

Knowledge intensive entrepreneurship and dynamic capabilities in low tech SMEs: Evidence from the Greek food sector

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Abstract

The objective of this paper is to explore the existence of dynamic capabilities in knowledge intensive low tech sector. Building on qualitative data from the food industry, analysis revealed that low tech companies that invest and build their strategy on knowledge intensiveness and innovation, develop relatively strong dynamic capabilities in all three areas (sensing, seizing and reconfiguration) in order to gain competitive advantages on either the market or the technology dimension, usually resulting in niche creation, adding value and surpassing price competition which is rather fierce in the today's globalized ecosystem. The study therefore provides both an empirical contribution to the emerging work on dynamic capabilities penetrating the barriers and proving the existence, role and nature of dynamic capabilities in the low tech sector on the condition of knowledge intensiveness, and by shaping a start for new theory grounding on the existence and role of dynamic capabilities in the area of low technology in general.

Keywords: knowledge intensive entrepreneurship, dynamic capabilities, low tech, food sector, case study

JEL Classification Codes: L26 - Entrepreneurship
L66 - Food; Beverages; Cosmetics; Tobacco; Wine and Spirits

Introduction

During the last ten years at least, a significant number of firms in traditionally named low tech sector enclose a dynamic approach of knowledge in order to flourish in mature, saturated and vulnerable markets. Entrepreneurs start new knowledge intensive business, transcending traditional limits and develop competitive advantages on knowledge - combination bases, which are encountered as vital for the company survival.

The recent focus on capabilities in entrepreneurship in general has allowed researchers to unfold abilities necessary for effective entrepreneurial activities and has added and constantly adds to a deeper understanding of the entrepreneurial processes.

Therefore, exploring KIE in Traditionally Low Tech (TLT) sector in terms of knowledge - based competitive advantages that provide the company's successful evolution is a matter of strategy. It further assists the general effort to understand the creation of enterprise-level competitive advantage at the undertaking creation stage and later during the company's lifespan.

This is one of the first attempts to explore dynamic capabilities in low tech sector SMEs. The contribution to relevant research is significant taking into account the increased importance of KIE in TLT sectors due to the central role of knowledge in innovative activities in the last decades (Foray, 2004). The results are important and promising both in terms of future research in many research fields including strategic management, entrepreneurship, innovation and knowledge management, as well as of entrepreneurial and managerial aids in order to shape new entrepreneurial courses in today's complex business environments.

Low Tech Sectors

In innovation research, the term 'low-technology' refers to those industrial sectors that have no or low R&D expenditures. The basis of this categorization is the R&D intensity indicator which measures the ratio of the R&D expenditure to the turnover of a company or to the output value of a sector. Sectors with an R&D intensity of more than 5% are characterized as 'high-tech', between 3 and 0.9% as 'medium-tech' and those below 0.9% as 'low-tech' (OECD, 2002).

TLT enterprises are often regarded as somewhat old-fashioned. Although their products and production processes may be highly complex and capital intensive, in comparison to high-tech industries, their markets are generally mature, slow-growing and subject to over-capacity and high levels of price competition. Traditional industries have been seen as more prone to competition from low-wage countries and less aggressive in terms of competition and innovation.

Nevertheless, TLT sectors are central to economic well-being. They dominate the economies of nations, providing more than ninety percent of output in the European Union, the USA and Japan. The TLT sector has on various occasions been the subject of the innovation debate in the past few years and its significance for the technological and socio-economic development was under investigation (e.g. Mendonca and Tunzelmann, 2004; Hirsch-Kreinsen *et al.*, 2005; Smith, 2008). Still, it has been highly neglected in terms of knowledge intensiveness, ways to innovate or strategic competitive advantage development.

Food, paper, textiles and clothing, furniture, plastics and metal products are registered as low tech sectors, in contrast to biotechnology, pharmaceuticals and nanotechnology which belong to high tech sectors.

Greek Food Sector¹

The 'food' sector (manufacturing of food products and beverages) includes processing of the products of agriculture, forestry and fishing into food and drinks for humans and individuals. The food

¹ A review of food sector experts' interviews

industry sector is one of the largest and most important manufacturing sectors in Europe. It is the second largest (after metal) in the manufacturing industry, with 14.5% of total manufacturing turnover (€917bn for the EU-27 in 2008). Europe's food market is made up of about 310.000 companies and 4.8 million employees.

The Food and Drink sector is the most important and most dynamic industrial sector of the Greek Economy. The sector accumulates 25% of the GNP of the industrial sector, thus taking the first place amongst all the industrial sectors. It employs 26% of the total employees in secondary sector and it accumulates 14% of total investments (including investments in trade and services). Nowadays, foodstuffs and wine make up 35% of Greek exports.

A research with in-depth interviews among experts enabled the delineation of the sector's profile. Despite its dynamism, the sector presents a traditional character, dominated by SMEs, dispersed in the whole country and covers all sub-sectors of food processing and fisheries. There are about 22000 companies of food and drink production, revealing a fragmented and mature industry with almost 84% to occupy 0-5 employees half of which are only primary school graduates. There is a 9.7% with 6-10 employees, 5.8% with 11-50, 0.5% with 100-500 and only 18 enterprises with more than 500 employees. About 53% is occupied by seasonal employment in canned fruits and vegetables enterprises.

The great majority of Greek food companies reserve a rather cautious attitude towards the adoption of innovations that prerequisite research for adaptation in their manufacturing procedures, as well as towards the participation in EU's RTD programmes that prerequisite co-operation with research organisations or other similar enterprises. However, this status is beginning to change and an increasing number of enterprises, especially the bigger ones, are interested in carrying out research and implement innovations.

Innovation is "pushed" by consumers either directly in very small companies or through retailers, special sector press and trade shows. Consumers demand quality, safety, health and differentiation. Issues about 'quality and manufacturing' and 'food safety' are seen by far the most important ones in terms of a strategic vision of the sector's companies, suggesting innovation challenges related to technological competition. It is also driven by legislation and needs for production improvements. The trends of innovation in the Greek F&D sector concern mainly organizational innovations, renewing processing lines and equipment, adoption of control technologies in processes and contaminants, development of new products as nutritional improvements, functional genomics and nutraceutical, development of technologies in tracking, tracing and adoption of Information Technologies for food chain management.

All experts agree that competition and legislation are the most important determinants for innovation, while high costs, bureaucracy and time consuming processes hinder it. Greek F&D companies are rather reactive than proactive. They are engaged in some innovative action to solve an important problem, confront a new competitor or react to a legislation or need that can hamper the company's further development. Environment protection, information systems, storing and distribution technologies are some of the most common innovative steps of medium and small companies in the sector.

Knowledge Intensive entrepreneurship in Low Tech sectors

Entrepreneurship has been correctly characterized as one of the most intriguing but equally elusive concepts (Baumol, 1968 in Peneder, 2006). Scholars of entrepreneurship have struggled to create an appropriate conceptual framework for the field (Bruyat and Julien, 2000; Busenitz *et al.*, 2003; Gartner, 2001; Low, 2001; Venkataraman, 1997; all in Ihrig *et al.*, 2006; Shane and Venkataraman, 2000) and have created dozens of definitions of entrepreneurship (e.g. Schumpeter, 1934; Kirzner, 1973; Covin and Slevin, 1991; Zahra and Garvis, 2000; Ireland *et al.*, 2001; Groen, 2005, Henrekson, 2007). In general *entrepreneurship* is defined as a context dependent process, through which individuals and teams create wealth by bringing together unique packages of resources to exploit market place opportunities. The term knowledge-intensive entrepreneurship has been used mainly for technology based firms in high tech sectors and lacks a very clear definition (Autio *et al.*, 2000; Brännback, M., 2003; Burger and Helmchen, 2008; Malerba, 2004, 2010). Furthermore, there is no definition for TLT sectors, while there is still a debate on whether there can exist KIE in low tech sectors.

In 2008, Burger and Helmchen proposed to label "knowledge-based" entrepreneurs those entrepreneurs who meet at least two of the following conditions: (i) creation of a new combination, (ii) creation of new knowledge, (iii) employ knowledge developed originally in science.

Traditional Low Tech (TLT) sectors cannot easily produce extreme novelties based on new, "out of the lab" technology. Thereupon, when a new venture enters the market, it owns to surprise in order to survive and become competitive. Knowledge bases, combinative knowledge and absorptive capacity contribute to the creation of novelties to serve the above precondition. On the other hand, the ability of transcending the sectoral context is crucial for KIE in TLT sectors (Kreinsen and Schwiege, 2010). Knowledge generation in LMT companies can be linked to knowledge beyond internal sources, derived widely from other firms and institutions of relevant or non relevant sectors. As levels of R&D are very low, the use of distributed knowledge is the main source of new ideas and techniques.

Combining the general and rather abstract definitions of KIE with the views on KIE and innovation in TLT sectors insofar, the following definition for the purposes of the present study is developed: Knowledge-intensive entrepreneurship is about cognition, heterogeneous knowledge selection and coordination in order to commercialize novel combinations or re-combinations at areas of products, processes, services or even organizational models and acquire a share in an existing or a new market. Such introductions can change market structures on both local and global levels although we refer to traditional mature sectors.

The Dynamic Capabilities Approach

An essential prerequisite for knowledge-intensive entrepreneurship is the capability of a company or even of an individual entrepreneur to question existing knowledge and to identify and acquire (new) relevant knowledge from other knowledge bases (Kirschen 2010). Papers drawn from Economics of industrial dynamics (e.g. Gans *et al.*, 2002;

Kirzner, 1973 etc) have outlined the importance of innovation. Innovativeness is closely related to KIE as well as the important seed and start up phases of traditional firms.

Kreinsen (2010) referring to conceptual considerations on the innovativeness of low-tech companies (cf. Bender and Laestadius, 2005), states that such reflective competences of firms depend heavily on specific *capabilities*, a term provided by the well-known "resource based approaches" of innovation research. The core finding of this approach is that innovativeness, and therefore also KIE processes, may be analyzed in terms of capabilities for orchestrating and mobilizing knowledge and other resources at the disposal of firms (cf. Teece and Pisano, 1994).

Searching the literature, knowledge intensiveness in LT sectors was heavily questioned though kinds of knowledge and ways of combining existing codified knowledge with practical knowledge in a competitive way (Napolitano, 1991, Pavitt, 1984, Chesbrough, 2006 in Lichtenthaler, 2009, Robertson and Patel, 2007, Hirsch-Kreinsen et al. 2005), PILOT project (2003-2008)) and a clear orientation to process innovation (Heidenreich 2009, Fagerberg, 2005).

Besides the numerous theories over the past two to three decades (e.g. Napolitano, 1991; Henderson and Clark, 1990; Heidenreich, 1996; Zahra and George, 2002; Bender, 2004; Bender and Laestadius, 2005; Barreto, I., 2010; Grimpe and Sofka, 2009), they either not cover the whole spectrum of KIE, ignoring the importance of knowledge intensiveness and do not correspond to LMT sectors or even SMEs. The entrepreneurial phenomenon *per se* is also rather inadequately captured besides the numerous approaches and views. The entrepreneurship literature has been criticized for being too concentrated on the process of launching new business concepts neglecting the strategic element of it (Hitt & Ireland, 2000; Hitt et al., 2003; Boccardelli, 2006).

The dynamic capabilities perspective has received increasing attention in the field of strategic management research, focusing on the competitive advantage that is provided by a certain resource constellation over time to fit changing business environments (Barreto, 2010). Research based on dynamic capabilities, has been used mainly in strategic management, marketing, human resources management, operations management, international management, information management and entrepreneurship (e.g., Arthurs & Busenitz, 2006).

Teece, Pisano and Shuen in their landmark article of 1997 proposed the dynamic capabilities framework which enables organizations to renew competencies and strategically manage the internal and external organizational skills, routines and resources required to maintain performance in the face of changing business conditions. They defined dynamic capabilities as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments." Since then, the dynamic capabilities view has generated an impressive flow of research and dynamic capabilities have been used to explain a series of strategic management phenomena.

After a decade, since Teece et al.'s (Teece, Pisano, & Shuen, 1997) landmark article the ambition of the dynamic capabilities framework is "nothing less than to explain the sources of enterprise-level competitive advantage over time" (Teece, 2007) providing "a panoply of processes and routinesas certain microfoundations for dynamic

capabilities". In this review article of 2007, Teece states "For analytical purposes, dynamic capabilities can be disaggregated into the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets". Following Teece's terminology, sensing capabilities denote the firm's activities in scanning and monitoring changes in operating environments and identifying new opportunities. Seizing capabilities are vital in selecting product and business model designs and architectures, enterprise boundaries and decision protocols. Reconfiguring capabilities are useful in asset 'orchestration', i.e. activities such as the management of complementary assets and knowledge management for future positioning.

There are a rather low number of studies that have investigated the types of firms that benefit from Teece's framework of dynamic capabilities. The framework has been found suitable for multinational companies in international environments (Teece, 2007), large, diversified and multidivisional firms (Zollo and Winter, 2002) while there are quite a few studies referring to the size of companies (Salvato, 2003; Kale & Singh, 2007; Doeving & Gooderham, 2008). Sapienza et al. (2006) assume that SMEs and new ventures need unique and dynamic capabilities in order to survive grow and reap the benefit of their innovation at international level. Furthermore, according to Protogerou et al. (2008), the firm's ability to combine and effectively use different types of knowledge is crucial to its success in innovation activities and performance.

Literature on high tech sector has made relevant suggestions without any empirical or even theoretical grounding. Even the ones that have tried to explore and verify them, stay caged in high tech sectors. Boccardelli and Magnusson (2006) in order to use the dynamic capabilities framework of strategy trying to investigate how firms go about to match their resource bases with opportunities in the marketplace, chose the Swedish mobile Internet industry. Zahra et al (2006) reviewed 19 studies focused on established firms in high technology industries that touched upon capability creation from 1992 to 2002 in the management, strategy and entrepreneurship journals.

The dynamic capabilities framework, till now has been ascribed only to highly dynamic environments and high tech sectors. Dynamic capabilities have been detected and analyzed only in high - technology industries and presuppose a rapid technological change, but ignored the huge importance and potential of LMT industries. Researchers suggested its use to more moderately dynamic environments (Eisenhardt & Martin, 2000) or even stable ones (e.g., Zahra et al., 2006; Zollo & Winter, 2002). Nevertheless they neglected mature industries. There are hardly any studies on the relationship between dynamic capabilities and knowledge intensiveness in low tech sectors. The framework further neglects SMEs which constitute the majority of European firms at all sectors. There is no evidence of the dynamic capabilities' existence and role in low tech companies either in their start up stage or later in their life and the development of their competitive advantages. Moreover, there is little evidence on their role in Knowledge Intensive Entrepreneurship (KIE) and none when KIE refers to low tech sector.

Research Design and Method

The logic of grounded theory was followed in the analysis of a multiple exploratory case study (Yin, 2003) with the individual low-tech company as the unit of analysis. For the purposes of this paper we followed a literal replication strategy (Yin, 2003) by choosing four information-rich cases (Patton, 2002) based on certain criteria: all new products launched by them should be product of knowledge intensiveness. We controlled for the industry context by taking the case companies from the same industry (Rouse and Daellenbach, 1999). Food sector was chosen as one of the most dynamic and representative low tech ones in Greece, where there is a rather significant dispersion regarding company types and sizes, market range and orientation. It has also a significant share of employment and value added for the European manufacturing industry and for the European economy as a whole. Questioning the existence of dynamic capabilities was really quite provocative. Table 1 describes the selected companies.

The firms were chosen among a sectoral database and after sectoral experts' interviews who gave information on the sector at Greek, European and global level as well as about new, knowledge intensive ventures. The goal was to acquire a sample of knowledge intensive ventures covering all Greece, within which would satisfy the following criteria:

- More than three employees
- The company should evidently be a first mover or assigned to the most innovative companies in the market or product field presenting knowledge intensive innovative products.
- The innovation which was implemented by the investigated company could be a new product as well as a new process (technology) which had not been offered to or applied in the (low-tech) industry/product field before.

Our respondents generally offered very detailed responses and provided detailed timelines and histories for their firms. The typical interview lasted 2.5-3 hours, with some lasting much longer. All interviews were taped and transcribed. The founders were all involved in all key aspects of the business and consequently have firsthand knowledge of the firm's founding activities.

Supplementary telephone conversations and reviews of company and public documents, such as administrative documents, reports, news (internet and press) and information from company web sites followed. Multiple data sources were used such as secondary sources (studies and literature, awards), information by different interviewees (entrepreneurs, core team members, experts, suppliers and customers), visits to the plant and a standardized questionnaire on hard facts and data of the cases which helped to receive a chain of evidence and inter-subjective validity for the analysis. Triangulation through the use of multiple data sources, multiple theoretical perspectives, and/or multiple methods (Schwandt, 2001) increases the credibility and validity of the results. The interview and documentation process generated a large volume of transcripts, plus detailed field notes and exploratory codings.

Table 1: Descriptive Summary of Sample

a/a	Legal form	Location	Year of foundation	number of employees	product family	sales structure Nation/Exports	patents trademarks	educational level of entrepreneurs	educated staff
1	Ltd	Korinthos	2003	9	organic, quasi classical pharmaceutical chocolate	93/7	Yes/yes	Master	7
2	SA	Agrinio	1955	180	Parboiled, exotic rice specialities, HO.RE.CA. products	80/20	Yes/yes	University Degree	16
3	SA	Serres	2001	30	Conventional, biological wheat flour and semolina gluten-free wheat flour biofunctional flour and relevant foods	80/20	Yes/yes	University Degree	16
4	Ltd	Kilkis	2006	18	snack crackers snack cheese ups	0/100	Yes/yes	PhD	12

Entrepreneurs of each firm and other senior managers were asked about the story of their venture's creation and history and firm's evolutionary behavior up to the present time; personal and work biographies and views on institutions and policies, as well as future expectations. The second part of the interview focused on the nature of the novel products, the NPD processes and all relevant organizational processes and routines that firms followed.

The data were analyzed the data for each case company using template analysis (King, 2004) in order to identify and categorize the different types of company-level dynamic capabilities. Teece's (2007) classification was used as the initial first-and second-level coding frame that was iteratively modified and supplemented according to data.

Analysis refers to both individual level (entrepreneurs/entrepreneurial teams) and organizational level (processes, routines and networking) in an attempt to capture those capabilities that enable and enact KIE under the aforementioned conditions. It further considers people, ideas and resources as three critical factors of success. However in all instances knowledge is the mediator for all activities.

Findings

All cases are companies which, although belong to low tech food sector, occupy totally knowledge - oriented strategies and all their products or processes within the new millennium are knowledge intensive. They all fulfil Burger and Helmchen's (2008) conditions, since all four create new knowledge and new combinations of knowledge and occasionally employ knowledge originally developed in science. In looking for patterns, one can note that results address usually both final product and relevant technology leading to innovations that change the market's landscape. Some of them can be considered disruptive, as A3's spectacular entrance to biofunctional foods with patents on several products, creating new niche markets such as gluten-free, cheese based crackers (A4) and quasi -pharmaceutical chocolate products (A1) or technology-based patenting innovative technologies for existing products which add to properties and other characteristics (A2).

In order to preserve the anonymity of cases and informants, knowledge intensive activities and resulting innovations will not be described in detail, but will rather focus on the common properties and define a measure on the firm level knowledge intensiveness.

Table 2: Dynamic capabilities of the case firms

CAPABILITIES	A1	A2	A3	A4
Sensing				
Processes to Direct Internal R&D and Select New Technologies.	Contact routines with University Dpts of relevant subject internet - try and error - personal contacts	Routines on selecting knowledge and new technology (long lasting relationships meetings / trial and error (experimenting) -A team headed by one of the entrepreneurs	Establishment of a stable and continuous cooperation with Dpts of Biotechnology formal sources: research projects and a spin off. Company's modern laboratory on pharmaceutical products Regular meetings of executives on development	Technology research, patent searching developed through training, individual studies and efforts, co-operations with clients, suppliers and companies of the sector, trade shows and company visits
Processes to Tap Supplier and Complementor Innovation.	Visits in trade shows, internet	Routines on selecting feedback (long lasting relationships/ meetings / trial and error (experimenting)	Formal and informal linkages to chemical industry and labs, manufacturing companies, cooperation with pharmaceutical companies in marketing, collaboration efforts with other food firms for alternative products	Cooperation on a regular basis with suppliers.
Processes to Tap Developments in Exogenous Science and Technology.	Contacts with experts of University of Volos, TEI of food tech. (Athens) - Univ. of Biotechnology Larissa - internet	Constant cooperation with Universities (NTUA, Thessaly), worldwide leading suppliers, most important international shows (machinery and final products) every year, try and error processes, joint research projects on innovative technologies even with competitors	Besides Univ. of Biotechnology and the spin-off, formal linkages with specialized laboratories for all new products testing, linkages with the medical world especially for the new research projects (e.g. a clinical research on cancer patients in the Diavalkaniko Hospital of Thessaloniki)	Technology literature research, patent searching, research institutes, relevant industry
Processes to Identify Target Market Segments, Customer Needs	Market research all over Greece	Regular market research by company's team. Special market research abroad.	Market research in Greece, monitoring of international trends on biofunctional foods. Focus and research on niche markets (eg patients, athletes)	Target markets identification abroad. Mainly niche markets
Processes to tap competitor and industry innovation	Internet, competitor products monitoring. Contacts with certain Univ. Dpts	Competitors benchmarking, mainly trends monitoring through trade shows, manufacturers, internet and TEI reports	Monitoring of food industry innovation in the biofunctional food section through conferences, papers, new products and international market analyses on such products	
Seizing				
Delineating the Customer Solution and the Business Model	NPD Business plans, selecting additional technology. Revenue architectures on value added due to ingredients but also design, market niche	Continuous technology and product improvement, NPDs and further development through expansions. Designing of Revenue architectures through flexibility, variety of innovative value adding products, etc, customer loyalty and target -customers expansion	Continuous product development (both improvements of existing products and innovative ones), new target groups, while building loyalty and commitment of existing ones. Business plans of the spin off that captures a more innovative and high tech image of the company and of the new lab.	Continuous product/process development and new revenue structures. All new products and processes are directed towards high value products and differentiation.
Selecting Decision-Making Protocol	Rapid decision making based on new products that add know - how (value) and revenues as the focal goal	Rapid and flexible decision making. All managers inform and get informed but usually important decisions are taken by the entrepreneur	Rapid decision making with Entrepreneurs to be the ones to decide. A team with strong ties devoted to the firm of both employees and researchers in most projects. An "open door" policy referring to new ideas collection. Creativity is awarded.	Real time tracking of competitor performance

Selecting Enterprise Boundaries to Manage Complements and "Control" Platforms	Cooperation with TEI Dpts of food technology and Universities	Total verticalization of the production with a parallel product portfolio expansion. An excellent cooperation with manufacturers, suppliers and TEI in order to reach any innovation first.	Cooperation with the Uni. Co-owned spinn-off (R&D in food technology - biotechnology) co-owned reserch lab (forthcoming). New partnerships within food industry, contacts for research with patients.	Innovativeness based on co-operations with R&D institutes and relevant companies
Building Loyalty and Commitment	self evident (family members)	Managers are extremely well paid and awarded even with company shares. There is a family climate and a culture of pioneering	Awards of new ideas, further training, a family culture	Embedded culture of loyalty.
Reconfiguration				
Decentralization and Near Decomposabil.	Works on open innovation and networking.	Decentralized structure at the operational level. Open innovation	Open innovation and networking.	Open innovation.
Knowledge Management	Embedded culture of constant learning and experimenting, while know how is achieved by studying (various knowledge sources) and trials. Research projects with Universities	Training at all levels. Knowledge and informatio diffusion meetings especially on innovation and new technology matters (vision: the first to introduce all novelty in Greece and Balkans). Both executive and employee meetings. Aggressive technology transfer. Processes of connecting customer feedback with the production of new ideas.	Cooperation with the University(developments/ absorptive capacity ranging from a thorough knowledge on subject to the use of biotechnology and food technology through training individual studies and efforts, co-operations with clients and suppliers, a strong research team devoted to the company's vision. Clinical research extended to cancer patients, athletes and other special categories.	Training at all levels. Knowledge and information diffusion meetings especially on innovation and new technology matters. Experimenting

A1 Firm

Dynamic Capabilities

A1 is a family company which owns dynamic capabilities in an informal way due to its small size. Sensing is rather strong partly because the company is relatively new and its initial vision and strategy is niche creation in Greece and Cyprus.

"We target on gaps which no biological products can cover. That calls for much research. It employs science, manufacturing, even marketing..."

A1's seizing capabilities emphasize mostly revenue structures, choosing target groups and working on building confidence and commitment. On the other hand it seems that this capability is very weak in terms of developing internal decision making processes since there are really no difficulties in business models and protocols delineation due to size and type. Reconfiguration appears strong and aggressive.

"The first products opened an entirely new niche market. Biotechnology helps a lot. Since foundation we present 3 to 4 innovative products each year. Knowledge and experimentation becomes more complicated, since new products - especially the last three years - cannibalize the old ones and become more sophisticated"

The firm has embedded a deep culture of constant learning and experimenting, while know how is achieved by studying (various knowledge sources) and trials. Since 2005, they have contacted several research projects.

"It was difficult in the very beginning. We could non contact any department. After our first project and our success, things became easier..."

Knowledge intensiveness

A1 uses a manifold of knowledge, information and opportunities which then is unfolded by further experimenting, trial and error loops, integrating the product concept, packaging, networking with pharmacies (pioneers) and organic shops, and training. There appears a constant hunt for knowledge, improvement on competencies through processes and routines of dynamic capabilities, although there are not captured in written procedures.

Information and knowledge is derived from food technology, plant technology, mechanical engineering, business management, environmental engineering in order to fulfill a vision that leads to risky decisions on novel concepts. It should be mentioned that the company is still unique in Greece. Two of the products aimed at a completely new market (a new niche segment not covered by any of imported relevant products), and the others at partially new customer groups. Future projects aim at more knowledge - intensive sophisticated products.

A2 Firm

Dynamic Capabilities

A2 is one of the largest purely Greek companies in the sector. It has a number of internal stakeholders, all participating in the development processes. It demonstrates a variety of sensing capabilities, such as constant cooperation with Universities (NTUA, Thessaly) and worldwide leading suppliers and manufacturers, organized visits and meetings at the most important international shows (machinery and final products) on a yearly basis, try and error processes, joint research projects on innovative technologies, and actively attendance of international industry seminars. Customer feedback and main competitors' and markets' benchmarking are daily tasks. There are also embedded routines on selecting knowledge, sharing expertise and experiences on new science and technology and regular market research.

"We want to innovate and I think we ought it to people to innovate. We want to be pioneers at least at European level. Of course we watch our competitors worldwide, we collect knowledge, we produce many ideas but most of them stay on the shelf. An idea is not good enough unless it thrills us, unless it makes us say Oh my God. That's unbelievable!"

A2 emphasizes the need of novelty but underlines the importance of clear processes. They have developed internal decision-making protocols, and manage complements and platforms through outsourcing and partnerships. They focus significantly on internal training and knowledge management in order to keep up with their vision. A2 has strong dynamic capabilities in all three areas: Sensing, Seizing and Reconfiguration and a clear direction towards knowledge.

Knowledge intensiveness

The company has developed certain absorptive capacity that ranges from a thorough knowledge on the properties and potential of rice and pulses from the field, to the use of biotechnology and food technology. The capacity was developed through training, individual studies and efforts, co-operations with clients and suppliers and the

build of a strong research team devoted to the company's vision. A2 has developed certain capabilities for networking, collaboration, and effective knowledge transfer and knowledge exploitation.

A2 extends the knowledge in the fields of food technology, chemistry, geonics, pharmaceuticals, mechanical and chemical engineering. The innovation culture nourished and developed in A2 leads to several innovative products, processes, methods and ideas and today they enter the research in the field of biofunctional food products. This research is extended to hyper-enriched food for special groups, biofunctional foods based on γ -rizarol, pharmaceuticals and the chemical industry. This dynamic and creative environment contributes further to the dynamic capabilities of the firm complementing its networking capability and the absorptive capacity.

A3 Firm

Dynamic Capabilities

A3 considers it very important to be in or close to the technology frontier. In order to realize this intention it has established a central R&D unit that supports the technology needs emanating from the entire group. There is an established continuous cooperation with Departments of Biotechnology, 5-year plans on research projects and other technology-development resources on lower levels in the organization monitoring the external developments.

"This company use every effective way of sensing opportunities or areas where knowledge can give birth to opportunities. And this is very difficult in Greece. Very difficult ..." (food expert commenting on A3)

Regular meetings of executives are held on development prospects. A3 has also created linkages with the medical world especially for the new research projects. The company does extensive market research in order to identify new market niches and customer needs and monitoring of food industry innovation in the biofunctional food section through conferences, papers, new products and international market analyses on such products.

Regarding the seizing and reconfiguration area, A3 has a strong capability in crafting new-product and technology architectures. Rapid decision making and an "open door" and a family culture policy with creativity awarded empower new ideas creation.

Reconfiguration is based on open innovation and networking though formal and informal linkages such as cooperation with the University, co-operations with clients and suppliers (e.g. chemical industry and labs), a strong research team devoted to the company's vision. Clinical research extended to cancer patients, athletes and other special categories.

Knowledge intensiveness

A3 uses and extends knowledge in the fields of biotechnology and biochemistry (plant bioactives; dietary fibre, functional starches; functional lipids; molecular nutrition and other relevant aspects of disease prevention and treatment), conventional organic chemistry, general food technology, geonics, mechanical and chemical engineering. Biofunctional foods based on wheat flour constitute a specific knowledge base, in which there are plenty of innovative food

products and process technologies and methods. Technological knowledge is the company's privilege and could not have been developed without the new food technology.

"This company is ahead of the others. They own an uncommon culture in Greece, they like risking; they enjoy investing in knowledge and innovation and be unconventional". (Food expert commenting on A3)

Due to its vision, the company is often required either to develop new competencies internally or to absorb new knowledge from external sources. Its innovations are knowledge intensive and vary between the more radical ones addressing new customer groups (e.g., cancer patients, athletes) and the more conservative ones addressing existing groups. However, they tend to increase their share in the radical end of the market spectrum. A3 was awarded with the "Entrepreneurial Innovation Prize" and the prize for the most innovative production process in 2010.

A4 Firm

Dynamic Capabilities

A4 is a rather new company, founded in 2007, established on an innovative world patented idea on special nutrition gourmet products. Sensing and seizing referred till now mainly to the development on a variety of products based on that very first patent. Products are all exported till now. Technology research, individual efforts, co-operations with suppliers and companies of the sector, trade shows and company visits support their current strategy towards more specialization in niches and products.

Seizing is focused around continuous product/process development and new revenue structures. All new products and processes are directed towards high value products and differentiation.

A4's organizational design could be categorized as too flexible owing to the fact that the company comprises of only 18 employees, 12 out of whom hold a University Degree.

"It is a pleasure working in a friendly environment with a great team of people. Besides production management, I monitor our process of developing and presenting new innovative products. But it is only a matter of coordination, since we all enjoy that part..." (A4's production director)

Still, reconfiguration is rather weak mainly due to the short life of the company. There is a formal agenda of knowledge and information diffusion meetings especially on innovation and new technology matters. Experimenting is fundamental.

Knowledge intensiveness

A4 started by creating new market niches in the area of gluten-free gourmet products. They turned to international market instead of the Greek one both because of the market size and the well approved mistrust of Greeks to such products. Although products enclose too much knowledge and experimentation, the marketing focuses on taste, quality and safeness rather than the patented complexity of their creation. Uniqueness come form food technology which turns such products suitable for special groups. These knowledge intensive innovations on the market dimension are very creative.

Regarding technology, the company uses low -risk technological solutions mostly in cooperation with local manufacturing companies. Accordingly there is a constant need of knowledge selection, assimilation and further exploitation all along the value chain. The company has provided all sources needed (e.g. human and knowledge networking capital), to successfully correspond to that strategy.

Discussion and conclusions

The objective of this paper was to explore the existence of dynamic capabilities in knowledge intensive low tech sectors. We conducted a multiple-case study in the food sector and built our analysis on qualitative data. Our analysis revealed interesting patterns regarding the portfolio of different types of dynamic capabilities and knowledge intensiveness.

The analysis proved that companies of so called low tech sector that base their strategy on knowledge, use in a formal or informal way all three microfoundations of dynamic capabilities as Teece called them (Teece, 2007). It is worth-mentioning that dynamic capabilities apply mainly for the innovative, knowledge intensive products, while they are rather neglected for the conventional ones, although there are also subject to improvements and upgrades knowledge entailing.

Our case analysis revealed that younger firms produce most radical innovations but have a weaker or rather one-sided portfolio of dynamic capabilities (A4, A1). There is also an obvious relationship among size and mainly seizing capability, regarding decision protocols and business model delineation (A1, A4). Organizations' internal understanding of the strength of their capabilities plays a significant role in perceiving knowledge based opportunities within mature, saturated markets. Such firms are usually the bigger ones (e.g. A2, A3) with a well-balanced and strong dynamic-capability profile are aware of their capabilities and able to make well-informed decisions to adjust their innovations so that customers will perceive the products as innovative, and yet to integrate them into the business model and organization.

This study makes several contributions to the research on dynamic capabilities. It provides both an empirical contribution to the existing dynamic capabilities framework, through its in-depth investigation of the capabilities of the four case low tech firms, and a start for new theory grounding on the existence and role of dynamic capabilities in the area of low technology.

The study proves the existence of dynamic capabilities at least in knowledge intensive low tech sectors and the ways they are manifested in practice. While the basic elements of sensing, seizing and reconfiguring were detectable in all four case companies, there were considerable differences due to size and age. This finding arises too many questions on the role and nature of dynamic capabilities in low technology and calls for further research in order to answer fundamental questions on the creation of dynamic capabilities, their relationships and linkages with knowledge intensiveness and specificities of low tech sectors.

From a managerial point of view, our study carries some important implications. Companies in mature low tech sectors with strong and versatile dynamic capabilities that build on knowledge have more

chances to survive and prosper in a globalized economy, than those that stick to conventional products or processes and try to survive with low price strategies. Knowledge intensiveness opens up possibilities for a company to gain competitive advantage and create or enter emerging markets and customer needs.

As with any research, there are limitations associated with this study, some of which point to promising directions for future research endeavors. First, the data is from four cases representing the food industry, and care should thus be taken in generalizing the findings to other product contexts. Second, the cases may have idiosyncratic characteristics. The suggested relationships need to be validated against other cases and methods to see if these inductive insights survive the empirical test.

Nevertheless, the study opens up avenues for future research. It introduces the complex triplex of low - tech industry firm-specific accumulated knowledge, dynamic capabilities, and innovation. It is further among the first attempts to establish the significant role and specify a framework and the nature of dynamic capabilities necessary for new knowledge intensive low tech ventures to achieve strong competitive advantages in an open economy. Research should comprise the rest of low tech industries for more generalized conclusions. The present study can aspire a promising research agenda for many research fields within the unexplored concepts of both KIE and low tech.

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