PRODUCTION TECHNOLOGIES AND INNOVATION IN KNOWLEDGE-INTENSIVE LOW-TECH VENTURES: EVIDENCE FROM THE GREEK WOOD AND FURNITURE INDUSTRY

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ABSTRACT

In this paper we argue that production technologies choice or development plays an important role in low-tech but knowledge-intensive venturing. A small but growing stream of literature emerges that stresses the importance of knowledge-intensive entrepreneurship in low technology industries and their role in advanced economies. Focusing on the empirical case of the Greek wood and furniture sector, we explore how new low-tech ventures use knowledge from multiple and often trans-sectoral fields to intensively create and deploy many forms of production-relevant knowledge in order to develop innovative production technologies, build their initial competitive advantage and enter mature and saturated markets. The results highlight that knowledge-based innovation is necessary to start a viable low-tech but knowledge-intensive venture. This refers mainly to production technology innovation and can be incremental or radical. The development process demands certain capabilities as networking, synthesizing competencies to tap into knowledge sources and learning. Entrepreneurs own specific traits and skills and are more than just passive technology adopters. Corporate venturing presents certain advantages compared to the new-to-the-world ventures regarding both sources access and necessary human and financial capital.

1. INTRODUCTION

Investments in knowledge and innovation are becoming critical in low-tech industries. Established or new-to-the–world companies of traditional businesses enclose a dynamic approach of knowledge in order to create competitive advantages and compete in mature markets (Hirsch-Kreinsen and Schwinge, 2011; Robertson and Smith, 2008). Yet, to our knowledge low-tech industries remain a rather unprivileged research topic in the framework

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of strategic entrepreneurship and management on the basis of knowledge-seeking activities and innovation development.

The present paper is part of an ongoing study on Knowledge-Intensive Entrepreneurship (KIE) and low-tech industries. The research used multiple case study design (Yin, 1989) to build theory (Eisenhardt, 1989) based on a capabilities approach in order to offer some insight and explain new knowledge-intensive venture success and failure within low-tech industries. The concept of Knowledge-intensive entrepreneurship uses knowledge as the core of all entrepreneurial activities. According to Malerba and McKelvey (2010) KIE refers to new firms with significant knowledge intensity in their activities that develop innovative opportunities.

The paper explores the role of production technologies in knowledge – intensive low-tech venturing. More specifically, we explore how new low-tech ventures use knowledge from multiple and often trans-sectoral fields to create and deploy many forms of production-relevant knowledge in order to develop innovation, build initial competitive advantage and enter mature and saturated markets.

Empirically, the focus of the paper was on the wood and furniture industries in Greece. The sectors are representative not only for Greece but for Europe and globally as well. They are old low-tech industries which showed little propensity and capacity to innovate in the past but due to global pressures today they have turned to knowledge-based innovation. Face-to-face interviews with local firms, research organizations and industry experts offered insight to analyze the nature of innovative activities both at the founding stage and later in the firms' lifespan, the central role of production technologies, the development of linkages and the complex use of knowledge sources.

The remainder of this paper is organized as follows. Section 2 provides a short literature review on the knowledge-intensive innovation pattern in low-tech sectors and the role of production technologies in general while the third section describes the research methodology. The fourth section gives a brief description of Wood and Furniture sectors regarding industry structure, technology and innovation in general and the fifth addresses more specifically these industries' profile in Greece. Section 6 contains the empirical part of the paper. Results draw on the types of knowledge-intensive ventures found in the sectors, their introductory innovation activities and the development of innovative production technologies using key knowledge sources. Types of knowledge linkages, capabilities needed and differences between new and corporate venturing will be further discussed. Finally, Section 7 summarizes the key findings and draws some conclusions.

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2. THEORETICAL BACKGROUND

2.1. Knowledge-intensive Innovation in Low-tech Industries

In the last few years a rich literature is emerging enhancing the role that traditional sectors play in modern economies and directing importance of innovation and technological change outside R&D-intensive fields (Hirsch-Kreinsen and Schwinge, 2011; Robertson et al. 2009). There is now a growing awareness that low-technology industries, which still make up a considerable share of production and employment in developed and developing economies, can be knowledge-intensive, develop knowledge-based innovation and invest in trans-sectoral knowledge seeking and learning (Hirsch-Kreinsen and Schwinge, 2011). According to Smith (2008) "Growth within the less glamorous, traditional sectors is certainly innovation-based, and moreover it rests on cognitively complex and deep knowledge bases, which from time to time are subject to discontinuous change"

Low-tech industries engage mainly in new product development and frequent changes of process technologies (Hirsch-Kreinsen 2008a, Robertson and Smith 2008, Robertson et al. 2009). While a very small percentage of individual low-tech firms engage in R&D activities, the majority apply mainly open innovation. Especially when referring to knowledge-intensive innovation, processes translate knowledge to innovation; i.e. in-house knowledge is developed by including new knowledge and technologies that stand out from the resources of the existing sectoral system (Robertson and Smith 2008; Hirsch-Kreinsen and Schwinge, 2011). This can be scientifically-generated knowledge as well as new combinations of technical and practical knowledge which create innovation. Process, organizational and marketing innovations are more common ((Heidenreich, 2009), while product innovations are in their majority incremental (Bender, 2004). Yet, there are many cases where product innovation cannot be separated from process innovation. While the phenomenon is more usual in the food sector there are many cases of innovative material treatments or additional process steps which introduce novelty. A significant feature of low-tech innovation is the engagement of many stakeholders all along the value chain in open innovation. Suppliers are of utmost relevance in this context, since low-tech firms rely heavily on raw material, machine and equipment technological advances (Bender, 2004, Heidenreich 2009).

2.2. Production Technologies and Knowledge-intensive Low-tech Ventures

Technology is the process of applying the findings of science and other forms of enquiry to applied situations. Rosenberg (1982) defined technology as "knowledge of techniques, method, and designs that work and, that work in certain ways and with certain consequences,

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even when one cannot explain exactly why." Adopting this view for knowledge-intensive low-tech industries, technology can be treated as a set of pieces of knowledge ultimately based on selected principles, know-how, methods, experiences, and also, of course, physical devices and equipment. Production technology therefore involves applying the work of researchers and industrial practice to develop new products and processes covering technologies for an extremely varied range.

Low-tech technologies are usually well-established with technological norms, methods and leitmotifs to exist for many generations (Hirsch-Kreinsen and Schwinge, 2011) and with an increasing trend towards improvements and automatization. At a first glance processes and products seem rather standard and at an advanced stage, lacking the prevailing technological contingency of high-technology undertakings. Low-tech industries are generally confronted as "borrowers" of technology which may come from other sectors such as machinery, ICT and raw material producers (Bender, 2004; Hirsch-Kreinsen and Schwinge, 2011). Entrepreneurial or managerial teams have to locate and organize the individual and often miscellaneous pieces of product and/or process technology they need in order to innovate. That may range from production lines to engineering and operating procedures.

Besides the skepticism of low-tech innovation, there is a growing stream of literature indicating the importance and complexity of process innovations in low-tech industries (Hirsch- Kreinsen, 2003; Bender, 2004; Trippl, 2010; Hirsch-Kreinsen and Schwinge, 2011). Bender (2004) defines as process innovation changes in the production process including design and logistics. Hirsch – Kreinsen (2008a, 2008b) commends on the incremental character of such activities. Yet, there is no relevant theoretical or empirical work to our knowledge on the role of production technologies in cases of venturing and innovation within low-tech industries, especially within the frame of knowledge-intensiveness.

Within the notion of knowledge-intensive entrepreneurship a venture creation is tightly connected to knowledge-intensive innovation (Malerba and McKelvey, 2010). When referring to low-tech manufacturing, the transformation of an innovative business concept into a marketable product presupposes the choice and set up of the suitable production technologies. Entrepreneurs, entrepreneurial teams or managerial teams try to identify and acquire advanced production technologies to combine and create the technologies they need. In cases where the output of innovation constitutes the initial competitive advantage, planning and installing the suitable production technology entails a great amount of creativity and trans-sectoral knowledge combination (Karagouni et al., 2012). Advanced

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production technologies enable "the firm to capture lucrative and more value added markets for growth" (Evers, 2011).

Knowledge is mainly incorporated into production via investment. The commitment to physical creation is a significant transition point in venture creation. Certain businesses require considerable tangible and intangible resources for the set up of production technology since most of them, besides the use of standard equipment and technology, develop production technology novelties.

Differences can be found when referring to new-to-the-world or corporate venturing. The set-up of production technology occurs in parallel with organization creation. This refers to the building of the physical structure, which can be common in the two types of ventures. It also refers to organizational processes that "surround production technology at the core" (Thompson 1967). The procedures which are usually required when installing the purchased equipment or the ex ante specification for systems to be constructed in an application-oriented manner, are both to a large degree based on the accumulated practical knowledge of the respective agent (Hirch-Kreinsen et al., 2003). Thus new-to-the-world ventures encounter more problems, obstacles and inconsistencies related to corporate ventures; these can count on their accumulated knowledge, existing organizational regimes, routines and processes and relevant experienced human capital.

3. METHODOLOGY

A multiple exploratory case study research design was selected (Yin, 2003) to allow for theory building, since the present paper is a part of a broader research on KIE in low-tech sectors. The individual low-tech company was the unit of analysis. This research design enables the specification and elaboration of theoretical constructs and their relationships that are not yet well-defined in literature (Eisenhardt, 1989). Our sample of knowledge-intensive ventures follows Malerba and McKelvey (2010) definition of KIE (see above) and satisfies the following criteria:

- Knowledge-Intensive venture creation among 1998–2007
- Corporate venturing or new-to-the-world venture
- Evidence of being assigned to the most innovative companies in the market or product field through knowledge-seeking activities.

The most representative low-tech sectors in Greece are the food and drinks, wood and furniture, and textiles and clothing industry, which have also a significant share of

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employment and value-added for the European manufacturing industry and economy. Data were collected from relevant sectoral databases, while sectoral experts gave information about new, knowledge-intensive ventures.

For the purposes of the present paper the authors used the sample of wood and furniture sector consisting of ten rich case-studies (Table 1). Face-to-face, in-depth interviews were conducted during 2009-2011 with different interviewees of the companies using a semi-structured questionnaire. Additional sources of information were employed such as plant visits, company reports, awards and company websites. Interviews with five industry experts and five scientists from Academia provided an excellent overview of the topics researched and a useful complement to the interviews.

There are four cases of corporate venturing and six of new-to-the-world firms. Regarding size there is one large, two micro, four small, and three medium sized enterprises. The ten cases belong to different subsectors of wood and furniture industries, are all knowledge-intensive and are located in different regions covering the whole of the Greek mainland. Six of the cases do not export at all, while two of them have a significant export orientation. Due to its heterogeneous composition, the ten-case sample is considered as quite representative of the two sectors in Greece.

Table 1. Ventures' demographics

a/a	Main Activity	Year of venturing	employees	Exports (% sales)	Main Type of Initial Innovation	Location
F1	veneers, veneer stitching	2007/N	8	10	Process	Larissa
F2	lacquered/printed MDF laminate flooring	2004/CV	126	25	Process	Grevena
F3	Kitchen, wardrobe	2007/N	14	0	Process and business model	Karditsa
F4	panels, flooring, glue – laminated products	2003/N	11	0	Product, Process	Grevena

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a/a	Main Activity	Year of venturing	employees	Exports (% sales)	Main Type of Initial Innovation	Location
F5	Evropanel for furniture - walls	2001/N	9	0	Process	Giannitsa
F6	Marine Plywood wooden flooring decorative panels	2005/CV	185	50	Process	Korinth
F7	Wood pellets	2003/N	16	0	Product using novel Production Technologies	Sykourio
F8	Kitchen, wardrobe	1998/N	30	0	Process / Technology	Thessaliniki
F9	decking fences	2006/CV	10/1014	60	Product/ Production Technology	Chalkida
F10	Mattresses	2005/CV	180	0	Business model	Xanthi

CV: Corporate Venturing, N: New-to-the-world-firm

4. WOODWORKING AND FURNITURE SECTOR

4.1. Industry structure

The wood product manufacturing industries or woodworking industries include the production of sawn wood, wood-based panels, joinery and carpentry materials, containers packaging and other wooden articles. The furniture industry is part of the down-steam value chain activities of this sector including other material as well. It is essentially an assembling industry, which employs various raw materials ranging from wood and wood-based panels to metals, plastics, textile, leather and glass. There are many different types of furniture with very different uses.

Woodworking and furniture industries are two vital, sustainable, innovative and eco-compatible sectors, with a turnover in 2008 of around €221 billion, an added value of around €60 billion and an employment rate of 2.4 million people in more than 365 000

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companies (Eurostat, 2009). The vast majority are SMEs, with the wood-based panel sub-sector and a handful of sawmills to be the exception. The furniture industry accounts for nearly half of this turnover, followed by the production of construction elements (19.3%), sawmilling (13.9%) and panel production (9.2%). The majority of furniture producers are micro-enterprises (less than 10 employees).

The sector faces growing competition from low-cost, emerging economies and a growing number of technical trade barriers. Furthermore, the furniture sector is not only facing difficulties in accessing wood as a raw material, but also a dramatic rise in the price of materials such as leather, plastics natural fibres and petroleum derivatives. The general financial and economic crisis has had a major impact on the entire sector: turnover decreased by more than 20% between 2008 and 2009 (eu.enterprise.sectors).

4.2. Technology and Innovation

Woodworking companies are considered highly innovative and knowledge-intensive (Smith, 2008; Hirsche-Kreinsen and Scwinge, 2010). Companies in the sector have built in high-quality innovation systems for both products and processes and excellent sectoral research and technological development knowledge centers. Global machinery manufacturers, suppliers, the chemical industry, Universities and independent research centers develop synergies assisting the advancement of process and product developments. Innovations turn around engineered wood products, wooden composites, novel fittings and other wooden products.

Furniture companies are also knowledge-intensive but less innovative regarding technical innovation. Knowledge evolves mainly around aesthetic, design and fashion related issues and focuses on creativity and strong image building. Yet, process and product innovation is evident in the undertaking of lengthy processes of restructuring and modernization, development of sustainable production methods and novel business models (e.g. modular design). Major factors of competitiveness for the sector consist of research and innovation (along the whole value chain and mainly material and fittings, skills and quality, design and added value, knowledge and know-how, together with better access to third country markets.

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5. THE WOODWORKING AND FURNITURE SECTOR IN GREECE

5.1. Industry structure

Woodworking and furniture industries play a significant role in Greek economy, with a turnover in 2008 of around €2 billion, an added value of around €1 billion and an employment rate of 35.000 people in more than 15.000 companies (Eurostat, 2009). The vast majority are micro-companies, with the wood-based panel sub-sector and a handful of sawmills to be the exception.

The sector is mature, highly fragmented and labour-intensive with many firms operating in a 'craft' production mode. 66% of the firms are less than 30 years old and cover mainly the domestic market, as exports are rather insignificant.

The industry faces growing competition from low-cost, emerging economies and a growing number of technical trade barriers. Decreasing production in absolute numbers was combined with the increasing number of trendy products from Italy and Spain, cheaper products from Turkey, China and India and different approaches such as of IKEA. Furthermore, it faces difficulties in accessing wood as a raw material and a dramatic rise in the price of materials such as leather, plastics natural fibres and petroleum derivatives. The general financial and economic crisis has had a major impact on the entire sector: In 2008 most companies had losses of profits (56.8%) or even damage (27.3%).

5.2. Technology and Innovation

Greek wood and furniture companies are not considered as innovative even with the Schumpeterian concept of innovation. Relevant research (Karagouni et al., 2010), which covered wood and furniture companies in the region of Thessaly, Greece, indicated only an 18% of innovative firms in the sample. Improvements of existing products and purchase of process innovation are the main innovation activities. Advancement of existing and development of new equipment (AMT), the import of design systems (CAD), the application of CIM and MRP, as well as the pilot use of new or improved raw material or semi-finished products are further innovations pursued by Greek wood and furniture manufacturers. A network of international machinery manufacturers and suppliers play a significant role in research and development advances regarding mainly medium and large organizations.

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Furniture companies invest on aesthetic value and fashion. Yet, design is still underdeveloped while process innovation refers more often to restructuring and modernization.

Major weaknesses of both sectors regard the lack of specialized technical personnel, overall organization and quality control while entrepreneurs' educational level is rather low. The last five years the sectoral context starts changing by becoming more knowledge-intensive. New entrepreneurs or successors have a high educational level and turn to research, innovation and knowledge management.

6. EMPIRICAL PART

6.1. Knowledge –intensive Innovation in Greek Wood and Furniture Sector

Our research revealed that Knowledge-intensive ventures are rather rare in the Greek low-tech industries and especially the wood and furniture sectors. Yet, there were certain cases found which created initial competitive advantages due to knowledge seeking and a harmonic combination of externally acquired and in-house developed knowledge.

More precisely, **three types of knowledge-intensive ventures** could be traced. The **first type** presents a more balanced emphasis on different dimensions of innovation[22] and relies mainly but not solely on external knowledge seeking. Five cases belong to this type. The **second type** develops only the technical dimension of innovation combining both internal and external knowledge development. This group contains three cases and only corporate ventures, raising certain questions on knowledge-intensive corporate venturing. The **last type** focuses again on only the technical dimension of innovation relying on only external knowledge and refers to two new-to-the-world ventures.

Although our research started without seeking ventures of certain types of introductory innovation, it turned out that knowledge-intensive wood and furniture ventures develop mainly process innovation (Table 1). Even in cases of innovative products or business models, process changes and novelties were necessary to support the initial innovation. This is in line with relevant literature (Heidenreich 2009, Fagerberg, 2005). Hirsch-Kreinsen (2008b) further notes this close relationship between product and process innovation. More precisely,

[22] ***Note:*** *Actually it covers the three axes of a new venture: technology axis which is relevant to the technical development of a novel concept up to full scale production, Market axis which refers to the interaction with the market and the business axis which includes the business steps needed such as commercialization and business scheme selection, business and relative model development and IPR protection.*

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Knowledge-based introductory innovations of the ventures cover all four categories of the venture idea newness: (1) new to the world : one case with novel business concept and one with patented process technology, (2) new to the market (national / international market): eight out of ten cases, (3) new to the firm: all cases, and (4) a first mover or assigned to the most innovative companies in the market or product field: all ten cases are first movers at least at national level. Knowledge-intensive and innovative venture ideas can produce (1) novel products supported by novelties in production technologies (six cases) (2) methods of production, processes and technologies (all ten cases), (3) methods of promotion (one case) and (4) business models (two cases) creating niche markets.

However, most of the initial innovations cannot typically be characterized as "breakthroughs" or "radical departures", since they more often constitute combinations of existing patents and innovations in general. W&F companies target more to innovate in functional parameters in order to produce initial competitive advantage, such as: quality (2 cases), functionality (3 cases), exploitation of innovations other produced but adapted to local conditions (3 cases), or present unique images either by a novel business model and method of promotion (one case), or innovative products which however do not constitute the core products of the company (one case). This can be a major characteristic of low-tech industries and specifically wood and furniture sectors.

In all cases of wood and furniture sector all innovations later in new ventures' lifespan turn mainly around the initial novel concept. Yet, they are not mere improvements or additions to product families and refer mainly to process or concept innovations.

Patents and intellectual property protection are not popular among the cases although they are knowledge-intensive and one would expect much more focus on protecting knowledge. Agents of wood and furniture sector believe in the strength of their unique ideas. "No one can really copy the whole package" according to some of them. As one interview partner put it: "it is not enough even to watch the way an entrepreneur makes his/her strategic moves". Another entrepreneur patented his novel technology but he is revealing its secrets to everyone who asks about it. *"I gave the technology to them. I will have more novel ideas. This is a way that we became famous. This is how they all visited my new company!"* There are two cases with patented technology but there are the exceptions. Almost all interviewees find the patenting procedure time-consuming.

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6.2 Production Technologies of Knowledge-intensive W&F Ventures

Besides focusing on a few technological core competencies, most of the cases sustain competencies in multiple technology fields. Table 2 provides an overview on the respective partnering activities. Machinery suppliers and suppliers of raw and intermediate products play the most important role. They belong to various fields which somehow are connected to different links of the relevant value chain. Because of increasing technology convergence, these fields are often relatively different from the core technologies and this puts further emphasis on the importance of successful technology exploitation (Patel & Pavitt, 1997). Other knowledge sources are also involved confirm the view in the literature (e.g. Granstrand, 2000; Garcia-Vega, 2006; Bender, 2004; Hirsch-Kreinsen and Schwinge, 2011) that low-technology sectors rely on a variety of knowledge sources and make use of distributed and trans-sectoral knowledge bases.

New entrepreneurs or entrepreneurial teams usually develop novel business ideas and consume resources to combine or modify existing technologies or even support the development of new ones. Thus, they develop linkages which go beyond traditional buyer-supplier relations being more interactive. In most cases they co-operate with machine manufacturers to develop extremely specialized equipment to fit specific requirements. A kitchen manufacturer co-developed a multi-task machine to fit his novel "box-concept" of line production. The CNC machine was then patented by the manufacturer (with the kitchen manufacturer's permission) and won an innovation prize in a world machine exhibition.

The most impressive case was a woodworking corporate venture. The entrepreneur engaged 20 machine manufacturers of various fields, which were ranged as the global leaders in specific technologies to co-operate under the guidance of a leading consultant international company to produce *"his technological miracle"*. This impressive operation ended with a patented MDF production technology which had cost more that 70 million Euros.

Table 2: Knowledge sources

Cases / Knowledge source	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Customers		1			2					
Suppliers of raw materials & intermediate products	4	3	7	2	1	1	2	3	3	4
Suppliers of machinery, packaging	3	20	4	3	2	5	4	6	4	5
Competitors (firms from the same sub-sector)	1	2			1		1			
Other firms	2	4	2	2	3	2	2	4	2	3
Universities, Technical	1	2	1	1	1	1	1	2	1	2

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Colleges										
Consultants	1	3	1	1	1	1	1	1	2	2
Other actors / organizations	1			1		1		3	1	3
Total	13	35	15	10	11	11	11	19	13	19

All major technologies are developed mainly by European manufacturers. American machine suppliers are also used in two cases. Greek companies are used for supportive constructions and ICT solutions. This is however not strange since Greece lacks relevant industries; the same phenomenon is observed in other countries and other sectors as well (i.e. Trippl, 2010).

In table 1 there are three cases presented where the novel initial business ideas turn around innovative products. Yet, all three cases developed novel production technologies as well. One of them bought patented technology by an American research organization. However this technology had to be modified to suit local conditions and raw material. An almost "turn-key solution" turned to a new research; problems of the pilot production led to a formal European research project. This case denotes a further direction towards the potential hidden behind the so-called "purchase of embodied technologies".

Yet, all cases show a rather weak relation to Universities and other research institutions. This can be attributed to the fact that there is only one relevant educational and research institute in Greece to fit the relevant field and it has been contacted by all ten cases (Table 2).

Among the cases, there are also two cases where the initial business idea is a novel business model. In both cases innovative production technologies, although incremental, supported the basic idea advancing existing ones. Both cases needed and developed co-operations with different technology areas and occupied international organizations.

In all cases wood processing technology, wood behavior science, chemistry, mechanical engineering, material engineering, ICT and extruding technology are engaged while certain other fields are involved in each case. A creative bricolage of research work and industrial practice results in innovative products and processes covering technologies for an extremely wide range. In parallel, improvements, parameterization and automatization are involved to solve problems and create new directions. These cases indicate that low-tech companies may be something more than just "borrowers" of technology. Yet, they verify the fact that entrepreneurial or managerial teams locate and organize the individual and often miscellaneous pieces of product and/or process technology they need in order to innovate.

The cases verified also existing literature (e.g. Smith (2008); Robertson et al., 2009) regarding the significance of raw materials and intermediate products in low-tech innovation. However their role during venturing does not appear to be that important; they rather support than

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guide the initial novelty. In most cases novel material adds to properties of the final product or constitutes part of improvements. There is only one case where the innovative material gave birth to an innovative production technology and the opening of a new niche market. Once again suppliers of innovative raw materials are in their majority foreign companies.

A quite interesting issue is the fact that novel production technologies as venture enablers arise either as solutions to specific problems in the cases of corporate venturing and as a medium to create niche markets in the cases of new-to-the-world firms. All cases indicate that entrepreneurs (even new ones) have a satisfactory knowledge of the sectors and a relevant experience. This is rather expected; innovation in production technology cannot start without any previous involvement in the relevant fields. Most case-study firms are established by agents between 34 and 42 years old which strengthen the assumption of the significance of prior entrepreneurial experience and knowledge. There is only one exception where the entrepreneur is 26 years old. In this case, though, there was a strong family company as a sectoral background, important knowledge background and a sense of worldview on economic and other specific knowledge since the entrepreneur is a PhD holder and prior member of international large organizations. There are also two cases of corporate venturing with entrepreneurs older than 50 years old. These own the two larger organizations of the sample.

All four cases of corporate venturing present certain advantages compared to the new-to-the-world ventures. Resources are richer and abundant, networking and contacts are easier, organizational capabilities are higher and better developed. This is in line with literature which states that corporate ventures can benefit from their parents' resources, which are an important requirement for enhancing the innovation process (Thompson 1965).

The four cases of corporate venturing have engaged a significant part of human, social and financial capital in reaching various knowledge bases and translate combinations in novel production technologies. Path dependencies secure easier and faster co-operations, more trust and advanced planning. There is always a better mapping of the relevant areas of interest, while the problems of spatial proximity can be easier overcome. Accumulated technical and practical knowledge can also secure and enable further advances required. New-to-the-world ventures reported many problems, and obstacles related to important lack of relevant knowledge, significant waste of time in searching for appropriate knowledge sources, severe difficulty in establishing contacts and trust with stakeholders, lack of proper human resources and many inconsistencies between planning and realization.

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Many times, even in cases of successful production establishment new entrepreneurs missed the qualified, interdisciplinary team which would embrace the design, engineering, production, marketing, procurement and quality departments due to the emphasis given on idea implementation though technology. Yet, all entrepreneurs admitted that learning was developed all along the founding stage. Even activities such as the installation and preparation of equipment and trial production were knowledge-generating activities.

All companies continued to be knowledge-intensive and innovative. Yet, the following innovations in these firms' lifespan are rather incremental and mostly product improvements, New Product Developments and applications of novel raw material. Process modifications are also reported; still not at the scale of the initial innovation.

All ten investments have survived the usually used five years criterion (Ensley et al., 2006). Most of them have shown an increasing sales rate till 2009. The severe economic crisis in Greece created significant problems in almost all of them.

7. SUMMARY AND CONCLUSIONS

A small but increasing stream of literature supports the ability of low-tech sectors to be knowledge-intensive, produce innovation and play a significant role in advancing technologies and technological change (von Tunzelmann and Acha, 2004; Robertson et al. 2009). Various scholars have also pointed out that low-tech innovation follows different ways of development than high-tech innovation; it engages open innovation forms instead of R&D, produces rather process than product innovation and is mostly supplier-dominated (Hirsch-Kreinsen and Schwinge, 2011). Yet, little is still known about the degree and modes of innovation development and technology embeddedness in low-tech new ventures. The paper claims that production technologies hold a significant role in knowledge-intensive venturing and deserve a further investigation, within the framework of knowledge-intensive entrepreneurship of low-tech sectors.

Empirically, the focus of the paper was on the wood and furniture industries in Greece. The sectors are rather representative not only for Greece but for Europe and globally as well. They are old low-tech industries which showed little propensity and capacity to innovate in the past but due to globalization and trade liberalization today they face enormous competition and have turned to innovation and learning challenges. Based on 20 face-to-face interviews with local firms, research organizations and industry experts, the nature of innovative production technologies and all innovative activities both at the founding stage and later in

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their lifespan, relevant knowledge sources and linkages and mechanisms of implementation have been analyzed.

The empirical results have shown that Greek wood and furniture new ventures prefer to invest on production technology innovation in order to secure a position within mature and saturated markets. Technologies are developed as accumulation of various pieces of knowledge sources out of the strict sectoral limits, selected to fulfill conditions and limitations of the initial business idea and combined in novel ways ending up even with machinery innovation. The study has shown that low-tech but knowledge-intensive entrepreneurs interact with a wide range of stakeholders all along the value chain and at global level. Yet, machine manufacturers and raw material providers are the most important links; this was rather expected since we refer to production technologies, but not to the extent found. The results also seem to contradict the common belief that low-tech companies are just "buyers of embodied technologies". Entrepreneurs co-operate with machine manufacturers to produce novel machines and equipment or even to develop novel processes.

Differences have been traced among corporate and new-to-the-world ventures. Established organizations seem to have the potential, capital and capabilities to develop far more advanced innovative production technology innovations than the newly established companies.

The study indicates that entrepreneurs need to own at least relevant technical and sectoral knowledge and must have developed corresponding capabilities to organize introductory innovations which will constitute the initial competitive advantage. Rather than being passive technology adopters adapting business ideas to existing production technologies, they must be active contributors to process development in order to differentiate. An overall knowledge of the sector all along the value chain and a competence of locating necessary knowledge sources out of the boundaries of the sector seem to be significant. Therefore bricolage, networking, synthesizing and learning capabilities may be core entrepreneurial capabilities for starting a new low-tech but knowledge-intensive venture. In terms of organizational practices, a variety of skill levels and forms of work organization is needed rather than simply the low-skill, hierarchical model that is often assumed. More precisely, technology-flows need to be managed by an interdisciplinary team in order to produce desired results in operations floor and translate them into viable competitive advantage.

Besides the managerial implications, the paper suggests that the role of production technologies should constitute a necessary part of innovation and venturing theory, especially for low-tech sectors, since it is the "vehicle" of business concept implementation in

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manufacturing sectors. Within the framework of Knowledge- intensive entrepreneurship capabilities, mechanisms and practices should be also developed at operations level, since that is the level where knowledge selection, combination and elaboration creates tangible results of newly created knowledge.

Given the nature of our study, we do not argue that our findings may be generalized to other low-tech industries and nations. Further empirical and theoretical research is required to enhance our understanding on this specific direction of knowledge –intensive entrepreneurship and namely the role of production technologies in low-tech but knowledge-intensive venturing.

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