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The relationship between team autonomy and new product development performance under different levels of technological turbulence☆

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ABSTRACT

Operations management researchers have frequently suggested that autonomy can motivate teams to actively and flexibly adapt to fast-changing environments, fostering innovation and creative problem solving. However, empirical studies have not consistently supported the benefits of team autonomy. We articulate the behavioral and mechanistic effects of team autonomy by integrating operations management and behavioral literatures. Further, we view team autonomy as a bipolar factor and argue that both the behavioral and mechanistic effects of team autonomy on operational outcomes are non-linear. Drawing on information processing theory, we propose that the benefits of team autonomy depend on the degree of technological turbulence. A study of 212 new product development projects supports these propositions. Specifically, the relationship between team autonomy and operational outcomes is ∩-shaped in technologically turbulent environments and U-shaped in technologically stable environments. Further, operational outcomes mediate the relationships between team autonomy and product success. We discuss the theoretical implications regarding new product development, operations management, the bipolarity of autonomy, and information-processing theory.

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1. Introduction

The influence of decision-making autonomy, such as team autonomy or operational autonomy in operational or innovation processes, is a key issue in operations management (OM) studies (Das and Joshi, 2007; Maritana et al., 2004; Tatikonda and Montoya-Weiss, 2001; Tatikonda and Rosenthal, 2000). OM researchers have frequently touted team autonomy as a means to promote innovation (Das and Joshi, 2007) and creative problem solving (Tatikonda and Rosenthal, 2000) by granting teams the freedom to engage in and support new ideas, experimentation, and creativity, and to take action. Team autonomy has become an integral mechanism used by managers to improve project operational outcomes in both project management and new product development (NPD) settings.

Some scholars suggest that team autonomy – the extent to which the team has authority and freedom in making decisions to fulfill its mission – can motivate teams to actively and flexibly adapt to fast-changing environments, which in turn can lead to better team performance with the implicit assumption of a linear relationship (Langfred, 2005; Patanakul et al., 2012). Others have pointed out the risks of isolation (Haas, 2010) and the loss of managerial control (Mills and Ungson, 2003) which may result from giving teams too much autonomy. As a result, the findings have been inconsistent and contradictory. For example, Cohen and Bailey (1997) concluded that team autonomy improves the performance of stable work teams but not for temporary project-based teams involving high levels of uncertainty. In contrast, Patanakul et al. (2012) found autonomous teams to be more effective in developing radical innovations than teams with less autonomy. While some studies confirmed the moderating effect of technological novelty (Olson et al., 1995; Patanakul et al., 2012), others did not (Tatikonda and Montoya-Weiss, 2001; Tatikonda and Rosenthal, 2000). A meta-analysis concluded that autonomy "appears to be helpful for teams, but additional research is needed to understand

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the environmental conditions that influence the extent to which autonomy improves performance" (Stewart, 2006: 46). A recent meta-analysis reached a similar conclusion (Chen et al., 2010). We believe these inconsistent results indicate that context may play a key role in the autonomy-team performance relationship. Hence, questions that beg to be answered are: *under what circumstances does team autonomy contribute to operational success* and *what mechanisms underlie these relationships*? Specifically, we ask how team autonomy affects NPD project operational outcomes and how technological turbulence affects the relationship.

Consequently, we propose a three-step theoretically-driven argument. First, to respond to repeated calls for the integration of behavioral and OM research (Bendoly et al., 2006; Bendoly and Hur, 2007; Croson et al., 2013; Powell and Johnson, 1980), we argue that team autonomy has both behavioral and non-behavioral effects on operational outcomes. Consistent with Bendoly and Hur (2007), the behavioral effects can be viewed as psychological functions of the capabilities of the team and the perceived characteristics of its work environment, which may lead to team motivation or stress. The non-behavioral effect can be viewed as mechanistic functions of the inherent capabilities of the team and the extent to which the work processes and procedures allow them to make use of those capabilities.

Second, we diverge from the traditional view that team autonomy is a facilitator that influences performance in a linear fashion. We consider team autonomy as a 'bipolar factor' that can act as both a situational constraint and a situational facilitator depending on its relative level (Bendoly and Hur, 2007). As such, we argue that both the behavioral and mechanistic effects of autonomy on operational outcomes performance are non-linear.

Finally, building on Tatikonda and Montoya-Weiss (2001), Tatikonda and Rosenthal (2000) operations model, in which technological uncertainty moderates the relationship between organizational process factors, such as project management autonomy, and operational outcomes, we argue that technological turbulence moderates the team autonomy-operational outcome relationship. Based on information processing theory (Galbraith, 1973; Tushman and Nadler, 1978), different levels of technological turbulence in an NPD project are associated with different information processing requirements, which in turn influence both the behavioral and mechanistic effects of team autonomy. In this study, we focus on technological turbulence because turbulence is an important dimension of environmental uncertainty (Duncan, 1972). Technological turbulence is highly relevant for teams involved in knowledge-intensive work, such as the development of new products and technologies (Calantone et al., 2003; Song and Montoya-Weiss, 2001) and autonomy is regarded as a valuable tool to adapt to a turbulent environment.

In this study, we focus on two key aspects of operational outcomes (Tatikonda and Rosenthal, 2000). The first is *development speed*, which delineates how quickly an idea moves from concept to a product in the marketplace and is a central variable of many OM studies (Chen et al., 2010; Swink et al., 2006). The second is *development cost*, which refers to the degree to which the team adheres to its developmental budget. As operational outcomes are not the end, but the means to achieve market performance, we follow Tatikonda and Montoya-Weiss (2001) to examine the mediating effects of these two operational outcomes on the financial success of NPD projects.

We aim to contribute to both the OM and NPD literatures by integrating behavioral operations with a bipolar concept and incorporating information processing theory to explain the conflicting empirical results on the effects of team autonomy on operational outcomes. This study is among the first to empirically test and confirm curvilinear relationships between team autonomy and operational outcomes under different levels of technological turbulence. The findings, based on the data from 212 NPD project teams, suggest that in technologically turbulent environments, a greater degree of autonomy leads to better project operational outcomes; however, due to the risks involved in granting high levels of autonomy, a shared power approach may be more effective. In technologically stable environments, a clearer distribution of power, either directive-oriented or autonomy-oriented, will result in faster, more effective decision-making than a shared-power approach.

2. Theory and hypotheses

We define team autonomy as the extent to which a team has the authority and freedom to make its own decisions to fulfill its mission (Gerwin, 1999; Langfred, 2005; Stewart and Barrick, 2000). While most researchers and practitioners advocate for the benefits of team autonomy, others emphasize the risks and costs. Without an integrated picture, the results from empirical studies are inconsistent and contradictory. We propose a theoretically-driven explanation for these inconsistencies in autonomy research. First, we discuss the behavioral and mechanistic benefits of team autonomy. Second, we introduce technological turbulence as an essential contextual variable influencing the team autonomy-operational outcomes relationships using information processing theory. We then discuss how the relationship changes from an inverted U to a U-shaped function as technological turbulence decreases. Finally, we discuss the mediating effect of operational outcomes between team autonomy and product success. Fig. 1 summarizes the core model.

2.1. The behavioral and mechanistic effects of team autonomy

We view the effects of team autonomy from two aspects, namely through a behavioral effect and a non-behavioral or mechanistic effect. In particular, we regard autonomy as either a constraining or facilitating factor as the degree of autonomy granted can either limit or increase a system's ability, or the ability of a team within that system, to attain a higher level of performance (Bendoly and Hur, 2007). Greater decision-making authority can increase a team's qualitative workload and eliminate constraints on the team's behaviors and performance. We argue that the behavioral and mechanistic effects of team autonomy are curvilinear because team autonomy can either facilitate or inhibit a team's ability to achieve its work goals, depending on the degree of authority

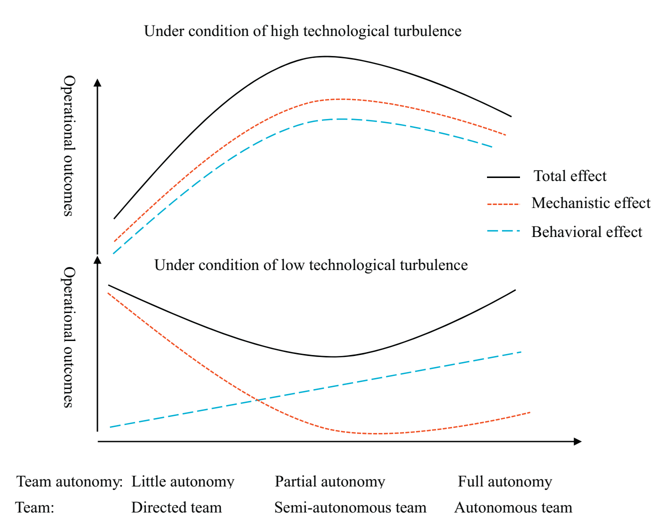

Fig. 1. Theoretical prediction on the relationship between team autonomy and operational outcome under different conditions of technological turbulence.

granted (Bendoly and Hur, 2007; O'Connor et al., 1982). In the paragraphs below, we further describe these effects.

2.1.1. Behavioral effects

The behavioral effects of team autonomy can be viewed as psychological functions of the capabilities of the team and the perceived characteristics of its work environment (Bendoly and Hur, 2007). Recent discussions suggest that a higher degree of autonomy can have two effects on motivation: "challenge-driven adjustment to motivation" and "stress-driven adjustment to motivation" (Bendoly and Hur, 2007: 25; Locke and Latham, 1990), depending on the individual capabilities of team members and the perceived work environment. Recent empirical studies consistently report that the relative weights of these two behavioral effects lead to three distinct behavioral states of individual workers (Bendoly, 2011; Bendoly and Prietula, 2008): 'indifference', in which a low state of motivation results from a lack of sufficient challenge; 'arousal', in which a high state of motivation results from being 'sufficiently, but not excessively' challenged (Locke and Latham, 1990); and 'depression', in which distraction, stress and a reduction in motivation result from the excessive challenges. These findings together imply an inverted-U relationship between challenges and both motivation and performance outcomes (Bendoly, 2011; Bendoly and Prietula, 2008).

A similar argument can be applied to NPD teams. A team with little autonomy may feel bored and indifferent, while increased autonomy can motivate team members to overcome challenges and vigorously pursue project objectives (Locke and Latham, 1990). This independence allows autonomous teams to leverage commitment, ownership, and accountability for their actions in pursuit of self-achievement and project success (Haas, 2010; Patanakul et al., 2012). However, when facing requirements beyond the team's capabilities, members can experience stress and demotivation (Bendoly and Hur, 2007; Treville and Antonakis, 2006).

2.1.2. Mechanistic effects

The non-behavioral effect can be viewed as mechanistic functions of the inherent capabilities of the team and the extent to which the work processes and procedures allow the team to make use of those capabilities (Bendoly and Hur, 2007). Increased autonomy can change traditional work processes and reduce superfluous managerial and bureaucratic constraints on teams, which can enhance the team's ability to be adaptive and responsive. Because dispersed, cross-functional teams are more likely than management to possess the detailed, tacit knowledge about trends in technical systems, autonomous teams can quickly formulate responses and produce effective solutions (Haas, 2010; Langfred, 2005). Without seeking approval from higher authorities, autonomous teams are able to swiftly implement their solutions (Cordery et al., 2010; Wall et al., 2002). Due to their independence, autonomous teams are more likely to create their own goals and operating procedures, such as shared processes, performance metrics, milestones, and reward systems, which can promote flexibility in information processing and facilitate knowledge integration and sharing among its members (Patanakul et al., 2012). The shared understanding of goals and work procedures in autonomous teams will allow team members to exchange information and synchronize actions, improving project team performance over time (Lorinkova et al., 2013; Yun et al., 2005).

However, increasing autonomy is not without mechanistic costs and risks that could constrain performance. There are two possible risks to autonomous teams regarding coordination and control mechanisms within an organization. First, autonomous team's independence may isolate them from their organization and encourage them to disregard input from outsiders and resist courses of action which may benefit the organization (Haas, 2010). Autonomous teams can be costly as their independence may limit their willingness or ability to share resources and capabilities with others (Patanakul et al., 2012). Second, management may lose control of an autonomous team that either misunderstands managerial directives or chooses not to do what is expected (Mills and Ungson, 2003). The former might result from unclear or uncertain messages from management; the latter might result from the potential for highly autonomous teams to act opportunistically (Shimizu, 2012). The risk of isolation may prevent teams from their optimal performance. The risk of losing control as a consequence of value incongruence between teams and their organization are relevant concerns for the organization.

For example, consider NPD teams working on the development of new models for a shoe manufacturing company. If each team is working independently, then each will develop its own models, which may be highly disconnected from one another. The absence of knowledge sharing can lead to duplicate work and more mistakes. However, if the teams are tightly linked through a fully integrated centralized hub, then management can become a bottleneck, constraining performance through attempts to monitor and regulate learning and performance. In this case, the mechanistic effects of autonomy lead to the inverted-U performance relationship, completely independent of any behavioral effects.

2.2. Information processing theory and the moderating effects of technological turbulence

The benefits of team autonomy are dependent on the costs and risks associated with the external environment. Such a view has a long history in information processing theory, which predicts that effectiveness is a function of the match between the information processing capabilities of an organizational structure with the information processing requirements resulting from task and environmental uncertainty (Galbraith, 1973; Tushman and Nadler, 1978). Thus, effective operations strategy requires the autonomy granted should match the autonomy required for operational success (Maritana et al., 2004). Though Tatikonda and Rosenthal (2000) suggest that technological novelty does not moderate the relationship between project management autonomy and project performance, other studies have found that the team autonomy–performance relationship is moderated by task uncertainty (Cordery et al., 2010; Haas, 2010), technological novelty and product innovativeness (Olson et al., 1995; Patanakul et al., 2012), and task interdependency (Langfred, 2005). Among many dimensions affecting environmental uncertainty, turbulence (i.e., the rate and unpredictability of change) was found to be particularly important (Duncan, 1972).

Technological turbulence – the rate and unpredictability of change associated with technology used to develop new products in an industry (Jaworski and Kohli, 1993) – is an important environmental contingency for NPD teams (Calantone et al., 2003; Eisenhardt and Tabrizi, 1995; Song and Montoya-Weiss, 2001). Turbulent environments, compared to stable environments, are highly uncertain and thus require timely information for improved decision making (Balkin et al., 2000; Wu et al., 2005). Technological turbulence is associated with difficulties beyond the unproven technologies themselves; high technological turbulence may lead to changing industry standards, making forecasts difficult (Wu et al., 2005). We argue the intensive information needs associated with high technological turbulence require organizational structures featuring high information processing capacities. We also argue that high technological turbulence can become a source of stress for NPD teams when the perceived requirements of the environment exceed the capabilities of the team. Hence, we expect technological turbulence influences both the behavioral and mechanistic effects of team autonomy, as discussed below.

2.2.1. Behavioral effects in technologically turbulent environments

We argue that the behavioral effects of team autonomy will vary under different conditions of technological turbulence because the information-processing requirements associated with technological turbulence can change the relative relationship between team capabilities and their perceived challenges. In a technologically turbulent environment, the stress related to high levels of autonomy should be more salient. When new technologies quickly emerge, the requirements for dealing with the fast-changing environment may lie beyond the team's capability (Chen et al., 2012). In such circumstances, we propose that the challenge-driven adjustment to motivation dominates until team autonomy increases to a certain threshold, where the stress-driven adjustment to motivation becomes dominant. Together, the challenge and stress related effects contribute to an ∩-shaped relationship between team autonomy and motivation (Bendoly and Hur, 2007). A similar non-monotonic behavioral effect between workload and revenue management has been recently empirically tested (Bendoly, 2011; Bendoly and Prietula, 2008).

2.2.2. Mechanistic effects in technologically turbulent environments

According to information processing theory, in a technologically turbulent environment, organic organizational structures are needed to match the intensive information processing requirements resulting from high environmental uncertainty (Galbraith, 1973; Tushman and Nadler, 1978). Autonomous teams can make quick decisions based on local knowledge and consider new alternatives to deal with the challenges of fast-changing technologies. In these circumstances, waiting for managerial approval will delay the NPD process, lowering project operational efficiency. For example, Olson et al. (1995) found that the use of a more participative structure is positively related to faster completion time, better product quality, and the completion of sales objectives, but only in the case of highly innovative NPD projects. Similarly, the results of Lewis et al. (2002) suggest that project uncertainty may augment the relationship between team autonomy and development speed and cost.

At the same time, the risks of team autonomy can become serious in a fast-changing environment, increasing more quickly when the degree of team autonomy passes a certain level where the risks begin to outweigh the benefits. We believe this will be the case for two reasons. First, with higher levels of independence, an autonomous NPD team is more likely to fail to identify recently discovered solutions or methods to accomplish their objectives which might already exist within their organization (Haas, 2010). Second, within turbulent environments, a highly autonomous NPD team is increasingly likely to fall off track and pursue unproductive paths (Patanakul et al., 2012). In short, in a highly turbulent environment, an insufficient degree of team authority can constrain the team's capabilities and limit team performance; however, an excess of team authority can lead to reverse directionality resulting from the risk of isolation and the loss of managerial control.

Such reverse directionality has been suggested as a way to understand work-in-process (Sakakibara et al., 1997) and workload (Bendoly and Hur, 2007). Other studies have found similar curvilinear relationships between team structures and processes and their performance (Stewart and Barrick, 2000). For example, Stern et al. (2008) found a U-shaped relationship between the autonomy of resident physicians and number of errors. Recently, an ∩-shaped relationship between managers' autonomy and corporate entrepreneurship success has been argued (Shimizu, 2012). The relationship between team autonomy and performance, however, may differ when technological turbulence decreases from high to low.

2.2.3. Behavioral effects in technologically stable environments

In a technologically stable environment where NPD teams face relatively little uncertainty (Wu et al., 2005), decision-making challenges are limited and information processing requirements become minimal. Hence, the minimal information requirements will slowly increase or never reach the limit of the team's capabilities (Chen et al., 2012), so a higher level of autonomy may always foster behavioral benefits. Hence, the behavioral effect of team autonomy may monotonically increase in a technologically placid environment.

2.2.4. Mechanistic effects in technologically stable environments

In a technologically stable environment, both mechanistic benefits and risks may be less obvious. According to information processing theory, a mechanistic or directive approach should work well in a placid situation. Managers are likely to have the experience and knowledge necessary to develop sound strategies, guidelines, and procedures. Armed with this knowledge, managers can provide adequate direction to NPD teams, who can then easily follow and implement managerial directives (Lorinkova et al., 2013; Martin et al., 2013).

On the other hand, if management is willing to completely delegate authority to NPD teams, then this unity of direction can be maintained. Self-directed NPD teams can work independently and assume responsibility and authority for team outcomes. At the same time, the risks of isolation and loss of control of an autonomous team should be less serious than is the case in technologically turbulent environments. In stable environments, decision variables are easily identified and the relationships between these variables are readily understood (Fredrickson, 1984). Practices are more standardized and problem solving is systematic (Eisenhardt, 1989). Some recent empirical studies support for these claims. For example, Martin et al. (2013) found that both directive and empowering leadership increased core task proficiency of work units in a field experiment.

In short, in turbulent environments, the benefits of both the behavioral and mechanistic effects become salient, but the costs and risks of autonomy increase more quickly when the degree of autonomy goes beyond a certain level (Bendoly and Hur, 2007; Haas, 2010). In stable environments where NPD teams face relatively little uncertainty (Wu et al., 2005), the behavioral and mechanistic benefits of autonomy are reversed, and we argue that the former will be dominant when there is a high level of autonomy and the latter will be dominant when there is a low level of autonomy. Thus, we hypothesize:

H1. Technological turbulence moderates the relationship between team autonomy and operational outcomes in such a way that while the relationship is ∩-shaped in technologically turbulent environments, the relationship is U-shaped in technologically stable environments.

2.3. The mediating effect of project operational outcomes

In the discussion above, we focused on the operations model (Tatikonda and Montoya-Weiss, 2001). Following their marketing model, we contend that team autonomy will influence product success through project operational outcomes. As a managerial decision variable, team autonomy is related to the execution of product development tasks. A well-executed project may lead to project operational success but still result in a market failure. This is because product success is influenced by many factors, such as corporate strategy or market conditions, which are out of the control of an NPD team. For example, Tatikonda and Rosenthal (2000) argue that in spite of high operational success, market failure can occur if a chosen project does not fit the company strategy, or if a product is introduced into the wrong market or with a poor marketing strategy. Thus, operational success is not an end but a means to market success as a company's ultimate objective.

The success of a new product is a function of the organization's NPD capabilities. Successful new products are more likely to emerge when development activities are well executed and produce high customer value. Operational success (i.e., high development speed and low development cost) reflects the organization's product development capabilities available to meet customer needs (Tatikonda and Montoya-Weiss, 2001). In order for a new product to achieve financial success, a company needs to develop a good product and launch it at the right time. We expect that with increased NPD speed, a product launch will have a better chance to achieve first-mover or fast-follower advantages, which are crucial to product success (Chen et al., 2012). Further, when NPD project costs are controlled, NPD teams should improve the expected returns from the product launch and achieve better market outcomes (Chen et al., 2012; Tatikonda and Montoya-Weiss, 2001). Several studies have supported the mediating model of team processes on product success in NPD projects (Swink et al., 2006; Tatikonda and Montoya-Weiss, 2001). Hence, we hypothesize:

H2. Project operational outcomes mediate the relationship between team autonomy and product success.

3. Methods

3.1. Data collection and sample

To test the hypotheses, a questionnaire based on previous research was developed (Cooper and Kleinschmidt, 1987; Jaworski and Kohli, 1993; Lynn and Akgun, 1998), following the well-accepted practices (Churchill, 1979). The questionnaire was pretested and refined before being finalized. Our data were collected as a part of an executive management program at a university in the Northeastern region of the United States. Students in the program were asked to identify individuals who were senior members or leaders of NPD teams. These individuals were then solicited to participate in our study as they were most likely to have a "big-picture" view of NPD projects and could provide more reliable and objective data. Respondents were informed their responses would remain anonymous. Each respondent was asked to consider a recently completed and familiar NPD project. Recency and familiarity were used as selection criterion to reduce the potential bias towards more successful projects. Additionally, the selected products must have been commercialized and launched for at least six months so that the respondents could provide assessments of NPD performance.

Of the initial 261 individuals identified to participate, 212 from 86 companies returned useful questionnaires (81.3% response rate). Our response rate was high because we used executive students as contacts to reach respondents. Similar to previous NPD studies (Cooper and Kleinschmidt, 1987; Olson et al., 1995; Patanakul et al., 2012; Tatikonda and Montoya-Weiss, 2001), the new products examined in this study represented a variety of industries. The profile of responding companies and respondents are reported in Table 1. In order to examine construct reliability and validity, we asked each respondent to recommend another person who was familiar with the same project to fill out a second questionnaire. We received second responses from 96 individuals.[1]

[1] All hypothesis testing was completed using the initial respondents.

Table 1
Profile of responding companies and respondents.

Industries	Percent
Communications	23.6
Electronic equipment	16.5
National security	14.2
Measuring and controlling instruments	13.2
Business service	6.6
Food	4.7
Fabricated metal products	4.7
Computer equipment	3.3
Chemical products	2.8
Computer service	2.4
Transportation equipment	1.9
Textile mill products	1.4
Space technology	1.4
Electric Services	.9
Business credit institutions	.9
Furniture	.5
Petroleum reefing industries	.5
Education service	.5
Total	100

Number of employees at the company	Percent
Under 100	8.0
101–250	7.1
251–499	9.9
500–5000	27.4
Over 5000	47.6
Total	100

Title of respondents	Percent
President/owner	1.9
Vice president	4.2
Product/project manager	34.9
Department manger	14.2
Senior engineer/technical lead	26.4
Engineer or technician	7.1
Other	9.4
Missing	1.9
	100

3.2. Measurement

Each construct was measured using multiple items and a 0 to 10 Likert scale (0—strongly disagree to 10—strongly agree). The following section briefly describes the study's measures, which are presented in Table 2.

3.2.1. Dependent variables

Following Tatikonda and Montoya-Weiss (2001), we measured development speed and development cost, as well as product success. Development speed is a primary means for firms to quickly adapt to a fast-changing environment (Eisenhardt and Tabrizi, 1995) and build new core competencies to differentiate themselves (Chen et al., 2012). Since respondents were from a wide variety of companies and industries, relative measures were used to ensure that project performance measures were comparable. Adapting the three items used by Kessler and Chakrabarti (1999), development speed was assessed relative to pre-set schedules, company standards, and similar competitive products and projects. Development cost was assessed relative to the original budget and the cost estimates. This three-item scale was adopted from Cooper and Kleinschmidt (1987). Similarly, a five-item scale was used to assess product financial performance relative to project expectations in

Table 2
Construct measurement and confirmatory factor analysis result.

Item description	Factor loading	*t*-value
Product success (Cooper and Kleinschmidt, 1987)(α = .96, ICC(1) = .53)[a]		
Overall, this project met or exceeded sales expectations	.96	17.88
This project met or exceeded profit expectations	.97	18.30
This project met or exceeded return on investment (ROI) expectations	.96	18.30
This project met or exceeded overall senior management's expectations	.91	16.15
This project met or exceeded market share expectations	.69	9.20
Development speed (Kessler and Chakrabarti, 1999) (α = .80, ICC(1) = .61)		
This project was developed and launched faster than our major competitors	.88	14.85
This project was completed in less time than what was considered normal and customary for our industry	.91	16.10
This project was launched on or ahead of the original schedule developed at initial project go-ahead	.76	12.90
Development cost (Cooper and Kleinschmidt, 1987) (α = .92, ICC(1) = .47)		
This project was launched within or under the original budget	.89	16.30
This project came in at or below cost estimate for development.	.94	17.84
This project came in at or below cost estimate for production	.83	14.56
Team autonomy (α = .83, ICC(1) = .37)		
The core team had the authority to make most of the decisions that impact this project	.84	13.76
The core team did not have to consult senior company management for most of the decisions that had to be made	.81	13.04
The core team was empowered to fulfill its mission	80	13.95
Team experience (Akgün and Lynn, 2002) (α = .71, ICC(1) = .45)		
There was a critical mass of experienced people on the team who had developed and launched similar products before	.63	8.56
People on the team brought with them a wealth of information gained from prior assignments within this company	.73	9.92
Department managers on this team (Engineering, Manufacturing, Marketing, etc.) had previously worked on similar products within the company	.66	8.84
Technological turbulence (Jaworski and Kohli, 1993) (α = .88, ICC(1) = .58)		
The technology used in this product was rapidly changing	.81	13.85
The technology in our industry was rapidly changing	.89	15.77
A large number of new product ideas have been made possible through technological breakthroughs in the industry	.75	12.32
Technological changes provided big opportunities in the industry	.75	12.40
Model fit index X^2 (df = 174) = 358.41, p = .00, CFI = .946, IFI = .946, RMSEA = .071, SRMR = .057		

[a] ICC values were computed based on the double respondent from 96 teams.

terms of sales, profit, return on investment, market share, and overall senior management's expectation (Cooper and Kleinschmidt, 1987). All dependent variables were validated in other studies (e.g., Patanakul et al., 2012).

3.2.2. Independent variables

We define team autonomy as the extent to which a team has discretion and freedom in deciding how to fulfill its mission. In the absence of a widely accepted scale, we developed a three-item scale to measure the teams' authority and freedom in decision-making. The items included: "The core team had the authority to make most of the decisions that impact this project," "The core team did not have to consult senior company management for most of the decisions that had to be made," and "The core team was empowered to fulfill its mission." This measurement is aligned with Langfred's (2004) employee autonomy scale.

3.2.3. Moderating variables

Environmental turbulence can be captured using archival or perceptual measures and considerable debate exists in the literature on the most appropriate measure for researchers to use (see Boyd et al., 1993). For example, some suggest that researchers interested in firm outcomes would benefit most from using archival measures. Others suggest that researchers interested in firm actions, such as executive decision making, should use perceptual measures. Finally, researchers examining the match between organizations and their environments would benefit from including both types of measures (Boyd et al., 1993). Thus, because our study considers the level of fit between team autonomy and the environment, the use of both perceptual and objective measures of environmental turbulence seems warranted.

Further, in the minds of project managers and team members, projects have different priorities with different intended outcomes and different expectation levels. These differences are likely to be a function of individuals' perceptions of the environment, which, therefore, may influence their basis for assessing a project's outcomes and the extent to which a project is viewed as a success. Under these conditions, the sole use of perceptual measures of the environment may confound empirical tests of cause-and-effects relationships on project performance. Moreover, as our model considers both the behavioral effects (which would support the use of a perceptual measure of environmental turbulence) and the mechanistic effects (which would support the use of an archival measure of environmental turbulence) of team autonomy, the use of either an objective or an archival measure alone might fail to fully account for the influence of both effects. Thus, based on the realities our study, which are subject to the effects of both objective conditions and subjective assessments of the environment, we believe the use of both perceptual and archival measures is appropriate and necessary.

Therefore, in our study, similar to Pagell and Krause (2004), we measured technological turbulence different ways, including a well-established perceptual measure and two archival measures (one well-established and one newly developed for the purposes of this study). For our perceptual measure, we adopted Jaworski and Kohli's (1993) widely referenced four-item perceived technological turbulence scale. This scale measures the degree of perceived technological change in a given industry. Sample items include "The technology used in this product was rapidly changing" and "The technology in our industry was rapidly changing."

Further, there is no widely-accepted archival measure for technological turbulence, so we used two different scales. First, we adopted an established measure of environmental instability. Following Dess and Beard (1984) and Keats and Hitt (1988), we calculated environmental instability as the standard errors of the regression slopes for the net sales and costs of goods sold of a given industry based on four-digit SIC codes in the US over the five-year period preceding the distribution of the survey. Next, we created a new archival scale measuring the degree of turbulence in industry-wide R&D spending, called R&D turbulence. Consistent with Dess and Beard (1984) and Keats and Hitt (1988), we calculated R&D turbulence as the standard errors of the regression slope for the average R&D spending of a given industry based on four-digit SIC codes in the US over the same five-year period preceding the distribution of the survey. The data for net sales, costs of goods sold, and R&D spending were collected through COMPUSTAT.

3.2.4. Control variables

We included a variety of control variables at the team/project, firm, and industry levels. At the team/project level, we included team experience, team co-location, product type, and team size. Prior team experience is not only an important factor influencing project operational efficiency, but also potentially affects the level of team autonomy and how effectively autonomy is used (Haas, 2010; Yun et al., 2005). We used three items from Akgün and Lynn (2002) to measure team experience (e.g., "There was a critical mass of experienced people on the team who had developed and launched similar products before."). Team co-location was suggested as an important team level variable (Lampel and Giachetti, 2013). We used two items to measure team co-location: "The core engineers on this team were located within a short walk of the core marketers," and "The core engineers on this team were located so close to the core marketers that they could talk to one another without using a telephone". Product type is an important contextual variable which may influence NPD practices and performance. We measured product type using the innovation typology from Patanakul et al. (2012) and we coded the innovations as incremental (0) or non-incremental (1). To control for team size, we logged the average of the number of core team members at the stages of pre-prototype and launch.

We controlled for firm level-effects using four dummy variables of firm size, measured categorically by the number of employees (Table 1). We used industry dummies and R&D spending to control for industry-level affects. We used two dummy variables: information technology (IT) industry and defense industry, using the rest of the industries as the control group. IT industry included computer equipment, electronic equipment, telecommunications, and computer service. Defense industry included space technology and national security. The industry profiles based on two-digit SIC codes are reported in Table 1.

3.3. Reliability, validity, and common method variance

We took several approaches to test construct reliability and validity. We assessed the internal consistency reliabilities of the multi-item constructs and, as indicated in Table 3, every scale had Cronbach's alphas exceeding the recommended $\alpha > .70$ (Nunnally, 1978). While many previous studies found no link between archival and perceptual measures (e.g., Pagell and Krause 2004), in this data set, environmental instability is significantly correlated with both technological turbulence and R&D turbulence, providing some consistency. For the 96 cases where we had multiple responses, interclass correlations (ICCs) revealed a strong level of inter-rater reliability: correlations were consistently significant at the $p \leq .001$ levels and ICCs were larger than .30 for the key constructs examined. That is, respondents within a team made similar judgments.

We conducted a confirmatory factor analysis (CFA) to assess convergence of the multi-item constructs (Joreskog and Kraft, 1989). The results of the CFA indicated the measurement model fits the data well (χ^2 (df = 174) = 358.41, p = .00, comparative fit index (CFI) = .946, incremental fit index (IFI) = .946, root mean square error of approximation (RMSEA) = .071, and standardized root mean residual (SRMR) = .057). This confirmed the unidimensionality of each construct in the model. Convergent validity is observed when the path coefficients from latent constructs to their correspondent indicators are statistically significant (Anderson and Gerbing, 1988). All items loaded significantly on their corresponding latent construct, with the lowest t-value being 8.84, providing evidence of convergent validity. The construct composite reliability of each multi-item construct is larger than its average variance extracted, which supports their convergent validity (Fornell and Larcker, 1981).

We used three methods to assess discriminant validity. First, none of the confidence intervals for the inter-factor correlations (Φ) contained a value of one ($p \leq .001$). Second, we conducted a chi-square difference test for all the pairs of multi-item constructs by comparing an unconstrained measurement model with a constrained model in which the inter-factor correlations are set to one (Anderson and Gerbing, 1988). In each case, the unconstrained model had a better fit than the constrained model. Third, each squared inter-factor correlation was smaller than the average variance extracted from the two constructs. All three analyses provide evidence to support the discriminant validity of our measures (Fornell and Larcker, 1981). Together, these results supported the construct validity of our measures and provided evidence that we could draw reliable conclusions based on our single respondent.

Although our hypothesis testing is based on a single source data, the following analyses indicate that common method bias should not be significant. First, self-reported data is most problematic for topics which generate strong sentiments, such as attitudes (Cote and Buckley, 1987). New product performance might be a less emotionally laden subject and hence less likely to be distorted by self-reports. In addition, social desirability bias often leads to response range compression (Podsakoff et al., 2003), which was not

Table 3
Descriptive statistics and correlation analysis results.

	Min	Max	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Product success	0	10	5.11	2.85	**(.96)**												
2. Development speed	0	10	5.51	2.81	.47**	**(.80)**											
3. Development cost	0	10	5.47	3.02	.44**	.63**	**(.92)**										
4. Team autonomy	0	10	6.84	2.27	.26**	.44**	.35**	**(.83)**									
5. Technological turbulence	0	10	5.75	2.75	.10	.16*	.07	.13	**(.88)**								
6. Team experience	0	10	6.30	2.17	.33**	.21**	.24**	.28**	−.01	**(.71)**							
7. Team Co-location	0	10	3.96	3.70	.08	.12	−.05	.21**	.02	.07	**(.86)**						
8. Product type	0	1	.73	.44	−.00	−.05	−.11	−.02	.38**	−.04	.03	–					
9.Team size	2	833	25.09	63.45	−.10	−.15*	−.16*	−.14*	.16*	−.04	−.06	.14*	–				
10. R&D (%)	0	15.34	.04	.05	.01	−.01	−.17*	.06	.05	.12	.22**	.04	.02				
11. R&D turbulence	1.01	1.92	1.22	.16	−.01	−.03	−.06	.14*	.01	.07	.21**	.13	−.06	.27**			
12. Instability	1.01	1.78	1.29	.22	−.03	−.07	−.05	.11	.31**	−.11	−.04	.14*	.16	−.06	.23**	**(.73)**	
13. IT	0	1	.43	.50	−.04	−.12	−.17*	.06	.25**	−.12	.08	.19*	.30**	.23**	−.07	.51**	–
14. Defense	0	1	.16	.36	.03	.03	.07	−.16*	−.15*	−.03	−.20**	−.06	−.03	−.23**	.55**	−.53**	−.38**

The numbers in parentheses are the Cronbach's alphas.

* $p \leq .05$.

** $p \leq .01$, two-tailed tests.

Table 4
Results of hierarchical moderated regression analysis with perceived technological turbulence.

	Development speed			Development cost			Product success	
	Model 1a[a]	Model 2a	Model 3a[b]	Model 1b	Model 2b	Model 3b	Model 4	Model 5
Team autonomy	$\mathbf{.48}^{**}$	$\mathbf{.50}^{**}$	$\mathbf{.52}^{**}$	$\mathbf{.41}^{**}$	$\mathbf{.44}^{**}$	$\mathbf{.46}^{**}$	$\mathbf{.20}^{*}$	$\mathbf{-.04}$
	(.08)	(.10)	(.10)	(.09)	(.11)	(.10)	(.09)	(.09)
Technological turbulence (TT)	$.18^{*}$	$.18^{*}$	$.30^{**}$	$.13^{\dagger}$	$.13^{\dagger}$	$.28^{**}$	.10	.02
	(.07)	(.07)	(.09)	(.07)	(.08)	(.09)	(.08)	(.07)
Team autonomy^2		.01	−.01		.02	−.01		
		(.03)	(.03)		(.03)	(.03)		
Autonomy × TT		.04	.01		.01	−.04		
		(.03)	(.03)		(.03)	(.03)		
Autonomy^2 × TT			$\mathbf{-.02}^{*}$			$\mathbf{-.03}^{**}$		
			(.01)			(.01)		
Development speed								$\mathbf{.30}^{**}$
								(.08)
Development cost								$\mathbf{.21}^{**}$
								(.08)
Constant	5.57^{**}	5.52^{**}	5.60^{**}	5.93^{**}	5.84^{**}	5.95^{**}	4.70^{**}	1.79^{**}
	(.57)	(.61)	(.60)	(.62)	(.65)	(.64)	(.62)	(.73)
Team experience	.12	.13	.13	$.26^{**}$	$.26^{**}$	$.26^{**}$	$.40^{**}$	$.31^{**}$
	(.09)	(.09)	(.09)	(.10)	(.10)	(.10)	(.10)	(.09)
Team co-location	.05	.05	.05	−.06	−.06	−.06	.05	.04
	(.05)	(.05)	(.05)	(.05)	(.06)	(.06)	(.06)	(.05)
Product type	−.39	−.38	−.35	−.60	−.60	−.55	−.07	.15
	(.43)	(.43)	(.43)	(.46)	(.47)	(.46)	(.46)	(.42)
Team size	−.15	−.12	−.10	$-.41^{\dagger}$	$-.41^{\dagger}$	−.38	−.17	−.04
	(.22)	(.22)	(.22)	(.23)	(.24)	(.23)	(.23)	(.21)
R&D	−.19	−.97	−.95	$-7.11^{\dagger}$	$-7.22^{\dagger}$	$-7.18^{\dagger}$	−1.17	.36
	(3.95)	(3.97)	(3.93)	(4.26)	(4.31)	(4.24)	(4.27)	(3.92)
R^2	.262	.275	.294	.257	.259	.288	.162	.315
Adjusted R^2	.214	.219	.236	.208	.202	.229	.107	.262
ΔR^2		.012	.019		.001	.029		.153
ΔF	5.42^{**}	1.67	5.31^{*}	5.27^{**}	.18	8.04^{**}	2.94^{**}	21.81^{**}
n	212	212	212	212	212	212	212	212

The numbers in parentheses are standard errors.
† $p \le .1$.
* $p \le .05$.
** $p \le .01$.
[a] We controlled four firm size dummies and two industry dummies, but do not report their results to save space.
[b] The largest VIF value for the quadratic moderator term in the Model 1b is 2.25, suggesting that multicollinearity is not an issue.

evident in our sample. Second, we used Harman's single-factor test to assess common method bias (Podsakoff et al., 2003). The results of exploratory factor analysis on all items for all latent constructs resulted in six factors with eigenvalues greater than one, with the first factor accounting for only 24 percent of the total variance. Third, we controlled for the effect of an unmeasured latent methods factor suggested by Podsakoff et al. (2003) and allowed items to load on their theoretical constructs and on a latent common methods factor. Then we compared the significance of the structural parameters both with and without the common methods factor. The results show all significant relationships hold. Fourth, our higher-order interaction hypotheses, if supported, can also provide additional evidence (Zhang and Li, 2010). As Aiken and West (1991) pointed out, supported interaction hypotheses are less subject to the common methods bias because it is unlikely respondents will have an 'interaction-based theory' in their minds which could systematically bias their responses.

4. Results

We mean centered the values of team autonomy and technological turbulence in order to reduce multicollinearity (Aiken and West, 1991). Following previous studies (Lampel and Giachetti, 2013; Patanakul et al., 2012; Patela and Jayaram, 2014; Wu et al., 2005), we used a cross-product term of team autonomy *squared* and our three measures of technological turbulence to test for curvilinear moderating effects in the hierarchical regression analyses.

Tables 4–6 present the results of the hierarchical regression analyses using perceived technological turbulence, environmental instability and R&D turbulence as moderators, respectively. H1 predicts that technological turbulence moderates the positive relationship between team autonomy and performance, with the relationship being ∩-shaped when technological turbulence is high and U-shaped when technological turbulence is low. As expected, when we use perceived technological turbulence as the moderator (Table 4), the R^2 changes in both Model 3a ($b = -.02$, $p \le .05$ for development speed) and Model 3b ($b = -.03$, $p \le .01$ for development cost) are significant. These findings indicate that team autonomy has a curvilinear relationship with project operational outcomes in the conditions of high or low perceived technological turbulence. Using our archival measure of environmental instability as the moderator (Table 5), the R^2 changes in both Model 3a ($b = -.43$, $p \le .01$ for development speed) and Model 3b ($b = -.45$, $p \le .01$ for development cost) are significant. These findings suggest that team autonomy has a curvilinear relationship with project operational outcomes in the conditions of high or low objective environmental instability. However, when using our new archival measure of R&D turbulence, we found no moderating relationship (Table 6). Thus, the results support H1 in the cases of perceived technological turbulence and environmental instability.

To illustrate, we followed Aiken and West (1991) to plot the interaction effect for two levels of perceived technological turbulence, defining low levels as minus two standard deviations from the mean, and high levels as plus two standard deviations from the mean. Fig. 2 clearly shows the team autonomy-development cost

Table 5
Results of hierarchical moderated regression analysis with environmental instability.

	Development speed			Development cost			Product success	
	Model 1a	Model 2a	Model 3a	Model 1b	Model 2b	Model 3b	Model 4	Model 5
Team autonomy	**.53****	**.57****	**.61****	**.44****	**.48****	**.51****	**.22***	**−.03**
	(.08)	(.10)	(.10)	(.09)	(.10)	(.10)	(.09)	(.09)
Environmental instability (EI)	−.68	−.35	1.86	.21	.81	3.08*	−.06	.10
	(1.11)	(1.13)	(1.38)	(1.19)	(1.21)	(1.46)	(1.19)	(1.08)
Team autonomy^2		.03	.04		.02	.03		
		(.03)	(.03)		(.03)	(.03)		
Autonomy × EI		−.60	−.94*		−1.06*	−1.40**		
		(.39)	(.40)		(.42)	(.43)		
Autonomy^2 × EI			**−.43****			**−.45****		
			(.16)			(.17)		
Development speed								**.30****
								(.08)
Development cost								**.21****
								(.08)
Constant	5.31**	5.03**	4.94**	5.72**	5.42**	5.33**	4.53**	1.74**
	(.57)	(.60)	(.59)	(.61)	(.63)	(.63)	(.61)	(.69)
Team experience	.10	.10	.08	.25**	.26**	.24*	.39**	.31**
	(.09)	(.09)	(.09)	(.10)	(.09)	(.09)	(.10)	(.09)
Team co-location	.05	.05	.04	−.06	−.07	−.06	.05	.04
	(.05)	(.05)	(.05)	(.06)	(.06)	(.06)	(.06)	(.05)
Product type	−.00	.05	.09	−.33	−.23	−.18	.14	.15
	(.41)	(.41)	(.40)	(.44)	(.44)	(.43)	(.44)	(.44)
Team size	−.05	−.09	.00	−.34	−.42†	−.32	−.11	−.03
	(.22)	(.22)	(.22)	(.23)	(.23)	(.23)	(.23)	(.21)
R&D	−.1.44	−1.22	−.68	−7.19	−6.82	−6.27	−1.50	.43
	(4.21)	(4.19)	(4.13)	(4.50)	(4.45)	(4.39)	(4.24)	(4.11)
R^2	.240	.253	.281	.247	.272	.297	.155	.314
Adjusted R^2	.190	.196	.222	.197	.217	.240	.100	.262
ΔR^2		.013	.027		.026	.025		.159
ΔF	4.81**	1.74	7.41*	4.98**	3.48*	6.93**	2.80**	22.74**
n	212	212	212	212	212	212	212	212

The numbers in parentheses are standard errors.
† $p \le .1$.
* $p \le .05$.
** $p \le .01$.

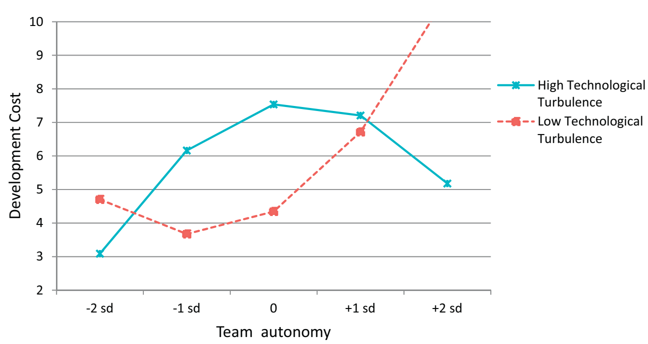

Fig. 2. Empirical results on the team autonomy and development cost relationship under different conditions of technological turbulence.

relationship changes from an ∩-shaped curve to a U-shaped curve as perceived technological turbulence decreases (plotted using Model 3b in Table 4). Similarly, we plotted the interaction effect of environmental instability (plotted using Model 3b in Table 5), which was similar to the curves represented in Fig. 2. This figure, as well as those regarding development speed, is available from the authors.

H2 predicts that operational outcomes mediate the relationship between team autonomy and product success. In Table 4, team autonomy is significantly associated with product success ($b = .20$, $p \le .05$, Model 4). In Model 5, the relationship between team autonomy and product success becomes insignificant ($b = -.04$, $p > .1$) after entering project operational outcomes. In Table 5, team autonomy is significantly associated with product success ($b = .22$, $p \le .05$, Model 4), but becomes insignificant ($b = -.03$ $p > .1$, Model 5) after project operational outcomes are added. In Table 6, team autonomy is significantly associated with product success ($b = .20$, $p \le .05$, Model 4), but becomes insignificant ($b = -.04$ $p > .1$, Model 5) after project operational outcomes are added. Further, we followed Preacher et al.'s (2007) moderated mediation procedure to test the significance of the indirect effect. The indirect effect of operational outcomes between team autonomy and product success is .29 ($p < .01$) under high perceived technological turbulence and is .22 ($p < .01$) under low perceived technological turbulence. Similarly, the indirect effects of operational outcomes between team autonomy and product success are found when using environmental instability or R&D turbulence. H2 was supported.

4.1. Post-hoc analyses

To further test H1, following Kessler and Bierly (2002) and Chen et al. (2012), we divided the sample into the top- and bottom-thirds based on percentile scores for technological turbulence and then conducted polynomial regression analyses in each subgroup. Table 7 shows the results of this subgroup analysis. When development speed is the dependent variable, the regression weight for the team autonomy quadratic term is positive and significant ($b = .10$, $p < .05$, Model 2a) when technological turbulence is low, suggesting the relationship between team autonomy and speed is U-shaped. In contrast, the regression weight of the quadratic term for autonomy is negative, though only marginally significant ($b = -.07$, $p < .1$, Model 2b) when technological turbulence is high, suggesting the relationship is ∩-shaped. Similarly, when development cost is the dependent variable, the regression weight is positive and significant ($b = .10$, $p < .05$, Model 2c) when technological turbulence is

Table 6
Results of hierarchical moderated regression analysis with R&D turbulence.

	Development speed			Development cost			Product success	
	Model 1a	Model 2a	Model 3a	Model 1b	Model 2b	Model 3b	Model 4	Model 5
Team autonomy	**.53****	**.57****	**.56****	**.44****	**.48****	**.46****	**.20***	**−.04**
	(.08)	(.10)	(.10)	(.09)	(.10)	(.10)	(.09)	(.09)
R&D turbulence (RDT)	−1.99	−2.57	−4.25*	−.48	−.36	−2.61	−.26	.44
	(1.56)	(1.65)	(1.98)	(1.68)	(1.78)	(2.13)	(1.68)	(1.53)
Team autonomy^2		.03	.02		.02	.01		
		(.03)	(.03)		(.03)	(.03)		
Autonomy × RDT		.60	.70		−.17	−.04		
		(.58)	(.59)		(.63)	(.63)		
Autonomy^2 × RDT			**.35**			**.47**†		
			(.23)			(.25)		
Development speed								**.30****
								(.08)
Development cost								**.21****
								(.08)
Constant	5.40**	5.23**	5.23**	5.75**	5.62**	5.61**	4.54**	1.75**
	(.58)	(.60)	(.60)	(.62)	(.65)	(.64)	(.62)	(.70)
Team experience	.10	.10	.11	.25**	.25**	.26**	.39**	.31**
	(.09)	(.09)	(.09)	(.10)	(.10)	(.10)	(.10)	(.09)
Team co-location	.05	.05	.05	−.06	−.06	−.07	.05	.04
	(.05)	(.05)	(.05)	(.06)	(.06)	(.06)	(.06)	(.05)
Product type	.08	.06	.14	−.30	−.30	−.20	.15	.19
	(.42)	(.42)	(.42)	(.45)	(.45)	(.46)	(.45)	(.40)
Team size	−.06	−.09	−.11	−.34	−.34	−.33	−.11	−.03
	(.21)	(.22)	(.22)	(.23)	(.23)	(.23)	(.23)	(.21)
R&D	.53	.82	1.23	−7.15	−7.16	−6.62	−1.27	.06
	(4.10)	(4.11)	(4.10)	(4.40)	(4.23)	(4.40)	(4.39)	(4.03)
R^2	.245	.253	.262	.247	.249	.262	.155	.315
Adjusted R^2	.195	.196	.201	.197	.191	.202	.100	.262
ΔR^2		.008	.009		.001	.014		.159
ΔF	4.94**	1.09	2.30	4.99**	.26	3.58†	2.80**	22.78**
n	212	212	212	212	212	212	212	212

The numbers in parentheses are standard errors.
† $p \leq .1$.
* $p \leq .05$.
** $p \leq .01$.

Table 7
Results of polynomial regression analysis.

	Development speed				Development cost			
	Low technological turbulence		High technological turbulence		Low technological turbulence		High technological turbulence	
	Model 1a	Model 2a	Model 1b	Model 2b	Model 1c	Model 2c	Model 1d	Model 2d
Team autonomy	**.45****	**.68****	**.56****	**.46***	**.42***	**.66****	**.47****	**.25**†
	(.16)	(.19)	(.12)	(.13)	(.16)	(.19)	.15	.15
Team autonomy^2		**.10***		**−.07**†		**.10***		**−.13****
		(.04)		(.04)		(.04)		(.05)
Constant	5.27	4.73	5.23	5.73	6.54	6.00	5.98	6.92
	(.66)	(.69)	(.95)	(.99)	(.65)	(.67)	(1.13)	(1.16)
Team experience	−.09	−.11	.32*	.28*	.20	.18	.37*	.30†
	(.17)	(.16)	(.13)	(.13)	(.17)	(.17)	(.18)	(.15)
Team co-location	−.00	.02	.06	.07	−.06	−.07	−.10	−.09
	(.09)	(.09)	(.08)	(.08)	(.10)	(.09)	(.09)	(.09)
Product type	−.81	−.67	.92	.70	−.97	−.82	.40	.03
	(.64)	(.63)	(.89)	(.90)	(.66)	(.64)	(1.07)	(1.05)
Team size	.30	.32	−.21	−.17	−.26	−.24	−.59	−.51
	(.45)	(.44)	(.29)	(.29)	(.46)	(.44)	(.34)	(.33)
R&D	9.20	9.63	−1.34	−1.20	−10.14	−10.19	2.53	6.69
	(7.88)	(7.65)	(6.68)	(6.69)	(7.90)	(7.62)	(7.94)	(7.85)
R^2	.232	.289	.404	.426	.266	.329	.258	.319
Adjusted R^2	.142	.193	.340	.354	.194	.250	.190	.246
ΔR^2		.057		.024		.062		.061
ΔF	2.59*	4.76*	5.43**	2.45†	3.69**	5.58*	3.62**	5.86**
n	68	68	74	74	68	68	74	74

The numbers in parentheses are standard errors.
† $p \leq .1$.
* $p \leq .05$.
** $p \leq .01$.

low; in contrast, the regression weight is negative and significant ($b = -.13$, $p < .01$, Model 2d) when technological turbulence is high. Similar results are found when using environmental instability. H1 is further supported.

5. Discussions

5.1. Theoretical implications

In this study, we build on a traditional operations model which examines the moderating effect of technological turbulence on the relationship between organizational process factors and operational outcomes (Tatikonda and Montoya-Weiss, 2001). To respond to the calls for the integration of OM and behavioral research (Bendoly and Hur, 2007; Powell and Johnson, 1980), we extend this model by articulating the behavioral and mechanistic effects of team autonomy. We further view team autonomy as a bipolar factor and argue that its two effects are non-monotonic because each mechanism has its benefits and risks, depending on the level of autonomy and technological turbulence. Moreover, we draw on information processing theory and argue that information processing requirements associated with technological turbulence influence the behavioral and mechanistic effects of team autonomy *differently*, leading to a different curvilinear relationship under different levels of technological turbulence. Our results support this hypothesis: the relationship is ∩-shaped in a highly turbulent environment and U-shaped in a stable environment when turbulence is measured by both perceptual technological turbulence and objective environmental instability. R&D turbulence, however, does not moderate the relationship.

The findings of this study suggest that the behavioral and mechanistic effects can be distinguished under different situations and one effect alone cannot fully explain the effects of team autonomy under different levels of technological turbulence. Combining these findings with those of previous studies on task uncertainty (Cordery et al., 2010; Haas, 2010; Patanakul et al., 2012), the results clearly suggest that the benefits of team autonomy are contingent upon environmental uncertainty.

We speculate the non-significant results for our new R&D turbulence measure is due to the fact that it captures a specific aspect of technological turbulence, namely the predictability of the pace (i.e., consistent or inconsistent pace) of technological turbulence (which may be fast, slow, or something else), instead of the direction, complexity or magnitude of technological turbulence. While industries with low year-to-year variance in R&D investments possess a predictable, constant rate of technological turbulence (either relatively fast or slow), industries with high R&D turbulence, where R&D spending rises and falls randomly year-to-year, will possess rates of change that are more uncertain. These are likely to be industries where the costs and benefits of R&D investment are unclear or industries where the technological regimes or competitive routines have not been institutionalized. High-tech industries, where the pace of technological turbulence is predictably fast and the direction of technological turbulence is particularly uncertain, will experience increasingly high R&D investments with relatively lower levels of variability over time. Further, our R&D turbulence measure only considers one of many inputs (i.e., R&D spending) which form the basis for an industry's technological landscape and the ultimate effect of this singular input is uncertain. Finally, those industries which present the greatest technological challenges to managers are likely to be those that experience technological turbulence in an order of magnitude (e.g., revolutionary, discontinuous technological change), a factor not accounted for in our predictability of the pace of R&D spending measure.

Nevertheless, we hope that future researchers might consider using our new archival measure of R&D turbulence. For example, as project outcomes are susceptible to environmental turbulence, future researchers may explore how the managerial challenges stemming from uncertainty associated with the pace of change differs from uncertainty from the magnitude of change. Is project planning more or less difficult in high-technology industries, where the rate and magnitude of change are both consistently high, or in other settings where the pace of change is more uncertain? Just as a firm's innovative performance is best measured using multiple indictors (Hagedorn and Cloodt, 2003), we believe that objective assessments of technological turbulence may be best captured using multiple indicators. Specifically, our measure captures turbulence in R&D inputs (namely R&D spending). Its use, in conjunction with measures of turbulence in R&D outcomes, might provide researchers with more reliable and valid assessments. For example, researchers might consider augmenting our measure by using industry-level patent data or calculate the standard errors of the regression slope for issued patents in a given industry, and develop a composite measure of turbulence in technological inputs and outcomes. Given that environmental turbulence can be characterized as multi-dimensional (e.g., amplitude, frequency, or predictability of changes) (Doty et al., 2006), using multiple indicators would seem necessary. We believe our measure provides one means to assess the predictability of the rate of technological turbulence.

5.1.1. Extending the NPD and OM literature

Our findings provide some possible explanations for the inconsistent results of OM research on team autonomy. The results of this study suggest that the relationship between team autonomy and performance could be negative or positive, linear or curvilinear, depending on the situation. In prior research, an implicit assumption of linearity has generally been made. If we take this assumption for granted, we might reach a wrong conclusion. Consistent with Tatikonda and Rosenthal (2000), we might conclude that the relationship between team autonomy and performance is stable regardless of technological turbulence since the results of Model 2a and b in Table 4 and Model 2a in Table 5 suggest that technological turbulence does not significantly moderate the strength of the relationships. The findings of this study emphasize the importance of the distinction between the strength and the form of a relationship and of the difference of their moderation tests. As Aiken and West (1991) note, without including a higher-order term driven by theory, attempts to test for a moderating effect using a linear interaction might reach inappropriate conclusions.

Accordingly, we provide a more fine-grained understanding of team autonomy and performance. In highly turbulent environments, team autonomy has an ∩-shaped relationship with performance. This is because in such situations, the benefits of autonomous teams may initially contribute to their success, but the risks of team autonomy become salient as the team approaches full autonomy. In such a situation, top management must remain actively involved in, but not in control of, the team's activities, which can reduce the downsides of both the behavioral and mechanistic effects. Specifically, top management involvement can not only mitigate risks by providing a unique perspective and by linking the team to the rest of the organization (Haas, 2010), but also reduce the stress of teams facing highly challenging tasks. By granting a moderate level of autonomy, management can better tie a semi-autonomous team into a loosely-coupled organization to take advantage of the benefits of autonomy (Patanakul et al., 2012). By maintaining some control, managers can also clarify project goals, reducing the ill-effects of loss of control (Mills and Ungson, 2003).

This finding is consistent with previous recommendations (Langfred, 2004) to give NPD teams authority while maintaining some form of control and oversight in an effort to maximize project operational outcomes. This approach is also consistent with Haas' (2010) risk mitigation strategy combining autonomy and external knowledge because management can act as a valuable source of additional information for the team. Thus, a balance between autonomy and control is a fundamental managerial issue (Crilly and Sloan, 2014). Future studies should examine the mechanisms that help managers balance the need to give teams autonomy with the imperative to keep the team connected to the rest of the organization (Haas, 2010), especially in turbulent settings.

In stable environments, however, partial autonomy can harm project operational outcomes. Partial autonomy implies “shared power” between a team and its management (Lorinkova et al., 2013). As such, the costs of shared authority and coordination costs within teams may outweigh the benefits in a stable environment for two reasons. On one hand, the potential benefits of shared authority may be limited in addressing simple and routine tasks; on the other, joint decision-making and collaboration, particularly between an NPD team and top management, may require considerable human capital, energy, and time to capture (Lorinkova et al., 2013; Minson and Mueller, 2012). Second, the performance of semi-autonomous teams may suffer from increased role conflict and ambiguity stemming from their shared role with management. Hence, semi-autonomous teams may be ineffective in a stable environment.

5.1.2. Extending the concept of bipolarity

We view team autonomy as a bipolar factor and argue that its behavioral and mechanistic effects are curvilinear. The ∩-shaped behavioral effect of autonomy results from the combined effects of challenge and stress that result from increased autonomy. This argument has a long history in psychology, such as the ∩-shaped relationship between arousal and performance (Yerkes and Dodson, 1908), and has been recently empirically tested on workload and revenue management (Bendoly, 2011; Bendoly and Prietula, 2008).

The ∩-shaped effect results from a reverse directionality of an excessive level of a bipolar variable in a turbulent environment (Bendoly and Hur, 2007). While Bendoly and Hur (2007) are not fully clear about the mechanism behind the reverse directionality, we particularly summarized two mechanisms of excessive team autonomy: the risks of isolation (Haas, 2010) and loss of managerial control (Mills and Ungson, 2003). Our results are among the first to empirically confirm the ∩-shaped effect of team autonomy in a technologically turbulent environment. In addition, from a behavioral perspective, a curvilinear relationship may be related to the bounded rationality of NPD teams. As Bendoly and Hur (2007) point out, the mechanism of reverse directionality needs to be further examined.

This study extends the concept of bipolarity arguing that a variable’s transition from a situational facilitator to a situational constraint depends on not only its relative level (Bendoly and Hur, 2007) but also its context. When information requirements associated with environments are higher than a team’s capabilities, an excessive degree of autonomy can lead to reverse directionality. When information requirements associated with environments are lower than a team’s capabilities, a higher degree of autonomy can monotonically lead to better team performance. We join the calls for more studies to examine the potential curvilinear relationships of bipolar factors such as team autonomy and workload with performance under different contexts (Bendoly and Hur, 2007; Maynard et al., 2012).

5.1.3. Extending information processing theory

We draw on and extend information processing theory, which predicts that environmental uncertainty moderates the team autonomy-operational outcomes relationship. Our theory and empirical results support the core idea of the theory: organizations will be more effective when there is a fit between the information processing requirements associated with environmental uncertainty and the information processing capacities of team structure (Tushman and Nadler, 1978). However, such a fit is not always as straight-forward as past research has implied because it is not the case that the more autonomous the team structure, the more effective it will be in a highly turbulent environment. This is partially because the intensive information process requirements associated with volatility can go beyond the team’s capabilities. Moreover, we argue that information processing requirements can also influence the behavioral aspect of team performance, which was largely ignored in prior OM research. Since the mechanistic effect of team autonomy is negative and its behavioral effect is positive in a stable technological environment, the prediction from information processing theory that an organic structure will have a negative effect is not necessarily so in such an environment.

5.2. Managerial implications

This study confirms the notion that autonomy is important for competitiveness in rapidly-changing environments. Our data suggests that NPD teams with increased autonomy generally produce better performance, in terms of faster development speed and lower development costs. Moreover, the effectiveness of autonomy on operational outcomes is contingent upon the degree of uncertainty. Therefore, it is important for managers to consider the degree of change or uncertainty before implementing a one-size-fits-all autonomy approach. Our findings give clear but fine-grained direction for managers. Either directed or autonomous teams are effective in technologically stable environments. The best approach may depend on the organizational culture or the preferred style of the management team. In contrast, when technological turbulence is high, a semi-autonomous team is more effective in handling the challenges of fast-changing technologies.

5.3. Limitations and future research

This study has several potential limitations. First, we have extensively discussed the single source problem. Our tests, however, suggest this bias is not serious. Second, we only surveyed launched projects that have been in the marketplace for at least six months to easily assess their performance, thereby restricting the range of our dependent variables. However, as the means of all three dependent variables are close to the middle point of 5 and their standard deviations close to 3, their wide ranges from 0 to 10 can alleviate this concern. In addition, most projects in our study were developed in large companies. Although firm size did not significantly influence the relationships studied, results should be cautiously applied to small firms. Third, we used students at an executive program as contacts to reach respondents to fill out the survey and the majority of the students came from the Northeastern US. On the other hand, the representation of a variety of industries might be more generalizable than other recent studies in which student-based teams (e.g., Langfred, 2004, 2007) or work teams in one organization (e.g., Cordery et al., 2010; Haas, 2010; Langfred, 2005; Mathieu et al., 2006) were investigated. Other researchers might want to conduct similar research in other regions to see if our results generalize to other geographic settings. Fourth, we only examined the impact of autonomy in terms of teams’ decision-making authority on project operational outcomes in NPD projects. Further research should examine this contingency using other types of projects or other environmental contingencies.

Fifth, our study employed cross-sectional data to test our hypotheses; hence we cannot answer whether autonomy is a response to uncertainty or a managerial choice. We believe decentralization is an effective adaptation to environmental uncertainty. From an evolutionary perspective, decentralization should increase with uncertainty. However, this assumes a rational world and managers do not always behave rationally. Longitudinal research exploring autonomy as an adaptation to uncertainty would help shed light on this issue. Sixth, even though our data indicates that a high control approach can be effective in a technologically stable environment, this approach may have negative long-term repercussions as teams may feel indifferent. Low employee morale and the failure to develop employees are two potential costs to a long-term directive approach. As our study indicates, the balance between autonomy and control is a delicate one that needs further exploration. Finally, we assume all NPD teams have bounded rationality under high technological turbulence; this assumption may not be true for highly skilled teams. A promising avenue for future research is to test the moderating effect of team capabilities or skills (Bendoly and Prietula, 2008).

Together our study posits three key messages. First, team autonomy may have behavioral and mechanistic effects on team effectiveness. Second, the team autonomy–performance relationship cannot be accurately interpreted without considering the impact of technological turbulence. Managers and scholars need to consider the benefits, risks, and costs of team autonomy, and more fully appreciate the need to balance these benefits and risks depending on the situation. Third, it is worth asking whether an autonomous team can handle the challenges of turbulence and whether the benefits of an autonomous team outweigh its coordination and control costs. We hope this study will motivate more research to better understand how environmental contexts can influence project effectiveness by integrating the contingency view with issues of decision-making and power.

References

Aiken, L.S., West, S.G., 1991. Multiple Regression: Testing and nteractions. Sage, Newbury Park, CA.

Akgün, A.E., Lynn, G.S., 2002. New product development team improvisation and speed-to-market: an extended model. Eur. J. Innov. Manage. 5 (3), 117–129.

Anderson, J.C., Gerbing, D.W., 1988. Structural equation modeling in practice: a review and recommended two-step approach. Psychol. Bull. 103 (3), 411–423.

Balkin, D.B., Markman, G.D., Gomez-Mejia, L.R., 2000. Is CEO pay in high-technology firms related to innovation? Acad. Manage. J. 43 (6), 1118–1129.

Bendoly, E., 2011. Linking task conditions to physiology and judgment errors in RM systems. Prod. Oper. Manage. 20 (6), 860–876.

Bendoly, E., Donohue, K., Schultz, K.L., 2006. Behavior in operations management: assessing recent findings and revisiting old assumptions. J. Oper. Manage. 24 (6), 737–752, 24.

Bendoly, E., Hur, D., 2007. Bipolarity in reactions to operational 'constraints': OM bugs under an OB lens. J. Oper. Manage. 25 (1), 1–13.

Bendoly, E., Prietula, M., 2008. In "the zone": the role of evolving skill and transitional workload on motivation and realized performance in operational tasks. Int. J. Oper. Prod. Manage. 28 (12), 1130–1152.

Boyd, B.K., Dess, G.G., Rasheed, A.M.A., 1993. Divergence between archival and perceptual measures of the environment: causes and consequences. Acad. Manage. Rev. 18 (2), 204–226.

Calantone, R., Garcia, R., Dröge, C., 2003. The effects of environmental turbulence on new product development strategy planning. J. Prod. Innovat. Manage. 20 (2), 90–103.

Chen, J., Damanpour, F., Reilly, R.R., 2010. Understanding antecedents of new product development speed: a meta-analysis. J. Oper. Manage. 28 (1), 17–33.

Chen, J., Reilly, R.R., Lynn, G.S., 2012. New product development speed: too much of a good thing? J. Prod. Innovat. Manage. 29 (2), 288–303.

Churchill, G.A., 1979. A paradigm for developing better measures of marketing constructs. J. Marketing Res. 16, 64–73.

Cohen, S.G., Bailey, D.E., 1997. What makes teams work: group effectiveness research from the shop floor to the executive suite. J. Manage. 23 (3), 239–290.

Cooper, R.G., Kleinschmidt, E.J., 1987. Success factors in product innovation. Ind. Marketing Manage. 16, 215–223.

Cordery, J.L., Morrison, D., Wright, B.M., Wall, T.D., 2010. The impact of autonomy and task uncertainty on team performance: a longitudinal field study. J. Organ. Behav. 31 (2–3), 240–258.

Cote, J.A., Buckley, R., 1987. Estimating trait, method, and error variance: generalizing across 70 construct validation studies. J. Marketing Res. 24, 315–318.

Crilly, D., Sloan, P., 2014. Autonomy or control? Organizational architecture and corporate attention to stakeholders. Organiz. Sci. 25 (2), 339–355.

Croson, R., Schultz, K., Siemsen, E., Yeo, M.L., 2013. Behavioral operations. J. Oper. Manage. 31 (1/2), 1–5.

Das, S.R., Joshi, M.P., 2007. Process innovativeness in technology services organizations: roles of differentiation strategy, operational autonomy and risk-taking propensity. J. Oper. Manage. 25, 643–660.

Dess, G.G., Beard, D.W., 1984. Dimensions of organizational task environments. Admin. Sci. Q. 29, 52–73.

Doty, D.H., Bhattacharya, M., Wheatley, K.K., Sutcliffe, K.M., 2006. Divergence between informant and archival measures of the environment: real differences, artifact, or perceptual error? J. Bus. Res. 59, 268–277.

Duncan, R.B., 1972. Characteristics of organizational environment and perceived environmental uncertainty. Admin. Sci. Q. 17, 313–327.

Eisenhardt, K.E., 1989. Making fast strategic decisions in high-velocity environment. Acad. Manage. J. 32 (3), 543–576.

Eisenhardt, K.M., Tabrizi, B.N., 1995. Accelerating adaptive processes: product innovation in the global computer industry. Admin. Sci. Q. 40 (1), 84–110.

Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. J. Marketing Res. 18 (1), 39–50.

Fredrickson, J.W., 1984. The comprehensiveness of strategic decision processes: extension, observations, future directions. Acad. Manage. J. 27 (3), 445–466.

Galbraith, J.R., 1973. Designing Complex Organizations. Addison-Wesley, Boston, MA.

Gerwin, D., 1999. Team empowerment in new product development. Bus. Horiz. 42 (2), 29–36.

Hagedorn, J., Cloodt, M., 2003. Measuring innovative performance: is there an advantage in using multiple indicators? Res. Policy 32, 1365–1379.

Haas, M.R., 2010. The double-edged swords of autonomy and external knowledge: analyzing team effectiveness in a multinational organization. Acad. Manage. J. 53 (5), 989–1008.

Jaworski, B.J., Kohli, A.K., 1993. Market orientation: antecedents and consequences. J. Marketing 57 (3), 53–70.

Joreskog, L.R., Kraft, K.L., 1989. LISREL 7: A Guide to the Program and Applications, second ed. SPSS, Chicago, IL.

Keats, B.W., Hitt, M.A., 1988. A causal model of linkages among environmental dimensions, macro organizational characteristics, and performance. Acad. Manage. J. 31 (3), 570–598.

Kessler, E.H., Bierly, P.E.JIII, 2002. Is faster really better? An empirical test of the implication of innovation speed. IEEE Trans. Eng. Manage. 49 (1), 2–12.

Kessler, E.H., Chakrabarti, A.K., 1999. Speeding up the pace of new product development. J. Prod. Innovat. Manage. 16 (3), 231–247.

Lampel, J., Giachetti, C., 2013. International diversification of manufacturing operations: performance implications and moderating forces. J. Oper. Manage. 31 (4), 213–227.

Langfred, C.W., 2004. Too much of a good thing? Negative effects of high trust and individual autonomy in self-managing teams. Acad. Manage. J. 47 (3), 385–399.

Langfred, C.W., 2005. Autonomy and performance in teams: the multilevel moderating effect of task interdependence. J. Manage. 31 (4), 513–529.

Langfred, C.W., 2007. The downside of self-management: a longitudinal study of the effects of conflict on trust, autonomy, and task interdependence in self-managing teams. Acad. Manage. J. 50 (4), 885–900.

Lewis, M.W., Welsh, M.A., Dehler, G.E., Green, S.G., 2002. Product development tensions: exploring contrasting styles of project management. Acad. Manage. J. 45 (3), 546–564.

Locke, E.A., Latham, G.P., 1990. A Theory of Goal Setting & Task Performance. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Lorinkova, N., Pearsall, M., Sims, H., 2013. Examining the differential longitudinal performance of directive versus empowering leadership in teams. Acad. Manage. J. 56 (2), 573–596.

Lynn, G.S., Akgun, A.E., 1998. Innovation strategies under uncertainty: a contingency approach for new product development. Eng. Manage. J. 10 (3), 11–18.

Maritana, C.A., Brushb, T.H., Karnanic, A.G., 2004. Plant roles and decision autonomy in multinational plant networks. J. Oper. Manage. 22 (5), 489–503.

Martin, S., Liao, H., Campbell-Bush, E., 2013. Directive versus empowering leadership: a field experiment comparing the impact on task proficiency and proactivity. Acad. Manage. J. 56 (5), 1372–1395.

Mathieu, J.E., Gilson, L.L., Ruddy, T.M., 2006. Empowerment and team effectiveness: an empirical test of an integrated model. J. Appl. Psychol. 91 (1), 97–108.

Maynard, M.T., Gilson, L.L., Mathieu, J.E., 2012. Empowerment—Fad or Fab? A multilevel review of the past two decades of research. J. Manage. 38 (4), 1231–1281.

Mills, P.K., Ungson, G.R., 2003. Reassessing the limits of structural empowerment: organizational constitution and trust as controls. Acad. Manage. Rev. 28 (1), 143–153.

Minson, J.A., Mueller, J.S., 2012. The cost of collaboration: why joint decision making exacerbates rejection of outside information. Psychol. Sci. 23 (3), 219–224.

Nunnally, J.C., 1978. Psychometric Theory. McGraw-Hill, New York, NY.

O'Connor, E.J., Peters, L.H., Rudolf, C.J., Pooyan, A., 1982. Situational constraints and employee affective reactions: a partial field replication. Group Organ. Stud. 7 (4), 418–428.

Olson, E.M., Warker, O.C., Ruekert, R.W., 1995. Organizing for effective new product development: the moderating role of product innovativeness. J. Marketing 59 (1), 48–62.

Pagell, M., Krause, D.R., 2004. Re-exploring the relationship between flexibility and the external environment. J. Oper. Manage. 21 (6), 629–649.

Patanakul, P., Chen, J., Lynn, G., 2012. Autonomous teams and new product development. J. Prod. Innovat. Manage. 29 (5), 734–750.

Patela, P.C., Jayaram, J., 2014. The antecedents and consequences of product variety in newventures: an empirical study. J. Oper. Manage. 32 (1–2), 34–50.

Podsakoff, P.M., MacKenzie, S.B., lee, J.-Y., Podsakoff, N.P., 2003. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J. Appl. Behav. Sci. 88 (5), 879–903.

Powell, G.N., Johnson, G.A., 1980. An expectancy-equity model of productive system performance. J. Oper. Manage. 1 (1), 47–56.

Preacher, K.J., Rucker, D.D., Hayes, A.F., 2007. Addressing moderated mediation hypotheses: theory, methods, and prescriptions. Multivariate Behav. Res. 42 (1), 185–227.

Sakakibara, S., Flynn, B.B., Schroeder, R.G., Morris, W.T., 1997. The impact of just-in-time manufacturing and its infrastructure on manufacturing performance. Manage. Sci. 43 (9), 1246–1257.

Shimizu, K.K., 2012. Risks of corporate entrepreneurship: autonomy and agency issues. Organ. Sci. 23 (1), 194–206.

Song, M., Montoya-Weiss, M.M., 2001. The effects of perceived technological uncertainty on Japanese new product development. Acad. Manage. J. 44 (1), 61–80.

Stern, Z., Katz-Navon, T., Naveh, E., 2008. The influence of situational learning orientation, autonomy, and voice on error making: the case of resident physicians. Manage. Sci. 54 (9), 1553–1564.

Stewart, G.L., 2006. A meta-analytic review of relationships between team design features and team performance. J. Manage. 32 (1), 29–55.

Stewart, G.L., Barrick, M.R., 2000. Team structure and performance: assessing the mediating role of intrateam process and the moderating role of task type. Acad. Manage. J. 43 (2), 135–148.

Swink, M., Talluri, S., Pandejpong, T., 2006. Faster, better, cheaper: a study of NPD project efficiency and performance tradeoffs. J. Oper. Manage. 24, 542–562.

Tatikonda, M.V., Montoya-Weiss, M.M., 2001. Integrating operations and marketing perspectives of product innovation: the influence of organizational process factors and capabilities on development performance. Manage. Sci. 47 (1), 151–172.

Tatikonda, M.V., Rosenthal, S.R., 2000. Successful execution of product development projects: balancing firmness and flexibility in the innovation process. J. Oper. Manage. 18 (4), 401–425.

Treville, S. d., Antonakis, J., 2006. Could lean production job design be intrinsically motivating? Contextual, configurational, and levels-of-analysis issues. J. Oper. Manage. 24 (2), 99–123.

Tushman, M.L., Nadler, D.A., 1978. Information processing as an integrating concept in organizational design. Acad. Manage. Rev. 3 (3), 613–624.

Wall, T.D., Cordery, J.L., Clegg, C.W., 2002. Empowerment, performance, and operational uncertainty: a theoretical integration. Appl. Psychol.: Int. Rev. 51 (1), 146–169.

Wu, S., Levitas, E., Priem, R.L., 2005. CEO tenure and company invention under differing levels of technological dynamism. Acad. Manage. J. 48 (5), 859–873.

Yerkes, R.M., Dodson, J.D., 1908. The relation of strength of stimulus to rapidity of habit-formation. J. Comp. Neurol. Psychol. 18, 459–482.

Yun, S., Faraj, S., Sims, H.P., 2005. Contingent leadership and effectiveness of trauma resuscitation teams. J. Appl. Psychol. 90 (6), 1288–1296.

Zhang, Y., Li, H., 2010. Innovation search of new ventures in a technology cluster: the role of ties with service intermediaries. Strategic Manage. J. 31 (1), 88–109.