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Transforming resources to improve performance of technology-based firms: A Taiwanese Empirical Study

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Abstract

This study analyzes how firms transform resources into performance, and proposes that dynamic capabilities serve as a link for transforming internal and external resources first into firm competitiveness, and then into financial performance. One hundred and ninety-six Taiwanese technology-based firms are adopted as a research sample. The resource-based view of the firm, social capital theory, and dynamic capabilities are integrated to formulate a comprehensive framework for explaining the performance variation of technological-based firms. Analytical results demonstrate that technological-based firms can transform their resources into profit via dynamic capabilities and competitiveness.

JEL classification : M10

Keywords: Transformation; Dynamic capability; Technology-based firms; Competitiveness; Performance

1. Introduction

This study investigates how technology-based firms transform resources into profit. According to the resource-based view of the firm (hereafter RBV), the key for firms in achieving and sustaining competitive advantage (and thus profit) is the ownership of valuable, rare, inimitable, and non-substitutable (VRIN) resources, preventing advantage from being replicated, imitated or replaced

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by competitors (Barney, 1986; Dierickx and Cool, 1989; Grant, 1991; Ray et al., 2004; Wernerfelt, 1984), and thus improving firm performance.

Whether VRIN resources guarantee profit for technology-based firms is a crucial question. Global giants such as IBM, Texas Instruments, and Philip, have pursued a resource-based strategy of accumulating technology assets, but apparently resources alone are not enough. In the present fast-changing environment, resources may be insufficient to sustain competitive advantage (Teece et al., 1997; Eisenhardt and Martin, 2000).

A further question is whether the conclusion of RBV is erroneous, and also whether transformation processes exist which are currently unknown but link resources and performance. This study proposed that firm resources must be value added and transformed into firm competitiveness, thereby increasing financial performance. In situations involving inappropriate or insufficient links, resources may not be correlated to performance.

Specifically, this study identified dynamic capabilities, namely the ability to integrate and reconfigure internal and external competences (Teece et al., 1997: 516), as well as supporting firm's willingness to cooperate, as the missing link between firm resources and profit. Thus, it attempts not to disconfirm RBV, but rather to improve it by integrating dynamic capabilities into the RBV theoretical concept.

To summarize, this study tries to identify the missing links between firm resources and firm performance by integrating RBV and dynamic capability studies. Taiwanese technology-based firms are taken as research subjects to empirically verify the proposed theoretical concept. This study has two objectives: first, to contribute to theoretical development through conceptual integration, and second, to provide practical implications for the strategic management of technology-based firms.

The balance of this article is organized as follows. The following section reviews the literature on RBV, dynamic capabilities, and relevant issues, and the conceptual framework and hypotheses of this study are developed accordingly. The third section then describes the research methodology, while the fourth section discusses the empirical results. Finally, research conclusions, limitations and suggestions are presented.

2. Literature review, conceptual framework and research hypotheses

The development of RBV can be traced back to Penrose (1959). Penrose conceptualized firms as a bundle of heterogeneous resources, and sustained firm growth thus depends on firm resources, such as management capability and technological expertise. Wernerfelt (1984) is often considered the founder of modern RBV, having proposed the resource position barrier concept in which scholars began to consider differentiated firm resources as sources of sustainable competitive advantage. Through the efforts of Rumelt (1984), Barney (1986), Dierickx and Cool (1989), and Grant (1991), RBV has become a key research perspective in the field of strategy. The core competence developed by Prahalad and Hamel (1990), and the competence-based competitive strategy (Heene and Sanchez, 1997) resemble RBV conceptually.

RBV holds that the sustained accumulation of resources is a better strategy than continuously adjusting firm operating categories to match environmental changes. Firms should also formulate their competitive strategies based on their distinctive resources. Therefore, firms with distinctive resources can continue surviving and developing due to competitive advantage, regardless of external environmental changes. However, core resources must include VRIN attributes (valuable, rare, inimitable, and non-substitutable) (Eisenhardt and Martin, 2000). Specifically, core resources should be tacit and complex (Schoemaker, 1990), so that they cannot be imitated

easily; they should be exclusive (Wernerfelt, 1984), so competitors cannot obtain them cheaply; they should not be able to be rapidly accumulated (Dierickx and Cool, 1989), thus making them difficult for competitors to build internally. This study first assumes that technological-based firms are no different from other firms, and also follow the logic of RBV. Therefore, it proposes that the competitiveness of technological-based firms increases with their resources.

H1. The competitiveness of technology-based firms increases with firm resources

Dynamic capabilities are especially important to technology-based firms. One unique feature of technology is its speed of development. For example new technologies in information industries have greater memory requirements, faster data processing speed, sharper and brighter visual effects, and so on. As new technology progresses at a fast speed, information product manufactures face enormous pressure to catch up in terms of R&D to prevent their product immediately becoming obsolete, and out-of-date products have the potential to create a serious inventory problem. Furthermore, sometimes technological breakthrough may completely substitute for existing technologies, for example the document processing function of personal computer created a substitute for typewriters, causing the entire industry to disappear. Similar examples include the digital camera replacing Polaroid, and mobile phones replacing pagers. Zhang (2005), for example, proposed that strategic flexibility enhance firm performance. Thus, for technology-based manufacturers, dynamic capability, or the capability to adjust to rapid environmental change, is particularly important to survival.

Following Teece et al. (1997), this study defines dynamic capability as firm ability to integrate, learn, and reconfigure and transform. Specifically, dynamic capabilities refer to the ability of firms to combine and coordinate different resources, to gain and internalize new knowledge from other organizations, and to transform and reconfigure their existing resource base into new processes or routines.

One precondition for being able to combine, coordinate, transform and reallocate existing resources is that such resources are abundant. Furthermore, according to the ‘‘absorptive capacity’’ proposed by Cohen and Levinthal (1990), existing knowledge influences the absorptive capacity of firms to gain new knowledge. Thus, the integration, reconfiguration and learning of resources only become meaningful when the resources themselves are abundant. Therefore, firm dynamic capabilities increase with available resources.

H2. The dynamic capabilities of technology-based firms increase with the availability of resources

Resources refer not only to firm resources. Generally, firm resources are frequently limited, and thus firms seek to gain resources from their environment (Pfeffer and Salancik, 1978). Examples include firms relying on their upstream suppliers to supply raw materials, their downstream channels to deliver goods, and research institutions to provide new technologies. These support firms or organizations provide resources that are necessary to the focal firm and complementary to its existing resources.

Bantham et al. (2003), Johnson and Sohi (2003), and Danilovic and Winroth (2005) indicated that firms which lack sufficient resource to thrive frequently use cooperative methods such as strategic alliances to gain complementary resources and capabilities from support firms. Network studies (such as Gulati, 1999) also provide a reminder of the importance of the cooperation of associated support firms in obtaining the requisite complementary resources. When the willingness to cooperate of support firms increases, focal firms will gain more available resources from them, thus increasing the dynamic capabilities of the focal firm.

H3. Technology-based firm dynamic capabilities increase with the willingness of support firms to cooperate

Though the social capital theory (Lengnick-Hall et al., 2004; Alder and Kwon, 2002) suggested that personal relationships among managers may influence firm cooperation, personal relationships will not be the major consideration if associated support organizations are for-profit firms, because their willingness to cooperate with focal firms is still basically economically driven. Associated support firms are willing to cooperate in obtaining economic benefits now, or in the future.

The resources of focal firms represent an index of the likelihood of future profits, as proposed in H1. More abundant focal firm resources increase the likelihood of profits, and thus make it more attractive for support firms to share profits through cooperation. Restated, associated firms evaluate the extent of firm resources and also consider the economic benefits that can be accrued through cooperation.

H4. The willingness of support firms to cooperate increases with firm resources

As mentioned earlier, dynamic capabilities are defined as firm ability to integrate, learn, and reconfigure and transform. The goal of integrating and combining resources, learning and internalizing new knowledge, and reconfiguring and reallocating resources, is to promote firm capability to survive and compete in a turbulent environment. Thus, the competitiveness of technology firms supposedly increases with dynamic capabilities.

Take two Taiwanese wafer manufacturers as an example. Taiwan Semiconductor Manufacturing Company Limited (TSMC) and United Microelectronics Corp. (UMC), which are the leading wafer OEM firms globally, are famous for their dynamic capabilities. Owing to their ability to absorb, internalize external technology and know-how, and to reconfigure and recombine their internal knowledge more effectively than competitors, both firms have better product quality, efficiency and yield rate.

H5. Competitiveness of technology-based firms increases with dynamic capabilities

Support firms help technology-based firms to improve their performance in two ways. First, allies can directly provide information, knowledge, and complementary resources. Second, support firms can help in procuring resources from third parties through the signaling role of the alliance (Lee et al., 2001). This study previously hypothesized that competitiveness (H1) and dynamic capability (H2) improve with the abundance of firm resources. According to the same logic, since cooperation with support firms both directly and indirectly increased the resources available to technology-based firms, these external resources will enhance firm dynamic capability (H3) and competitiveness.

H6. The competitiveness of technological-based firms increases with willingness of support firms to cooperate

By definition, the ultimate objective of any for-profit organization is to improve its financial performance, namely profit, with technology firms being no exception. Better financial performance can be achieved through numerous ways. Pure financial manipulations (for example, buying and selling in stock markets) or monopoly positions can both result in excellent financial performance. However, the most basic and direct way to obtain profit is to achieve competitiveness.

Generally, a positive relationship should exist between firm competitiveness and financial performance. However, as mentioned above, numerous factors influenced financial performance,

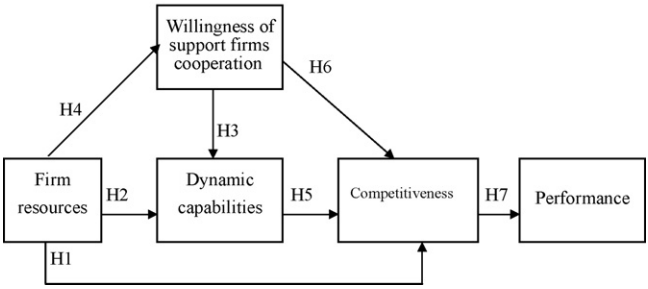

Fig. 1. Conceptual framework of this study.

and no definite relationship exists between competitiveness and financial performance. Furthermore, in a rapidly changing environment, a competitive technology-based firm may not always be profitable, since it may be in a business where profits are expected only in the future. However, when other influences can be excluded by a large sample investigation, it is reasonable to hypothesize that other things being equal, the financial performance of technology-based firms increased with their competitiveness.

H7. The financial performance of technology-based firms improves with their competitiveness

The conceptual framework of this study can be shown in Fig. 1.

3. Methodology

3.1. Sample and data collection

Taiwanese technology-based firms were adopted as the research sample in this study. Technology firms were selected because their products typically have short product life cycles (Chiou et al., 2002), making them appropriate for the purpose of this study. Taiwan is a major international producer of information related products. However, with Mainland China becoming the world factory because of its low production cost, and given the rapid obsolescence of information products, Taiwanese technology-based firms face increasingly severe competition. Therefore, research evidence from Taiwanese technology-based firms provides rich information and implications for managers.

The research samples used in this study were taken from the Taiwan Hsinchu High Technology Industrial Park Council's Science Industry Association Registry and the Taiwan Manufacturers Registry, published by the China Credit Information Service.

Since the information required for this study could only be obtained from upper management, firm CEOs were selected as the primary informants. Sample firms were contacted by phone to confirm that the targeted respondents were indeed the CEOs. Respondents were then contacted and their cooperation requested. After mailing the questionnaires, respondents were re-contacted to ascertain whether they had received the questionnaires and were urged to return the questionnaires rapidly (cf. Sivadas and Dwyer, 2000).

A total of 1000 sample firms were randomly selected. Twenty-two questionnaires were returned because of wrong addresses. Of the 978 questionnaires distributed, 218 responses were received. Twenty-two responses were removed from the sample because of the respondent firms reporting that certain questions did not apply to them, or because of key answers being missing

(for example, financial performance index). The final sample contained 196 firms, representing a return rate of 19.6%.

Analysis of variance (ANOVA) was employed to analyze the difference between early and late respondents (Armstrong and Overton, 1977), with the aim of determining whether non-response bias existed. Responses returned within 4 weeks of questionnaire delivery were classified as early ($n = 121$), while those received after 4 weeks were classified as late ($n = 75$) (cf. Mishra et al., 1998). ANOVAs were conducted for annual sales and employee numbers across the early and late responding groups. Analytical results demonstrated no significant difference between these two groups in any of the three measures (for annual sales: $p = .803$; for number of employees: $p = .917$).

3.2. Measure development

The constructs were measured in two ways: for constructs employed in previous research, the question items were adopted directly with some modifications to make them more applicable to the Taiwan context. For constructs developed in this study, question items were designed based on previous conceptual studies, and discussions with CEOs and experts from technology-based firms were conducted to confirm the content validity. The developed question items were Likert and semantic-differential scales. Questionnaires were pre-tested on a group of CEOs before delivery to clarify construct concepts and modify ambiguities in wordings.

This study contained five constructs: firm resources, willingness of support firms to cooperate, dynamic capabilities, competitiveness, and performance.

3.3. Firm resources

This study measured firm resources with five variables based on past research, including specialized know-how (Amit and Schoemaker, 1993; Leonard-Barton, 1992), financial capital (Brush et al., 1997; Tsai and Ghoshal, 1998), management capability (Collis, 1991; Lippman and Rumelt, 1982), reputation (Deephouse, 2000; Hitt et al., 2001) and experience of past alliances. Respondents rated their firms for the five variables on a semantic-differential scale (see Table 1).

3.4. Willingness of support firm to cooperate

Respondents were asked to identify a key support firm first, and four questions were asked regarding the specified firm, dealing with support firm willingness to provide resources, willingness to prioritize the focal firm, willingness to maintain a cooperative relationship with the focal firm, and willingness not to take advantage of the focal firm. A five-point Likert scale (ranging from strongly agree to strongly disagree) was adopted to measure support firm willingness to cooperate.

3.5. Dynamic capabilities

This study employs the definition of dynamic capability employed by Teece et al. (1997) to measure the construct of dynamic capabilities. Four questions are asked: (1) whether the resource integration capability of the firm was sufficient or insufficient; (2) whether the resource reconfiguration capability of the firm was sufficient or insufficient; (3) whether the resource learning capability of the firm was slow or fast; (4) whether the ability of the firm to respond to changes was slow or fast. The measurement was performed using a semantic-differential scale.

Table 1
Measurements and scales

Constructs	Scale	Type	Measurement items
Firm resources	1–7	SD	1. The company's specialized know-how was (lower than the industry average—higher than the industry average) 2. The company's capital was (lower than the industry average—higher than the industry average) 3. The company's operational management capability was (lower than the industry average—higher than the industry average) 4. The company's reputation was (lower than the industry average—higher than the industry average) 5. The company's cooperative alliance experience was (lower than the industry average—higher than the industry average)
Willingness of support firms' cooperation	1–5	Lkt	1. Although the company's production capability is small-scale, the most important partner remains willing to continue to provide resources 2. The most important partner is willing to give priority to providing the company with resources 3. The most important partner is not willing to lightly severe cooperative relations with the company 4. The most important partner will not seek to take advantage of the company
Dynamic capabilities	1–7	SD	1. Resource integration capability (insufficient-sufficient) 2. Resource reconfiguration capability (insufficient-sufficient) 3. Learning capability (slow-fast) 4. Ability to respond to the rapidly changing environment (slow-fast)
Competitiveness	1–7	SD	1. Innovative speed (slower than the industry average—faster than the industry average) 2. Speed responding to market (slower than the industry average—faster than the industry average) 3. Production efficiency (lower than the industry average—higher than the industry average) 4. Product quality (lower than the industry average—higher than the industry average) 5. Degree of production method flexibility (lower than the industry average—higher than the industry average) 6. R&D capability (lower than the industry average—higher than the industry average)
Performance			Average ROA (Return on Assets) of 2002–2004

Note: SD: semantic-differential scale; Lkt: Likert scale.

3.6. Competitiveness

Six questions were used to assess the competitiveness of technology-based firms: innovation speed (Bruderl and Preisendorfer, 2000; Lee et al., 2001), speed of responding to the market (Hill and Jones, 2004), production efficiency (Hill and Jones, 2004; Pisano and Wheelwright, 1995); product quality (Hill and Jones, 2004; Lee et al., 2001), and manufacturing flexibility and R&D capability (Dollinger, 1995; Lee et al., 2001). The measurement was performed using a semantic-differential scale.

3.7. Financial performance

This study adopted Return on Assets (ROA) to indicate financial performance. Respondents are asked to provide their average ROA during the last 3 years in the questionnaire. Researchers emphasized that individual company data would not disclosed to others under any situation, to increase subject willingness to answer. However, missing data still occurred. For firms which did not offer this information, but which expressed their willingness to receive the research findings (i.e. providing the name and address of the firm), this study attempted to find ROA from other information sources, for example the www website of the company or the ministry of finance (MOF) of Taiwan.

4. Results and discussion

4.1. Reliability

Measurement reliability was assessed by calculating the Cronbach's alpha coefficient. A coefficient exceeding .70 was adopted as the acceptable level of construct measurement. The Cronbach's alpha of all constructs revealed that they all exceeded .70, indicating acceptable reliability (Nunnally, 1978). These results supported the uni-dimensionality of the scales.

4.2. Hypothesis testing

Path analysis in LISREL was performed for hypotheses testing. The path-analysis procedure is becoming common in studies in which a small sample size restricts the use of full structural equation models (cf. Li and Calantone, 1998; Chaudhuri and Holbrook, 2001).

The model fit indexes indicated that the model was acceptable ($\chi^2_{(3)} = 2.73$, $p = .18$, GFI = .93, AGFI = .90, RMSEA = .067, NFI = .95, TLI = .95, and CFI = .96). Six of the seven hypotheses are supported (see Table 2), including H1 (competitiveness increases with firm resources) ($\beta = .21$, t-value = 3.41), H2 (dynamic capability increases with firm resources) ($\beta = .18$, t-value = 3.22), H3 (dynamic capability increases with the willingness of support firms to cooperate) ($\beta = .49$, t-value = 9.16), H4 (willingness of support firms to cooperate increases with increasing firm resources) ($\beta = .39$, t-value = 4.02), H5 (competitiveness increases with increasing dynamic capabilities) ($\beta = .64$, t-value = 12.58), and H7 (financial performance improves with increasing competitiveness) ($\beta = .52$, t-value = .11). Meanwhile, one hypothesis

Table 2
Hypothesis testing results

Hypothesis	Causal path	Coefficient	t-value
H1	Firm resources → competitiveness	.21	3.41**
H2	Firm resources → dynamic capabilities	.18	3.22**
H3	Willingness of support firms' cooperation → dynamic capabilities	.49	9.16**
H4	Firm resources → willingness of support firms' cooperation	.39	4.02**
H5	Dynamic capabilities → competitiveness	.64	12.58**
H6	Willingness of support firms' cooperation → competitiveness	.08	.11
H7	Competitiveness → performance	.52	9.47**

Note: **$p < 0.05$.

was rejected: H6 (competitiveness increases with increasing willingness of support firms to cooperate) ($\beta = .08$, t-value = .11).

Most of the hypotheses proposed in this study were accepted. That is, the hypothesis that resources themselves do not guarantee performance was confirmed, technology-based firms require some links to transform their resources into superior financial performance. In this study, dynamic capabilities and support firm cooperation are two key components for firms to enhance their competitiveness, and thus leading to superior financial performance. The rejected hypotheses provided further evidence of this inference logic. The rejection of H6 indicated that resources provided by support firms do not directly influence competitiveness, but rather influence competitiveness through firm dynamic capabilities. The role of dynamic capabilities for technology-based firms is clearly extremely important.

5. Conclusion

RBV considers firms as a bundle of resources, and proposes that idiosyncratic resources are fundamental influences on firm competitive advantage and thus performance. However, some recent studies, including Deeds et al. (1999), Eisenhardt and Martin (2000), Makadok (2001), Teece et al. (1997), Zollo and Winter (2000) and Zott (2003), have found that RBV are not necessary applicable in dynamic markets, owing to alteration being nonlinear and unpredictable.

Social capital theory (Lengnick-Hall et al., 2004; Alder and Kwon, 2002) stresses that internal resources alone are insufficient, and network position and relationships with other institutions influence focal firm ability to enjoy superior information and bargaining advantage. Social capital is especially important because when facing a turbulent market, firms require the cooperation of support firms to adapt to the environment. For example, the shorter product life cycle of technology products increases the pressure to introduce new products. To increase the speed of new product introduction, firms require the cooperation of their suppliers and channel members.

This study proposed that idiosyncratic resources and social capital are necessary but not sufficient conditions for financial performance. The empirical results indicated that whether from the firm itself or from support firms, resources do not directly influence performance. Instead, resources and social capital must be complimented by dynamic capabilities.

This study does not aim to reject the theories developed by RBV and social capital research. Instead, this study tried to refine the two paradigms through the integration of dynamic capabilities. To be specific, VRIN resources owned by the technology-based firms, and complementary resources provided by support firms, influence firm performance, in the condition that technology-based firms are able to integrate/combine internal and external resources, re-configure their resource deployment, and learn/absorb outside knowledge into internal routines.

Furthermore, this study proposes that the observation of the competitiveness of technology-based firm is important as well as financial performance. Innovation speed, market response speed, production efficiency, product quality, production flexibility, R&D capability, and so on, are developed as indicators of the competitiveness of technology-based firms. Empirical results demonstrated that dynamic capabilities influence competitiveness, and subsequently financial performance.

The research findings identified dynamic capability as a key concern for technology-based firms. The measurement items of dynamic capabilities and competitiveness adopted in this study are thus helpful for managers of technology-based firms. Since the empirical results revealed

relationships among dynamic capability, competitiveness, and ROA, managers may assess their firms accordingly, and may promote their financial performance through the improvement of items listed in Table 2.

This study is primarily based on perceptual data, with the exception of ROA. This approach makes it difficult for management to determine appropriate actions based on the study results (Wang et al., 2004). Despite the extensive employment of such data in strategy research, future studies may consider adopting hard data.

This study focuses on technology-based firms. However, technology firms differ according to sub-industry. For example, manufacturers differ from service firms, and hardware firms differ from software firms. Consequently, dynamic capabilities are likely to differ among sub-industries. This topic also deserves further investigation.

Though Taiwan has become the third largest manufacturer of information technology products in the world, generalization of the research findings to other countries is limited because of the exclusively Taiwanese focus of this study. Future studies may consider the inclusion of different regional samples.

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