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1. Introduction

Firms are increasingly required to be accountable to their stakeholders from the perspective of corporate social responsibility (Bowen, Bansal, and Slawinski, 2018). Facing ambidexterity such as balancing exploitation for economy and exploration for environment has been becoming a business challenge to the future growth of firms (O'Reilly and Tushman, 2016). Ambidexterity refers to the ability to manage the trade-off between exploitation and exploration to excel at both simultaneously (Aoki and Wilhelm, 2017; Andriopoulos and Lewis, 2009). For instance, few energy firms are willing to take the risk of ambidextrous management, between fossil fuels and carbon neutral, where they fully understand the social significance of the carbon neutral project but struggle to balance a profitable business for fossil fuels with a technologically uncertain business for carbon neutral which furthermore cannibalizes the existing profitable business (Nikkei, 2021).

There has been a considerable interest in studying organizational innovation about a spin-off from its incumbent firm to address this dilemmatic issue (e.g., Bower and Christensen, 1995). Most studies have been conducted at firm level about managing structural ambidexterity between a spin-off and its incumbent firm (e.g., Benner and Tushman, 2003; March, 1991). Structural ambidexterity is a method to simultaneously pursue exploitation and exploration by physically separating organization units (Aoki and Wilhelm, 2017; Benner and Tushman, 2003), for instance a nascent spin-off firm pursuing innovation and a large incumbent firm striving for efficiency. However, there remains a lack of conceptually validated understanding about structural ambidexterity through industry level approach. Then, I arrive at the following research question: "Why and how can structural ambidexterity at industry level occur in a nascent and socially responsible industry?"

Using a case study methodology (Eisenhardt, 1989; Yin, 2018), I examine an industry business case—a hydrogen station industry in Japan (METI, 2018)—in which I can trace the formation process of structural ambidexterity at industry level.

2. Theoretical background

2.1 Structural ambidexterity

The literature has shown that there are four necessary conditions to explain the mechanism by which structural ambidexterity can be established at firm level. First, the units of exploitation and exploration should be structurally separated within a firm so that the explorative unit can secure its autonomy and avoid potentially harmful spillovers from the exploitative unit (e.g., O'Reilly and Tushman 2016). Second, the units of exploitation and exploration should be strategically integrated so that both exploitative and explorative units can complement each other for the firm's strategic resources and its common visions (e.g., O'Reilly and Tushman 2013, Ossenbrink, Hoppmann and Hoffmann 2019). Third, frontline managers and employees in units should dedicatedly specialize in either exploitation or exploration (Grupa, Smith and Shalley, 2006). Fourth, firm's leaders are responsible for a contradictory structural linking mechanism between exploitation and exploration to simultaneously manage the tensions and leverage shared resources under a common strategic vision and an overarching set of values (Ossenbrink, Hoppmann and Hoffmann 2019). Smith and Tushman (2005) noted the integrative mechanism for leaders to successfully manage the organizational tensions arising from structural ambidexterity.

2.2 Structural ambidexterity across organizations

There has been an increasing amount of research about structural ambidexterity across organizations to balance exploitation and exploration by utilizing external resources through strategic alliances, joint ventures and buyer-supplier relationships (e.g., Aoki and Wilhelm 2017, Koza and Lewin, 1998, Russo and Vurro, 2010). As well as mechanisms at firm level, prior studies show that it can be

empirically effective for a firm to structurally separate and strategically integrate between exploitation and exploration businesses at structural ambidexterity across organizations under the leaders' management and initiatives (e.g., Lavie, Kang, and Rosenkopf, 2011). However, there are few conceptual or empirical studies about structural ambidexterity through industry level approach in order to help to solve social issues which are common challenges to industries such as climate change.

It is true that seemingly similar but different studies from structural ambidexterity at industry level have been conducted in the semiconductor industries of Japan and the U.S., where the government and industry sectors cooperated to establish a time-limited industrial collective organization to mitigate the technology uncertain risks for a new product development, respectively (Browning, Beyer and Shetler. 1995, Sakakibara 1981). However, these studies are about industrial technology cooperation for an advanced product development, not about the industrial market cooperation for its expansion while being aware of incumbent exploitative market. Based on these research background, it is worthwhile to study the case of structural ambidexterity at industry level where each incumbent firm collaboratively creates a collective enterprise with a dedicated mission at a nascent market stage by simultaneously separating its respective exploration unit while independently managing its incumbent exploitation business.

3. Research Methodology

I use a case study approach which focuses on the Japanese hydrogen station industry for explanation building about structural ambidexterity at industry level. The purpose of this study is to develop a theoretical explanation. Rationales for a single case study as theoretical sampling are a critical, unusual, revelatory, longitudinal case and opportunities for unusual research access (Eisenhardt and Graebner, 2007; Yin, 2018). For triangulation of data and evidence, I use the following four sources: 1) Documentation, 2) Archival records, 3) Direct and participant observation and 4) Interview data (Table1). As a middle manager in the industry, I have had opportunities for unusual research access to observe many phenomena since the industry was incubated in 2000, and can complement industry insights to documentation and archival records with caring about potential biases. A series of tentative explanatory propositions are derived from my observations and review of existing literature. Then I will compare my collected data against the explanatory propositions, revise the earlier propositions and repeat these partly deductive and partly inductive processes (Christensen, 2006; Eisenhardt, 1989; Yin, 2018) until the propositions fit the data and evidence.

4. Research setting¹

The Japanese hydrogen station industry has unique characteristics. 1) Hydrogen energy contributes to socially responsible businesses for carbon reduction. 2) The industry is nascent compared to the incumbent giant gas station industry. 3) The industry has a 20-year history of public-private collaborative efforts for its development. The industry seemed to have successfully launched the commercialization of hydrogen stations in 2014 for supplying hydrogen to fuel cell vehicles which drive by hydrogen fuels. However, it faced severe difficulties within a few years due to the future market uncertainties and lack of resources for further building up the hydrogen station network nationwide. Consequently, the annual number of hydrogen station construction dramatically reduced from 32 in 2015 to 6 in 2017. To overcome these difficulties, in 2018 after two-year intensive negotiations including approval process from Japan Fair Trade Commission, the industry and government successfully started a collective enterprise under structural ambidexterity at industry level where hydrogen station business was spun off from eleven incumbent firms.

5. Initial findings for theoretical models with tentative explanatory propositions

Based on my observations of phenomena at the industry and my review of existing literature, I propose a process model (Figure 1) which can explain the evolution of structural ambidexterity from firm level to industry level. Furthermore, I present a theoretical model (Figure 2) with following tentative explanatory propositions for structural ambidexterity at industry level and will link them to the supporting empirical evidence in the analysis stage (Eisenhardt and Graebner, 2007). In parallel, I will confirm that my collected data including expected interview data do not support the rival explanations.

Organizational factor

As discussed in the previous theoretical background section, when the issues such as the trade-off of resource allocation and conflicts of organizational routines are not resolved within a firm, the firm is

¹ Unless otherwise noted, the material in this section is drawn from Komiyama (2020)

likely to consider structural ambidexterity across organizations to seek new opportunities. Furthermore, when it has become clear that no single explorative unit could survive through structural ambidexterity across organizations, the firms are likely to collectively consider to survive through structural ambidexterity at industry level by establishing a collective enterprise for a dominant market with the intervention of the government. These considerations suggest the following tentative proposition:

P1: Severe resource constraints between exploitation and exploration at firm level are likely to motivate firms to shift from structural ambidexterity at firm level to that at industry level by creating a collective enterprise.

Environmental factor

Scholars have examined the environmental factors which need to be scaled up can trigger firms to take collective action (Bowen et al., 2018; Lee, Struben, and Bingham; 2017). Lee et al. (2017) argued that collective action is required to scale up in a nascent market where there is a high degree of uncertainty in both supply and demand. Furthermore, there is a research case in which local firms collectively shared their technologies to tackle with environmental issues such as water and air quality, which are common resources in the region to continue their incumbent business (Bowen et al., 2018). These considerations suggest the following tentative proposition.

P2: Corporate social responsibility, when necessary for a scale-up to achieve the industry target, is likely to motivate firms to establish a collective enterprise at industry level among exploration units of each firm.

Moderators

The strategic occurrence of a collective enterprise for a dominant market is anomalous globally under anti-trust policy, and the studies on how government intervention has moderated the occurrence are very limited. Prior studies suggested three common points for the government-industry successful cooperation (Spencer, Murtha, and Lenway, 2005; Browning, Beyer, and Shetler, 1995; Browning and Shetler; 2000): 1) the government promises long-term financial support as the mission-oriented program is related to the government's responsibilities, 2) legislative support is available for the establishment and operation of the collective organization, 3) the government and industry share a common roadmap. These considerations suggest the following tentative proposition.

P3: Government intervention in structural ambidexterity at industry level with long-term commitment can facilitate the creation and subsequent operation of a collective enterprise for a dominant market.

I propose that co-opetition capability of each firm at the industry can be an important moderator for firms to collectively take cooperative action and form a collective enterprise for a dominant market. I adopt the definition of co-opetition capability, which Bengtsson, Raza-Ullah and Vanyushyn (2016) defined as two types features of the firm: 1) ability to think paradoxically and 2) ability to attain and maintain moderate tension. These considerations suggest the following tentative proposition.

P4: Co-opetition capabilities of each firm, accumulated within the industry over the long term, can facilitate the creation and subsequent operation of a collective enterprise under structural ambidexterity at industry level.

Internal dynamics

After launching a new industry organization in the exploratory business, the autonomy of the organization (e.g., Christensen, 1997), the strategic integration with the incumbent firms for reliable and stable access to the resources are necessary for the survival of the organization (e.g., Ansari, Garud, and Kumaraswamy, 2016; O'Reilly and Tushman, 2016). These considerations suggest the following tentative proposition.

P5: A collective enterprise for exploratory business is motivated to initiate the stable organizational interface design with the incumbent firms pursuing exploitative business.

6. Expected contributions

6.1 Theoretical contributions

This study theoretically contributes to the literature in three ways. First, this research develops an evolving process model to explain why structural ambidexterity at firm level has been evolving to that at industry level (Figure 1). Second, this study will provide interdisciplinary theoretical explanations about the mechanism by which explorative business of each firm in a nascent and socially responsible market spins off from its incumbent exploitative business to establish structural ambidexterity at industry level through a collective enterprise. Third, this research will develop theoretical propositions to explain how structural ambidexterity at industry level is formed based on identified factors and moderators.

6.2 Practical contributions

In grand challenges such as climate change where firms may have to think about going beyond economic principles and legal constraints, there may be occurring more and more phenomena around the world where exploitative competition and explorative cooperation must be contradictorily balanced through structural ambidexterity at industry level. When the government and industry sectors may have to cooperate for grand challenges with a purpose of financially establishing a nascent market for explorative business, the proposed model in this paper may provide a practical implication about organizational formation mechanism of structural ambidexterity at industry level by extending these theoretical explanations to new phenomena in a nascent and socially responsible industry.

Table 1 Data sources

	Data Sources	Qualitative Data
Documentation	Government issued report	<ul style="list-style-type: none"> • Strategic Energy Plan (185 pages) • Basic hydrogen strategy (35 pages) • Strategic Roadmap for Hydrogen and Fuel Cells (180 pages) • Hydrogen & Fuel Cell Strategy Council handouts & minutes (18 meetings, 2013-2020FY) • Hydrogen & Fuel Cell Strategy Council's Working Group handouts & minutes (7 meetings, 2013-2020FY) • Press-release papers
	Firms' report	<ul style="list-style-type: none"> • Integrated reports • Press-release papers
	Media articles	<ul style="list-style-type: none"> • Newspaper(Nikkei)
Archival records	Industry analysis reports	<ul style="list-style-type: none"> • Industry data & reports
	Research articles	<ul style="list-style-type: none"> • Academic papers
Direct & Participant observation	Author	<ul style="list-style-type: none"> • Contextual data through observation
Interviews	Government/Industry	<ul style="list-style-type: none"> • Review for explanatory findings with personal insights

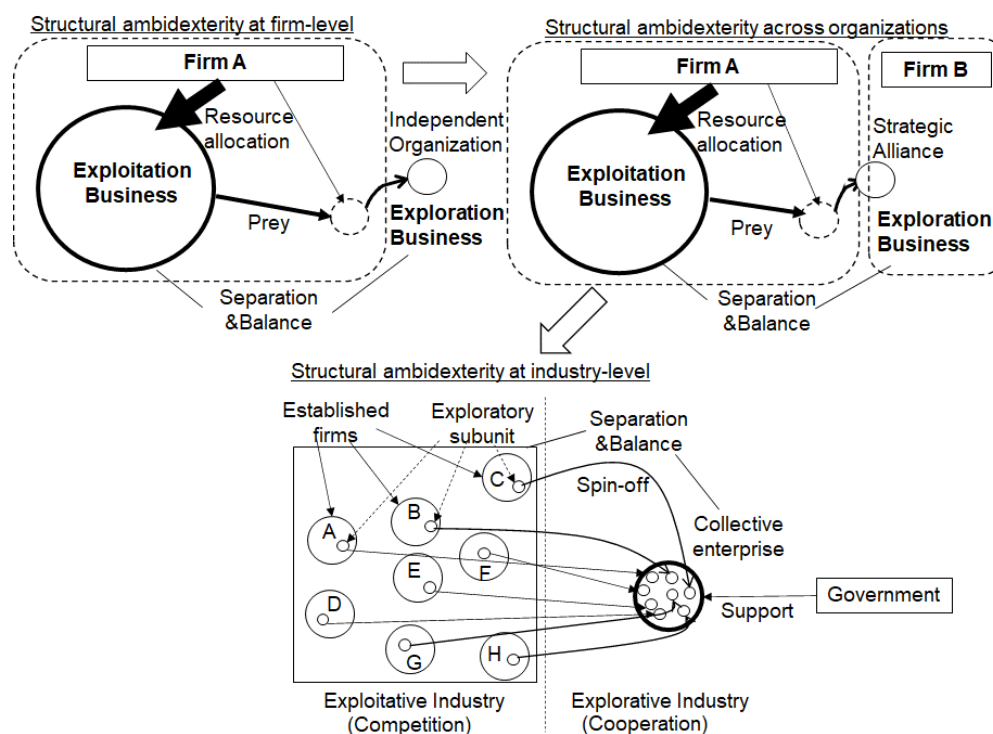


Figure 1 Evolving process model of structural ambidexterity

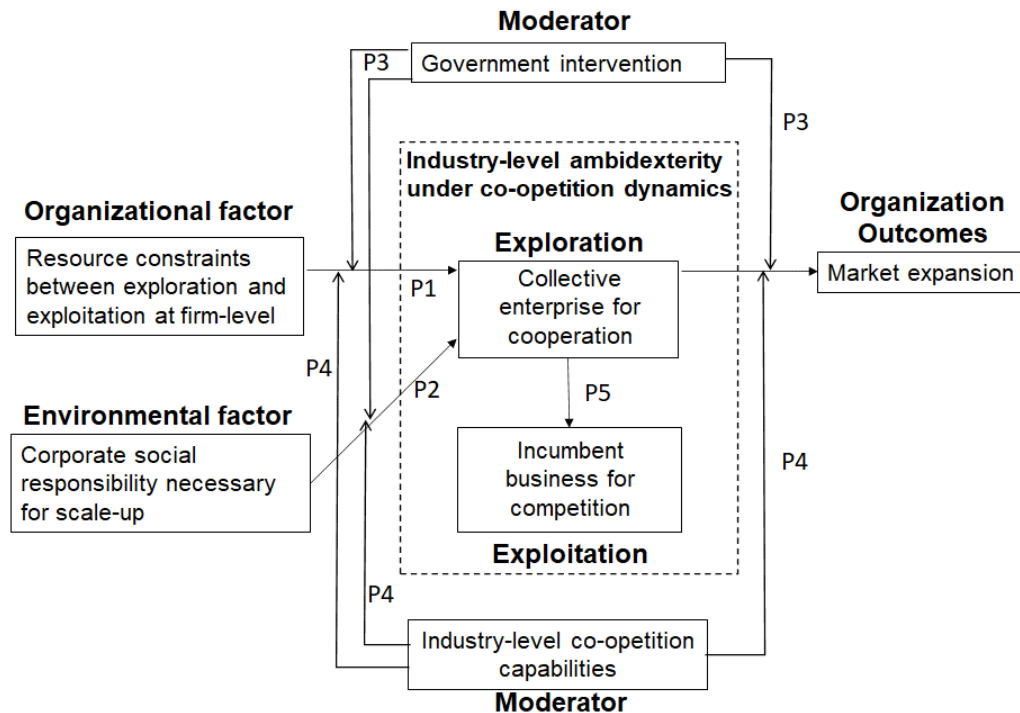


Figure 2 Theoretical model for structural ambidexterity at industry level

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