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The Effects of Firms Resources and Capabilities on its Performance of IC Design Industry in Taiwan

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Abstract: The aim of the study is to examine the relationship between firms resources and capabilities and its performance of IC design industry in Taiwan. The resource-bases view of the firms has become an important conceptual framework in strategic management but has been criticized for lack of an empirical base. A few researchers have been able to develop measures of resources and capabilities, identify their importance in a specific industry context and link firm's resource positions to firm performance. In this study, we examine the relationship between firms' resources and capabilities and its performance of Taiwan's IC design industry. The empirical findings are as: R and D resources and capabilities have no effects on firms performance. Marketing resources and capabilities, operation resources and capabilities, human resources and management all have positive effects on firms performance. Physical capital resource and management have no effects on firms performance. The analysis in this study provide a more convincing evidence for examining a more long-term relationship between resources and capabilities on firms performance, thus provide a implications for the management of firms' resources acquisition, allocation and utilization activities of Taiwan's IC design industry so as to facilitate their firms performance.

Key words: Resource-based view, firm performance, IC design industry, strategy management

INTRODUCTION

The traditional industry analysis approach focus on the importance of industry structure and market positioning of organization (Porter, 1990); however, the newly emerged resource-based view has emphasized on each firm's unique resources, core competence and dynamic capabilities in a rapidly changing global market (Prahalad and Hamel, 1990). In this resource-based view, a firm's competitive advantage itself rather than external environments is the primary source of firm's profitability (Grant, 1991). Resource-based theory views firm-specific resources as the cornerstone of competitive advantage and firm performance (Peteraf, 1993). Firm resources are defined in various ways throughout the studies. Barney (1991) classified firm resources into physical capital resources, human capital resources and organizational capital resources; moreover, he also pointed out that resources include all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc., which were controlled by a company that enables the firm to conceive and implement strategies that improve its efficiency and effectiveness. The source of sustained competitive advantage is firm resources which are valuable, rare, imperfectly imitable and non-substitutable. The resource-based theory has emphasized the role of resource as the ultimate source of competitive advantage (Barney, 1991, 2001, 2002). Firms obtain competitive advantage due to the presence of one or more resources that allow for product and service differentiation or even uniqueness that is valued by one or more customers (Gouvea and Kassicieh, 2001). Performance differences between firms are a result of their different knowledge bases and differing capabilities in developing and deploying resources. Most researchers recognize the impossibility of identifying all key resources both now and in the future (Fahy *et al*., 2006). Indeed, resource-based view emerged as an illuminating framework for diagnosing the source of sustainable competitive advantage, as it provides a mechanism for stating which

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of the many resources typically available to the firm are crucial in terms of gaining advantage (Fahy, 1998, 2002). Krasnikov and Jayachandran (2008) indicated that capabilities enable firms to reap greater relative advantage in market performance than efficiency performance.

This study tries to explore the effects of firms' resources and capabilities on its performance in Taiwan's IC design industry. First, we develop our hypothesis based on earlier studies and industry context. Second, we estimate the data for the 77 firms in this sample over a 8 years period from 2000 to 2007. Third, drawing from these estimate, we summarize the empirical results and discussions. Then, the final section is our conclusions and future researches.

LITERATURE REVIEW AND HYPOTHESIS

Taiwan's IC design industry context: The silicon-based semiconductor is an electronic device that allows data, voice and video to be processing. These discrete electronic devices are formed into ICs (Integrated Circuits) for application in various products and systems. PC-related ICs are the major application for IC products and they are the focus of Taiwan's IC fabless industry as well. Given the foreseeable potential of telecommunication and multimedia ICs, more R and D effort is anticipated before any significant success. IC design is part of a complete semi-conductor product development cycle. For most electronic products nowadays, major product functions are incorporated into the IC chips; therefore, ICs are the core technology of these electronics products. It is also the most important portion of the value chain of electronics manufacturing.

In 2005, Taiwan 's contract chip-making industry seized a 69.2% share in the world market. While, the IC packaging industry garnered 44.8%, the IC testing industry gained 60%. Taiwan is known as a very powerful and competitive competitor in global IC industry due to the country's unique vertical disintegration business model. It takes decades for Taiwan's Semiconductor Industry to develop into a complete industrial cluster and at the same time it has also taken on an important role not only in the economic growth of Taiwan but also in the semiconductor Industry around the world. For these superior characteristics, a very superior foundation is created for a leading IC design industry.

Despite of the disadvantages of limited research resources, the lack of experienced R and D engineers and designers and little influence over the global electronics market, Taiwan's IC design expanded to 21.5% in 2005 in the global market. Morevoer, the production value of Taiwan's IC design industry was nearly US$11.8 billion in 2008, with most business focusing on information application and consumer electronic products, making the country the world's second-largest IC designer.

Under the dynamic changing environments, Taiwanese IC design firms should match global market needs as its foundation to conduct new product development. Market performance provides a future-oriented consideration of an organization's ability to transform itself to be in face of anticipated and unanticipated environmental challenges. The finance literatures argue strongly that maximization of shareholder wealth (market performance) is the ultimate criterion of firm effectiveness (Natarajan *et al*., 1985).

Firm resources-based view with firm performance: In past researches, the relationship between firm resources and firm performance had been demonstrated (Allen and Pantzalis,1996; Pantzalis, 2001; Goerzen and Asmussen, 2007). Teece *et al*. (1997) suggested that production innovation, combination and allocation business resources are the factors for the success in global competitive environments.

The resources-based view bases on the securing of competitive advantages on two concepts: resources and capabilities. Resources are those intangible and tangible assets linking to the firm in a semipermanent way, whereas capabilities are related to the way of accomplishing different activities, depending on the available resources (Grant, 1991; Wernerfelt, 1984). A firm's resources and capabilities have value only in context. One can easily identify generic categories of capabilities (for manufacturing businesses, such categories would include product design, production, supply chain, customer relationship, etc.), but the specifics depend on the industry environment. For example, product design skills in the IC design industry are clearly distinct from the capabilities that support drug discovery and development in the pharmaceutical industry. Hence, any empirical study of the resource-based view must consider resources and capabilities in the industry context where they potentially hold value. Few of prior studies offer guidance on the types of resources and capabilities likely to be important in the IC design industry. Due to the core competence of the IC design firms originates from innovation through R and D in next-generation IC products to meet market needs. The impact of resources and capabilities on performance is governed by two characteristics of the knowledge that drives them: the difficulty that rivals face in copying them (imperfect, imitability) and the difficulty they have in obtaining them from the market (imperfect mobility). Marketing, R and D, human and operations capabilities may differ with respect to the imitability and mobility of the knowledge that supports them.

Thus in this study, we do not consider all resources and capabilities of the firms but focused on financial resource (which including R and D expenditure, marketing expenditure and operation expenditure) and non-financial resources (which including human resource and physical capital resource) which might have influences on firms performance of Taiwan's IC design industry.

R and D resources and capabilities: Research and development (R and D) is concerned with the design of products and production processes. One of the most essential sources for IC design firms' innovation is their own R and D efforts. Research can refer to both basic research and applied research. Basic research directly affects the understanding of a topic or field without a specific immediate commercial application in mind whereas applied research affects the understanding of a topic to meet a specific need. Development refers to activities that apply knowledge to produce useful products or services. For most organizations, product innovation is the center of their R and D efforts. R and D resources and capabilities are a firm competency in developing and applying different technologies to produce effective new products and services. R and D capability refers to the processes that enable firms to invent new technology and convert existing technology to develop new products and services. Therefore, R and D capability depends on the routines that help a firm develop new technical knowledge, combine it with existing technology and design superior products and services. Trajtenberg (1990) pointed out that investment in R and D has been regarded as one of the key strategies to ensure technological potential. Romer (1990) revealed that the internal drivers for small and medium-sized firms growth from innovation were technology, R and D and the ability to generate a competitive edge in the firm's product market.

R and D capital reflects the amount of knowledge a firm has accumulated through its R and D efforts and may indicate the future potential of the firm to develop new products or services. Basically, increase in the R and D expenditure allows IC design companies to learn and absorb new technology more effectively and the more silicon Intellectual Property (IP) and patents will be innovated and these intellectual capital assets will eventually contribute to innovative products and firm performance. Thus, R and D expenditure should influence firm performance in the future. The time lag can vary among industries, among companies within an industry and among R and D projects within a company (Morbey, 1988).

Earlier studies have shown a positive correlation between R and D and company growth in sales (Morbey, 1988). Romer (1990) and Lichtenberg (1992) have shown the relationship between the investment in R and D expenditure and the increases in productivity and profit growth. Perelman (1995) found a negative relationship between R and D and technical efficiency. However, few studies demonstrate any relationship between R and D and future profitability. Some researchers noted that these inconsistent findings result from difficulty in developing good measures of R and D or innovation (Cohen, 1995), while others argue that a lack of sufficiently detailed data make it difficult to distinguish between measures of scale and scope economics (Henderson and Cockburn, 1996). Much of the earlier studies examines firm's R and D resources and capabilities in manufacturing and production, empirical ambiguity remains over exactly how resources and capabilities affect firm performance in more knowledge intensive industry such as IC design. We therefore like to infer the following hypothesis:

H1: R and D resources and capabilities have a positive impact on firms performance of IC design industry in Taiwan.

Marketing resources and capabilities: Marketing, in its primary definition, is the process of designing a product according to the market's need. The term is commonly used in reference to advertising and sales. Although, at that stage it is too late to market a product because it already exists, it is essential for IC design companies to undertake marketing as early as the design stage. Not only R and D can affect firm's performance, but also advertising plays a significant role in the creation of brand value (Chu and Keh, 2006). Mizik and Jacobson (2003) discussed that brand-based advertising can create a comparative advantage for firms. In addition, marketing capability involves the processes that enable a firm to build sustainable relationships with customers (Day, 1994). Marketing capability represents a firm's ability to understand and forecast customer needs better than its competitors and to effectively link its offerings to customers (Day, 1994). Market knowledge usually develops over time through learning and experimentation.

The resource-based view has had an influence on the dialogue in the marketing strategy literature by helping researchers articulate the drivers of competitive advantage (Bharadwaj *et al*., 1993; Capron and Hulland, 1999). Fundamentally, marketing is one of the major practices that is able to anticipate customers' needs. Thus, marketing capability is the organizational competence that upholds the market share and communication with both potential and existing customers. In addition, marketing capability involves processes that enable a firm to build long-term relationships with customers (Day, 1994). Marketing

capability is based on market knowledge about customers' needs and past experience in forecasting and responding to these needs (Day, 1994).

Empirical ambiguity remains over exactly how marketing resources and capabilities affect firm performance in more knowledge intensive industry such as IC design industry. We therefore like to infer the following hypothesis:

H2: Marketing resources and capabilities have a positive impact on firms performance of IC design industry in Taiwan.

Operation resources and capabilities: Operation resources and capability are focused on performing organizational activities efficiently and flexibly with a minimum wastage of resources; therefore, these capabilities are related to efficient manufacturing and logistics. In the productive perspective, efficiency frontier occurs when a firm exploits the business resources and capabilities more efficiently. In the financial perspective, efficiency frontier means at each risk point, choosing an investment set of the maximum except profit. Operations capability is the skills and knowledge that enable a firm to be efficient and flexible producers or service providers that use resources as fully as possible. Operations capability is frequently based on processes that have been benchmarked and codified. For example, many firms have pursued total quality management and international standards organization programs to enhance quality and efficiency. Similarly, many firms have implemented business process reengineering to redesign business systems and work flow and to employ information technology to enhance efficiency.

Empirical ambiguity remains over exactly how operation resources and capabilities affect the small and medium-sized firms' performance in more knowledge intensive industry such as IC design industry.

Empirical ambiguity remains over exactly how operation resources and capabilities affect firm performance in more knowledge intensive industry such as IC design industry. We therefore like to infer the following hypothesis:

H3: Operation resources and capabilities have a positive impact on firms performance of IC design industry in Taiwan.

Human resources and management: Human resources refer to education, employment or industry experience and other types of experiences that help to prepare the entrepreneur for the challenges of business ownership. Deficiencies in either of these key areas can hamper a firm's ability to launch, develop new products and services, hire needed employees, or grow. Barney (1991) indicated that human Resources refer to the number and characteristics of personnel available to formulate and implement strategy. There are a number of ways in which the human resources management can help an enterprise to create more value. If the human resources management are functioning well, employee productivity rises and customer service improves, thereby enabling the firm to create more value. Important aspects of human resources identified in the literature include the individual-level experience, knowledge and skills of available personnel (Cavusgil and Zou, 1994; Daily Certo and Dalton, 2000).

In Taiwanese IC design industry, well-educated manpower is crucial to develop innovative products and promote firm performance. Taiwan has been able to form a pool of high-quality technology manpower due to educational policy, social value systems, public training systems and the return of overseas experts. The unique profit sharing system popular in the industry also spurs IC design engineers to maintain their high performance. Emphasis on adequate human resource management is currently one of the major concerns of firms, because various studies have found that there is a positive relationship between human resource management and business performance (Huselid, 1995).

Miles and Snow (1984) defined the most adequate human resource practices for each of the strategic types. These relationships have generally been supported in the empirical literature (Peck, 1994). Defender firms usually have less developed systems of human resource management, because they use recruitment and internal selection. They design traditional compensation systems based on a fixed salary and rarely appraise employee performance. However, they attached major importance to long-term training (Miles and Snow, 1984). In contrast, prospector firms make use of more developed human resource management systems: they resort to recruitment and external selection, they design evaluation systems based on performance and reward is based on variable compensation. However, they offer limited and informal training (Miles and Snow, 1984).

Empirical ambiguity remains over exactly how human resources and management affect firm performance in more knowledge intensive industry such as IC design industry. We therefore like to infer the following hypothesis:

H4: Human resources and management have a positive impact on firms performance of IC design industry in Taiwan.

Physical capital resources and management: Miller and Shamsie (1996) suggested that based on the notion of barriers to imitability, all resources may be classified into two broad categories: property-based and knowledge-based resources. Property-based resources are legal properties owned by firms, including financial capital, physical resources, human resources, etc. Different property-based resources may exhibit different characteristics; human resources tend to have a high degree of imperfect mobility. Compared to property-based resources, physical resources are known for their imperfect substitutability.

Physical capital intensity is a measure of the firm-specific physical capital resources that is embodied in the machinery and equipment that the firm uses in production and logistics. The efficiency with which this is carried out can significantly lower cost, thereby creating more value. Firms with a higher level of capital intensity are expected to have high asset specificity and potentially more variability in capital utilization. As the rental cost of unused capital can be high, it is expected that firms have the incentives to use their production resources efficiently. However, empirical studies show a somewhat mixed strand of results. For example, Lim (1980) and Sheehan (1997) gave support to the hypothesis that firms with higher levels of capital intensity perform better, whereas Mahadevan (2000) reported a negative effect of capital intensity on production.

Empirical ambiguity remains over exactly how physical capital resources and management affect firm performance in more knowledge intensive industry such as IC design industry. We therefore like to infer the following hypothesis:

H5: Physical capital resources and management have a positive impact on firms performance of IC design industry in Taiwan.

MATERIALS AND METHODS

Data sample: The financial panel data of IC design firms listed in Taiwan stock exchange and the over-the-counter securities exchange market were retrieved from Taiwan Economics News Service (http://tej.com.tw) and the data span the period of 2000-2007. The number of firms engaged in IC design varied with time so that the number of firms from 66 in the year of 2000 to 77 firms in the year of 2007. The financial panel data for each focal firm in values have already been converted into constant 2001 dollars using appropriate deflators from the Statistical Yearbook of the Republic of China, 2008.

Variables and measure

Dependent variable (Firm performance): Firm performance is usually measured by sales growth, profit margin and return on assets. In this study, we choose the annual total sales as a proxy to examine Taiwan's IC design firms' performance, because it provides a less biased performance statistics than any other measures. For example, the returns on assets, in cross-sectional comparisons of firms that are expected to vary according to the asset-intensity requirements of their market niches (Bettis, 1981).

Independent variables

R and D resources and capabilities: R and D intensity, defined as a firm's investment in R and D as a proportion of its total sales, is the major vehicle by which firms create firm specific technological knowledge as it portrays the investment share directed towards the creation and absorption of technological knowledge (Almor *et al*., 2006). Thus, R and D intensity is expected to be correlated with the amount of firm specific technological knowledge contained in each unit of output. R and D intensity is generally defined in 2 ways: first, as R and D expense from the income statement divided by annual sales and second, as R and D expense divided by firm Total Assets. The traditional measure of R and D has been R and D expenditure divided by sales to give a normalized R and D intensity measurement.

However, it has been suggested that R and D intensity which is the R and D expenditure per employee is one of the better proxies for innovation (Hill and Snell, 1989). Because the number of employees tends to have less short-term variability than sales, the R and D per employee ratio may be more robust in determining a long-term commitment to innovation. Thus, in this study, we employed annual R and D intensity to examine the Taiwan's IC design firms' performance.

Marketing resources and capabilities: With regarding to the measurement of marketing resources and capabilities, in this study, we employed the marketing expenditure per employee ratio as the proxy to examine the relationship with Taiwan's IC design firms' performance.

Operation resources and capabilities: With regarding to the measurement of operation resources and capabilities, in this study, we employed the managerial expenditure per employee ratio as the proxy to examine the relationship with Taiwan's IC design firms' performance.

Human resource and management: In the field of high knowledge-intensive IC design industry, the quality and

commitment of its manpower, including R and D, marketing, sales, services and management, play key roles in boosting competitive advantage and firm performance. Thus, we are interesting to understand whether Taiwan's IC design companies allocate and utilize appropriate human resources in R and D, marketing, sales, services and managerial activities and thus facilitate to those IC design firms' performance. Thus, in this study, we employ the annual total number of employees as the proxy to examine its relationship with Taiwan's IC design firms' performance.

Physical capital resources and management: Earlier studies use capital intensity to show firm's fixed asset resources (Burger and Hamman, 1999). Thus, in this study, we employ the physical capital intensity that is the ratio of the fixed asset book value to employees as the proxy to examine its relationship with Taiwan's IC design firms' performance.

ANALYTICAL METHODS

Here, we will introduce the method of statistical analysis. In this study, STATA v.9.0 is introduced to analyze our panel data.

Wooldridge test for serial correlation in panel-data models: Wooldridge test implements a test for serial correlation in the idiosyncratic errors of a linear panel-data model discussed by Wooldridge (2002).

Fisher type unit root test for panel data: Fisher type unit root test for panel data combines the p-values from N independent unit root tests, as developed by Maddala and Wu (1999). Based on the p-values of individual unit root tests, Fisher's test assumes that all series are non-stationary under the null hypothesis against the alternative that at least one series in the panel is stationary.

Fit panel-data models using GLS: Fit panel-data models using command xtgls which fits cross-sectional time-series linear models using feasible generalized least squares. In STATA, this command allows estimation in the presence of AR(1) autocorrelation within panels and cross-sectional correlation and heteroskedasticity across panels.

RESULTS OF QUANTITATIVE ANALYSIS

Variables analysis: In Table 1, we summarize all dependent and independent variables in this study.

Table 1: All dependent and independent variables in this study

Variables	Description
lntotsales	Annual total sales
lnrndint	Annual R and D intensity (the ratio of R and D expenditure and employees)
lnmarkgint	Annual marketing intensity (the ratio of marketing expenditure and employees)
lnmangint	Annual managerial intensity (the ratio of managerial expenditure and employees)
lncaptalint	Annual capital intensity (the ratio of fixed asset book value and employees)
lnempee	Annual total nnmber of employees

Table 2: Descriptive statistics for all variables

Variables	Mean	SD	Min.	Max.
Total sales	2623297	5938265	1289	6.13e+07
Rndint	1044.739	715.5775	0	6029.447
Markgint	359.2005	316.1871	0	2625.674
Mangint	409.7703	346.6525	0	4693.897
Employee	191.3501	277.5578	10	1864
Captalint	1147.89	1312.824	22.157	13322.81

Table 3: Autocorrelation analysis for dependent variable-totsales

Autocorrelation analysis	Values
H0	No first-order autocorrelation
F(1, 76)	36.157
Prob>F	0.0000

Wooldridge test for autocorrelation in panel data

In Table 2, we provide descriptive statistics analysis for these dependent and independent variables in this study. It is noticeable that the listed IC design firms vary in every aspects of variables. The annual total sales range from NT$ 1.29 thousand to NT$ 61.30 billion and the average annual total sales is NT$ 2.62 million. The average number of employees is 191, with a maximum number of 1864 and a minimum number of 10. As we can see that most of the Taiwanese IC design firms are small and medium-sized. The average R and D intensity is 1.04 thousand NT dollars, with a maximum of 6.03 thousand NT dollars and a minimum 0 NT dollar.

Autocorrelation analysis-Wooldridge test: In Table 3, it displays the autocorrelation analysis test for regression model when dependent variable is totsales. The result presents an significant outcome and symbolizes that variables within this model are first-order autocorrelated because of F (= 0.0000) is < 0.05. To adjust the problem of autocorrelation, this study use AR1 autocorrelation structure in the command xtgls to analyze this model.

Autoregression test-Fisher's test: In Table 4, it shows the Fisher test for panel unit root. Based on the results, all firms' resources variables do not have autoregression problem ($p<0.05$).

Hierarchical regression analysis: As the autocorrelation within panels that come from previous examinations, this study uses command xtgls with parameters including corr

Table 4: Fisher test for panel unit root using an augmented Dickey-Fuller test

Variables	χ^2	p-value
lnmarkgint	695.3255	0.0000
lnmangint	601.1557	0.0000
lnrndint	556.4043	0.0000
lnempee	382.9842	0.0000
lncaptalint	189.0026	0.0288

Ho: Unit root

Table 5: Fit panel-data models using-GLS

lntotsales	Coefficient	z	P>|z|
lnempee	1.1286890	21.88	0.000
lnrndint	0.1660717	3.45	0.283
lnmarkgint	0.4187053	9.56	0.000
lnmangint	0.5156903	7.37	0.001
lncaptalint	-0.0436003	-1.23	0.218

Wald Chi^2 (7) = 724, Log likelihood = 293.5229, Prob>χ^2 = 0.0000

(ar1) to assist our measurement. In Table 5, we show the result of independent variables on firms' performance of Taiwan's IC design industry.

EMPERICAL RESULTS AND DISCUSSION

This study provides a detailed examination of the relationship between firms' resources and capabilities and its performance in Taiwanese IC design industry. Theoretical linkages are made between research in resources-based theory and firms' performance of this industry. By combining the perspective of the resource-based view with the methods of empirical economics, we have outlined an approach for making the resource-based view operational.

R and D resources and capabilities: According to Table 5, the result shows that the R and D resources and capabilities (lnrndint) have a positive coefficient (0.1660717) but it is not significant (p = 0.283>0.05), so they have no effects on firms performance. This result does not support the hypothesis H1.

This result might be these reasons. First, a firm that spends on R and D activities may appear to be obtaining low output at present, although it will obtain higher output in the future. Second, it may occur that some firms have insufficient R and D expenses compared to their competitors, so that such R and D costs may not lead to the expected innovation, which consequently does not improve the firm's market performance. Third, the whole IC design industry maintains R and D expenditure at a high level percentage from 9 to 12% of total revenue. R and D may be engaged in a non-R and D department and some of the R and D expenditure cannot be shown in the financial statement of a firm. Fourth, in general, R and D capability is likely to be more imitable and mobile than marketing capability. Fifth, the association of firm size provide advantage in the conduct of firms' R and D efforts (Cohen, 1995) or their innovative activities. Based on the absence of fully functioning markets for innovation, larger firms may be better at spreading the fixed costs of R and D over a larger sales. They may also be able to exploit economics of scale in the conduct of the R and D activity itself. Sixth, another reason arising from some larger firms in this industry, their R and D brought about a positive shift in the technical frontier, this upward movement of the production frontier caused a loss in efficiency for those small and medium-sized firms that could not utilize the frontier technology in actual production. In those mature industries likes textile and chemical industries, R and D results in catching up with the frontier rather than raising the frontier, because those industries require less innovations than IC design industry.

Marketing resources and capabilities: In Table 5, the result shows that the marketing resources and capabilities (lnmarkgint) have a positive coefficient (0.4187053) and it is significant (p = 0.000<0.05), which means that they have positive effects on firms performance. In other words, this result does support our hypothesis H2.

Krasnikov and Jayachandran (2008) indicated that, in general, marketing capability has a more powerful impact on firms' performances than R and D resources and operations capabilities and the effect of marketing capability on firm's market performance is more significant than on firm's technical efficiency. The superior performance impact of marketing capability underscores its ability to generate tangible benefits, such as effective customer acquisition and retention, by managing customer relationships and being more responsive to customer needs. Furthermore, the knowledge and processes that underpin R and D capability and drive innovations are likely to be more codified than the knowledge that supports marketing capability. Overall, this argument suggests that R and D knowledge and processes are codified and shared to a greater degree than the more tacitly held marketing knowledge and processes.

Operation resources and capabilities: In Table 5, the result shows that the operation resources and capabilities (lnmangint) have a positive coefficient (0.5156903) and it is significant (p = 0.001<0.05), thus they have positive effects on firms performance. This result does support our hypothesis H3.

A set of manager acts rationally with full information, choosing the one likely to maximize profit or present value of the firm (Hart, 1989). Operation resource and capability not only provide the direction for business strategy but

also are the key of business performance and creating advantage and the main source of firm's benefits. In other words, the appropriated business resource allocation and utilization is the key factor that decides the business operation efficiency and profitability. Furthermore, operating performance is considered an important outcome variable by both practitioners and strategy researchers (Bettis, 1981). Overall, operations capability has been described as focusing on efficient delivery of quality products and services, cost and flexibility (Tan Keah *et al*., 2004).

Human resources and management: In Table 5, the result shows that the human resources and management (lnempee) have a positive coefficient (1.128689) and it is significant ($p = 0.000<0.05$). The result tells us that they have positive effects on firms performance. This result does support our hypothesis H4.

Human resources and management are principal mechanisms by which managers integrate the actions of individuals to keep them conformant with the interests of the firm (Goold and Quinn, 1990). Thus, human resources and management has great effects on a firm's performance. Ulrich and Lake (1990) suggested that an organization's human resources may be its most important and enduring assets. Most of Taiwan's IC design firms are small and medium-sized, they have been heavily engaged in manpower development. The ability to innovate and adapt new technology to make product modifications is likely because of the greater creativity and innovativeness of small-firm employees. The percentage of total R and D manpower has risen from one-third in the early stages to over a half in recent years. The average design experience has also increased from 4 to 7 years. Some major IC design companies adopted the strategy of hiring experienced design engineers with solid theoretical background to give up original copy and duplicate manner of technology follower and try to raise its innovative capability (Chang and Tsai, 2002).

Physical capital resources and management: In Table 5, the result shows that the physical capital resources and management (lncaptalint) have a negative coefficient (-0.0436003). As the p-value is not significant ($p = 0.218 >0.05$), they have no effects on firms performance which also means this result does not support our hypothesis H5.

The result concludes that IC design firms purchase a large amount of specialized assets and equipment and they are likely to have a low level of backlog. Barton (1988) and Bettis (1981) have shown that capital expenditures are associated with related diversification. Thus, IC design firms have excess capacity in which such resources are likely to use as technological diversity in order to diversify their products.

CONCLUSIONS AND FUTURE RESEARCHES

Few of earlier researches have discussed the relationship between the firms' resources and capabilities and firms' performance of Taiwan's IC design industry. Present prior research obtained a negative relationship between Taiwan IC design firms' resources and capability and their technical efficiency. In this study, we use more longitudinal data (8 years to three years) to address the source of firms performance, it should have more accurately described the status of Taiwanese IC design industry. Present results showed that R and D resources and capabilities and physical capital resource management both have no effects on firms performance; operation resources and capabilities, marketing resource and capabilities and human resources and management all have positive effects on firms performance. Krasnikov and Jayachandran (2008) reached a similar results, he indicated that capabilities enable firms to reap greater relative advantage in market performance than efficiency performance.

The resource-based view has been offering an importance perspective in explaining the variation of firm performance. The more firm specific and difficult to imitate is a resource, the more likely a company is to have a distinctive competency. As a result, previous researches in this stream argue that firms should give more efforts to its resources than to its competitive environment. Given the importance of the interplay with market forces, the resource-based perspective further posits that all firms must engage in exchange with their environment to obtain resources and to neutralize threats and to secure competitive advantages. What a firm wants is to create a status where its own resource position directly or indirectly makes it more difficult for others to catch up. Furthermore, a company may have firm-specific and valuable resources, but unless it has the capability to use those resources effectively, it may not be able to create a distinctive competency.

Most of Taiwan's IC design firms are small and medium-sized firms, they are characterized as resource-constrained when comparison is made to large-sized firms. Facing the shortage of resources, small and medium-sized firms should cooperate with external partners in order to ensure their competency. According to the statistic from IEK (2005) 59% of total production values in Taiwan's IC design industry were contributed by top ten companies and 41% were allocated to the remaining of more than

200 IC design firms. Obviously, besides facing the competition with large size firms, small and medium-sized firms should deliberate about how to properly ally with strategic partners.

A firm's innovation projects should align with its resources and capabilities, leveraging its core competencies and helping it achieve its strategic intent. Once, the strategic intent has been articulated, the firms should be able to identify the resources and capabilities required to close the gap between the strategic intent and the current position. Furthermore, a firm's new product development process should maximum the likelihood of projects being both technically and commercially successful. To achieve these goals, Taiwan's IC design firms need (a) an in-depth understanding of the dynamics of innovation of products, (b) a well-crafted technology acquisition strategy, including internal and external acquisitions and (c) a well-design product exploitation strategy to match the market needs.

Resource and capability not only provide the direction for business strategy, but also are the key of business performance and creating advantage and the main source of firm's benefits (Collis and Montgomery, 1995). In other words, the appropriated firm resources acquisition, allocation and utilization is the key factor that decides the firm operation efficiency and profitability. Because resources and capabilities play a dominant role in achieving a sustainable competitive advantage, managers would be expected to design strategy to leverage firm's resources and capabilities.

The firm resources factors considered here aren't exhaustive in explaining firm's performances. There may other factors that may affect firms' performances, but the availability of data limited the scope of this study. Further examination should consider the difference of firm size within the industry, to find out their variance on IC design firms' performances. This, will provide the more information for firms and managers to promote resources and capabilities tailored and firm strategies in this industry. Nevertheless, examinations of the effects between the relationship of technology acquisition strategies and technology exploitation strategies and IC design firms' performances would be an interesting issue for future research.

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