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COMPETITION NETWORK STRUCTURE AND PRODUCT MARKET ENTRY

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This study proposes and tests a theory of the effects of competition network structure on product market entry. Competition networks are defined as the patterns of interdependence between rivals that emerge from direct competition. Studying networks based on competitive interdependence allows us to extend social network theory to new territory and to enhance our understanding of product market entry. We propose that the size, interconnectedness and diversity of competition networks influence subsequent product market entry in a systemic way. We test our hypotheses in a unique dataset drawn from the aircraft modification industry.

INTRODUCTION

We theorize that the rate at which firms enter new product markets is influenced by the structure of each firm's competition network. Competition networks are defined as the relational structures of interdependence between rivals that emerge from direct competition. The idea of competition networks is important because it has the potential to facilitate the development of more encompassing theories of interorganizational networks and to expand our understanding of product market entry specifically and competitive dynamics generally.

The idea that social networks can be based on ties of competitive interdependence makes this study different from social network research based on cooperative relationships (Burt, 1992, 2007; Carpenter, Li, and Jiang, 2012; Provan, Fish, and Sydow, 2007). To develop this idea we build on a core proposition of competitive dynamics theory that competition creates interdependencies expressed through patterns of action and response (Barnett and Pontikes, 2008; Baum and Korn, 1999; Chen, 1996; Gimeno and Woo, 1996; Smith *et al.*, 1991; Tsai, Su, and Chen, 2011). Our goal is to build on the strong foundation provided by studies of dyadic and triadic relations between firms and their competitors (Gimeno, 2004; Madhavan, Gnyawali, and He, 2004) by using social network theory to examine whole networks of competition. Although Yao, Ferrier, and Yu's, 2007 study was the first we are aware of to investigate whole networks of competition, it is limited by its reliance on ideas based on cooperation.

We shift the level of analysis to competition network structure because we think the overall structure of competitive relationships should play a critical role in product market entry. Combining competitive dynamics theory (Baum and Korn, 1999; Chen, 1996; Gimeno, 2004; Smith *et al.*, 1991) and social network theory (Borgatti and

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Lopez-Kidwell, 2011; Burt, 1992; Knoke and Yang, 2008; Simmel, 1964) leads to new questions that can help us understand product market entry, such as: How do the size and interconnectedness of a firm's competition network influence its product market entry? How does diversity in a firm's network of competitors influence its product market entry behavior?

We test our theory with data from the market for modifications of aircraft in the United States, using data from the Federal Aviation Administration. The industry that serves this market is diverse, widely distributed, and devoid of cooperation between competitors. It thus has few of the characteristics that would encourage a conventional network analysis. We nonetheless find that several competition network structure constructs are related to product market entry.

THEORY DEVELOPMENT

We study product market entry because it is an important element of competition and because it can change the structure of competition networks. Entering new markets changes the mix of competitors a firm faces by increasing or decreasing contact with old rivals and by creating contact with new rivals. Product market entry thus alters the need for competitive action. This sets it apart from competitive moves such as advertising or price changes, which do not usually change which firms compete with each other. There is wide agreement that competition is an important motive for product market entry (Baum and Korn, 1999; Hage, 1999; Mitchell, 1989; Yao *et al.*, 2007). While studies like these demonstrate other reasons for product market entry (to sell new or existing products, deploy slack resources, or exploit learned capabilities for entry), we focus narrowly on how the structure of competition networks influences product market entry. Our theorizing is thus concerned primarily with product market entry that occurs as firms try to escape from, preempt, imitate, or respond to competitors. We control for other causes of product market entry without integrating them into our hypotheses.

Competition networks emerge from the interaction of social entities (Simmel, 1964). Competitive relationships exhibit the essential attributes of relational form that make network theory viable (Knoke and Yang, 2008) because they are expressed over time in sequences that vary in intensity, frequency, and strength. The important difference between cooperation and competition networks is that, while in cooperation networks action follows private information flows, in competition networks action follows from selective attention to public actions (Gimeno, 2004; Smith *et al.*, 1991; Tsai *et al.*, 2011). Following a long tradition in competition theory, we assume that firms pay more attention to direct competitors (Barnett and Pontikes, 2008; Baum and Korn, 1999; Chen, 1996; Gimeno, 2004; Mitchell, 1989; Smith *et al.*, 1991).

Borgatti and Lopez-Kidwell (2011) distinguish between network flow models and network architecture models. Most social network research involves flow models in which private information is transmitted through cooperative ties. Examples are Granovetter's strength of weak ties theory (1973) or small world theory (Guimerà *et al.*, 2005). In contrast, a network architecture model is one in which effects propagate across connections without strictly flowing. In an architecture Model A acts, which leads B to act differently, so that C acts differently, and so on. Signals are transmitted but do not necessarily stay the same as they are received and acted on. Davis's theory of organizational adaptation (1991) and Burt's theory of brokerage (1992, 2007) are examples of network architecture model research.

This study differs from prior attempts to combine competitive dynamics and social network theory (Yao *et al.*, 2007) by proposing that competition networks belong to the network architecture

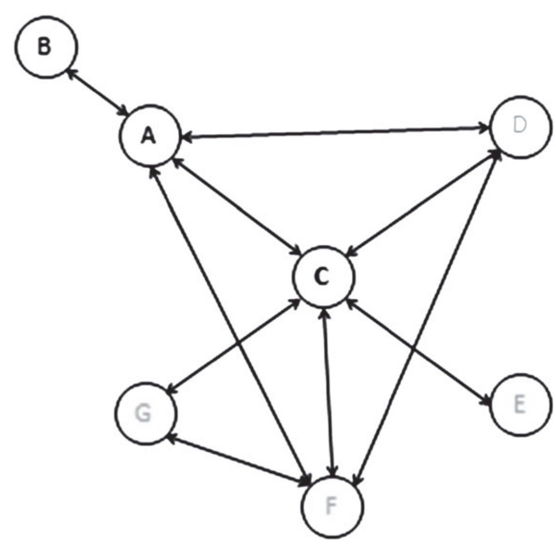

Figure 1. Competition network of C

category. In Figure 1 firm A competes with firms B and C, who do not compete with each other. If A reacts to a move by B, C might respond to A's action or do nothing. Similarly, if A fails to react to a move by B, C is not prevented from responding to the lack of action. This suggests that in a competition network signals originating from indirect connections (B is connected to C indirectly through A while A and C compete directly) are transformed by how mediating competitors respond to them. My enemy's enemy might be my friend (Gimeno, 2004), but what matters to me is what my enemy does. This resonates with Burt's (2007) finding that direct connections are effectively the source of stimuli for the focal firm, rather than brokers who control information flows from distant parts of the network. Because of this we focus on the structure of the ego network rather than position in the total network. If we exclude B, Figure 1 depicts C's ego network of direct competitors.

Our basic proposition is that the structure of an ego network at a given time will influence a firm's later product market entry behavior. By structure we mean the size, interconnectedness, and diversity of the ego network. While recognizing that other factors influence product market entry (Hage, 1999; Mitchell, 1989) we focus on the effects of competition networks structure.

Large networks provide more stimuli for product market entry. Other things being equal, a larger network should expose the firm to more opportunities to enter markets and motivations for doing so. Firms with large networks will be better positioned to observe more product innovations or identify new customers and competitors. Product market entry should become more common as the firm enters contested markets in search of parity with numerous rivals or uncontested markets to get away from competitors. Although limits on a firm's slack resources or saturation of available markets could cause the relationship between network size and product market entry to be nonlinear, for this study we propose a simple linear relationship.

Hypothesis 1: The rate of product market entry will increase as ego network size increases.

As Burt has long argued (1992, 2007) the interconnectedness of networks influences the performance of the firms in them. Densely connected networks should have different effects on patterns of competition than sparsely connected ones. When a firm's competitors also compete with each other, their actions will be interdependent. The more densely connected a network is the more interdependent action should be. Burt (1992, 2007) theorizes that dense ties in a network mean that its members act in similar ways, reducing the variety of actions the focal actor is exposed to. In densely connected networks, entering a single product market may be useful for responding to several rivals. If this is the case, firms can lower the cost of competing by taking fewer actions, which suggests that network density should lead to lower levels of competition driven product market entry. Reduced levels of product market entry in densely connected networks are also more likely because any entry activity could provoke multiple responses. If entering a new product market causes ripple effects of subsequent competitive activity and thus makes competition more costly overall, firms with dense competition networks may be more selective in their product market entry choices. Since product market entry is costly and responses to it may propagate rapidly through a densely connected network, we would expect firms to respond to density by entering fewer markets, ceteris paribus.

Hypothesis 2: The rate of product market entry will decrease as ego network density increases.

The diversity of competitors in a firm's ego network should influence product market entry in a similar way. Our argument concerning density is that interdependence reduces the variety of actions a firm responds to. A related argument is that when rivals are similar on meaningful attributes they should behave in similar ways, even if they are not interdependent. A network of diverse competitors should have different effects on product market entry than a network of similar competitors (Baum and Korn, 1999; Mitchell, 1989; Tsai *et al.*, 2011). When a firm's rivals are similar, fewer product market entries may be necessary to remain competitive. Spender's (1989) description of the emergence of industry recipes for action is an example of how competitors develop similar resource bases and competitive routines. When a firm's rivals are diverse, it may need to enter more markets to maintain parity, achieve advantage (Li and Greenwood, 2004), or escape or preempt competition. This suggests that product market entry will be more frequent when a firm's ego network is diverse. As with network size, although the relationship between network diversity and product market entry may be nonlinear if resource constraints limit a firm's ability to enter many new markets or if the firm has entered most of the available markets, we propose a simple relationship.

Hypothesis 3: The rate of product market entry will increase as competitor diversity increases.

METHODS

The research setting for this study is the aircraft modification industry in the United States. One of the reasons we chose to study this industry is that we could find little evidence that firms competing in it cooperate, making this a setting where a conventional network study would not be possible. Although embeddedness in collaborative networks (Afuah, 2013; Hage, 1999; Madhavan *et al.*, 2004; Whittington, Owen-Smith, and Powell, 2009) is an important driver of innovation and subsequent market entry, our primary purpose in this study is to show that network theory can be applied equally well to competitive relationships.

Aircraft modifications are an aftermarket in which aircraft owners buy services that replace or modify original equipment. Competitors include small firms whose sole business is the installation of third-party equipment, aftermarket equipment makers who install their own products, fixed-base operators who maintain and modify aircraft, major systems sellers who retrofit aircraft to support original equipment sales, airline maintenance operations that upgrade their own and others' fleets, and airframe manufacturers who offer aftermarket modification services. Some modifiers focus on specific types of aircraft (helicopters or jets) or modifications (galley reconfiguration or radio replacement), while others are broad generalists.

Aircraft are registered with the Federal Aviation Administration (FAA) on the basis of type certificate data sheets (TCDS). TCDS often cover multiple models of a single aircraft type. Type certificate data sheets are frequently amended and renewed. For example, TCDS A16WE covers 12 models of the Boeing 737 and was updated 21 times between 1998 and 2011.

Modifications of aircraft registered in the United States must also be approved by the FAA. Approved modifications are formalized in supplemental type certificates (STCs). In order to offer a new product or extend existing products to new aircraft types a firm must apply for a new STC. Since each STC is issued to a single firm and specifies modifications not covered by its prior STCs, every STC represents an act of product market entry. Because an STC may apply to several aircraft types, it may represent simultaneous entry into several markets. An example is STC SA1514SW which allowed Rockwell Collins to modify radio systems in Boeing 737 aircraft covered by TCDS A16WE. This data makes it possible to identify product market entry and competitors who perform the same modifications on the same aircraft types and hence for the same set of customers. Rockwell Collins and Honeywell both have STCs for modifying radio systems in 737 to 400 seconds, making them direct competitors in that product market.

Data

The primary sources for this study are the FAA databases of supplemental type certificates (FAA, 2011a) and type certificate data sheets (FAA, 2011b). We limit data to modifiers who were granted STCs later than 1989, since this provides us with ample data without requiring us to account for variation in the regulatory environment. In the 1990s, 1,934 entities had at least one STC issued to them. Among U.S. aircraft modifiers, the average was 6.8 STCs issued in the 1990s and 6.5 in the 2000s. Ninety-four percent of firm-years in the period have no new STCs. Since there is no reason to assume that the year is a natural unit for product market entry, we test our hypotheses by relating independent variables based on activity in the decade 1990–1999 to product market entry between 2000 and 2009. Using decade-long windows allows us to create reliable variables from infrequent events.

We made a systematic effort to determine whether firms were going concerns for all or part of the 2000s. If firms (1) created or modified STCs during the 2000s; (2) were listed as an active corporation in a state register in the 2000s; (3) had a business telephone listing in the 2000s; or (4) could be identified as purchased, merged, or having changed their names during the 2000s, we included them as going concerns. We gathered this data using internet searches performed during 2013, and eliminated 215 entities as a result. Identification as a going concern does not mean a firm is an active competitor. We analyzed the population of going

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concerns and found that firms with one or two STCs in the 1990s were typically operators modifying aircraft they owned, rather than service providers modifying customer aircraft. We therefore chose our sample by identifying going concerns that were issued at least three STCs in the decade beginning in 1990 for fixed wing or rotary wing aircraft. Of the going concerns, 671 met this test. The four-firm concentration ratio for STCs among these firms for the two-decade period is 13.8 percent.

Measures

We measured the dependent variable, future product market entry, as the count of new STCs issued to each firm between 2000 and 2009.

We measured direct competition by identifying STCs that apply similar modifications to the same aircraft model/types. We identified modifications on the basis of descriptive noun pairs. Examples of noun pairs are "collision avoidance" or "fuel tank." Our process was to use a text analysis package to identify the nouns in the text descriptions of STCs. After eliminating proper names, numbers, and identification codes, aggregating plurals and variants, and eliminating nondescriptive nouns like "system" or "installation," we limited the list to nouns that occurred in more than 50 STCs. This gave us a list of 227 frequently occurring meaningful descriptive nouns that appeared in more than 80 percent of STCs issued after 1990. Since nouns in isolation are difficult to interpret, we then identified co-occurrences of noun pairs across STCs. STCs that share noun pairs involve the same kinds of modifications. We define direct competition as occurring when different firms have STCs that share one or more noun pairs and one or more model/type. Of 671 firms in the sample, 611 had one or more direct competitors in the 1990s who we considered to be going concerns in the 2000s.

Degree is the network theory name for ego network size. Degree as of 2000 was calculated as the count of direct competitor going concerns, as defined above. Density is measured as the percentage of possible competitive ties between members of the ego network that are actually realized.

Our third hypothesis concerns the diversity of competitors, on the assumption that firms with different attributes will compete in different ways. To examine diversity in competition networks in a way that builds on prior research and gives us insight into the effects of diverse competitor action, we develop a measure of diversity using a construct from the competitive dynamics literature, multimarket contact (Chen, 1996; Gimeno and Woo, 1996; Li and Greenwood, 2004). The literature has demonstrated that when rivals compete in few markets, they often compete aggressively, but that when rivals are in contact in multiple markets, the level of competitive action between them generally declines (Baum and Korn, 1999). This is a desirable characteristic for a diversity measure in this study because it speaks directly to the variety of action a firm faces from its network of competitors. To convert multimarket contact from a dyad level measure to a network level measure, we calculated multimarket contact between each firm and its direct competitors and used these values to calculate a measure of the diversity of the competitive relationships each firm is in.

We measured multimarket contact using the method developed by Baum and Korn (1999), which weights each shared market by its centrality in a firm's portfolio of markets. We measure the centrality of market *m* in a company *i*'s portfolio as the proportion of *i*'s other product markets that share a word pair or a model/type with market *m*. We measure multimarket contact between going concerns *i* and *j* in the decade from 1991 to 2000 as follows:

$$\frac{\sum M_i \left[C_{im} \times \left(D_{im} \times D_{jm}\right)\right] + \sum M_j \left[C_{jm} \times \left(D_{im} \times D_{jm}\right)\right]}{M_i + M_j}$$

for all $\sum \mathrm{M_i}(\mathrm{D_{im}} \times \mathrm{D_{jm}}) > 1$, where m denotes a given market in the set of markets M_i or M_j served by firms *i* and *j*, respectively. C_{im} and C_{jm} are the centralities of market *m* to firms *i* and *j*, and D_{im} and D_{jm} are indicator variables set equal to 1 if firms *i* or *j* are active in market *m* during the decade and 0 otherwise. The diversity of a focal firm's multimarket contact is measured as the coefficient of variation (standard deviation divided by mean) of multimarket contact with the firm's direct competitors. The coefficient of variation is a commonly used measure of dispersion. We also tested measures based on the diversity of competitor ego network size, network density, and prior market entry behavior, measured as the number of STCs issued to each competitor in the 1990s. These alternatives produced similar results.

Controls

We controlled for whether the firm was a TCDS holder because holders are usually airframe makers, making them distinct from other modifiers. We controlled for the kinds of aircraft the firm works on by identifying aircraft as fixed or rotary wing and as being single or multiengine since these broad market categories imply different skills. The controls are the percentage of a firm's STCs in the 1990s involving rotorcraft or multiengine aircraft.

It is necessary to control for learned market entry capability because if firms have learned to enter product markets in the past, they are likely to continue to do so regardless of differences in network structure (Hage, 1999).We measured learned market entry capability as the count of STCs issued to each firm in the 1990s. This measure is correlated with a firm's age in years as of 2000 ($r = 0.29$). Age in years is never significant when included as a control, which is consistent with the idea that learning by doing matters more than the passage of time.

RESULTS

Descriptive statistics and correlations are shown in Table 1. The controls for multiengine aircraft and rotorcraft are negatively correlated, as expected. About 10 percent of firms are type certificate holders, which is significantly correlated with product market entry. The three independent variables are moderately correlated with each other.

To analyze our model we used a negative binomial regression (Whittington *et al.*, 2009). This method is appropriate because a Pearson goodness-of-fit test indicates that the distribution of the dependent variable is overdispersed. A Poisson regression would underestimate standard errors and generate misleading results. To guard against inferential overreaching, we interpret as significant only results that are robust across models.

Table 2 presents the results of the negative binomial regression models. Model 1 presents the control variables, Models 2–4 present the hypothesized effects separately and Model 5 presents the fully specified model. In Model 1 the coefficients for learned market entry capability and type certificate holder variables are positive and significantly different from zero. Experienced firms and TCDS holders enter more markets over time. The coefficients for the percentage of rotorcraft and multiengine markets are not significantly different from zero.

In Model 2 of Table 2, ego network size is entered. Hypothesis 1 is supported. As the number of competitors in ego networks increases, the rate of product market entry increases. In Model 3 the variable for ego network density is entered into the control model. Its coefficient is not significantly different from zero, so that Hypothesis 2 is not supported. In Model 4 the diversity of multimarket contact variable is entered into the control model. The estimated coefficient is positive and significant and thus supports Hypothesis 3. Model 5 shows the fully specified model. The results are stable.

We performed a number of post hoc tests. We tested for nonlinear effects of network size and diversity, since exhaustion of slack resources or other causes may place limits on how much product market entry is possible for any firm. Post hoc tests show that the squared term for network size is significant, indicating that the relationship between network size and product market entry has an inverted U shape. We tested for interactions between the independent variables, but no significant effects were observed.

Table 1. Descriptive statistics and correlations[a]

	Mean	Std dev.	1	2	3	4	5	6	7
1. New product market entry	12.21	47.34							
2. Learned market entry capability	20.24	42.85	0.63***						
3. Percentage of multiengine	0.68	0.35	0.06	0.04					
4. Percentage of rotorcraft	0.12	0.31	−0.04	−0.02	−0.40***				
5. Type certificate holder	0.10	0.29	0.29***	0.25***	0.00	0.10**			
6. Network size	135.10	164.66	0.42***	0.64***	0.22***	−0.16***	0.18***		
7. Network density	0.43	0.23	−0.12*	−0.18***	0.06	−0.07	−0.08*	−0.19***	
8. Diversity of multimarket contact	1.21	0.51	0.10**	0.11**	0.09*	−0.08*	0.05	0.29***	0.24***

[a] $n = 671$.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 2. Negative binomial regressions on number of new product market entries, 2001–2010[a]

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	1.64***	1.39***	1.25***	0.02	0.21
	(0.19)	(0.19)	(0.24)	(0.26)	(0.26)
Learned market entry capability	0.02***	0.01***	0.01***	0.02***	0.01***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Percentage of multiengine	−0.11	−0.46*	−0.44	−0.17	−0.52*
	(0.23)	(0.23)	(0.23)	(0.23)	(0.23)
Percentage of rotorcraft	−0.50	−0.39	−0.39	−0.45	−0.33
	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)
Type certificate holder	0.66**	0.70**	0.73**	0.73**	0.73**
	(0.26)	(0.25)	(0.25)	(0.25)	(0.25)
Network size		0.003***			0.003***
		(0.0006)			(0.0005)
Network density			−0.02		−0.27
			(0.32)		(0.33)
Diversity of multimarket contact				1.07***	1.03***
				(0.15)	(0.16)
AIC	3,492.9	3,475.1	3,477.3	3,454.8	3,439.3
2 × log-likelihood	−3,480.9	−3,461.4	−3,461.3	−3,440.9	−3,421.3
Degrees of freedom	666	665	665	665	662

[a] $n = 671$.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
Main entries are estimated coefficients, with standard errors in parentheses.

DISCUSSION

The aircraft modification market is not a setting where network theory would normally be applied because there is little cooperation between the firms competing in it. By demonstrating that competitive interdependence can be used as the basis for whole network analysis, this study greatly expands the range of possible applications of network theory and reveals new effects of the structure of competition networks on product market entry.

The second major contribution of this paper is finding that the size and diversity of ego networks influence product market entry. Using our measure of the diversity of multimarket contacts (and measures of diversity-based on other competitor attributes), we found support for our argument that the diversity of competitors in ego networks should have a positive relationship with the level of future product market entry. Our finding that ego network size influences competitive behavior is aligned with results from prior studies. Developing and testing our measure of network diversity takes the field a step further toward the goal of understanding how the network structure of competition influences competitive behavior.

In contrast, our hypothesis that network density would influence product market entry was not supported. While we proposed that dense ties would produce interdependent patterns of action within networks, leading to reduced product market entry, no such reduction was detected. It could be that increased slack is a secondary effect of density. If firms enter fewer markets in response to densely connected rivals, this may free resources to enter markets for reasons other than direct competition. A second avenue for exploration of this result would be to condition density with tie strength (Burt, 1992). Our treatment of competition as binary leaves out information about factors that could make some ties more important than others. Future scholarship has an opportunity to correct these omissions.

The control for the percentage of offerings related to multiengine aircraft is sometimes significant, but the volatility of this result leads us to reject it as a meaningful finding. The control for rotorcraft percentage is never significant. The positive and significant TCDS holder variable result was robust. Airframe manufacturers enter more product markets, and as expected, they usually modify their own original equipment. We used a simple measure of learned capability to control for an alternative explanation of product market entry. It comes as no surprise that firms that have entered many product markets in the past continue to do so (Hage, 1999;

Mitchell, 1989). It is more interesting to us that the effects of learning do not overshadow the effects of competition network structure.

Post hoc analysis detected a significant nonlinear effect of network size on product market entry but not for the diversity variable. When ego networks are small, entry increases at a decreasing rate. We can partly infer that this trend reflects the exhaustion of slack resources or decreasing opportunities for entry as markets become crowded. When ego networks are large the rate of product market entry declines as degree increases. The inflection point of the inverted U is about 2 standard deviations above the mean. Closer inspection reveals that a cluster of 45 firms occupies the region at and above the inflection point. These firms fit into three categories: airframe manufacturers (e.g. Learjet); major systems manufacturers (Honeywell), and major airlines (Delta). These firms compete primarily in other arenas; modification is a support activity for their main businesses. The implication is that competition with "pure" modifiers matters little to their main strategies and thus has less influence on product market entry. "Pure" modifiers are committed to the modification market and experience stronger effects on product market entry from rivalry in this industry. Future studies of competition networks will benefit from greater attention to segmentation in competition than this note was able to give.

CONCLUSION

This study shows that social network theory can be applied in settings where cooperative ties are absent and, therefore, expands its range of application. This study makes a further contribution by providing new insights into the relationship between network structure and competitive behavior. By showing that ego network size and the diversity of competitor relationships influence product market entry, we show that behavior is influenced by the structure of the whole competition network in addition to dyadic or triadic rivalry (Gimeno, 2004; Madhavan *et al.*, 2004).

Because the effects of competition networks do not depend on cooperation, formalizing them has the potential to expand the range of phenomena we can study with social network methods. Many new settings and questions become available to network-oriented scholars as a result of this study. The most obvious new questions concern multiplex relationships: How do cooperation and competition networks interact? Do firms with strong cooperative ties stay close to their original markets, or do they migrate into new markets? Do simultaneous cooperation and competition lead to market partitioning? Are network concepts that move beyond the ego network, such as betweenness or closeness centrality, equally applicable to cooperation and competition networks? Questions that relate to change in structure are also intriguing: Do changes in structure resulting from product market entry by first movers have different effects from changes caused by entry of followers? Under what conditions do competitors act to stay close to each other or move apart?

The study responds to calls for research that addresses the question of how networks develop (Carpenter *et al.*, 2012; Provan *et al.*, 2007) by including learned market entry capability in the study. Controlling for learned behavior is important because it is a parsimonious alternative explanation for many network phenomena. While we were able to provide only a partial test for the effect of slack resources on market entry, our results suggest that this is also a factor in how networks change.

This study suffers from the usual limitations of large-scale archival studies. Because our sample is made up of diverse competitors acting over a long period of time, it was not practical to gather data on commercial performance. The study is also limited by our decision to examine aggregate outcomes rather than individual events. More work is required to deal with the strength of ties, the forms of relationships between constructs, different classes of events, environmental change, and time-based heterogeneity within firms and networks. Some may see endogeneity as a potential limitation of papers like ours that analyze correlations between network structure and measures of company behavior or performance. Although we acknowledge this position, we feel that the temporal separation of our dependent and independent variables and the fact that firms do not always choose who they compete with or how their networks are structured reduces the risk endogeneity poses to our conclusions. We recognize that omitted variables could play a role in our findings, despite our efforts to control for known effects. Our choice has been to focus on correlational effects over time, while controlling for factors outside of competition network structure, in order to provide a simple presentation of our theory.

By developing the idea of competition networks, this study demonstrates connections between the network structure of competitive relationships and product market entry and thus opens the door to network studies of industries and populations that have been overlooked because they are not characterized by cooperative relationships. As this study shows, competition network theory has the potential to help explain firm behavior in settings where levels of rivalry and cooperation are low because competitors are diverse, numerous, and widely dispersed.

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