Technology Entrepreneurial Styles: A Comparison of UMC and TSMC

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Abstract—Technology entrepreneurship concerns the ways in which entrepreneurs draw on resources and structures to exploit emerging technology opportunities. Based on this concept, this paper examines and compares technology entrepreneurial styles of two leading Taiwanese semiconductor firms, UMC and TSMC. We show that the two firms' technology entrepreneurship originated and developed in distinctive ways: UMC became oriented toward agility in organizational networks and in business diversification, while TSMC became oriented toward stability in self-dependent development and in business focus. We explain these differences in behavior by referring to the distinctive backgrounds of the firms' entrepreneurs. Implications for theory and practice are discussed.

Keywords—Technology entrepreneurship; UMC; TSMC

I. INTRODUCTION

In recent years, there has emerged a growing body of research on the influence of entrepreneurship on a firm's growth (e.g., [1], [2], [3]), especially the impact of technology entrepreneurship on high-tech industries (e.g., [4], [5]). According to Garud and Karnoe [1: 277], “technology entrepreneurship is a larger process that builds upon the efforts of many. Skills and resources required to take an idea from its inception to commercial use have to be mobilized by drawing upon the generative impulses of actors from multiple domains”. Indeed, technology entrepreneurship probes the relationship between entrepreneurship and technological innovation, and examines how entrepreneurs explore and exploit organizational resources and technological systems by crafting strategies to pursue opportunities in a process of technology development [6].

In this article, we further argue that firms' technology entrepreneurial styles may be determined by the personal and professional backgrounds of entrepreneurs, including work experience, growth context, education, family, and achievement motivation. The technology entrepreneurial styles in turn lead to the individual entrepreneurial behavior and entrepreneurial activity of high-tech firms. In addition, the process of undertaking entrepreneurial behavior and entrepreneurial activity may need some endeavors in the area of organizational function, e.g., human resource policy or organizational design.

Considering human resources, the effective management of human resources can address the demands of survival [7], [8], stabilization [9], and facilitate entrepreneurial processes [10], [11] for start-up firms. Entrepreneurial ventures can thus draw on the appropriate strategic human resources to devote themselves to entrepreneurial behaviors and activities pursuing entrepreneurial success. On the other hand, organizational design may be another impulse for entrepreneurial behaviors and activities. Specifically, because of the heterogeneous characteristics of organizational designs, e.g., functional structure for efficiency/specialization [12], matrix structure for flexibility [12], and network structure for flexibility/decentralized/interfial ties [13], [14], [15], firms can reach their entrepreneurial goals for particular needs. Empirically, this research is based on an in-depth, inductive comparative case study [24], [25] of the historical involvement of UMC (United Microelectronics Corporation) and TSMC (Taiwan Semiconductor Manufacturing Company) in the semiconductor industry. These firms, the world's top two wafer-fountry companies, are the most reputable representatives of firms that developed from latecomers into globally competitive companies. For data collection, in addition to the deep insights from one of authors who has more than 10 years of work experience and practical observations in the semiconductor industry, we collect important information from the companies' websites, related books, interviewees, and Internet search engines. The research procedure suggested by Glaser and Strauss [26] is adopted, which includes data collection, data analysis and conceptualization in an iterative fashion.

II. TECHNOLOGY ENTREPRENEURSHIP OF UMC AND TSMC

A brief comparison of UMC and TSMC is summarized in Table 1.

Table 1: A comparison of UMC and TSMC

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<th>Entrepreneurial Behavior</th>
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A. Origin of the entrepreneurial style of UMC

The unique entrepreneurial style of UMC, agility, can be ascribed to Robert Tsoo's background including growth context, education, work experience, and achievement motivation. First, Tsoo's growth context may have built his character to become agile. As a student in high school, he left home from Taichung to Taipei in...
Taiwan and rented an iron-sheet house in which he lived with people from various levels, e.g., carters and taxi drivers. This sophisticated environment cultivated his diversified experiences and life philosophy, which in turn trained him to be tougher and nimbler in face of rapid environmental changes.

Second, Robert Tsao holds a BS in Electrical Engineering from the National Taiwan University, and an MS in Management Science from the National Chiao Tung University (NCTU). Tsao's educational background in Management Science to a certain extent established his knowledge in leveraging strategies to acquire resources and creating more entrepreneurial opportunities, which in turn in a way facilitated his agile entrepreneurial style.

Third, he has served as Chairman of UMC since 1991, after joining as Vice-President of Engineering in 1980. Before UMC, he served as Deputy Director of ERSO. In the RCA-training period, he developed his semiconductor specialty in process technology. Over the period of ERSO and RCA-training, he met key entrepreneurial partners mastering in marketing (John Hsuan), IC design (Ming-Kai Tsai), and factory management (Ing-Dar Liu), and recruited them to become top managers in UMC. Underlying this important human resource of TMT, UMC thus was able simultaneously and agilely to manage both parts of design and of manufacture in the semiconductor value chain.

Finally, his achievement motivation led him to recognize that the most important, and seemingly only, business goal for survival in Taiwan's industrial competitive environment is competition. As the former Director of ERSO, Ding-Hua Hu, said to Tsao: "Losers are always in the wrong" when Tsao decided to start UMC in 1980. Such agility, therefore, is considered an imperative factor for UMC. Tsao's background formed the UMC's entrepreneurial style of agility, which in turn prompted UMC's entrepreneurial behaviors: (1) agility in organizational networks, and (2) agility in business diversification.

(1) Agility in organizational networks

Because of the common entrepreneurial belief of entrepreneur and TMT in requiring the resource through external organizational networks, e.g., joint venture, strategic alliance, and M&A, UMC thus effectively facilitates the exploitation of identified opportunities in product and technology development and capacity expansion. Specifically, UMC adopted the concept of vertical disintegration to outsource its packaging in order to expand its telephone IC market share in 1982, and it initiated a series of overseas product development contracts and alliances to strengthen its product design capability in the 1980s. In supporting corporate transformation from IDM to pure-play foundry in 1995, UMC initiated three joint ventures with its customers. It was able to use operating and financial leverage to acquire the huge capital expenditure needed for building new fabs and at the same time to secure the business from its partners.

UMC has proved to be adept at acquisitions. It bought the money-losing semiconductor business of Nippon Steel Corporation in 1998 and transformed it to a successful enterprise. That gave it a beachhead in Japan, something that TSMC lacks. As compared to the competitive advantage of TSMC, UMC thus was able simultaneously and agilely to manage both parts of design and of manufacture in the semiconductor value chain.

(2) Agility in business diversification

UMC's entrepreneurial style triggers the recruitment of the top management team (TMT) with various professional backgrounds from Tsao's local colleagues in the early start-up stage, contributing to agility in business diversification in UMC. When entering the growth stage, UMC used an organizational design with a matrix structure, crossed by regional business groups and functional departments, to pursue the goal of success in flexibility in the face of environmental change. In addition, in terms of the UMC conglomerate, it adopted an organizational design with a network structure to help advance agile business diversification. UMC is building a diversified electronics conglomerate in the semiconductor value chain. Tsao's aim is to achieve world-class standing in each sector. In UMC's conglomerate of network structure, the existing businesses mainly include design houses and foundry providers. These subsidiaries hold partnership relationships in a semiconductor value chain. In addition, UMC stabilizes the standing of its subsidiaries through interlocking holdings. For example, UMC shifted the base of computer and communication-product business departments into the USA and set up two design companies, ITE and Davicom, in 1996. In 1997, UMC spun off its commerce, memory, and multimedia product business departments, and established the three design houses of Novatek, AMIC, and MediaTek. Thus, UMC became a pure foundry provider.

B. Origin of the entrepreneurial style of TSMC

The unique entrepreneurial style of TSMC, stability, can be ascribed to Chang's background pertaining to growth context, education, work experience, and achievement motivation. First, as to Chang's growth context, Morris Chang was born to a traditional Chinese family. His grandfather chose his Chinese name according
to the famed Chinese book *The Analects of Confucius*: "I daily examine myself on three points: whether, in transacting business for others, I may have been not faithful; whether, in intercourse with friends, I may have been not sincere; whether I may have not mastered and practiced the instructions of my teacher". The first point in this sentence extended in meaning to Chang's Chinese name. His father impressed on him the implication of the allusive name. To a certain extent, Chang thus formed his character of faithfulness and stability as a result of his meaningful name.

Second, Morris Chang obtained his bachelor's and master's degrees from MIT in 1952 and 1953 respectively. During his career at Texas Instruments (TI), he pursued doctoral studies in electrical engineering at Stanford University, obtaining his doctorate in 1964. To a certain extent, the interplay between excellent education and work experience established his professional knowledge in the semiconductor industry and contributed to the creation of the focused business model of pure foundry.

Third, Chang's career at TI spanned more than 25 years, including a two-and-a-half-year TI fellowship. Integrity, one of the most important TI's business cultures, was in concert with Chang's belief. He managed the largest semiconductor operation in the world as a group vice-president of the Semiconductor Group in 1972. Under Morris Chang's stewardship, TI's calculator ICs fueled much of the explosive growth of the pocket calculator market in the 1970s. His achievements reached beyond the semiconductor field to the end-user when he was in charge of consumer products from 1978 to 1980. He resigned from TI in October 1983 and joined General Instruments (GI) as president and chief operating officer in February 1984. One year later, he resigned from GI because his entrepreneurial aspiration conflicted with the president's belief of acquisition. His work experience in the USA formed and ascertained Chang's faith in stability rather than agile acquisition.

Finally, regarding Chang's achievement motivation, the Taiwan government, in the 1980s, impressed Chang with their patriotism in actively working to advance the national economy. This profoundly triggered his affection for and confidence in Taiwan. Therefore, he insisted on his entrepreneurial ideal and committed himself to the Taiwan government to establish a worldwide leading semiconductor company. Underlying this achievement motivation, TSMC always urged an entrepreneurial style of stability to sustain stable growth of TSMC. Chang's background led to the unique entrepreneurial style of TSMC, stability, which in turn triggered TSMC's entrepreneurial behaviors: (1) stability in self-dependent development, and (2) stability in business focus.

(1) Stability in self-dependent development

Initially, TSMC acquired its process technology and manufacturing capability from ERSO. Then, TSMC adopted an organizational design with a functional structure, which enables managers of each department to concentrate on and specialize in an individual department, and thereby the business benefited from attaining the growth goal of stability in semiconductor process technology development and manufacturing capability. Under this organizational design, the R&D department of TSMC has devoted significant engineering resources and R&D investment in process technology development to catch up with the world's leading IDM companies. Through continuous efforts in recruiting both young graduates worldwide and experienced talent, TSMC has been able to develop advanced process technologies independently because of accumulated technical knowledge and competence. In addition, to reinforce the capability of self-dependent development, in 1998 TSMC recruited Dr Shang-yi Chiang, a talented and experienced R&D manager, from Hewlett-Packard. To date, Chiang has served as R&D manager for six years. He contributed to the advance of TSMC's process technologies from two years behind ITRS to one year ahead of ITRS. He also enabled TSMC to become the first worldwide 12-inch foundry to produce wafers.

On the other hand, in manufacturing capability, the e-commerce department of TSMC has built up infrastructures (the eFoundry platform) to pursue manufacturing excellence and quality delivery. Through a series of quality certifications, as well as IDM qualification procedures, TSMC has established its good reputation. TSMC's wafer capacity expansion was mainly self-funded before the first joint venture of WaferTech, with the purpose of enhancing its services in North America.

Based on a functional organizational structure, TSMC accelerated its wafer capacity expansion to ensure that the competitive advantage of economies of scale, and its self-dependence and accumulated competence in advanced process technology development, and its manufacturing excellence, won the respect of IDMs and outsourcing orders. In other words, the entrepreneurial characteristic of TSMC, stability, is demonstrated in its entrepreneurial behavior of self-dependent development.

(2) Stability in business focus

When it was launched in 1987, TSMC set the IC foundry as its core business. Corporate development activities have been focused on establishing its global leading position in the semiconductor foundry industry. Then, few in the industry believed that a pure-play silicon foundry would be successful because nearly all chip companies considered wafer processing to be a critical core competency. To become an international pure foundry company, Chang has loaded TSMC's ranks with American-trained managers such as Britt Brooks, Doug Chance (the successive general managers of TSMC), and other international professional managers. Among the managers, most of them are Chang's former colleagues of TI. Chang considered that the managers from international businesses are adept in establishing institutions that would benefit TSMC in the start-up stage. Underlying the American-trained managers, TSMC thus
was able to build up an international-level company to focus on the pure foundry business, turning this corporate focus into a competitive advantage. Moreover, TSMC's re-positioning as eFoundry indicated its migration from being a production-oriented manufacturer to a foundry-centric total customer-service provider. The strategy of focus, combining its strong corporate culture and persistent execution ability, won the confidence of customers and led to TSMC's steady growth.

III. DISCUSSION AND CONCLUSIONS

The idiosyncratic technology entrepreneurship led the two firms to sustain their cutting-edge positions in the semiconductor industry. Through the comparative case study of UMC and TSMC, we find that the technological entrepreneurial style is affected by its entrepreneur's background, which is parallel to the literatures on entrepreneurs (e.g., [27], [28]). For instance, Kisfalvi [28] argued that entrepreneurs' characters are determined by his/her life issues. In addition, Dodd [27] describes entrepreneurship as passion, "the relationship between the entrepreneurs and their businesses was one of romance, love, and passion".

Additionally, we find that the agile entrepreneurial style of UMC facilitates its entrepreneurial behavior in effective utilization of organizational networks and of diversification. On the other hand, UMC's organizational functions, e.g., local entrepreneurial human resource and organizational designs of matrix and network structures, also play important roles in prompting its entrepreneurial behaviors and entrepreneurial activities. This is because local entrepreneurial human resources and matrix and network structures with flexibility in the use of the specialized disintegration of value chain are consistent with UMC's needs in creating entrepreneurial growth with agility.

In contrast, TSMC's entrepreneurial style of stability contributes to its entrepreneurial behavior in self-dependent development and business focus. TSMC's organizational functions, e.g., international entrepreneurial human resources and organizational design of functional structure, act upon its entrepreneurial behaviors and entrepreneurial activities. The international entrepreneurial human resources and functional structure, combined with efficiency and specialization, coincide with TSMC's needs in pursuing entrepreneurial growth with stability and focus.

Technology entrepreneurship of high-tech ventures can also be regarded as a business venturing behavior characterized by continual risk-taking (e.g. [29], [30]) and opportunity-identifying (e.g., [6]). For instance, on the basis of various identified opportunities, UMC took the risk to enter the IC wafer fab in Taiwan in 1980, to initiate three joint-venture wafer foundry companies with Chinese-founded IC firms in the USA in 1995, and even to merge five semiconductor wafer foundry units, UMC, USIC, UICC, and UTEK, in 1999. Likewise, TSMC took the risk of pioneering an entirely new business model in 1987, to insist on recruiting international professional managers disregarding the disfavor of local employees in the start-up stages, and even different from its conventional business style, to merge with WSMC and TI-Acer in 1999 to expand foundry capacity.

We suggest that, as high-tech firms evaluate if they have adequate capability for self-dependent development, they should refer to TSMC's practice of technology entrepreneurship. That is, high-tech firms could steadily focus on a specific business to establish and consolidate their professional positions. As Van Horn and Harvey [31] argued, the success of an entrepreneurial venture is strongly influenced by the development and utilization of business core competence. On the other hand, when firms consider it is essential to acquire resources for responding to opportunities emerging from a technology development process in a limited time, UMC's practice of technology entrepreneurship can be a good example. Entrepreneurial ventures can demonstrate agility in using various organizational networks, including strategic alliances, joint ventures, licensing arrangements, and joint R&D development, to speedily obtain the necessary technology and resources for value creation of firms (e.g., [32], [33], [34], [35]).

This paper sheds light on how an entrepreneur's background can impact upon the technological entrepreneurial style in several respects, e.g., behavior and activity of technology entrepreneurship, even entrepreneurial human resources, and organizational design, which can contribute to the creation of entrepreneurial rents in entrepreneurial endeavors. Furthermore, the success of UMC and TSMC demonstrated to other entrepreneurs that Taiwan, as a technological latecomer, still had opportunities to overcome the barriers to entry and to catch up with the new technology frontiers.

REFERENCES


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