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Does rivals' innovation matter? A competitive dynamics perspective on firms' product strategy☆

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A B S T R A C T

We build on the awareness-motivation-capability (AMC) framework of competitive dynamics research to examine how a signal of a rival's innovation, in the form of research and development (R&D) intensity, may influence a focal firm's product actions. We argue that a rival's R&D intensity increases a focal firm's awareness of a competitive threat and thus its motivation to react by increasing its product actions. However, this competitive impact is conditional on the focal firm's size and performance relative to the rival, as well as the strategic homogeneity of the two. We use the AMC framework to analyze such moderating effects.

Firms often operate in industries characterized by hyper-competition (Chen, Lin, & Michel, 2010; Gimeno & Woo, 1996), in which they must closely gauge the competitive signals sent out by rivals and incorporate such information when planning their own actions, so as to defend their positions. In view of such competitive dynamics, some researchers have argued that rivals' competitive signals create awareness and motivation in a focal firm (Chen, 1996), which must then assess its capabilities as to whether and how to respond to the rivals (Chen & Miller, 2014). This logic has inspired researchers to identify factors related to a focal firm's awareness, motivation, and capabilities, and to use these factors in predicting its competitive behavior (Marcel, Barr, & Duhaime, 2010). For example, empirical studies have offered ample evidence that factors such as rivals' action characteristics (e.g., potential impact, visibility, action volume) (Chen & Miller, 1994; Chen, Smith, & Grimm, 1992; Derfus, Maggitti, Grimm, & Smith, 2008), the geographic distance between rivals and focal firms (Yu & Cannella, 2007), and rivals' competitive success (Hsieh, Tsai, & Chen, 2015), may determine focal firms' competitive behavior.

However, researchers have not yet studied the competitive signals embedded in rivals' financial statements, although these statements may contain important information about the commitments, current strategies, and future plans of rivals, which provide key information for focal firms to use in analyzing the potential threats the rivals are likely to pose (Porter, 1980). For example, a given rival's financial statements, by revealing its resource allocations, may signal to a focal firm the rival's strategic intent and upcoming competitiveness (Porter, 1980). As a result, the focal firm may use this competitive information to develop knowledge about the rival (awareness), gauge the need to react (motivation), and assess the abilities required to compete successfully (capability). Thus, understanding the implications of firms' financial statements is critically important to competitive dynamics research.

In this study, we build on competitive dynamics research to develop an integrative model that links the competitive cues contained in a rival's financial statements to a focal firm's subsequent competitive actions. We focus on a particular form of competitive cue in the financial statements, namely, research and development (R&D) intensity, and use it to explain the focal firm's subsequent product actions. A firm's R&D intensity represents an important aspect of its absorptive capacity (Cohen & Levinthal, 1990) and is directly related to its learning and innovation outputs (Acs & Audretsch, 1988). Although the innovation and learning literature has reported investigations of this concept, few studies have considered its competitive implications. Researchers recognize that in technology industries, constant technological change threatens firms' competitive profile and may rapidly render firms' market advantage obsolete (Tushman & Anderson, 1986). The emergence of innovative ideas and ever-changing technology allow most products to enjoy only a short span and no matter how innovative a product is when introduced, its technological and functional superiority will decline over

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time and be surpassed by more innovative products introduced later by rivals (Tushman & Anderson, 1986). To remain competitive, a focal firm needs to constantly gauge rivals' R&D efforts and plan its subsequent actions accordingly (Katila & Chen, 2008; Smith, Collins, & Clark, 2005); therefore, competitive signals indicating rivals' learning and absorptive capability, such as R&D intensity, are likely to influence a focal firm's product strategy.

On the basis of these ideas, we address the following research question: *How will a given rival's R&D intensity influence a focal firm's subsequent product action*? We propose that in technology industries, a rival's R&D efforts may increase a focal firm's awareness of future competitive threats and the need to react, driving it to more product actions. However, this competitive impact depends on several factors that influence the focal firm's awareness, motivation, and capability. We argue that the focal firm's size relative to the rival influences its awareness, its performance relative to the rival influences its motivation to react, and the strategic homogeneity between the two determines its capability to act. We test our hypotheses with a sample of 235 firm-rival pairs in the computer software sector and 9838 observations between 1987 and 2010.

1. Theory and hypotheses

Research on competitive dynamics conceptualizes competition as a dynamic process of firms' actions and responses (Chen, 1996). This logic highlights the interdependence between the payoff to a firm and to its rival such that the competitive position of a focal firm will be threatened if the rival undertakes offensive or defensive actions (Rindova, Becerra, & Contardo, 2004). In view of this interdependence, competitive dynamics researchers have conceptualized awareness, motivation and capability (AMC) as the key behavioral drivers of firms' competitive actions (Chen, 1996). Awareness refers to a firm's knowledge of competitive signals, motivation captures a firm's logic and intention to take an action, and capability reflects a firm's internal strengths that make its actions possible. "Simply stated, a competitor will not be able to respond to an action unless it is aware of the action, motivated to react, and capable of responding" (Chen & Miller, 2014: 2). A logical sequence is apparent in the AMC framework; awareness is the prerequisite in that a firm must be aware of a rival's action before it can consider motivation and capability and then needs to judge whether an action is advisable (motivation) before determining if it has the capability to carry out the action (Chen & Miller, 2014; Derfus et al., 2008; Ndofor, Sirmon, & He, 2011; Yu, Subramaniam, & Cannella, 2009).

Competitive dynamics research, especially the AMC framework, offers a particularly useful perspective for examining firms' innovation and product strategy in technology industries (Katila & Chen, 2008), in which firms must aggressively invest in innovation and constantly introduce new products. Even then, the competitive advantage associated with any new product may be quickly eroded by rivals' innovation efforts; as a result, a focal firm must closely follow signals indicating rivals' innovation efforts so as to predict their actions. This logic has inspired some researchers to examine firms' innovation strategy on the basis of a "competitive view." Bowman and Gatignon (1995) have documented that firms tend to react to rivals' new products and Katila and Chen (2008) found that rivals' exploration and exploitation can influence the frequency and innovativeness of a focal firm's new product introductions.

A key source of competitive intelligence indicating a rival's innovation efforts is its R&D intensity, as shown in its financial statements. Indeed, management researchers have long recognized the significance of the competitive information contained in financial statements (Healy & Palepu, 1993; Porter, 1980). For example, information in financial statements may indicate current performance, motivation to change or maintain current strategies, or plans managers have made regarding resource allocations (Fombrun & Shanley, 1990). In competitive situations, a particularly important piece of information to be obtained from a rival's financial statements is R&D intensity, defined as the ratio of the rival's R&D expenditure to its total revenue (Greve, 2003). Because R&D transforms basic knowledge into "codified outputs" such as patents or commercialized products (Coff, 2003), a rival's R&D intensity represents its absorptive capacity, which is related to its innovation outputs and future competitive advantage (Cohen & Levinthal, 1990), which implies future threats to a focal firm.

In this paper, we build on the AMC framework to examine how a given rival's R&D intensity, as reflected in its financial statements, may influence a focal firm's subsequent product actions. Our premise is that in pair-wise competitive relationships, firms are highly interdependent in that if one gets ahead, the other falls behind (Rindova et al., 2004). We argue that a rival's R&D intensity as shown in financial statements provides the awareness and motivation for a focal firm to engage in product actions but that this relationship can be constrained or enhanced by factors that influence the focal firm's awareness, motivation and capability. Competitive dynamics scholars have shown that rival firms' size, past performance, and strategic homogeneity influence their competitive engagements (Chen, Su, & Tsai, 2007). Following prior research (Chen et al., 2007), we conceptualize a focal firm's size relative to that of the rival as a proxy for awareness; its performance relative to that of the rival as motivation; and the two firms' strategic homogeneity as capability. We argue that the impact of a rival's R&D intensity on a focal firm's subsequent product action will be moderated by these variables.

1.1. Direct effects of rival's R&D intensity

Increases in a firm's R&D intensity can be an effective response to the challenges the firm encounters in the competitive market (Gentry & Shen, 2013). By investing heavily in R&D, a rival may generate new knowledge to advance new products, develop new approaches to improve existing products, and enhance its overall innovation capability (Cohen & Levinthal, 1990; Gentry & Shen, 2013). The R&D intensity of a rival can thus be understood by a focal firm as an important component of the rival's repository of technological competencies (Coff, 2003; Ndofor et al., 2011). In particular, firm performance is often interdependent in competitive markets such that more innovative products of a rival necessarily put a focal firm at a competitive disadvantage. Thus, the focal firm tends to follow closely information about the innovation strategy of rivals, and awareness of such information greatly influences its own competitive strategy. Indeed, by investing heavily in R&D, a rival shows its intention to move forward with innovative products and its determination to compete hard in the impending rivalry. In addition, a rival with strong R&D intensity may be able to introduce radically improved products, thereby destroying the focal firm's current core competence (Tushman & Anderson, 1986). These competitive implications are likely to capture the focal firm's attention (awareness) and give it the incentive to react (motivation), both of which often lead to aggressive reactions on the part of the focal firm (Chen et al., 1992; Marcel et al., 2010; Porter, 1980). Additionally, since information about a rival's R&D intensity is publicly available, this competitive signal tends to trigger the focal firm's alertness so as to drive it into aggressive defense, the most effective defense of which is perhaps an immediate increase in product actions.

H1. A rival's R&D intensity will be positively related to a focal firm's frequency of product actions.

1.2. Moderating effects

Although a rival's R&D intensity poses a direct threat, the strength of this influence may depend on other factors influencing the focal firm's awareness, motivation, and capabilities. In this paper, we use relative firm size (a focal firm's size compared with that of a given rival) to capture awareness (Chen et al., 2007), relative firm performance (a focal firm's performance compared with that of a given rival) to capture motivation (Miller & Chen, 1994), and strategic homogeneity (a focal firm's strategic profile relative to that of a given rival) to capture capability (Zhang & Rajagopalan, 2003; Chen et al., 2007). In the following sections, we discuss the moderating effects of these three components.

1.2.1. Relative firm size

The impact of firm size on strategy has long been recognized (Chen, Williams, & Agarwal, 2012; Porter, 1980; Tellis, 1989). For example, Hofer (1975) argued that firm size can moderate the impact of firm strategy on performance. Researchers have also argued that firms larger in size may exhibit structural inflexibility, lack of innovation propensity and higher bureaucratic challenges (Chen & Hambrick, 1995; Chen et al., 2012). Empirical studies have offered evidence that smaller firms tend to have a greater propensity for action than larger ones (Chen & Hambrick, 1995).

Building on these ideas, we argue that a focal firm's size may moderate the impact of a rival's R&D intensity on a focal firm's competitive action. First, the structural complexity and bureaucracy associated with larger firms may buffer them from competitive engagements and promote insularity (Chen & Hambrick, 1995; March, 1981), resulting in less awareness of rivals' competitive signals. In addition, larger firms may be characterized by complacency and inertia that cause them to underestimate the ability of their rivals, resulting in their knowing less about the rival's actions (Chen & Hambrick, 1995). Larger firms may believe that “they are powerful enough to ignore threats from their weaker rivals” (Miller & Chen, 1994: 7) and this reduced awareness may lower the potential impact of the rival's R&D intensity on the focal firm's competitive actions.

H2. The positive association between a rival's R&D intensity and a focal firm's frequency of product actions will be weaker if the focal firm is larger than the rival.

1.2.2. Relative firm performance

Well performing firms tend to become complacent and content with the status quo, and thus to resist change (Miller & Chen, 1994; Miller & Friesen, 1983). Under such circumstances, managers may believe that what they have done in the past is adequate, so there is little incentive for change. Because superior performance may make a focal firm feel that little vigilance is required, it may be less willing to engage in environmental scanning or search (Aguilar, 1967; March, 1981; Miller & Chen, 1994). This reduced motivation may delay managers' strategic decisions such that even if they notice a rival's stronger inputs in R&D, they may not feel a strong need for reaction in the form of increasing their strategic competitive actions.

In contrast, if a focal firm's performance is weaker than that of its head-on rival, this in itself may provide an incentive for it to be highly alert to what the rival is doing and to search for reasons for their weak performance, i.e., to “scan their environments to find out what is wrong” (Miller & Chen, 1994: 4). The motivation to search actively for reasons for their poor performance increases the probability of noticing the rival's inputs in R&D and may provide strong motivation to react to these inputs (Miller & Chen, 1994).

H3. The positive association between a rival's R&D intensity and a focal firm's frequency of product actions will be weaker if the focal firm has better performance than the rival.

1.2.3. Strategic homogeneity

Despite the awareness and motivation, a focal firm may not be able to respond to a rival's activity if it lacks the capability to do so (Chen & Miller, 2014). Indeed, strategy researchers have long recognized that different firms may be similar in key capability dimensions, and such strategic homogeneity may have implications for strategy formulation (Zhang & Rajagopalan, 2003). Echoing this idea, competitive dynamics researchers have highlighted the homogeneity or similarity aspect in assessing competitive interaction (Chen et al., 2007; Nadkarni, Chen, & Chen, 2015), suggesting that firms with homogeneous profiles tend to possess comparable capabilities and are therefore more likely to respond to each other's attacks (Chen et al., 2007). For example, Gimeno and Woo (1996) found that strategically homogeneous firms have an increased level of rivalry, and Porac and Thomas (1990) and Young, Smith, Grimm, and Simon (2000) suggest that a firm's ability to compete with rivals is partly determined by the extent to which they possess the same resources.

In our context, if strategic homogeneity between a focal firm and a rival is high, the focal firm may be more likely to react if awareness and motivation are in place. In contrast, if strategic homogeneity is low, the focal firm tends to possess a set of capabilities very different from that of the rival, so that even if the focal firm has formulated awareness of the rival's competitive signal and motivation to react, it may not have the capability required to compete head-on against the rival.

H4. The positive association between a rival's R&D intensity and a focal firm's frequency of product actions will be stronger if the two firms have higher strategic homogeneity.

2. Methods

2.1. Sample and data

We tested our hypotheses with data from the computer software sector (e.g., computer programing, prepackaged software, data management, etc.), defined by the three-digit SIC code (737) offered by the COMPUSTAT database. We focused on the computer software sector for several reasons. First, this sector is characterized by fast-changing technology and intense competition, in which product actions represent an important means of developing competitive advantage. Second, the strategic groups that exist within the computer software sector helped us clearly identify competitive pairs. Third, because larger software companies are publicly traded firms, they often announce their competitive actions via publicly available channels such as news releases and business wires.

We used three criteria to derive a sample from the selected industry sector. First, we focused on large (total sales > $ 100 million) firms, because competitive relationships are more obvious for larger firms and because their product actions are readily observable and typically have greater impact on rivals' competitive strategies than do the actions of smaller firms. Next, we focused on single business firms (>70% revenue from primary business), because these firms have significant market dependence such that competitive interdependence is particularly strong between them (Derfus et al., 2008). Finally, because researchers in competitive dynamics have highlighted the matched-pairs design, with a particular focus on the top players in an industry, as an ideal approach for examining firms' competitive interactions (Ferrier, Smith, & Grimm, 1999), we selected matched-pairs in the computer software industry sector on the basis of 4-digit SIC codes, that is, firms having the same 4-digit SIC codes were considered head-on competitors (Derfus et al., 2008; Ferrier et al., 1999). In our sample, we selected 8 industries in the sector: 7370, 7371, 7372, 7373, 7374, 7375, 7376, and 7379. From each industry, we picked the top two single-business firms (those with sales ranked first and second) during the time frame 1987–2010 and used them as the basis for constructing pairwise competitive relationships. Because firms' market shares as well as the identity of the top two single-business firms in each industry changed over time, we selected firms that appeared even once as one of the top two. As a result, we included 42 firms in our final sample and formulated 235 pairwise relationships.

We then constructed longitudinal observations on the basis of quarterly information obtained from several data sources. To collect data on firms' product actions, we followed previous studies (Nadkarni & Chen, 2014; Rindova, Ferrier, & Wiltbank, 2010) using the LexisNexis Academic database, which includes data from a comprehensive list of business wires and newspapers that report firms' activities. We followed the established *structured content analysis approach* to identify firms' product actions. We then used the COMPUSTAT database to collect information about firms' R&D expenditures and sales, along with additional data for calculating our main independent variables (firm relative size, relative performance, and strategic homogeneity) as well as the control variables (industrial munificence, industrial dynamism, industrial concentration, and relative slack resources).

Finally, we used a matched-pairs design to combine information from different data sources. Although our action data allowed us to observe firms' product actions on a daily basis, firms' R&D information was available only quarterly, therefore, we matched the rival's R&D data in a given quarter with the focal firm's product action data in the immediately following quarter. This design allowed us to observe how the product actions of the focal firm may change immediately after receiving the signal from the rival. For all other variables, we used the data from the year immediately preceding the action data. Thus, we constructed longitudinal observations for each rival-focal firm pair on the basis of quarterly data during 1987–2010. If a rival or a focal firm had no record in the COMPUSTAT database in a given year, we excluded the pair from our sample, which yielded an initial sample of 13,464 pairwise observations. However, a significant portion of the observations had missing information about R&D expenditure, which reduced our useable sample to 9838 pairs. When we filled in the missing R&D expenditure information with a very small number and reran all of the analyses, we obtained consistent results. Thus, we concluded that the missing data did not bias our results.

2.2. Measures

2.2.1. Dependent variable

We measured the focal firms' *frequency of product actions* as the counts of new product introductions reported in news releases, magazines, and trade journals, a method used in prior studies (e.g., Lavie & Rosenkopf, 2006; Nadkarni & Chen, 2014). Following prior studies, we used the *structured content analysis* procedure to collect data: for each sampled firm, we downloaded the headlines from the LexisNexis Academic database containing its name[1] and then asked two coders to read the headlines to ensure that the news release reported information about firms' product actions (such as introducing a new product, updating an existing product, eliminating or changing the features of a product etc.). To validate this method, we asked an independent expert to use the same procedure to code a random subsample of 50 product actions; overall agreement > 80% was achieved. In addition, we randomly selected a subsample of 130 firm-quarter observations and asked the expert to read through the entire articles, rather than just the headlines, and to recode the product actions for this subsample. A high Cronbach's alpha score (0.86) confirmed the consistency of the two coding procedures. We counted the number of product actions reported in the news releases and aggregated each focal firm's product action data on a quarterly basis.

2.2.2. Independent variables

We followed established procedure to measure firms' *R&D intensity* as quarterly R&D expenditures divided by sales (Greve, 2003). The measure was lagged by one quarter in the analysis.

Relative firm size was measured as the ratio of a focal firm's size divided by the rival's size (Chen et al., 2007). We obtained information about each firm's total sales in a given year and then calculated its firm size as the logarithm of its total sales (Greve, 2008). Following a similar procedure, we created a measure of *relative firm performance*, operationalized as the ratio of a focal firm's performance divided by the performance of the rival. We calculated each firm's return on sales (ROS) (net income divided by total sales) (Hitt, Hoskisson, & Kim, 1997).

We followed Zhang and Rajagopalan (2003) to measure *strategic homogeneity*, as reflected in six strategic dimensions: (1) advertising intensity (advertising expenditure/sales), (2) R&D intensity (R&D expenditure/sales), (3) plant and equipment (P&E) newness (net P&E/gross P&E), (4) nonproduction overhead (selling general, and administrative expenses/sales), (5) inventory levels (inventories/sales), and (6) financial leverage (debt/equity) (Finkelstein & Hambrick, 1990; Zhang & Rajagopalan, 2003). We first calculated a score for each dimension for both the focal firm and the rival on the basis of data from COMPUSTAT. Variance between the focal firm and the rival for each strategic dimension was first computed on a yearly basis and then standardized by the sample with Mean = 0 and S.D. = 1. Next, we multiplied the standardized score by −1 and used the average of the six standardized dimensions to arrive at an overall measure of strategic homogeneity.

2.2.3. Controls

We controlled for *industry concentration*, *industry dynamism*, and *industrial munificence*. We used the Herfindahl index for *industry concentration* (Derfus et al., 2008). To compute a standardized index of *industry dynamism*, we regressed industry values of shipments over 5 years against time and then used the standard error of the regression coefficient related to time divided by the average value of industry shipments (Nadkarni & Chen, 2014). *Industrial munificence* was measured as the percentage change in firm sales from the previous year to the present one (Derfus et al., 2008). For all industry variables, we used a one-year lag in the regressions.

Relative organizational slack was measured as the ratio of a focal firm's slack divided by the rival's slack (Chen et al., 2007). First, we used a composite measure to capture *organizational slack* on the basis of the average of (1) current ratio, computed as current assets/current liabilities (available slack), (2) debt-equity ratio (potential slack), and (3) the general and administrative expenses-to-sales ratio (recoverable slack) (Nadkarni & Chen, 2014). Second, we computed the ratio on the basis of individual slack scores. We also controlled for the rival's *frequency of product actions* by the same method we used to capture the focal firms' *frequency of product actions*.

2.3. Statistical method

Our data involved a panel of observations, with product action frequency as the dependent variable. Because our dependent variable was based on count data and had values of zeros, we followed prior studies and used negative binomial regression (Katila, Rosenberger, & Eisenhardt, 2008). Our data had repeated observations for each firm-rival pair; researchers have suggested the use of the Generalized Estimating Equations (GEE) regression method to control for within-group heterogeneity (Katila et al., 2008). In the analyses, we standardized all the independent variable data and used quarterly/yearly lags. Also, because the dependent variable had many data points with the value of zero, we used zero-inflated negative binomial regressions as a robustness check; the results were consistent.

3. Results

Table 1 contains descriptive statistics and correlations for all variables used in our analyses. Table 2 summarizes results from the GEE models. We calculated the variance inflation factors (VIFs) based on OLS models by regressing our dependent variable on all independent

[1] If the firm's name varied, we included all of them.

Table 1
Descriptive and correlations[a].

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10
DV												
1. Focal firm new product	2.45	5.54	1									
Controls												
2. Industry munificence	0.12	0.23	−0.03	1								
3. Industry dynamism	0.04	0.03	−0.19	0.25	1							
4. Industry concentration	0.10	0.07	−0.24	−0.16	0.11	1						
5. Rival firm new product[b]	3.42	6.18	0.21	−0.04	−0.20	−0.24	1					
6. Relative organizational slack	1.13	0.86	0.01	−0.01	0.07	0.08	−0.06	1				
Study variables												
7. Rival R&D intensity[b]	0.03	0.04	0.10	0.03	−0.07	−0.22	0.07	−0.04	1			
8. Relative firm size	1.08	0.86	0.07	0.02	−0.09	−0.07	−0.06	−0.10	0.16	1		
9. Relative firm performance	1.95	64.46	−0.01	−0.01	−0.01	0.00	−0.02	0.02	−0.02	0.00	1	
10. Strategic homogeneity	−0.01	0.51	−0.07	−0.02	0.00	0.03	0.00	0.00	−0.07	−0.08	0.00	1

N = 9838.
[a] Correlations with value greater than |0.02| are significant at $p < 0.05$.
[b] Quarterly observations.

variables, including the interaction terms, and found that the VIF values were in the acceptable range (<4.50).

In model 1, we tested the main effects of rival R&D intensity on the focal firm's product action frequency. We found that rival R&D intensity was positively associated with the focal firm's product action frequency ($\beta = 3.248$, $p < 0.001$). Thus our first hypothesis was supported.

Table 2
Results from negative binomial regressions[a].

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	1.468***	0.097+	1.480***	1.455***	0.173**
	(0.037)	(0.053)	(0.037)	(0.038)	(0.053)
Controls					
Industry munificence	−0.264***	−0.310***	−0.278***	−0.284***	−0.343***
	(0.066)	(0.066)	(0.066)	(0.067)	(0.067)
Industry dynamism	−12.987***	−10.426***	−13.128***	−13.121***	−10.773***
	(0.582)	(0.588)	(0.584)	(0.591)	(0.598)
Industry concentration	−8.060***	−6.953***	−8.064***	−8.231***	−7.167***
	(0.235)	(0.233)	(0.235)	(0.241)	(0.238)
Rival firm new product	0.029***	0.040***	0.029***	0.029***	0.039***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Relative organizational slack	0.168***	0.220***	0.169***	0.170***	0.220***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Study variables					
Rival R&D intensity (RRD)	3.248***	12.297***	3.037***	3.293***	11.561***
	(0.329)	(0.539)	(0.331)	(0.334)	(0.543)
Relative firm size		0.943***			0.887***
		(0.314)			(0.027)
RRD × relative firm size		−6.544***			−6.137***
		(0.314)			(0.315)
Relative firm performance			−0.000		−0.001
			(0.001)		(0.001)
RRD × relative firm performance			−0.097**		−0.092*
			(0.033)		(0.036)
Strategic homogeneity				−0.601***	−0.544***
				(0.028)	(0.028)
RRD × strategic homogeneity				2.441***	2.100***
				(0.386)	(0.395)
Wald chi2	3196.24***	4948.50***	3209.06***	3630.93***	5218.98***

Standard errors in parentheses.
[a] Regressions are based on GEE procedure; the number of observations is 9838, and the number of pairs is 235.
*** $p < 0.001$.
** $p < 0.01$.
* $p < 0.05$.
+ $p < 0.1$.

Our second hypothesis predicted that the positive association between the rival R&D intensity and the focal firm's product action frequency would be weaker if the focal firm was larger than the rival. In model 2, we tested the interaction effects between rival R&D intensity and relative firm size. The interaction term, rival R&D intensity × relative firm size, was negative and significant ($\beta = -6.544$, $p < 0.001$), which was in line with Hypothesis Two. Because non-linear models are difficult to interpret on the basis of coefficients alone (Hoetker, 2007), we graphed the marginal effects of rival R&D intensity at both the high (one standard deviation above the mean) and low (one standard deviation below the mean) levels of relative firm size, with all other variables held at the mean. Fig. 1 illustrates that the positive impact of rival R&D intensity was weaker when the focal firm was larger than the rival, which was consistent with Hypothesis Two. Moreover, in unreported tests, we ran regressions using sub-samples split by the mean relative firm size and obtained consistent results (small relative firm size: $\beta = 7.178$, $p < 0.001$; large relative firm size: $\beta = 0.125$, $p > 0.1$).

Our third hypothesis predicted that the positive association between rival R&D intensity and focal firm product frequency would be weaker if the performance of the focal firm was better than that of the rival. The interaction term, rival R&D intensity × relative firm performance, was negative and significant ($\beta = -0.097$, $p < 0.01$), which was in line with Hypothesis Three. We then graphed the marginal effects of rival R&D intensity at both the high (one standard deviation above the mean) and low (one standard deviation below the mean) levels of relative firm

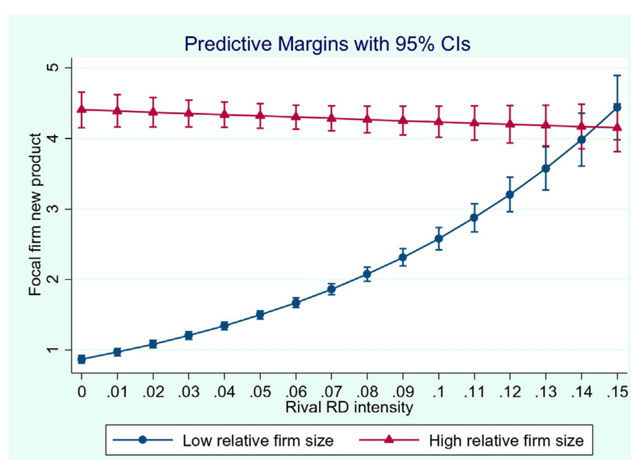

Fig. 1. Interaction plot for the moderator effect of relative firm size.

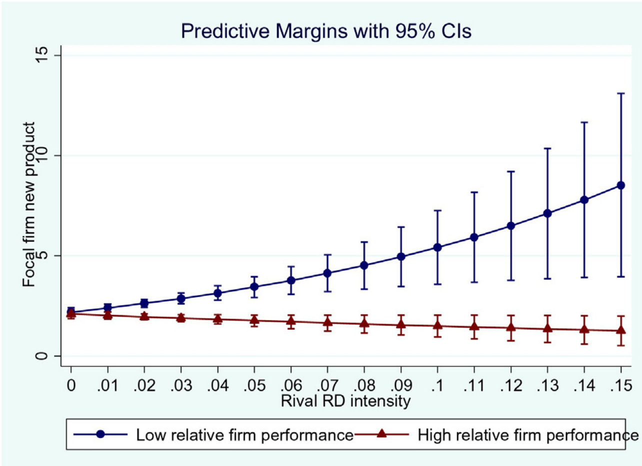

Fig. 2. Interaction plot for the moderator effect of relative firm performance.

performance, with all other variables held at the mean. Fig. 2 illustrates that the positive relationship between rival firm R&D intensity and focal firm product action frequency became weaker when the performance of the focal firm was better than that of the rival, which was consistent with Hypothesis Three. However, our additional split-sample tests raised some concern in that the results obtained by using sub-samples split by relative firm performance were opposite to those of our prediction. Thus, Hypothesis Three did not receive support.

Hypothesis Four predicted that the positive association between rival R&D intensity and the focal firm's product action frequency will be stronger if strategic homogeneity between the focal firm and rival firm is high. The interaction term rival R&D intensity × strategic homogeneity was positive and significant ($\beta = 2.441$, $p < 0.001$) and in line with Hypothesis Four. Fig. 3 illustrates that the positive impact of rival R&D intensity was stronger (slope is steeper) when strategic homogeneity was high, which was consistent with Hypothesis Four. The interaction plot reveals that the moderating effect became more highly significant as rival R&D intensity increased. When we ran regressions using sub-samples split by the mean of strategic homogeneity, the results were consistent (high strategic homogeneity: $\beta = 2.675$, $p < 0.001$; low strategic homogeneity: $\beta = 0.437$, $p > 0.1$), which further supported Hypothesis Four.

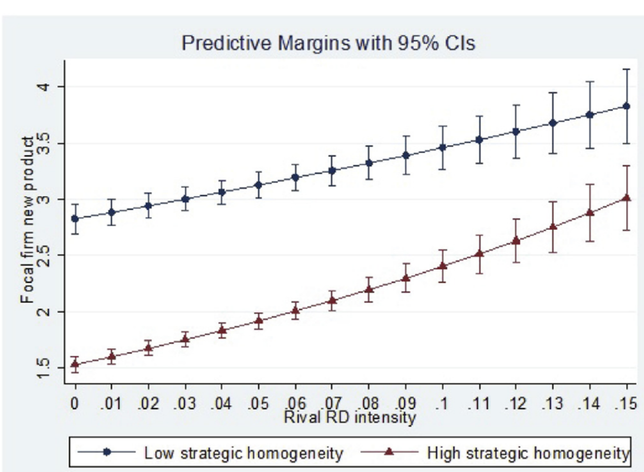

Fig. 3. Interaction plot for the moderator effect of strategic homogeneity.

4. Discussion

In this paper, we introduce an integrative model to examine how a focal firm will plan its product actions in response to a rival's competitive signals. Drawing on the AMC framework in competitive dynamics (Chen, 1996), we use a particular type of competitive signal — the rival's R&D intensity — to predict a focal firm's product actions. We also examine the moderating role of firms' relative size, relative performance and strategic homogeneity in such competitive situations. Based on a sample of firms in the computer software sector, we found that the rival's R&D intensity in Time 1 tends to influence the focal firm's frequency of product actions in Time 2. We also found that the size of the focal firm relative to that of the rival, as well as the strategic homogeneity of the two, moderated this relationship.

Our study makes several contributions. First, although prior studies have utilized signaling theory to argue that a focal firm's product strategy is often in response to a rival's competitive signals (Bowman & Gatignon, 1995; Robertson, Eliashberg, & Rymon, 1995), few empirical studies have examined how the competitive signals contained in firms' financial statements may influence inter-firm rivalry. Porter (1980) has contended that a rival's financial statements may contain valuable competitive intelligence that a focal firm can use to detect a rival's current strategy, future plans, and strategic goals. In this paper, we incorporate this view into a theoretical model that links a rival's R&D intensity to a focal firm's product actions.

Moreover, our study considers the joint effects of the *behavioral drivers* of a focal firm's competitive moves (Chen & Miller, 2014). We found that when the focal firm is larger, it tends to be less aware of the rival's action and therefore less reactive to the rival's competitive signal. We also found that when the focal firm and the rival have relatively high strategic homogeneity, the focal firm tends to be more reactive to the rival's competitive signal. Indeed, the notion of strategic homogeneity reflects the capability component in the AMC framework, in that the greater the strategic homogeneity between the focal firm and the rival, the more likely the focal firm will be to respond to the rival's competitive signal (Chen et al., 2007). Although we also hypothesized that a focal firm's performance relative to that of a rival may moderate its response to the rival's competitive signal, our empirical test did not strongly support this hypothesis. Prior studies have linked firms' performance to motivation, suggesting that better performance may reduce the focal firm's motivation to undertake more actions (Miller & Chen, 1994); however, those firms that perform better may be stronger in terms of capability, and therefore more likely to undertake competitive actions when they are attacked. Future research may further reveal additional implications of firm performance.

Finally, competitive dynamics research has long recognized that a firm's capability is an important behavioral driver of its competitive actions (Ndofor et al., 2011). However, firms' resources and capabilities may also serve as "de-motivators" that reduce a firm's incentive to act in response to a competitive threat. In an unreported test, we found that when a focal firm has more slack than the rival, the relationship between the rival's R&D intensity and the focal firms' frequency of product actions decreases. Thus, slack resources, traditionally considered indicative of capability, may also have implications for motivation. For instance, as a firm becomes more capable, it may also develop *complacency* (Miller & Chen, 1994), which leads to *competitive blind spots* as proposed by prior studies (Ng, Westgren, & Sonka, 2009; Zajac & Bazerman, 1991).

We admit a few limitations of our study. First, our study focused only on one industry, the computer software industry, to study firms' competitive interactions. Although this approach is common in competitive dynamics research (e.g., Chen et al., 2007; Marcel et al., 2010), it may limit the generalizability of our findings. Second, our sample included only 42 large single-business firms, which do not vary greatly in terms of firm size, so that the moderating effects of relative firm size must be interpreted with caution. Third, although we mapped the moderators such as relative size, relative performance and strategic homogeneity onto specific components of the AMC framework, one factor may possibly have divergent impacts on awareness, motivation, and capability. Future research may develop more fine-grained theoretical frameworks and methodologies to address such limitations.

5. Conclusion

The practical implications of our research are as follows. First, firms' financial statements may contain critical competitive intelligence, such as R&D intensity, that invites competition; therefore, managers may need to be careful about assessing the competitive implications of their information disclosure. Second, accurate prediction of rivals' actions requires that managers jointly consider factors influencing competitors' awareness, motivation and capability. Third, although larger, better performing firms may pose formidable threats, they may not respond quickly to competitive signals, which may allow their competitors leeway to explore means of achieving temporary competitive advantage.

References

Acs, Z. J., & Audretsch, D. B. (1988). Innovation in large and small firms: An empirical analysis. *The American Economic Review*, 678–690.

Aguilar, F. J. (1967). *Scanning the business environment.* Macmillan: Elsevier.

Bowman, D., & Gatignon, H. (1995). Determinants of competitor response time to a new product introduction. *Journal of Marketing Research*, *32*(1), 42–53.

Chen, M. -J. (1996). Competitor analysis and interfirm rivalry: Toward a theoretical integration. *The Academy of Management Review*, *21*(1), 100–134.

Chen, M. -J., & Hambrick, D. C. (1995). Speed, stealth, and selective attack: How small firms differ from large firms in competitive behavior. *The Academy of Management Journal*, *38*(2), 453–482.

Chen, M. -J., Lin, H. -C., & Michel, J. G. (2010). Navigating in a hypercompetitive environment: The roles of action aggressiveness and TMT integration. *Strategic Management Journal*, *31*(13), 1410–1430.

Chen, M. -J., & Miller, D. (1994). Competitive attack, retaliation and performance: An expectancy-valence framework. *Strategic Management Journal*, *15*(2), 85–102.

Chen, M. -J., & Miller, D. (2014). Reconceptualizing competitive dynamics: A multidimensional framework. *Strategic Management Journal*, *36*(5), 758–775.

Chen, M. -J., Smith, K. G., & Grimm, C. M. (1992). Action characteristics as predictors of competitive responses. *Management Science*, *38*(3), 439–455.

Chen, M. -J., Su, K. -H., & Tsai, W. (2007). Competitive tension: The awareness-motivation-capability perspective. *Academy of Management Journal*, *50*(1), 101–118.

Chen, P. -L., Williams, C., & Agarwal, R. (2012). Growing pains: Pre-entry experience and the challenge of transition to incumbency. *Strategic Management Journal*, *33*(3), 252–276.

Coff, R. (2003). Bidding wars over R&D-intensive firms: Knowledge, opportunism, and the market for corporate control. *Academy of Management Journal*, *46*(1), 74–85.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*, 128–152.

Derfus, P. J., Maggitti, P. G., Grimm, C. M., & Smith, K. G. (2008). The Red Queen effect: Competitive actions and firm performance. *Academy of Management Journal*, *51*(1), 61–80.

Ferrier, W. J., Smith, K. G., & Grimm, C. M. (1999). The role of competitive action in market share erosion and industry dethronement: A study of industry leaders. *Academy of Management Journal*, *42*(4), 372–388.

Finkelstein, S., & Hambrick, D. C. (1990). Top-management-team tenure and organizational outcomes: The moderating role of managerial discretion. *Administrative Science Quarterly*, 484–503.

Fombrun, C., & Shanley, M. (1990). What's in a name? Reputation building and corporate strategy. *Academy of Management Journal*, *33*(2), 233–258.

Gentry, R. J., & Shen, W. (2013). The impacts of performance relative to analyst forecasts and analyst coverage on firm R&D intensity. *Strategic Management Journal*, *34*, 121–130.

Gimeno, J., & Woo, C. Y. (1996). Hypercompetition in a multimarket environment: The role of strategic similarity and multimarket contact in competitive de-escalation. *Organization Science*, *Vol. 7*, 322–341 (INFORMS: Institute for Operations Research).

Greve, H. R. (2003). A behavioral theory of R&D expenditures and innovations: Evidence from shipbuilding. *Academy of Management Journal*, *46*(6), 685–702.

Greve, H. R. (2008). A behavioral theory of firm growth: Sequential attention to size and performance goals. *Academy of Management Journal*, *51*(3), 476–494.

Healy, P. M., & Palepu, K. G. (1993). The effect of firms' financial disclosure strategies on stock prices. *Accounting Horizons*, *7*(1), 1–11.

Hitt, M. A., Hoskisson, R. E., & Kim, H. (1997). International diversification: Effects on innovation and firm performance in product-diversified firms. *Academy of Management Journal*, *40*(4), 767–798.

Hoetker, G. (2007). The use of logit and Probit models in strategic management research: Critical issues. *Strategic Management Journal*, *28*(4), 331–343.

Hofer, C. W. (1975). Toward a contingency theory of business strategy. *Academy of Management Journal*, *18*(4), 784–810.

Hsieh, K. Y., Tsai, W., & Chen, M. J. (2015). If they can do it, why not us? Competitors as reference points for justifying escalation of commitment. *Academy of Management Journal*, *58*(1), 38–58.

Katila, R., & Chen, E. L. (2008). Effects of search timing on innovation: The value of not being in sync with rivals. *Administrative Science Quarterly*, *53*(4), 593–625.

Katila, R., Rosenberger, J. D., & Eisenhardt, K. M. (2008). Swimming with sharks: Technology ventures, defense mechanisms and corporate relationships. *Administrative Science Quarterly*, *53*(2), 295–332.

Lavie, D., & Rosenkopf, L. (2006). Balancing exploration and exploitation in alliance formation. *Academy of Management Journal*, *49*(4), 797–818.

Marcel, J., Barr, P. S., & Duhaime, I. M. (2010). The influence of executive cognition on competitive dynamics. *Strategic Management Journal*, *32*, 115–138.

March, J. (1981). Decision in organizations and theories of choice. In A. H. Van de Ven, & W. Joyce (Eds.), *Perspectives on organization design and behavior* (pp. 200–225). New York: Wiley.

Miller, D., & Chen, M. -J. (1994). Sources and consequences of competitive inertia: A study of the U.S. airline industry. *Administrative Science Quarterly*, *39*(1), 1–23.

Miller, D., & Friesen, P. H. (1983). Strategy-making and environment: The third link. *Strategic Management Journal*, *4*(3), 221–235.

Nadkarni, S., & Chen, J. (2014). Bridging yesterday, today, and tomorrow: CEO temporal focus, environmental dynamism, and rate of new product introduction. *Academy of Management Journal*, *57*(6), 1810–1833.

Nadkarni, S., Chen, T., & Chen, J. (2015). The clock is ticking! Executive temporal depth, industry velocity, and competitive aggressiveness. *Strategic Management Journal*, *37*(6), 1132–1153.

Ndofor, H. A., Sirmon, D. G., & He, X. (2011). Firm resources, competitive actions and performance: Investigating a mediated model with evidence from the in-vitro diagnostics industry. *Strategic Management Journal*, *32*, 640–657.

Ng, D., Westgren, R., & Sonka, S. (2009). Competitive blind spots in an institutional field. *Strategic Management Journal*, *30*(4), 349–369.

Porac, J. F., & Thomas, H. (1990). Taxonomic mental models of competitor definition. *Academy of Management Review*, *15*, 224–240.

Porter, M. E. (1980). *Competitive strategy: Techniques for analyzing industries and competitors.* New York: Free Press.

Rindova, V. P., Becerra, M., & Contardo, I. (2004). Enacting competitive wars: Competitive activity, language games, and market consequences. *Academy of Management Review*, *Vol. 29*, 670–686.

Rindova, V., Ferrier, W. J., & Wiltbank, R. (2010). Value from gestalt: How sequences of competitive actions create advantage for firms in nascent markets. *Strategic Management Journal*, *31*(13), 1474–1497.

Robertson, T. S., Eliashberg, J., & Rymon, T. (1995). New product announcement signals and incumbent reactions. *Journal of Marketing*, *59*(3), 1–15.

Smith, K. G., Collins, C. J., & Clark, K. D. (2005). Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms. *Academy of Management Journal*, *48*(2), 346–357.

Tellis, G. J. (1989). The impact of corporate size and strategy on competitive pricing. *Strategic Management Journal*, *10*(6), 569–585.

Tushman, M. L., & Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly*, *31*(3), 439–465.

Young, G., Smith, K. G., Grimm, C. M., & Simon, D. (2000). Multimarket contact and resource dissimilarity: A competitive dynamics perspective. *Journal of Management*, *26*, 1217–1236.

Yu, T., & Cannella, A. A., Jr. (2007). Rivalry between multinational enterprises: An event history approach. *Academy of Management Journal*, *50*(3), 665–686.

Yu, T., Subramaniam, M., & Cannella, A. A. (2009). Rivalry deterrence in international markets: Contingencies governing the mutual forbearance hypothesis. *The Academy of Management Journal*, *52*(1), 127–147.

Zajac, E. J., & Bazerman, M. (1991). Blind spots in industry and competitor analysis: Implications of interfirm (mis)perceptions for strategic decisions. *Academy of Management Review*, *18*(1), 37–56.

Zhang, Y., & Rajagopalan, N. (2003). Explaining new CEO origin: Firm versus industry antecedents. *Academy of Management Journal*, *46*(3), 327–338.