliance will result in new product development success as well as failure, if power asymmetry is low. In addition, we find that the odds of new product development success are usually higher regardless of the level of industry variety, if power asymmetry is high. These results suggest that to get a clear understanding of the benefits (or costs) of variety in multi-partner alliances, future research should always take power asymmetry into account. Moreover, they highlight that business managers should carefully design their multi-partner alliances, both in terms of variety and power relations.
INTRODUCTION

The alliance literature has a rich tradition of examining “comparative interorganizational differences on certain attributes or dimensions” (Parkhe, 1991, p. 582) and new product development (NPD) in alliances. Most of this literature has focused its attention on dyadic alliances and alliance portfolios (Cobeña et al., 2017), but there exists a growing interest in the effects of inter-organizational differences – here called variety – on NPD in multi-partner alliances (MPAs) (e.g. Arranz and de Arroyabe, 2012, Branstetter and Sakakibara, 2002, Raesfeld et al., 2012a, Raesfeld et al., 2012b, Sakakibara, 1997, Schwartz et al., 2012, Spanos and Vonortas, 2012). These studies show that MPAs with different partners create access to complementary resources that can be combined to develop new products (Cui and O’Connor, 2012, Nieto and Santamaria, 2007). At the same time, however, the coordination efforts necessary to manage resource flows between multiple partners greatly increases when variety increases, thereby increasing the costs of NPD (Goerzen and Beamish, 2005, Phelps, 2010).

Despite this invaluable understanding, the dominant approach to conceptualizing variety in alliances is based on an implicit assumption of equal power. However, power is rarely distributed equally among MPA partners (Albers et al., 2015, Bunderson, 2003, Hoehn-Weiss et al., 2017). The literature on interpersonal variety suggests that this power asymmetry may affect the likelihood that variety in MPAs will result in successful NPD in two opposing ways (Bunderson, 2003). The “personalized” perspective on power argues that when power relations are asymmetric, a powerful partner’s resources may be given disproportionate weight, while the powerless partners’ contributions may be overlooked (Bunderson, 2003, Bunderson and Reagans, 2011), thereby diminishing the NPD-related benefits of variety. On the other hand, the “socialized” perspective on power argues that a powerful partner can facilitate the mobilization of unshared resources and engage powerless partners in the NPD process.
(Bunderson and Reagans, 2011, Pitcher and Smith, 2001), thereby reducing the coordination complexities associated with variety.

These insights suggest that to get a clear picture of the effects of variety on NPD in MPAs, research should take power asymmetries into account. Unfortunately, we have limited insight into power asymmetries within MPAs, compared to our depth of understanding about dyadic alliances (Albers, Schweiger and Gibb, 2015, Hingley et al., 2015). Moreover, previous research has overlooked the implications of power asymmetries on the relation between variety and alliance performance. An exception is the work of Hoehn-Weiss, Karim and Lee (2017) that shows that redundancies within the alliance portfolio exacerbate non-uniformity of power imbalance’s negative influence on firm performance. Yet substantial opportunity exists to expand our understanding of the role power asymmetry plays on NPD in diverse MPAs. Accordingly, we address the following research question in our paper: What is the moderation effect of power asymmetry on the relationship between variety and new product development in multi-partner alliances? In the sections that follow, we develop our hypotheses, explain our methods, present our empirical results, discuss our findings, describe our study’s implications, and provide suggestions for future research.

THEORY AND HYPOTHESES

Variety and new product development in MPAs

Following previous literature, we consider variety in functional purpose and partner characteristics as two key domains that affect NPD success (Jiang et al., 2010). Earlier studies (e.g. Cui and O’Connor, 2012, Goerzen and Beamish, 2005, Marhold et al., 2017, Nieto and Santamaria, 2007, Phelps, 2010) have shown that different variety domains affect NPD in another way (Lee et al., 2014). Therefore, we briefly explain the effect of variety in functional purpose and two partner characteristics – industry and organizational type – on NPD in alliances with multiple partners.
**Functional variety.** Functional variety refers to the partners’ different functional activities (Jiang, Tao and Santoro, 2010). Cui and O’Connor (2012) found that functional portfolio diversity negatively influences innovative firm performance. Cross-functional resource mobilization is difficult due to a lack of overlap in prior knowledge and common ground between partners (Cui and O’Connor, 2012). In turn, this increases the likelihood of coordination failures, such as project delays and suboptimal product development (Gulati et al., 2012). Therefore, we hypothesize:

Hypothesis 1: Functional variety has a negative effect on the NPD success of MPAs.

**Organizational variety.** Organizational variety refers to the different organizational types of the partners (Jiang, Tao and Santoro, 2010). It is shown that organizational variety positively influences MPAs innovation performance (Raesfeld, Geurts and Jansen, 2012a, Raesfeld, Geurts, Jansen, Boshuizen and Luttge, 2012b, Schwartz, Peglow, Fritsch and Günther, 2012). Organizations collaborating with others from “different sizes, structures and purposes increase their breadth of search, learning capabilities, and resource access” (Jiang, Tao and Santoro, 2010, p. 1139). Moreover, the risk of coordination failures is limited because the present non-commercial partners are usually able to manage the partners’ contradicting goals, interests, and perspectives (Wu and Pangarkar, 2015). Therefore, we hypothesize:

Hypothesis 2: Organizational variety has a positive effect on the NPD success of MPAs.

**Industry variety.** Industry variety refers to the different industries partners are involved in (Jiang, Tao and Santoro, 2010). Goerzen and Beamish (2005) and Jiang, Tao and Santoro (2010) show that there is a U-shaped relationship between industry portfolio diversity and economic firm performance. At low levels of industry variety, the common background of partners facilitates the integration of supplementary resources (Das and Teng, 2000, Jiang, Tao
and Santoro, 2010). At moderate levels of industry variety, the potential of coalitions with like others increases partners’ concerns about knowledge leakage, which leads to problems of unshared resources (Harrison and Klein, 2007, Li et al., 2012). At high levels of industry variety, partners are open and receptive to coordinating others’ resources (Harrison and Klein, 2007), increasing the possibility of developing new resource combinations (Jiang, Tao and Santoro, 2010). Therefore, we hypothesize:

Hypothesis 3: Industry variety has a U-shaped effect on the NPD success of MPAs.

Power asymmetry and the relationship between variety and new product development
Power asymmetry refers to the composition of differences in proportion of power held among partners in an alliance, that is inequality or relative concentration (Harrison and Klein, 2007). Scholars have dedicated considerable effort to understand power asymmetry’s effects on NPD in dyadic alliances (e.g. Colurcio et al., 2012, Gil and Beckman, 2007, Kim and Park, 2015, Rutherford and Holmes, 2008, Stuart, 2000, Tang et al., 2014, Wang, 2011, Yang et al., 2014). However, theories (e.g. resource dependency theory and transaction cost theory) used in this literature are not well-suited to explain power effects in MPAs because the dynamics of power change drastically when moving from two to multiple partners. In a dyadic alliance either one partner is more powerful than the other or both are equal, but a greater number of options arises when multiple partners are involved. Thus, power in MPAs requires distinctive theoretical development from dyadic alliances (Albers, Schweiger and Gibb, 2015). Here, we build on theories from literature on power in interpersonal teams because it provides two perspectives that can explain the effect of power asymmetry on the relationship between variety and NPD success in MPAs: a “socialized” and “personalized” perspective (McClelland, 1975).

A “socialized” perspective of power – grounded in functionalism theory – suggest that a powerful partner can coordinate the complexities associated with diverse MPAs. A powerful partner can identify, assess, and legitimize resource contributions from different partners and
then arrange resource transfers to others (Bunderson and Reagans, 2011, Dhanaraj and Parkhe, 2006). In this way, it enables partners to realize their combined potential for innovation (Gibb et al., 2016, Heidl et al., 2014, O'Sullivan, 2005). Furthermore, a powerful partner can ensure an “equitable distribution of value and mitigate appropriability concerns” (Dhanaraj and Parkhe, 2006, p. 663). This will help powerless partners to feel safe and encouraged contributing to the NPD process (Bunderson and Reagans, 2011, Dhanaraj and Parkhe, 2006). Additionally, a powerful partner can decrease an alliance’s instability: the higher the stability, the higher the alliance’s potential for value creation (Dhanaraj and Parkhe, 2006).

A “personalized” perspective on power – grounded in conflict theory – suggests that a powerful partner will diminish the NPD-related benefits of variety in MPAs. A powerful partner may share only certain parts of its resources at strategic times. Also, powerless partners are less likely to share their resources due to problems of freeriding and opportunism. This reluctance to share resources can undermine the joint innovation efforts (Bunderson and Reagans, 2011, Hoehn-Weiss, Karim and Lee, 2017). In addition, the partners’ different resources are often not equally represented in the NPD process of alliances. Powerful partners can impose their resources – even if not the most valuable to developing new resource combinations – while the partners that possess unique or even superior resources are not involved (Bunderson, 2003, Bunderson and Reagans, 2011, Corsaro et al., 2012, Harrison and Klein, 2007).

From the “personalized” perspective on power, it can be concluded that higher levels of power asymmetry would reduce the NPD-related benefits from variety in MPAs. Yet we expect a powerful actor to use its power to achieve joint NPD goals because it may: a) undermine its own power position, if it uses its power to enhance self-interests (Bunderson and Reagans, 2011, Kim et al., 2005); b) damage its reputation as a trustworthy partner, if it acts opportunistically (Bae and Gargiulo, 2004, Bunderson and Reagans, 2011); c) find it difficult to form new partnerships, if it develops a reputation as a bad ‘team player’(Bunderson and
Reagans, 2011); and d) risk that other partners withdraw their support, if they perceive they are being exploited (Dhanaraj and Parkhe, 2006). Therefore, we argue – in line with the “socialized” perspective on power – that higher levels of power asymmetry will decrease the coordination challenges of variety in MPAs. Accordingly, we hypothesize that:

Hypothesis 4a: Power asymmetry weakens the negative relationship between functional variety and new product development success of multi-partner alliances.

Hypothesis 4b: Power asymmetry strengthens the positive relationship between organizational variety and new product development success of multi-partner alliances.

Hypothesis 4c: Power asymmetry flattens the U-shaped relationship between industry variety and new product development success of multi-partner alliances.

In Figure 1, the hypothesized relationships are visualized.

METHODS

Sample

The hypotheses were tested in a set of multi-partner R&D alliances funded by the Dutch Technology Foundation STW. The foundation funds application-oriented research projects in which research institutes and potential users of the generated knowledge such as large, medium-sized, and small businesses, non-profit organizations, and healthcare institutes, collaborate. As the partner composition of MPAs funded by STW are consistent with our definition of variety, it was an appropriate research setting to test our hypotheses. We used the publicly available data of 409 MPAs initiated between 2000 and 2004. Besides basic information, such as project
title, project budget and starting date, the data includes information about: a) the users involved in the project; and b) the project results five years after the project finished.

**Measures**

*Dependent variable.* STW’s evaluation of the degree to which a concrete product was developed five years after project completion was used as a measure of NPD success. Based on a survey among researchers, project managers and users involved with the project, STW classified projects into three categories: (A) there was no concrete product: more research was necessary to obtain a useful product for users; (B) a partial product was developed; verification and refinement were still required and users could not independently use it; or (C) a full product was developed: it was a finalized concept that users could autonomously use.

*Independent variables.* To measure MPA variety, we classified each partner into different categories. For *functional variety*, we coded the partners’ functions into three categories: (A) researcher and/or developer; (B) producer; or (C) user. For *organizational variety*, we coded the partners’ organizational types into six categories: (A) companies; (B) governmental parties; (C) research institutes; (D) hospitals and medical institutes; (E) universities and schools; and (F) special interest groups. For *industry variety*, we coded the partners’ industry, using the Dutch version of the SIC coding, into nine categories: (A) mining of minerals; (B) industry; (C) wholesale and retail trade; (D) information and communication; (E) consultancy, research, and other business services; (F) public administration, public services, and compulsory social insurance; (G) education; (H) health and welfare; and (I) other. As suggested by Harrison and Klein (2007), variety at the MPA-level was calculated with the Blau index, normalized for the number of categories. The normalized index was computed as follows: $B^* = \frac{1 - \sum p_k^2}{1 - 1/k}$, where $p$ is the proportion of unit members in $k$th category.

We operationalized *power asymmetry* as the degree of concentration in the partners’ centrality within the alliance because organizations that are central nodes of a network are
generally assumed to gain power (Astley and Sachdeva, 1984, Bonacich, 1987, Freeman, 1978, Koka and Prescott, 2002, Lavie et al., 2007, Tichy and Fombrun, 1979). Specifically, we used Bonacich’s (1987) measure of power centrality, considering it measures the total amount of potential influence a node can have on all others via both direct and indirect channels (Hughes-Morgan and Yao, 2016). Each user’s Bonacich (1987) power centrality within the STW’s network between 2000 and 2004 was calculated using the standard formula in UCINET (version 6.623; Analytic Technologies, Harvard, MA, USA). As the coefficient of variation captures the dominance of those that have higher amounts of a certain attribute (Harrison and Klein, 2007), it was used as a measure of asymmetry at the MPA-level. The coefficient of variation was computed as follows: \( \sqrt{\frac{\sum (D_i - D_{\text{mean}})^2}{D_{\text{mean}}^2/n}} \), where \( D_i \) is the amount of attribute \( D \) of user \( i \), \( D_{\text{mean}} \) is the average amount of attribute \( D \) within a project and \( n \) is the number of users.

**Control variables.** We included three control variables in our analysis. Project budget was measured as the amount of funding (in thousand Euros) the project received from STW. The number of partners was calculated as the absolute number of partners involved in the project. In our sample, 49 percent of the projects was focused on nanotechnology. The immaturity of this technology could influence the degree to which a concrete product is developed. Therefore, we controlled for a focus on nanotechnology by creating a dummy variable for whether the project is directed at nanotechnology (1) or not (0).

**RESULTS**

Table 1 presents the mean and standard deviations as well as the correlations for all variables. Table 2 presents the results of the multi-nominal regression used to test our hypotheses. To meaningfully interpret the inverted U-shaped effect and interaction effects, the variables were centered before analysis. First, Table 2 shows that an increase in functional variety caused an increase in the odds of developing no product, compared to a partial product, with an odds ratio
of 1.29, 95% CI [1.08 to 1.55]. However, Table 2 shows that functional variety did not significantly predicted whether a partial or a full product was developed. Thus, Hypothesis 1 is partially supported.

Second, Table 2 shows that an increase in organizational variety caused a decrease in the odds of developing no product, compared to a partial product, with an odds ratio of 0.37, 95% CI [0.18 to 0.76]. Yet Table 2 shows that organizational variety did not significantly predicted whether a partial or a full product was developed. Thus, Hypothesis 2 is partially supported.

Third, Table 2 shows that direct and squared effects of industry variety had a positive and negative significant effect respectively on the odds of whether a partial or no product was developed, indicating a U-shaped relationship. The uncentered turning point was 1.25, which was located well in the data range [0.97 to 2.79]. Furthermore, Table 2 shows that direct and squared effects of industry variety had a positive significant and negative insignificant effect respectively on the odds of whether a partial or a full product was developed. This indicates that industry variety had a positive linear effect on the odds of developing a full product, compared to a partial product. Thus, Hypothesis 3 is partially supported.

Fourth, Table 2 shows a significant positive interaction effect between functional variety and power asymmetry on the odds of whether no product or a partial product was developed. Figure 1a shows that the negative effect of functional variety on the odds of developing a partial product, compared to no product, was substantiably strengthened when power asymmetry was high. In addition, Table 2 shows a positive, but insignificant interaction effect between functional variety and power asymmetry on the odds of whether a partial or full product was developed. Thus, Hypothesis 4a is rejected.

Fifth, Table 2 shows a significant negative interaction effect between organizational variety and power asymmetry on the odds of whether no product or a partial product was developed. Figure 1b shows that the effect of organizational variety on the odds of developing a partial,
compared to no product, was substantially strengthened under high power asymmetry. Additionally, the results show a positive, but insignificant interaction effect between organizational variety and power asymmetry on the odds of whether no product or a full product was developed. Thus, Hypothesis 4b is partially supported.

Sixth, Table 2 shows a significant negative interaction effect between power asymmetry and industry variety on the odds of whether a partial or no product was developed. Figure 1c shows that the U-shaped relationship between industry variety and the odds of developing a partial product, compared to no product, was flattened under high power asymmetry, while it became negative and linear (i.e. shape flipped) under low power asymmetry. In addition, Figure 1d shows that the positive effect of industry variety on the odds of developing a full product, compared to a partial product, was substantially weakened when power asymmetry was high. Thus, Hypothesis 4c is partially supported.

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Insert Table 1 & 2 and Figure 2 about here
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DISCUSSION
The results show that the relationship between organizational variety and the chance of developing a partial product – compared to no product – is strengthened, if power asymmetry increases. This confirms previous research (e.g. Bunderson and Reagans, 2011, Dhanaraj and Parkhe, 2006, Gibb, Sune and Albers, 2016, Heidl, Steensma and Phelps, 2014, O'Sullivan, 2005, Pitcher and Smith, 2001) arguing that powerful partners can contribute to the NPD success of MPAs by leveraging knowledge mobility, mitigating appropriation concerns, and maintaining alliance stability. In contrast to our expectations, however, the relationship between functional variety and the chance of developing a partial product – compared to no product – is strengthened too, if power asymmetry increases. Therefore, our study also confirms previous research (e.g. Bunderson, 2003, Bunderson and Reagans, 2011, Corsaro, Cantù and Tunisini,
suggesting that powerful partners can hinder the NPD success of alliances by decreasing resource exchange. These contradictory results suggest that power asymmetry amplifies the effects of variety on NPD in MPAs, instead of leveraging its positive and mitigating its negative effects. Below, we speculate on the reasons underlying this amplifying effect.

The findings may imply that the NPD-related benefits associated with organizational variety encourage the “socialized” use of power in high-asymmetric MPAs (Bunderson, 2003, Gulati, Wohlgezogen and Zhelyazkov, 2012). When powerful partners expect benefits from the combination of diverse resources, they may perceive it as worthwhile to help the alliance to reach its collective NPD goals. In contrast, a powerful partner may incur additional coordination costs while it does not gain any additional NPD-related benefits, if the partners within the alliance portfolio are similar (Hoehn-Weiss, Karim and Lee, 2017). As a result, there is a higher likelihood that a powerful partner will use its power to coordinate resource exchange in a MPA, as organizational variety increases.

Furthermore, the coordination costs associated with functional variety seem to encourage the “personalized” use of power in high-asymmetric MPAs (Bunderson and Reagans, 2011, Gulati, Wohlgezogen and Zhelyazkov, 2012). When coordination challenges fuel worry about the benefits of a MPA, a powerful partner may doubt whether effortful forms of coordination are worthwhile. In turn, it may try to minimize individual efforts and risks, while it tries to maximize individual benefits (Ariño and de la Torre, 1998, Gulati, Wohlgezogen and Zhelyazkov, 2012). Another explanation may be that the coordination issues associated with functional variety may be too demanding, even for a powerful partner: its ability to distinguish between truly critical issues and those that there are merely proximate or recent may be limited (Gulati, Wohlgezogen and Zhelyazkov, 2012, Park and Ungson, 2001). As a result, there is a
lower likelihood that a powerful partner is motivated or able to use its power to solve the coordination issues in MPAs, as functional variety increases.

In contrast to our expectation, we did not find a significant interaction effect between power asymmetry and functional & organizational variety on the likelihood that a complete product was developed – compared to a partial product. Our results suggest that this could be since it is generally harder to make a conceptual product than a complete product. Indeed, Markham and Lee (2013) show that the number of ideas that survives the NPD process steeply declines. Moreover, variety “should enhance innovation due to the amount and variety of knowledge to be shared, thereby enable the alliance partners to fill out their initial resource and skill endowments” (Nieto and Santamaria, 2007, p. 371). Yet it may be less important in the latter stages of product development, such as during testing, validation, and commercialization.

Another result is that there is a higher likelihood of developing both no product and a complete product – compared to a partial product – in MPAs characterized by high industry variety and low power asymmetry. Although this result seems contradictory, it underscores the varied results in research into the effect of inter-organizational differences – assuming equal power relations – on alliance performance (see Cobeña, Gallego and Casanueva, 2017, Lee, Kirkpatrick-Husk and Madhavan, 2014). The opposing effects may stem from variety’s dual effect on NPD performance; although it increases failures, it also increases the number of innovative solutions (Phelps, 2010). Thus, MPAs characterized by low industry variety may typically achieve at least some result, but less often create fully developed innovative solutions. In contrast, high industry variety may open opportunities for successful re-combinatory NPD, but if the partners are unable to successfully coordinate their differences, the effects may be detrimental.

This contradictory effect of industry variety disappears if high power asymmetry characterizes a MPA. The results show that power-asymmetric MPAs are generally more likely
to result in the development of a partial or full product. An exception is when there is high industry variety, in which low power asymmetry is more beneficial to achieve a fully developed product. As the partners are from different industries, there are less competitive concerns that would lead them to withhold valuable resources and many opportunities to stimulate NPD (Jiang, Tao and Santoro, 2010, Phelps, 2010). Based on the above discussion, it could therefore be expected that the positive effect of industry variety is amplified – but this is not the case. A possible explanation may be that partners from unrelated industries face many different routines, structures & processes, political & economic systems, and governmental policies, limiting the overlap in backgrounds, experiences, and technological bases (Cui and O'Connor, 2012). In turn, it becomes extremely difficult for a powerful partner to accurately assess the value of others’ resources to the NPD process. Therefore, it may advance – despite its best intentions – the resources of partners in similar industries, while it may overlook resources of others in dissimilar industries, even when those could be important to NPD success. This is in line with the findings of Tarakci et al. (2016) who show that power asymmetry benefits group performance only when its aligned with the power holder’s competence.

IMPLICATIONS

The main theoretical implication of our study is that research on the NPD-related consequences of variety in MPAs is always underspecified, if power asymmetries are not considered. It is difficult to imagine any MPA in which power differences do not exists. Nevertheless, power asymmetries are generally neglected in studies on MPAs (Albers, Schweiger and Gibb, 2015, Hingley, Angell and Lindgreen, 2015). Also, there exists little research that systematically examined how power asymmetry influences the effect of variety on NPD success. Our study confirms previous research that found that different types of variety affect NPD in different ways. In addition, we show that power asymmetry is pervasive in MPAs and has important
implications for the relationship between variety and NPD. We expected a powerful actor to always use its power to achieve mutual NPD objectives, but we found that the relationship between power asymmetry, variety and NPD is much more complicated. We speculated that this is because a powerful actor may either not be willing or able to use its power for the benefit of the MPA, depending on the type of variety it is supposed to coordinate. To determine the actual variety of a MPA and the resulting likelihood that it will result in new innovative products, we therefore stress that future research should focus on the question: *when is a powerful partner willing and able to use its position to solve coordination challenges and when to maximize its individual benefits?*

For practicing managers, our study’s results highlight the difficulty of developing a fully functional new product, compared to the creation of a conceptual product, in a MPA. To increase their chances of success, we suggest managers to form an alliance with partners from many different industries and equal power relations. At the same time, however, we want to caution managers for such an alliance because the combination of high industry variety and low power asymmetry dramatically increase the odds of failure as well. If practicing managers aim for more certain, but less developed, results, we encourage them to form a MPA characterized by unequal power relationships and consisting of partners: a) with a single functional purpose; b) with many different organizational types; c) from either few or many different industries. Moreover, we want to emphasize that unequal power relations generally enhance the likelihood that an alliance creates a conceptual product – except when functional variety is very high and/or organizational variety is very low, then partners are better off with equal power relations.

**LIMITATIONS AND FUTURE RESEARCH**

Despite the theoretical and managerial implications of our study, it is subject to some limitations that suggest avenues for further research. One limitation is that this study cannot provide direct
evidence of the causal mechanisms we hypothesized. Although the hypotheses concerning the moderating effect relied on the argument that a powerful partner is motivated to use its power to coordinate variety in MPAs, our data did not allow use to observe motivation. Although our results are partly consistent with our theoretical expectations, they also indicate that a powerful partner might not be able to coordinate a MPA, if the coordination issues become too large. Therefore, a better understanding of the mechanisms that underlie the observed effects of power asymmetry and variety on NPD in MPAs is needed.

A further limitation of our study results from our measurement of NPD as a subjective evaluation by an external party. We considered a subjective measure appropriate because the NPD objectives are usually rather specific for each alliance (Schwartz, Peglow, Fritsch and Günther, 2012). In addition, same-source variance did not affect our findings because the same individuals did not assess both antecedents and outcomes. However, we acknowledge that there are several other types of performance measures (see Christoffersen, 2013). In line with Schwartz, Peglow, Fritsch and Günther (2012), we therefore encourage researchers to use multiple indicators of NPD success in future research.

In addition, we have limited our focus three types of variety: functional, organizational and industry. However, an overview of Lee, Kirkpatrick-Husk and Madhavan (2014) shows that there are more types of partner characteristics commonly studied in diversity research. Moreover, Jiang, Tao and Santoro (2010) suggests that variety research should also consider variety in governance structure of alliances. Consequently, more research is needed into the effect of power asymmetry on the relationship between other types of variety and NPD.

Another limitation arises from the selection of publicly funded multi-partner R&D alliances as sample. Although we did not select only successful projects, Schwartz, Peglow, Fritsch and Günther (2012) suggests that R&D projects with a considerable risk of failure may be excluded in our sample because they are screened on several criteria before allocation of
funding. Therefore, future research might compare the effects of power asymmetry in subsidized multi-partner R&D projects to its effect in projects that did not receive public funding.

REFERENCES


FIGURE 1
Hypothesized relationships visualized

TABLE 1
Means, standard deviations and correlations

|   | Mean  | S.D.   | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      |
|---|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1 | Partial vs. no product | 0.23   | 0.42   | 1.00   |        |        |        |        |        |        |        |        |
| 2 | Partial vs. full product | 0.30   | 0.46   | -0.36  | 1.00   |        |        |        |        |        |        |        |
| 3 | Field of nanotechnology | 0.49   | 0.50   | 0.07   | -0.02  | 1.00   |        |        |        |        |        |        |
| 4 | Project budget | 458.88 | 252.44 | -0.12  | 0.04   | 0.09   | 1.00   |        |        |        |        |        |
| 5 | Number of project partners | 5.54   | 2.53   | -0.13  | 0.05   | -0.10  | 0.20   | 1.00   |        |        |        |        |
| 6 | Power asymmetry | 0.97   | 0.41   | -0.21  | 0.11   | -0.14  | -0.03  | 0.16   | 1.00   |        |        |        |
| 7 | Functional variety | 3.45   | 3.01   | 0.02   | 0.00   | -0.11  | 0.10   | 0.68   | -0.02  | 1.00   |        |        |
| 8 | Organizational variety | 0.83   | 0.59   | 0.02   | -0.06  | -0.08  | -0.17  | -0.41  | -0.19  | -0.15  | 1.00   |        |
| 9 | Industry variety | 1.28   | 0.15   | -0.10  | 0.08   | -0.08  | 0.17   | 0.85   | 0.04   | 0.66   | -0.28  | 1.00   |

Note: N = 409 MPA
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**Note:** N = 409; Model 1, Nagelkerke Pseudo $R^2 = .04$, $\chi^2(6) = 14.63$, $p = .02$; Model 2, Nagelkerke Pseudo $R^2 = .10$, $\chi^2(14) = 37.05$, $p < 0.01$; Model 3, Nagelkerke Pseudo $R^2 = .18$, $\chi^2(24) = 69.38$, $p < 0.1$.  


FIGURE 2
The interaction effects between variety and power asymmetry on NPD performance

a. Functional variety

b. Organizational variety

c. Industry variety

d. Industry variety

*Compared to no product; **Compared to partial product