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Interaction Model of Superior Performance Based On Technological Resources and Competitive Actions in the Nascent Cycle of the Tablet Industry

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Abstract: Drawing on and integrating the resource-based view (RBV) and competitive dynamics literature, this study developed an interaction model to explore competitive contests by investigating how the interaction between technologically heterogeneous resources and competitive actions affects performance in the nascent market. The proposed model was examined using structured content analysis and data extracted from more than 3,200 news articles regarding the interfirm rivalry between Google and Apple in the table industry. The findings, first, indicate that in nascent markets, aggressive competitive action can exert a negative effect on firm performance. Second, this paper presents empirical evidence supporting the RBV through testing how the technological resource heterogeneity of these firms contributed to their performance (in terms of technological value and technological rarity). Finally, we found that technological resource heterogeneity mitigates the potentially negative effects of aggressive competitive action on the performance of high-technology firms during the nascent cycle.

Keywords: Competitive dynamics; Resource-based view; Interfirm rivalry; Structured content analysis; Tablet industry.

1. Introduction

Competition among leading firms in the field has always been a topic of interest in the domain of strategic management. From the perspective of competitive dynamics, the actions of firms that are based on market competition have been considered an antecedent for exploring competitive advantages (Ferrier *et al.*, 1999; Ferrier, 2001; Ferrier and Lee, 2002; Ferrier and Lyon, 2004; Miller and Chen, 1994; Rindova *et al.*, 2010) and Comparably, the resource-based view (RBV) has emerged as having a critical and central role in understanding how firms defend their competitive position by leveraging their resources (Barney, 1991;2001; Peteraf and Barney, 2003).

These two theories could be integrated to depict market competition. The strategic management literature has indicated that competitive dynamics and the RBV are complementary perspectives (Grimm *et al.*, 2006; Sirmon *et al.*, 2008). Recent studies have primarily adopted an integrative approach to linking competitive dynamics and the RBV, proposing that competitive action has a mediating role in the causal nexus between firm resources and firm performance (Grimm and Smith, 1997; Grimm *et al.*, 2006; Ndofor *et al.*, 2011; Sirmon *et al.*, 2008). Considering the core concept of the RBV, firms that typically create economic value must exploit internal or attainable resources and capabilities to develop effective competitive actions and meet the market demands of marketplace competition (Grimm and Smith, 1997; Ndofor *et al.*, 2011).

Despite empirical support, this mediating combination appears to be confined to the effect of a firm's resources on its conduct toward firm performance. In some circumstances, particularly in a nascent market or highly uncertain environment, overly complex or varied competitive action may "negatively" affect firm performance (Ferrier and Lyon, 2004; Rindova *et al.*, 2010). In such a context, using this mediating structure to demonstrate how firm resources affect firm performance may lead to the erroneous inference that superior resources "indirectly" exert negative effects on firm performance. Consequently, such a mediating relationship might not be generalizable in a competitive or highly uncertain environment.

We believed that in a nascent market, firms expose themselves to a certain degree of risk when they develop and implement competitive actions to advance their competitiveness. This phenomenon was largely expressed in the work of Chatterjee *et al.* (1999), which conceptualized the insight of tactical and strategic risks, and Ferrier (2001), which further conceived the concept of decision risk. In this paper, we argue that in technology industries, resource availability and resource disposal (in terms of technological value and technological rarity) can neutralize the effect of decision risk on performance erosion. In other words, the availability of a firm's technological value and rarity reduces the potential for negative performance resulting from the implementation of overly complex or varied competitive actions. This argument is particularly relevant to the nascent cycle of technology industries subjected to high uncertainty and rapid change.

This study constructed an interaction model to conceptualize our argument for extending the competitive action–firm performance relationship. This interaction model was done by including firm resources, which have interaction effects with competitive actions on firm performance. By using structure content analysis, we assessed how the interaction of a firm's technologically heterogeneous resources (in terms of technological value and technological rarity) and the composition of its competitive action repertoire affect its performance. We collected news articles associated with the dyadic competition between the Apple and Google campaigns in the global tablet industry. We also set our observation period within the first 3 years of the industry (from January 2010 to December 2012), which is the period largely considered as the nascent cycle of our target industry.

Our findings contribute to strategic management research in various ways. Our major contribution to the field is our conceptualization of an interactive relationship between firm resources, competitive actions, and performance. We tested how the technological resource base of firms (in terms of technological value and technological rarity) mitigates the negative effects of competitive action on firm performance in a nascent market. In addition, our findings contribute to the literature on competitive dynamics by identifying that the composition of aggressive competitive actions (through the investigation of strategic complexity and strategic variability) can negatively affect firm performance in nascent markets. Finally, we contribute to research on the RBV by empirically examining the underlying logic of resource value and resource rarity through constructing and testing an interaction variable, namely technological resource heterogeneity. Through our empirical analysis, this study contributes empirical evidence to the RBV literature.

2. Theatrical Background

2.1. Competitive Dynamics

Competitive dynamics are considered as complex competitive processes employed by firms. Competition in the field has been regarded as a system of stimulation; being stimulated by innovation motivates firms to explore new and perceived needs, and to develop approaches that are suitable for meeting such needs (Schumpeter, 1950). Schumpeter (1950) coined the phrase the "perennial gale of creative destruction" to describe the early roots of the action-based advantage of competitive dynamics, arguing that the dynamics in both firms and markets that lead to economic equilibrium disturbances continually and radically shape (and reshape) market opportunities (D'Aveni, 1994; D'Aveni *et al.*, 2010; Liao *et al.*, 2014; Srivastava *et al.*, 2001).

An influential model in competitive dynamics is the awareness-motivation-capability (AMC) model proposed by Chen (Chen *et al.*, 1992; Chen *et al.*, 2007). The AMC model comprises three essential drivers of competitive behaviors: awareness, which refers to the insight of managers into competitors, industries, and markets; motivation, which refers to the stimulant involved in competitive rivalry, a firm's previous performance, and market dependences; and capability, which refers to a firm's resources and the ability to execute actions (Chen *et al.*, 1992; Chen *et al.*, 2007). Using this model and concentrating on the rivalry between action and reaction dyads, this study shows how a single aggressive action can influence markets, rivals, and customers.

Competition involves various forms of retaliation. In particular, the speed and timing of actions has been observed by the time elapsed between an action initiated by an attacker and the reaction responded by the defender. (Chen *et al.*, 1992); (Caballero and Hammour, 1996); (Chen and MacMillan, 1992). Moreover, previous studies in this field have examined whether a firm's competitive actions mitigate threats from competitors (Chen *et al.*, 1992; Chen and MacMillan, 1992; Ferrier *et al.*, 1999; Ferrier, 2001; Ferrier and Lee, 2002). Chen and MacMillan (1992) observed that a firm's strategic actions could suppress the countermoves of competitors.

In addition, previous research on competition between firms has focused on competitive interdependences to depict the aggregate effects of competitive behaviors on market performance. These aggregate effects were considered to be derived from the composition of action repertoires of the firm (Ferrier *et al.*, 1999; Ferrier, 2001; Ferrier and Lee, 2002; Ferrier and Lyon, 2004; Miller and Chen, 1994; Ndofor *et al.*, 2011; Rindova *et al.*, 2010). For example, launching a wide range of novel, aggressive, complex, or heterogeneous actions may enable a firm to outperform its competitors, thereby providing a competitive advantage.

In summary, the perspectives of competitive dynamics typically provide suitable factors for characterizing firm dynamics and explaining how firms act and react toward the actions of competitors. Recent empirical research in this field has explored the potential patterns of how competitive actions affect performance. By framing such the causal link, theoretical models might assist to systematically explaining how firms secure their advantages through market competition.

2.2. Resource-based View

The RBV, which focuses inwardly on the distinct resources of firms, provides a theoretical framework for addressing whether resources are a basis of competitive advantage (Barney, 1991;1996; Barney and Hesterly, 2011; Peteraf, 1993). The central concept in this field is that an organization is a collection of unique resources and capabilities, which is the primary source of its returns and provides the basis for its strategies (Barney, 1991; Wernerfelt, 1984).

RBV logic is based on two underlying assumptions pertaining to why a firm might outperform competitors in the industry (Barney, 1991): resource heterogeneity and resource immobility. Resource heterogeneity implies that resources and capabilities vary among firms. A firm's strategy for superior performance depends on its idiosyncratic resources and enhanced ability to use these resources in performing economic activities (Barney, 1991;1996; Peteraf, 1993). Resource immobility refers to the imperfectly transferred attribute of resources that are costly to duplicate or substitute. Immobile resources thus allow superior economic rent to be long-lasting (Barney, 1991;1996; D'Aveni *et al.*, 2010; Peteraf, 1993).

Based on resource heterogeneity and immobility, Barney (1996) further proposed a valuable, rare, inimitable, and organizational-support (VRIO) framework for assessing the resource potential of firms. If a firm's resources meet the requirements of the VRIO framework, then the resources present the firm with a competitive advantage, and even a sustainable competitive advantage, in the market (Arend, 2006; Barney, 1996; Barney and Hesterly, 2011).

Although the RBV has long been considered a dominant stream in the field of strategic management, the RBV has been criticized on the basis of its static equilibrium logic (Foss and Ishikawa, 2007; Priem and Butler, 2001). There remains a limitation of the RBV's static logic regarding how it emphasizes resources as sustainable sources of rent creation in dynamic environments. This enables RBV proponents to adjust their views from a state of equilibrium (static) to one of disequilibrium (dynamic) (Helfat and Peteraf, 2003). Some recommendations have been made in the streams of research on entrepreneurship (Foss and Ishikawa, 2007; Langlois, 2007; Sarasvathy and Dew, 2005; Zahra *et al.*, 2006), dynamic capabilities (Bowman and Ambrosini, 2003; Teece *et al.*, 1997; Teece, 2007), and the Austrian economics (Foss and Ishikawa, 2007; Foss *et al.*, 2008) for reinforcing dynamic insights in the RBV.

In summary, despite the criticism of traditional RBV logic, the core insights of the RBV and the VRIO framework provide a substantial competitive model for addressing firm strategy by concentrating on identifying a firm's distinct resources (at one point in time) and how these resources can yield competitive advantages.

2.3. Competitive Dynamics and Firm Resources

Considering resource patterns as a firm's competitive actions, research on competition between firms is aimed at explaining how firm resources complement the view of competitive dynamics. McGrath *et al.* (1998) indicated that the allocation of firm resources should be considered as a competitive action that enables a firm to dominate and influence market competition. (Chen and MacMillan, 1992) extended this concept by focusing on market resources and considering resource competition in two dimensions: market commonality and resource similarity. Chen argued that firms involved in a specific competitive group (particularly two firms in a major pairwise comparison) can share the highest degree of market commonality and resource similarity in the marketplace; hence, the patterns of resource competition can be depicted and predicted (Chen and MacMillan, 1992; Chen and Miller, 2012).

However, research explaining the patterns of interfirm competition is limited when competition is observed only from the market side. A firm's internal processes (i.e., how they allocate, manipulate, acquire, and leverage resources to generate economic rents) affect its action repertoires in competitive markets (Ndofor *et al.*, 2011) Recent studies have thus focused primarily on linking the RBV with the perspective of competitive dynamics. According to Sirmon *et al.* (2008), for competition, firms act based upon its comparative resource advantages. Furthermore, Ndofor *et al.* (2011) indicated that the mediating role of competitive repertoires that enables a firm' profitability is determined according to its technological resources.

In summary, to integrate the RBV and the perspective of competitive dynamics, previous studies have focused on the role of firm resources in leveraging strategic actions to enhance firm performance. Using a mediating causal combination to depict this relationship assumes that firm resources exert a positive effect on competitive action, thereby augmenting firm performance. However, previous studies have shown that in a nascent market, an overly complex arrangement of competitive actions can diminish firm performance (Ferrier and Lyon, 2004; Rindova *et al.*, 2010), thus inferring a paradox that firm resources "indirectly" contribute negatively to firm performance. Therefore, the relationship among firm resources, competitive actions, and firm performance may need to be redefined in order to be generalizable in the context of nascent markets.

3. Hypotheses

This research integrated the RBV and competitive dynamics literature to investigate the potential interaction effects of firm resources and competitive actions on firm performance. We investigated how firms leverage their technological resources to decrease the potential risk when they implement strategies. This study proposed that technologically heterogeneous resources mitigate the decision risk of developing action repertoires in the nascent cycle of an industry. We examined technologically heterogeneous resources, which is reflected by two traits that are particularly salient for this study: technological value, which refers to the added value perceived by customers in the demand side of the market in terms of technological advances; and technological rarity, which refers to the technological components or materials and technologies controlled and supported by relatively few suppliers in the supply side of the industry.

Base on observations of the demand side of the market in technological industries, the perceived value of a firm's offerings is frequently justified by customers according to the extent to which the firm's engagement in frontier technologies is involved. This study captured this notion by assuming that technological rarity is a necessary and sufficient determinant of technological value. In our research context (i.e., the global tablet industry), for example, tablet devices that are equipped with a high-definition display have a higher perceived market value than that of devices with lower definition display specifications. This shows that technological components or frontier technologies play a determining role in leading technological trends and in guiding the perception of market value in technological industries.

As RBV research has largely asserted, a potentially valuable resource is a prerequisite for firms to perform under parity conditions; thus, competitive advantages can be achieved by obtaining valuable resources that are rare (Arend, 2006; Barney, 1991;2001; Barney and Hesterly, 2011). This study extended this concept by hypothesizing that an interaction relationship exists between the technological rarity and technological value of a firm's resources (i.e., technological resource heterogeneity) and how they collectively affect its performance. Accordingly, we proposed that the following hypothesis:

> *Hypothesis 1: A firm's technological rarity strengthens the effect of its technologically valuable resources on market performance.*

Strategic complexity has been defined as the degree to which various types of action are involved in a firm's action repertoires (or sequences) within a certain period (Ferrier *et al.*, 1999; Ferrier and Lee, 2002; Ferrier and Lyon, 2004; Miller and Chen, 1994). Firms can deploy either a narrow or wide range of attacks that indicate how complex a firm's acting strategies are in responding to competitors (Ferrier, 2001; Grimm and Smith, 1997; Kirzner, 1973). A narrow range of actions indicate a relatively low degree of complexity of acting strategies, whereas a wide range of actions indicates relatively high complexity.

Previous studies have generally argued that firms that implement more complex competitive actions are more capable of competing, hence their superior performance (D'Aveni, 1994; Ferrier *et al.*, 1999; Miller and Chen, 1994). However, a review of the competitive dynamics literature indicated that a potentially negative relationship exists between increasing levels of strategic complexity and firm performance (Ferrier and Lyon, 2004; Rindova *et al.*, 2010). Other studies have used a curvilinear (U-shape) relationship to depict this relationship by integrating the concepts of decision risk and action risk (Ferrier, 2001; Ferrier and Lee, 2002). They argued that these two types of risk may prevent firms from securing their competitive performance.

Although there appears to be no consensus on constructing a theory to link strategic complexity and firm performance, linking it to an nascent market (as the tablet industry is) may reveal a negative relationship between strategic complexity and performance (Ferrier and Lyon, 2004). This is particularly true in highly uncertain and rapidly changing environments, where decision risk is typically high (Ferrier and Lee, 2002). In such environments, managers cannot foresee the competitive dynamics or predict long-term developments. Thus, whether their competitive actions succeed remains unknown; consequently, developing competitive actions that are more complex than usual may result in additional decision risk (Ferrier and Lee, 2002; Rindova *et al.*, 2010).

In a nascent industry, a highly uncertain and rapidly changing environment is expected. Theoretically, the causal nexus between strategic complexity and firm performance is potentially dominated by the scheme of decision risk, thus presenting a negative trend.

> *Hypothesis 2: The complexity of a firm's strategic actions negatively influences the variation of its performance in a nascent market.*

On inspection of the competition in industries, strategic variability can be considered as a firm's ability to formulate and perform a series of differentiated actions derived from its strategic repertoire. Such ability might limit the abilities of competitors in predicting (and possibly understanding) how the focal firm implements its strategies, thereby postponing and disrupting the actions or reactions of competitors. The philosophy of action risk at the firm-specific level thus posits that a firm that typically outperforms its competitors exhibits a relatively high level of variability in its strategic implementation (Ferrier *et al.*, 1999; Ferrier and Lee, 2002).

However, decision-making with high strategic variability can cause performance erosion. Previous studies have revealed that increasing the variability of actions leads to a decrease in action intensity because it increases the consumption of resource bases (Rindova *et al.*, 2010). In particular, the quality of decision-making regarding a firm's competitive actions would be determined and limited by the firm's resource base (Ferrier and Lee, 2002). In addition, considering the operational context in high-stakes and dynamic conditions, the timing of actions is crucial to a firm's strategic success. Timing indicates the opportunities that are fluctuate according to market dynamics, technological change, and the actions of competitors (Grimm *et al.*, 2006). Managers who catch the ideal timing when implementing the appropriate actions may be successful in their endeavors, but those who delay their action would miss the opportunity. Rapid decision-making is thus critical for managers seeking to implement actions with the most appropriate timing. Under this condition, the speed of decision-making regarding a firm's competitive actions is crucial to its profitability.

In a rapidly changing environment, a high level of variability may weaken the effects of strategic actions on firm performance because implementing high-variability strategic actions is time-consuming and consumes resources. Thus, company managers may need to direct their strategic focus toward mitigating decision risk to advance the possibility of strategic success. Theoretically, the causal relationship between strategic variability and firm performance would be majorly affected by the scheme of decision risk in uncertain and rapidly changing environments; thus, this relationship would present in a negative form. Therefore, we proposed the following hypothesis:

Hypothesis 3: The variability of a firm's strategic actions negatively contributes to the variation of its performance in a nascent market.

The competitive dynamics literature generally supports the notion that firms that are more aggressive are more prosperous. However, aggressive firms might be unable to depose or even threaten their competitors through only limited resources. Ndofor *et al.* (2011) indicated that possessing numerous technological resources might assist firms with formulating and implementing competitive strategies that are more complex than those of their competitors, and hence their superior performance (assuming that a positive relationship exists in the causal nexus). Evidently, strategic actions act as a fulcrum, as such, "when these actions leverage the firm's resources, superior performance results" (Ndofor *et al.*, 2011).

According to Ndofor *et al.* (2011), a firm's technological resource availability appears to be a premise of developing competitive actions. They theorized that leveraging resources toward performance is mediated through competitive actions. Based on the aforementioned discussion of strategic complexity and variability, firms may face performance erosion if they increase the level of strategic complexity and variability in a highly uncertain and competitive environment. Such mediating causal relationship among firm resources, competitive actions, and performance might lead to a paradox that a higher degree of technological resource availability "indirectly" contributes to performance decline in competitive marketplace.

We hypothesized that competitive actions and firm resources may exert an interaction effect on performance. A firm's resource availability may mitigate the negative effects of the complexity and variability of a firm's strategic actions on its performance. Theoretically, how a firm's actions affect its performance is collectively determined by decision risk and action risk (Ferrier and Lee, 2002). Particularly, in a competitive market, because of the relatively higher degree of environmental uncertainty, this relationship is majorly determined by decision risk (Rindova *et al.*, 2010). In other words, possessing necessary resources can advance a firm's awareness of actions to address environmental uncertainty, especially direct and immediate competition from its rival firms.

This study examined how the potential interaction between technological resources and competitive actions affects firm performance. Regarding technological resources, we investigated a firm's technological resource heterogeneity in terms of technological value and technological rarity; for competitive actions, we explored the traits of a firm's action repertoire in terms of strategic complexity and strategic variability. Accordingly, we proposed the following hypotheses:

Hypothesis 4a: A firm's technological resource heterogeneity (measured by both technological value and technological rarity) mitigates the effect of strategic complexity on the firm's market performance erosion.

Hypothesis 4b: A firm's technological resource heterogeneity (measured by both technological value and technological rarity) mitigates the effect of strategic variability on the firm's market performance erosion.

4. Methods

4.1. Data and Sample

We used DigiTimes as the source of news because its news offerings cover global high-technology sectors. DigiTimes provides worldwide information technology news derived from daily newspapers, Web sites, and various international media for industry professionals and investment analysts. The reports of DigiTimes cover most high-technology industries, such as computers, consumer electronics, light-emitting diodes, telecommunications, semiconductors, displays, and green energy.

Data were collected according to the contextual news recorded for the global tablet industry during the period from January 2010 to December 2012. This period is generally considered as the nascent cycle of the modern tablet industry. Within this period, Apple's iPad was first released (in the beginning of 2010) and other competitive rival companies largely entered this industry. We screened news information according to two major groups in the tablet industry: the iOS-based (Apple Inc.) campaign and the Android-based (Google) campaign (e.g., Acer, Asus, Amazon, Dell, HTC, HP, LG, Samsung, and the hardware partners of Google). These two campaigns shared over 95% of the market share in the global tablet industry during the survey period. We collected 3,207 news articles related to interfirm rivalry between the Google and Apple campaigns, from which we extracted 4,551 effective action events to build up the panel data for a quantitative analysis. Our initial analysis revealed 1,826 events related to Apple's actions and 2,725 events in the Google campaign.

To measure market performance, we collected monthly global market share information on mobile operating systems, specifically for tablet devices, from International Data Corporation and Strategic Analytics.

4.2. Action Repertoire Design

Following the design adopted by Ferrier *et al.* (1999) this study defined the following action repertoires for the analysis: product action, pricing action, promoting action, service action, strategic action, and signaling action (Table 1). Both the Apple and Google campaigns had unique action repertoires. The collected news articles were categorized into the aforementioned repertoires according to the featured events they were related to. For example, news articles reporting Apple's product and marketing activities were placed into Apple's product and promoting action repertoires.

In addition, for the weighting scheme of the action repertoire, we adapted the scheme proposed by Ferrier *et al.* (1999). This study hypothesized that product-related actions should be the most influential actions, whereas signaling-related actions should be the least influential, specifically because we measured firm performance based on market share.

Table-1. The action repertories

Actions	Quantitative Weight
product action	6
pricing action	5
promoting action	4
service action	3
strategy action	2
signaling action	1

Adapted from Ferrier, W.J., Smith, K.G., and Grimm, C.M. 1999. The role of competitive action in market share erosion and industry dethronement: a study of industry leaders and challengers. *Academy of Management Journal*. 42, 372-388.

4.3. Measures

4.3.1. Firm Performance

Firm performance was measured using market share. Previous studies have defined market share as the proportion of the market (calculated based on either shipments or revenue) within which a firm competes (Harrison, 2001; Kozmetsky and Yue, 1998; Murphy *et al.*, 1996). As a measure of performance outcomes, market share appropriately indicates the changes in competition and frequently inspires strategy deployment and implementation (Farris *et al.*, 2010). Moreover, market share clearly represents how firms compete and illustrates the effectiveness of a firm's actions or the success of a product (compared with those of competing firms) in the context of market rivalry (Brignall and Ballantine, 1996; Ruekert and Walker, 1987).

4.3.2. Strategic Complexity

Using the Herfindahl index, we calculated the level of strategic complexity according to the action repertoire settings (Ferrier *et al.*, 1999; Ferrier and Lee, 2002). The measure of strategic complexity was obtained using the following calculation sequences. First, the sum of squares of each ratio of action repertoires (based on the total number of actions) was calculated. Second, strategic complexity was measured by subtracting the sum of squares from 1.

For the empirical analysis at the second stage of the analysis, the time-series data of strategic complexity were collected for Google and Apple on a monthly basis. Typically, firms exhibiting high strategic complexity are more aggressive in developing and implementing complex competitive actions in response to the actions of and their relationships with rival firms (Ferrier *et al.*, 1999; Ferrier and Lee, 2002; Miller and Chen, 1994; Ndofor *et al.*, 2011).

$$Strategic\ Complexity = 1 - \sum_{i=1}^{N} (\ s_i/S)^2$$

where N = 6, the total number of action repertoires; s_i is the number of action events in a specific repertoire in a given month; and S is the number of action events in a given month.

4.3.3. Strategic Variability

In this study, the dimension of strategic variability was defined as the level of dissimilarity of strategic actions of firms from one move to the next. This research used the standard deviation to measure the strategic variability for both the Google and Apple campaigns on a monthly basis. A higher score for this dimension indicates that a firm's competitive actions are subject to higher variability, whereas a lower score indicates that its actions are in accordance with a general pattern or norm. The range of strategic variability was between 0 (no distance) and 5 (the most distance) in this study according to the weights of the action repertoires shown in Table 1.

$$Strategic\ Variability = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N-1} (\ d_i - \bar{d}\ )^2}$$

where N is the number of actions in a given month; N - 1 is the number of action pairs; d_i is the distance of the action pair in a row for a given firm; and $\bar{d}$ is the mean distance of the action pairs for a given firm in a given month.

4.3.4. Technological Value

In this paper, technological value is defined as the customer-perceived value of a firm's offerings according to technological demands. We used the "5Cs" defined by Covello *et al.* (2010) for the tablet products and services as the basis to quantify the technological value of a firm's products and services in the tablet industry. These "5Cs" are: (1) consumption: focusing on information consumption instead of production; (2) content: tablet devices that are tightly integrated with content, such as information and applications; (3) connected: maintaining a constant connection to the Internet; (4) constant operation: tablet devices should power up immediately and have an all-day battery life; and (5) commerce: ensuring that consumers are always ready to purchase a product. While Apple has mastered the 5Cs with its iPad products, the 5Cs represent the five key successful factors that not only distinguish tablet devices from the traditional personal computers, but they also change the ways in which people use and think about computing devices.

To quantify technological value, this study screened the news articles related to (1) the 5Cs for the tablet devices, and (2) the technological advances in software and hardware specifications of the tablet products. In addition, this study weighted each aspect of 5Cs and technological advances equally according to the screened news. Technological value was calculated based on the mean weight of the associated news on a monthly basis.

4.3.5. Technological Rarity

Technological rarity refers to supplied technological components, materials, and state-of-the-art technologies that were considered rare in our research context. Hence, this study captured technological rarity with a focus on the supply side of the market. We screened the collected news articles that were associated with whether a firm's supply systems were supported by lock-in and technologically advanced models, such as exclusive licenses, patents, contracts, as well as key supporting components and technologies. To quantify technological rarity, we used a similar method to the one used for weighting technological value; the screened news articles were weighted equally, and then the average weight (per news article) of technological rarity was calculated on a monthly basis to obtain the time-series data.

4.3.6. Variables for Interaction Effects

To test the interaction effect between technological value and technological rarity on firm performance (Hypothesis 1), this study used technological value × technological rarity as an interaction variable in the regression models. In addition, to test the interaction effects between competitive dynamics and technological heterogeneity of resources on firm performance (Hypotheses 4a and 4b), this study developed the other two interactional combinations for the analysis, including technological value × technological rarity × strategic complexity and technological value × technological rarity × strategic variability.

4.3.7. Control Variables

In this study, we controlled for the news exposure rate, trend effect, and seasonal effect. The effect of news exposure rate, as we observed in the analysis, was controlled to account for the overestimated effects of competitive actions on firm performance where the news exposure rate was relatively high. Specifically, news exposure rate was controlled to ensure the accuracy of the estimated effect of competitive action on firm performance. The news exposure rate was measured based on the average number of actions per news article on a monthly basis.

Controlling for the trend and seasonal effects was undertaken to control the confounding effects of unobservable factors that could not be investigated and identified (Harvey, 1990; Tych *et al.*, 2002). These factors might include the dynamics of industrial technology or a firm's internal changes of specific or critical business models and operations leading to substantial contributions to firm performance. Through the observation of the time-series data of the Apple iOS and Google Android market share within the survey period, their developments revealed in a quadratic trend over time. Therefore, we controlled for the trend effects in a polynomial time equation by including time and time square ($time^2$). Regarding seasonal effects, because we observed time-series data related to performance of the Apple and Google campaigns, seasonal effects on July were included in the regression models.

4.4. Analysis

This study conducted structured content analysis to investigate the proposed theories. At the first stage, the extracted news events were entered into a quantifying process to obtain a panel data set, which was achieved by using Nvivo Version 9.0. The data set was the compiled for a panel analysis that was conducted at the second stage of the analysis by using eViews.

5. Results

The models arranged in this study included four models. Modeling arrangements comprised no interaction and interaction for the Google and Apple campaigns, yielding Model 1 (Apple-no-interaction), Model 2 (Apple-interaction), Model 3 (Google-no-interaction), and Model 4 (Google-interaction). The test results presented in the following subsections are the descriptive statistics and multicollinearity tests, hypothesis test, and model diagnosis.

5.1. Descriptive Statistics and Multicollinearity

Table 2 lists descriptive statistics and intercorrelations for the designed variables. In the analysis of this study, inspecting both Apple and Google revealed no significant multicollinearity, because the biggest value of the corrections among the variables was 0.86 for Value-Rarity in the Apple section (Table 2). This result did not reach the benchmark of 0.9 for indicating potentially significant multicollinearity among the independent variables.

Table-2. Descriptive Statistics and Intercorrelations

Apple								
	Means	S.D.	1	2	3	4	5	6
1. Market Share	0.61	0.11	1.00					
2. Action exposure rate per news	3.06	0.04	0.37	1.00				
3. Strategic Complexity	0.21	0.004	0.10	-0.45	1.00			
4. Strategic Variability	1.52	0.01	-0.15	-0.001	-0.49	1.00		
5. Value	2.01	0.47	0.32	0.11	0.04	-0.17	1.00	
6. Rarity	1.78	0.33	0.42	0.18	-0.05	-0.08	0.86	1.00
Google								
	Means	S.D.	1	2	3	4	5	6
1. Market Share	0.35	0.13	1.00					
2. Action exposure rate per news	3.42	0.03	-0.006	1.00				
3. Strategic Complexity	0.17	0.003	-0.38	-0.81	1.00			
4. Strategic Variability	1.43	0.01	0.02	0.66	-0.77	1.00		
5. Value	1.52	0.32	0.50	-0.10	-0.18	0.04	1.00	
6. Rarity	1.09	0.23	0.49	-0.10	-0.16	0.06	0.78	1.00

Note: S.D.: Standard Deviation

5.2. Hypothesis Tests

Hypothesis 1 was proposed to test whether the interaction effect between technological value and technological rarity of firm resources is on firm performance. Table 3 shows the test results of the interaction model. The results of Model 2 (*Technological Value* × *Technological Rarity* = 0.1006, $p < .01$) and Model 4 (0.09970, $p < .1$) provided full support.

*Hypothesis 2 propose*d that the relationship between strategic complexity and firm performance presents a negative development in a nascent market. The results of the four models supported the proposed hypothesis (Model 1 = -1.3320, $p < .1$; Model 2 = -2.4466, $p < .05$; Model 3 = -13.465, $p < .05$; Model 4 = -11.566, $p < .05$), presenting a significant and consensually negative trend in predicting this relationship.

Hypothesis 3 proposed that a negative relationship exists between strategic variability and firm performance in a nascent market. Table 3 shows that Hypothesis 3 obtained partial support because only the Google models (Model 3 = -1.7507, $p < .05$, and Model 4 = -1.4013, $p < .1$) exhibited a negative trend in this relationship, whereas the Apple models presented a positive relationship (Model 1 = 0.8379; Model 2 = 1.1787).

Through Hypotheses 4a and 4b, this study tested whether technological resource heterogeneity mitigates the effects of firms' competitive actions on performance erosion in a nascent market (therefore, a positive result was expected from the tests of these two hypotheses). Hypothesis 4a predicted the interaction effect between technologically heterogeneous resources and strategic complexity on firm performance, and Hypothesis 4b proposed the interaction effect between technologically heterogeneous resources and strategic variability on firm performance. As shown in Model 2 (Apple-interaction) and Model 4 (Google-interaction), the results indicated that Hypothesis 4a obtained full support from the samples (*Technological Value* × *Technological Rarity* × *Complexity* of Model 2 = 0.0940, $p < .05$; that of Model 4 = 0.1415, $p < .1$), where both of the estimates were positively significant. However, Hypothesis 4b was only partially supported by the sample data (*Technological Value* × *Technological Rarity* × *Variability* of Model 2 = -0.0468, $p < .01$; Model 4 = 0.0542, $p < .05$), where only the estimate from Model 4 (i.e., Google) was positive.

5.3. Model Diagnoses and Robustness

The diagnostic results (Table 3, the section of Model diagnoses) indicated that three of the four models met the criteria of BLUE according to the rules of the classical linear normal regression model (CLNRM) when using the ordinary least squares (OLS) regression method.[1]

[1] OLS is the Best Linear Unbiased Estimator (BLUE) that means that out of all possible linear unbiased estimators, OLS gives the precise estimates of the vectors and parameters of the regression.

Table-3. Regression results and model diagnoses

Variables/Models	Model 1 Apple-no-interaction	Model 2 Apple-interaction	Model 3 Google-no-interaction	Model 4* Google-interaction
Time	-0.0666***	-0.0714***	0.0466*	0.0441***
Time squared	0.0016***	0.0017***	-0.0011**	-0.0010*
Seasonal effects (7)	0.0849**	0.0800**	0.0058	0.0142†
Action exposure rate per news	0.1520	0.2721**	0.1912	0.1842
Technological Value	0.0051*	0.0049*	-0.0014	-0.0780
Technological Rarity	-0.0331	-0.0004	-0.1286	0.0132
Strategic Complexity	-1.3320†	-2.4466*	-6.1651*	-5.1290*
Strategic Variability	0.8379*	1.1787***	-1.7507*	-1.4013†
Interaction variables				
Technological Rarity× Technological Value		0.1109**		0.0913†
Technological Rarity× Technological Value × Strategic Complexity		0.0940*		0.1415†
Technological Rarity× Technological Value × Strategic Variability		-0.0468**		0.05420*
Other additives				
Autoregressive Term (1)		-0.3719		
Model diagnoses				
Adjusted R-squared	0.95	0.98	0.91	0.93
F-statistic (*p-value*)	74.35 (0.0)	106.7 (0.0)	29 (0.0)	31.5 (0.0)
DWTS	1.94	2.07	1.67	1.58
BGLM at second order (*p-value*)	0.29 (*0.75*)	1.05 (*0.4*)	0.83(*0.47*)	0.72(*0.51*)
Ramsey RESET (*p-value*)	0.67 (*0.43*)	3.27 (*0.11*)	0.83(*0.39*)	1.21(*0.30*)
White Test (*p-value*)	21.6 (*0.052*)	0.48 (*0.84*)	5.29(*0.33*)	0.47(*0.84*)
JBTS (*p-value*)	0.34 (*0.85*)	0.02 (0.98)	0.56 (*0.75*)	0.54(*0.76*)

Note: Significance of estimates reported: † (p<0.1), * (p<0.05), **(p<0.01), ***(p<0.001).
Seasonal effects (7): Seasonal effects in July.
Autoregressive Term (1): refers to the autoregressive model of order 1.
BGLM: Breusch-Godfrey Serial Correlation LM test.
JBTS: Jarque-Bera Test.
Model 4*: The use of the corrective method of "Autocorrelation Consistent Standard Errors and Covariance"
The survey period is from January 2010 to December 2012 (36 months)

Among these four models of this study, Model 4 might not be considered BLUE because the Durbin–Watson statistics (DWTS = 1.58) was out of the range of the benchmark, within 1.6 and 2.4, for the diagnostics of the first-order autocorrelation, although it passed the Breusch–Godfrey Lagrange Multiplier (BGLM) test for its second-order autocorrelation in the residual. To enhance the robustness of Model 4, we applied the corrective method of autocorrelation consistent standard errors and covariance to enhance the robustness of the estimates of Model4. Other diagnoses, including the Ramsey RESET test for examining the estimate unbiasedness, the WHITE test for determining the heteroskedasticity of the residuals, and the Jarque-Bera test (JBTS) for the residuals' normality, did not present significant violations on the CLNRM conditions ($p > .05$).

In addition, the adjusted R2 values were greater than 90% for all four models. Comparisons between the interaction models and the no-interaction models for Apple and Google determined a significantly increasing adjusted R2. Regarding Apple, the increase was 3% from 0.95 to 0.98, and regarding Google, the change was approximately 2%. The results, accompanied the significant estimates regarding the interaction measures in Models 2 and 4, indicating the considerable potential of the interaction measures in estimating firm performance.

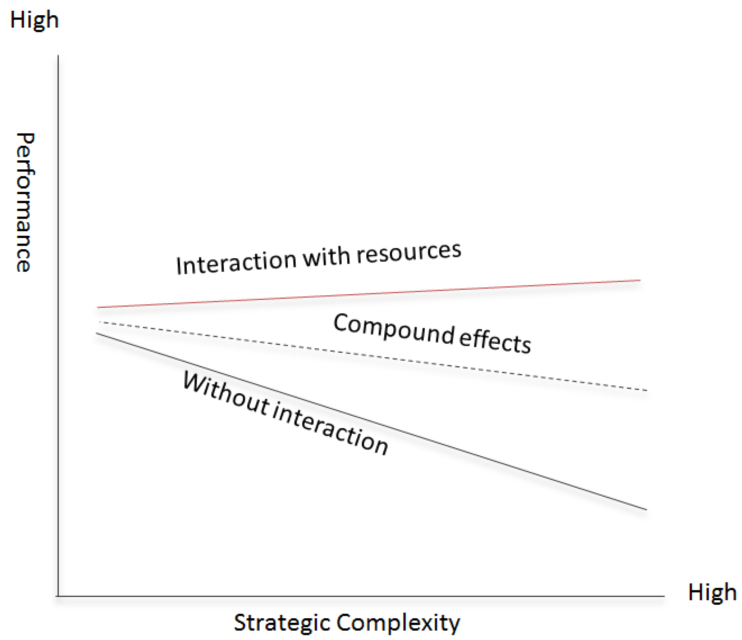
6. Discussion

This study aimed at extending the integrative approach, by proposing an interaction model, to linking the perspective of competitive dynamics and the RBV. This study presented a special case in the context of the nascent cycle of the global tablet industry. We proposed that in the nascent cycle of technology industries, the availability of technologically heterogeneous resources plays a role in neutralizing the negative effects of competitive actions on firm performance. Using a structured content analysis, this study analyzed the Apple–Google dyadic competition by investigating the changes of operating system market share in the tablet industry. The empirical results reinforced the theoretical position of resource management logic in the competitive dynamics literature (Ndofor *et al.*, 2011; Sirmon *et al.*, 2008).

Our analysis results provide strong empirical support regarding the traditional understanding of the RBV logic; specifically, that competitive advantages can be achieved by obtaining valuable resources that are rare (Barney, 1991; Peteraf, 1993; Peteraf and Barney, 2003). By demonstrating an interaction relationship between technological rarity and technological value, the findings of this study support previous investigations showing that endogenous resources and capabilities are drivers of resource value (Barney, 2001; Mahoney, 2005; Peteraf and Barney, 2003; Pitelis, 2009; Schmidt and Keil, 2013). Furthermore, we found that technological rarity that is made available from the supply side of the market improves the value of a firm's technological demand. In other words, through leveraging technological rarity, a firm can enhance its technological value proposition, which subsequently yields superior performance.

This paper also provides a deeper insight into competitive dynamics, showing that under conditions of high market uncertainty, decision risk shapes the scheme of above average rent creation by firms (Ferrier and Lyon, 2004; Rindova *et al.*, 2010). This paper suggested that in the emerging cycle of technology industries, a firm that develops overly complex competitive actions faces performance erosion. In addition, with the same theoretical background of decision risk, this study conceptualized a negative relationship between strategic variability and firm performance. We expressed that the rapidly shifting characteristics of technologies limit a firm's ability to time its actions and develop a resource base in technology industries. Our empirical findings partially support this argument, implying that in a rapidly changing market, firms that adopt more focused strategies to compete have more strategic success.

Figure-1. Effects of strategic complexity on performance



Among the more contributive findings of this study are the interaction effects between competitive actions and technological resource heterogeneity (i.e., the combination of resources in technological value and technological rarity) on firm performance. First, support of the interaction relationship associated with strategic complexity and technological resource heterogeneity indicated that in the nascent cycle of technology industries, technological resource heterogeneity mitigates a certain level of the negative impact of strategic complexity on firm performance. In our analysis (Table 3 and Figure 1), both Apple (Model 2) and Google (Model 4) exhibited a similar pattern. Strategic complexity (without interaction) exerted a negative effect on performance, whereas the interaction effect of strategic complexity and technological resource heterogeneity contributed a positive effect on performance. By simply adding these two effects, the compound effect on performance is thus gained. An inspection of the compound effect revealed that the negative effect of strategic complexity on firm performance was significantly mitigated. Such analysis implies that firms that must develop complex strategies require technological support through (1) managing their supply chain to introduce idiosyncratic resources, and (2) developing competences that are necessary for producing valuable offerings to fulfill or lead customer needs. Firms can thereby mitigate the decision risk, particularly in rapidly changing environments, thereby enhancing firm performance.

Figure-2. Effects of strategic variability on performance (Google)

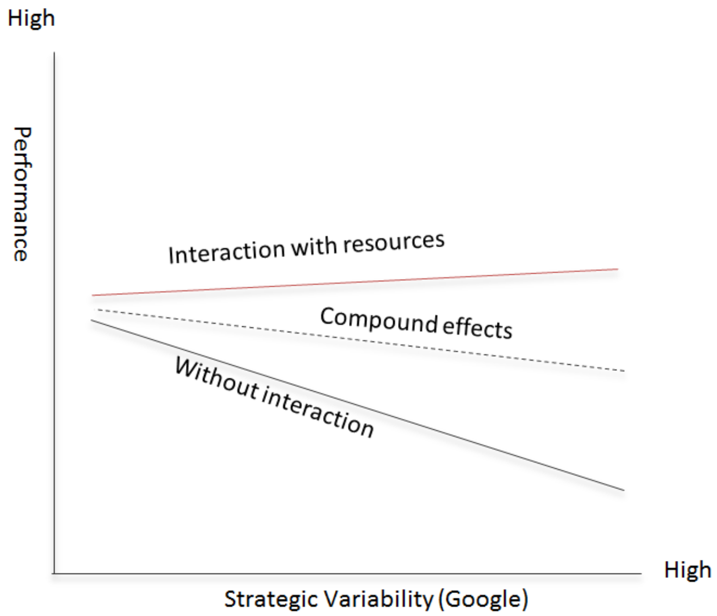
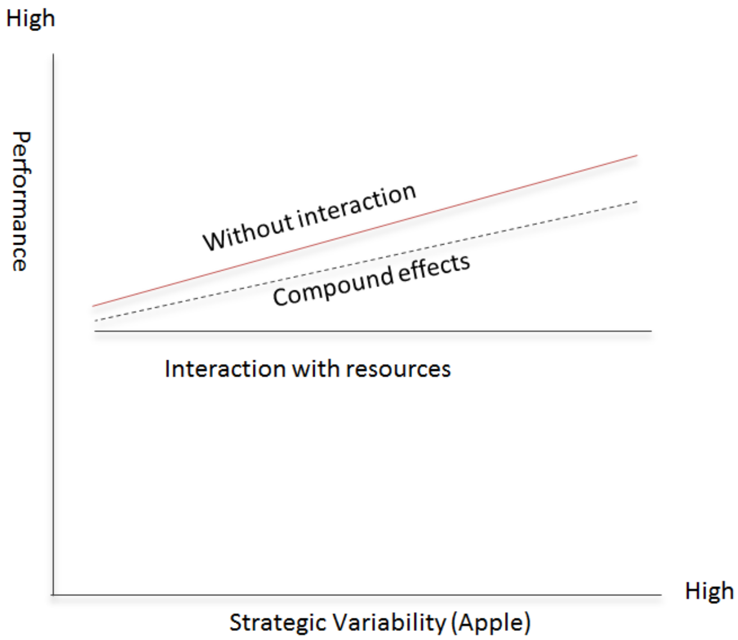


Figure-3. Effects of strategic variability on performance (Apple)



In addition, regarding the interaction effect between technological resource heterogeneity and strategic variability on firm performance, this study revealed that Apple (Model 2) and Google (Model 4) exhibited distinct patterns. In the Google model, as Hypothesis 4b predicts, the estimated interaction (technological value × technological rarity × strategic variability) on firm performance was positive. In other words, the greater the interaction effect between technological resource heterogeneity and strategic variability is, the higher the performance gains. This is inconsistent with the Apple model, however, which indicated that this relationship exhibited a negative tendency.

This difference can be clarified by investigating how technological resource heterogeneity strengthens or weakens the effects of strategic variability on firm performance. For Google (Figure 2), strategic variability (without interaction) exerted a negative effect on performance, whereas the interaction effect appeared to be positive. The compound effect on performance (gained by adding the previous two effects) was thus smaller than that of strategic variability (without interaction). In other words, technological resource heterogeneity strengthens the effect of strategic variability on performance.

However, the investigation of Apple model (Figure 3) contrasted that of the Google model, indicating that technological resource heterogeneity mitigates the effect of strategic variability on firm performance. This investigation reveals that in the tablet industry, Apple's competitive performance might be eroded if its strategic variability is implemented and developed focusing specifically on tablet product functions and distinct components. Moreover, this finding may be realized as a divergence between first- and second-mover advantages. We discuss the implication as follows.

As we observed in the tablet industry in general, Apple's success was overall acknowledged as a first mover with its tech-leading role in various aspects of strategic actions, such as conceptualizing state-of-the-art designs in computing devices, using the App platform as a business model paradigm in the field of technology, and providing an improved customer experience. However, Apple recently faced its difficulty in maintaining its market share in the tablet industry. This may be because Apple's recent competitive strategies have focused largely on product- or function-related actions, such as the size of the display panel of the iPad and other minor incremental improvements in hardware or software. Such actions were able to be widely considered to be narrowly focused, presenting only minor variation in strategic philosophy (i.e., strategic variability).

By contrast, the Google campaign, as a second mover, could benefit by implementing its "machine sea" tactic, which was focused on product- or function-related actions. In this campaign, Google has a leading role in providing Android operating systems for more than 40 hardware partners, which locate in various market segments in the global tablet industry. The Google campaign's strategic success is evident based on its increase in market share, which has occurred at a pace with which Apple may be unable to compete.

6.1. Limitations

A potential limitation of this study is related to the news article screening procedure and the quantifying process. Although the screening procedure was based on relevant theories and industry-related knowledge, they were subjectively obtained and selected by the researcher. In addition, for coding resource portfolios, the weights of technological value (the 5C aspects and advanced specifications) and technological rarity (distinct techniques and key components provided by suppliers) were equivalently counted. This was because we could not design the scheme of the weights to adequately reflect the potential levels of resource advantages.

In addition, this study extracted the competitive behaviors of firms as observed by a data-mining process in the DigiTimes news bank. However, the competitive actions of firms derived from the internal insights that were undetectable could be considered as factors yielding competitive advantages. These were frequently observed in secret agreements, managerial knowhow, executive-level entrepreneurship and leadership, and intellectual property placement. The relationship among firm resources, competitive actions, and performance is complex. Future research may address additional internal managerial actions and resource portfolios.

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