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Micro firms internet adoption patterns: the case of the Greek jewellery industry

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Abstract

Purpose – The purpose of this paper is to investigate internet adoption of very small B2B firms in Greece. This study aims to construct a model which will classify companies according to internet activities undertaken and then to explore whether different adoption can be interpreted by business demographics and a limited number of perceived barriers.

Design/methodology/approach – This empirical research was carried out by the means of survey focussing on the Greek jewellery industry. Data were submitted to a sequence of statistical analyses resulting to a model of Internet adoption. The model was then bench marked to representative domestic and international adoption patterns.

Findings – Firms can be classified into three groups, ranging from non-adopters to relatively mature adopters, similarly to previous patterns of international B2B small to medium enterprises. Business size and type, international cooperation and knowledge with regards to internet proved to be significantly correlated to adoption status.

Research limitations/implications – The paper focusses on one Greek business sector and thus the applicability of its results to cross-type international micro-businesses remains questionable.

Practical implications – The findings of this study can assist company owners to plan their internet strategy, software vendors to target firms by offering tailored solutions and governmental authorities to implement initiatives aiming to confront the highlighted internet adoption disablers.

Originality/value – This is one of a few information and communication technology studies that focus on very small companies and perhaps the only one providing an empirical classification model of internet adoption for this business size.

Keywords Greece, B2B, Cluster analysis, Internet adoption pattern, Very small firms

Paper type Research paper

1. Introduction

More than 99 percent of all European businesses are small to medium enterprises (SMEs). SMEs provide two out of three of the private sector jobs and contribute to more than half of the total value-added created by businesses in the European Union (EU). What is even more intriguing is that nine out of ten SMEs are actually very small or micro-enterprises with less than ten employees and no more than €2M annual turnover (Europa, 2003, 2011).

Small firms, rather than SMEs more broadly, are considered to be highly idiosyncratic (Beckinsale *et al.*, 2006; Parker and Castleman, 2007) and can be characterized as social formations in which interpersonal relationships with family, friends and other businesses often influence their electronic commerce (e-Commerce) adoption decisions (Castleman, 2004; Simpson and Docherty, 2004). Micro-enterprises may share common characteristics such as size and geography, but they exhibit a great deal of diversity in the nature of the business, the technology skills of the entrepreneurs and their attitudes toward technology (Wolcott *et al.*, 2008).

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Though SMEs' adoption of e-Commerce has been extensively researched (Parker and Castleman, 2009), internet adoption of the smaller businesses is not clearly understood (Harindranath *et al.*, 2008; Simmons *et al.*, 2011). Due to all kinds of variations among enterprises of different sizes and industries, it has been acknowledged that not all SMEs need to adopt information and communication technology (ICT) tools to the same degree of sophistication, there is no "one-size-fits-all" ICT policy (Kotelnikov, 2007; Taylor and Murphy, 2004) and thus it is necessary not only to distinguish large firms from others, but also to distinguish between very small, small and medium-sized firms (Bordonaba-Juste *et al.*, 2012). Consequently, the applicability of generalized SMEs theories to the micro-size environment is questionable. Furthermore, the fundamental differentiation of micros when compared to larger – small or medium – organizations reinforces the need of research that will focus on this business segment. Given that the vast majority of global firms are classified as micro-sized, specific understanding of this sector's internet adoption is really valuable to both practitioners and academics.

The motivation of this study is to provide information concerning the current state of internet adoption by domestic micro-B2B firms as well as to highlight issues that may affect their future internet initiatives such as the process of adoption followed and the factors acting as enablers or disablers. In line with the above mentioned, this study aims at contributing to current research by constructing an empirical model of micro-firms' internet adoption. In brief, the aims of this quantitative research is to develop a classification with regards to firms' current internet engagement, to elaborate on the structure of this classification seeking to explore if it can be treated as a pattern (process of adoption) and finally to estimate the impact of typical contextual characteristics and specific perceived barriers on the positioning of firms.

For the purpose of this paper a literature review concerning internet adoption patterns and factors affecting adoption small business decisions is carried out (Section 2). Literature review is followed by the conceptual framework of the study (Section 3). Section 4 provides an overview of the survey method and Section 5 provides the results of the statistical analyses and the formulation of the induced research hypotheses. The manuscript concludes with a discussion over the findings, implications and suggestions of further research (Section 6).

2. Background

2.1 Internet adoption patterns

There have been numerous studies carried out in order to formulate models of internet adoption in the context of SMEs. Literature review indicated two significant perspectives under which the previous models can be defined. On the basis of sequential or not sequential adoption of internet applications by business entities, the first dimension classifies the proposed models either as stage (or maturity) or as contingent (Levy and Powell, 2003). The second dimension is consistent to the research approach undertaken in each case of model construction and distinguishes the conceptual (or theoretical) prescriptive models that have been generated deductively from the empirically formulated descriptive models of inductive studies.

Information system stage models were studied even before the emergence of the internet and the e-Commerce (e.g. Nolan, 1973). Implying that businesses move in stages from novice to advance web applications, stage models provide frameworks that describe an organization's current position as well as predictions of its future technology adoption. Though the stage models appear sequential, a firm might jump to a later stage by assessing all previous stage issues simultaneously (Lefebvre *et al.*, 2005).

Early conceptual stage models of internet adoption that target SMEs can be found in the studies of Grant (1999), Poon and Swatman (1999) and Rao *et al.* (2003), while in some cases, SMEs' internet adoption has been examined by applying prescriptive stage models suitable for all sizes of firms (e.g. Ching and Ellis, 2004; Martin and Matlay, 2001). In addition to SMEs' internet adoption, models that describe the progress of smaller B2B firms are also available in the literature. For example Lefebvre *et al.* (2005) determined a four-stage model from a focus group, which was afterwards tested and validated using data from a sample of 192 manufacturing SMEs.

In contrast to the theoretical approach of conceptual stage models, inductive studies aim to empirically construct patterns of SMEs' internet adoption, typically through sampling and subsequent statistical analysis. Among the first studies of this kind is that of Daniel *et al.* (2002) that presents a four-stage adoption model through which SMEs are expected to sequentially pass during their e-Commerce progression. A similar quantitative approach has been undertaken by Sila and Dobni (2012) who developed a three-stage linear model by exploring the patterns of B2B e-Commerce usage in a sample of 229 SMEs.

Despite the popularity earned by the staged approach, there have been some criticisms and suggestions that it is inadequate to describe the actual adoption of internet by SMEs (Mendo and Fitzgerald, 2005; Beckinsale *et al.*, 2006; Martin and Matlay, 2001). Early contingent (non-sequential) models can be found in the studies of Tagliavini *et al.* (2001), Boisvert and Begin (2002) and Levy and Powell (2003). Proposing that when considering different types of businesses internet adoption depends either upon the owner's perception attitude or to the fulfillment of case-by-case specific needs, contingent models substitute the linear stages of maturity with disconnected to each other "user profiles" that coincide with explicit enterprise growth and value goals.

Additionally to strict staged or contingent models, literature reveals efforts that conclude to hybrid adoption patterns blending aspects of both types. In these cases the linearity remains due to an overall increase of the adoption level from side to side, but at the same time two or more of the intermediate groups differentiate mainly due to different decision making rather than from the degree of internet adoption they present (e.g. Elia *et al.*, 2007). This category contains the only relevant study discovered with regards to the Greek commercial context (Papastathopoulou and Avlonitis, 2009) even though their model assesses large domestic firms' e-Commerce adoption.

Still, in most studies concerning adoption patterns, conclusions are drawn either in a solely theoretical manner or from samples' snapshot (static) data analyses, and therefore models produced are mainly aligned to as-is adoption classifications. Since the actual progression of firms' internet adoption through time is rarely documented, the validity of staged or contingent theories remains questionable when considering future firm behavior. A good insight into how the adoption pattern of the same population can evolve over the time is provided by Caniato *et al.* (2009). In 2003, using data from the European International Manufacturing Strategy Survey (IMSS) III, the authors formulated a model consisting of four distinct e-business strategies. However from their later analysis of IMSS IV data in 2009, the clusters reduced to three, namely low, partial and full adopters forming an evolutionary model which is rather familiar to the staged approach. It is important to mention that this swift was consistent even within the longitudinal sub-sample participating in both surveys.

2.2 Contextual characteristics affecting internet adoption

Al-Qirim (2008) suggests that SMEs' decisions to adopt business internet applications are affected from a set of factors which are classified as technological, organizational,

environmental or entrepreneurial. Respectively, Thatcher *et al.* (2006) mention that B2B e-Commerce adoption decisions are influenced by organizational, industrial, governmental and cultural factors. Sila (2013) tested and verified the influence of contextual variables including firm size, firm type and management level on B2B SMEs' e-Commerce adoption factors. Tan *et al.* (2010) summarize that the most popular demographic characteristics under examination include industry/firm type and size (by number of full-time employees and annual sales turnover). Still, the results of previous studies that analyze the impact of various factors on commercial internet adoption are mixed. For example, Bordonaba-Juste *et al.* (2012), Levenburg *et al.* (2005) and Dholakia and Kshetri (2004) found that firm size affects the adoption of the internet and e-Commerce, Zhang and Moussi (2008) suggest that firm size plays a role only in influencing a firm's decision regarding whether or not to have internet access and Chuang *et al.* (2007) and Jean *et al.* (2006), found the size was insignificant in e-Commerce adoption. Moreover, some studies have explored the co-influence of two or more demographic variables on internet adoption. For instance, it has been found that different types of SMEs (manufacturing and service) across different sizes need different ICT applications and therefore their internet-based ICT practices will also vary (Kotelnikov, 2007; Tong, 2009) and that small B2B manufacturing firms find few opportunities or little market demand to justify a serious commitment or sizable investment in e-Commerce (Le and Koh, 2002).

Another issue that is often analyzed in line with SMEs' internet adoption regards internationalization. Narayanasamy *et al.* (2011), mention that web technologies create an opportunity to develop strong links between SMEs in different countries. Purcell and Toland (2004) suggest that in the case of remote developing countries, ICT has the potential to be a significant enabler in creating a niche in the global economy. Moreover, Moen *et al.* (2004) argue that internet creates borderless virtual business platforms on which suppliers, producers and customers can freely interact without going through the predefined channels on the value chain. In addition, a number of empirical studies have concluded to that as the import/export volumes increase, firms become more active with regard to e-Commerce (Lefebvre *et al.*, 2005).

3. Research framework

3.1 Research objectives

The overall aim of this study is to provide an empirical model that will facilitate the understanding of micro-firms' internet adoption. In detail, our primal objective is to classify firms into groups of different internet adoption by taking into account the web activities they have already implemented. The second objective is to assess the contextual factors that affect firms when incorporating internet activities and consequently to explore which are the main enablers or disablers toward internet adoption progression.

After completing this analysis, we expect to be able to discuss in detail over several issues of micro-firms' internet context including: first, the structure of the classification established and its position with regards to adoption pattern theory; second, the types of firms that are the most/least active adopters with reference to the main contextual factors that discriminate them; third, the similarity of this model when compared to previous models of internet adoption targeting different types and sizes of companies; and fourth, suggestions that might strengthen micro-firms internet adoption.

3.2 Methodology

Despite that many studies of internet adoption pattern recognition target SMEs, the literature review revealed no evidence of adoption models that focus on companies of

very small size. Daniel *et al.* (2002) empirical model was constructed by data generated from a survey applied to significantly larger firms, which is also the case of Caniato *et al.* (2009), Sila and Dobni (2012) and Lefebvre *et al.* (2005) studies. A relatively high proportion of micros (61 percent) can be found in the paper of Rao *et al.* (2003) but in that study the model itself was conceptually formulated, presumably for cross-size SMEs. In addition the research of Papastathopoulou and Avlonitis (2009) has been applied to companies from the same country as ours, but differentiates as it targets only large enterprises.

Given the scarcity of internet adoption studies that focus on micro-firms, and assuming that there is no "one-size fits all" policy, we argue that no available theory can be reliably applied to the micro-size internet context. Under this perspective, this research employs an inductive approach to develop an empirically grounded taxonomy, where classes emerge from a data set which reflects the similarities and dissimilarities between organizations (Bailey and Johnson, 1996).

The methodology followed is consistent to the generic inductive reasoning process and presented in Figure 1. In order for the information to be acquired (observation), a survey was designed and implemented. For the purpose of the survey, a questionnaire was developed and distributed by post, targeting a single industry population of interest. After collecting the data, we proceeded to a set of statistical analyses aiming to formulate the empirical model and conclude to relevant hypotheses with regards to micro-firms' internet adoption. The model established and its distinct characteristics set the basis of a further discussion, including implications, proposed initiatives and further research.

4. Survey method

4.1 Survey instrument

The survey was carried out by the means of a postal questionnaire that was designed based on an online desk research and the literature review. Internet activities under measurement were selected from the official statistical office of the EU (Eurostat) and more precisely from the Information Society statistics database. Despite that both

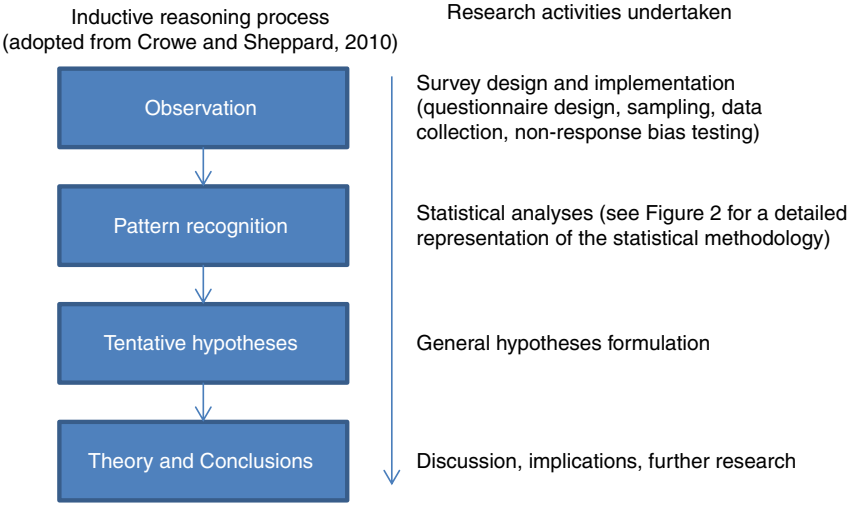

Figure 1.
Research methodology

literature and Eurostat database demonstrate a wide range of online commercial activities, previous studies that explore smaller business ICT adoption (e.g. Matthews, 2007), suggest that firms of this target group do not take advantage of opportunities presented. This inability can be justified due to the challenges faced in their own attitudes toward technology, their capabilities, resources, access, operations and business and social context (Wolcott *et al.*, 2008). Aligning to this proposition it was decided that internet applications under examination should cover only simple activities.

The questionnaire was divided into two sections. The introductory first section aimed at capturing demographic and other – non IT related – information such as the company size in terms of annual revenue and number of employees, firm's region within Greece, the business type and finally customer and supplier origin (Greece or abroad). In addition to demographics, a limited number (three) of other possible issues that might affect internet adoption was included in the questionnaire in order to facilitate the understanding of firms' behavior. The three variables of this category included simple (yes/no) statements concerning: ease of access to relevant infrastructure/IT services (Jennex *et al.*, 2004), affordability of costs firms have to pay in order to setup, maintain and upgrade e-Commerce systems/infrastructure (Solaymani *et al.*, 2012) and existence of organizational understanding/knowledge with regards to what internet can offer to its exploiters (Kshetri, 2007; Taylor and Murphy, 2004).

Section 2, explored firms' as-is ICT adoption status. This part of the questionnaire had two main sub-sections: pc utilization and internet activities. Since this paper focusses on measuring the implementation of internet-based activities, pc applications that do not utilize the web do not rely on the scope of the current study and are excluded from further analysis.

As suggested by Malhotra and Birks (2007), before proceeding to the survey the questionnaire was submitted to a pilot-testing process in order to identify and eliminate undesirable problems including limited comprehension, difficulty, language use and indiscreetness. During this process, six micro-firm managers filled in the questionnaire and were separately interviewed so that their suggestions to be documented.

After completing the interviews a limited number of issues was highlighted and addressed in the final instrument. A point noted as requiring extra attention was that of firms' annual revenue due to confidential considerations. Finally it was decided to use an ordinal variable that grouped ranges of revenue instead of asking responses on precise amounts in an open manner. In addition, it is mentioned that the initial instrument contained 16 of Eurostat's internet activities. Following the suggestions made, the research team excluded six variables (such as Web-EDI) as being too advanced to be applicable. Table I lists the final set of internet activities under examination, which were classified into four generic groups as presented.

All of the above-mentioned activities were stated as simple choice variables having two predefined answers (yes/no). In that way, companies were asked to mention the activities undertaken or services provided without having to considerate the degree of utilization. In prior to the activities question set, respondents were also asked to indicate the frequency of internet usage, by using a four-point scale from "every day" to "never."

4.2 Population definition

The population of interest for this study includes B2B firms classified as very small sized under the EU Recommendation 2003/361/EC (Europa, 2003). Both adopters and non-adopters of internet applications reside in the target group. Moreover, indications emanating from both groups were expected to strengthen the research findings.

Internet activities groups	Internet activities	Corresponding Eurostat activity code[a]
Information-based activities	E-mail	isoc_ci_eu_i (I_IUEM)
	Business information search	isoc_ci_eu_e (E_IMON)
	Data exchange with partners	isoc_bde15disc
Non-commercial transactions	e-Banking	isoc_ci_eu_en2 (E_IBK)
	Public sector transactions	isoc_ci_eg
Web site features	Product promotion	isoc_ci_eu_en2 (E_WEBACC)
	Visitor communication	isoc_ci_eu_en2 (E_SM_PCUQOR)
	After sales services	isoc_ci_eu_e (E_IASS)
Commercial transactions	e-Procurement	isoc_ec_ebuy
	e-Sales	isoc_ec_esel

Note: [a]Code as defined by Eurostat's information society statistics database
Source: Eurostat (2013a)

Table I.
Internet activities under examination

Aiming to avoid operational differences and the consequent different needs that may occur between different types of businesses, it was decided that focussing on a single sector should lead to more solid conclusions. Applying this argument, the Greek jewellery industry was chosen, as a suitable case study of a highly fragmented sector with a large percentage of very small businesses, many of which are involved into B2B transactions supplying a wider sales network. Besides fitting to the micro-sized B2B target group, the selection of this sector was also made upon its importance for both the Greek and the European economies. In 2009, CBI reported that the EU jewellery industry included about 28,800 large and many smaller companies, and that Greek consumers spent on precious jewellery, an EU leading average of €96.9 per consumer and annum (CBI, 2009). In addition, it is one of the industries that have been deeply affected by the economic crisis. The aggregated turnover of Greek jewellery follows a continuous annual reduction that approximates 80 percent in wholesale since 2010. As a result, no more than 1,500 companies exist today, while some years ago there were about 6,500 (Reporter.gr, 2013). Finally, as the valuable gem/metal supply chain is rather global, internet can facilitate by default many of the inherited commercial transactions. Therefore any conclusions drawn can immediately help toward the preservation of this traditional profession.

4.3 The survey

The sample was drawn from the Hellenic Center of Silversmiths' Trade S.A. (HE.CE.SI.T), an authority operating under the auspices of the Ministry of Regional Development and Competitiveness. HE.CE.SI.T database held all industry's company names, as well as postal information and firms' codes according to the European statistical classification of economic activities, which are indications that rely on the business type (manufacturer, wholesaler, retailer, etc.).

From the total of 1,154 database records, 732 firms were found to be manufacturers or wholesalers (B2B firms) and received a questionnaire along with a cover letter and a reply prepaid envelope. During a five-week time period and after a telephone follow-up procedure, 359 fully completed responses were returned. After screening the questionnaires, 178 were eliminated because they were sent from larger, out of target companies, reducing the volume of usable responses to 181. Because of the relatively low relevant (usable) response rate (32.7 percent), non-response bias statistical analysis was conducted following the time trends extrapolation method presented in Armstrong and Overton (1977). In this method, late

respondents are assumed similar to non-respondents and treated as such in order to be compared with (early) respondents. In case of revealing any significant differences, non-response bias is likely to occur. Responses were classified into two groups (early: weeks 2-3 vs late: weeks 4-5) by applying to them a binary variable (early vs late). χ^2 tests were conducted by cross-tabulating this binary variable to the ten internet utilization variables, producing no indications of significant differences at a 0.05 level.

5. Study findings

5.1 Sample responses

All data analysis was conducted using SPSS v17. Before proceeding to the evaluation of the research hypotheses, we provide a brief description of the sample's responses. Table II lists the values assigned to the contextual variables exploited throughout the study and Table III the figures of the statements concerning the perceived barriers firms encounter while adopting internet applications.

The mean value of employees per firm was 3.61 (SD = 2.419), while almost one out of two enterprises (48.1 percent) employed up to two people. Moreover, all firms declared having less than €2M annual revenue and 86.2 percent less than €500K. Firms from Athens, which is the country's largest city, represented 55.2 percent of

Contextual variables	Variable categories	Frequency (% of sample)
Number of employees[a]	1 or 2 employees	87 (48.1%)
	3 or more employees	94 (51.9%)
Annual revenue	Up to €150,000	94 (51.9%)
	€150,000-€500,000	62 (34.3%)
	more than €500,000	25 (13.8%)
Firm's region	Athens	100 (55.2%)
	Thessaloniki	38 (21%)
	Other	43 (23.8%)
Customer's origin	Local	85 (47%)
	Abroad	0 (0%)
	Both	96 (53%)
Suppliers origin	Local	44 (24.3%)
	Abroad	16 (8.8%)
	Both	121 (66.9%)
Business type	Manufacturing	135 (74.6%)
	Wholesaling	46 (25.4%)
Sales strategy	B2B	141 (77.9%)
	B2B and B2C	40 (22.1%)

Notes: [a]Mean number of employees = 3.61, SD = 2.419

Table II. Contextual variables responses

Barrier variables	Variable categories	Frequency (% of sample)
Infrastructure availability as a barrier	Yes	10 (5.5%)
	No	171 (94.5%)
Cost as a barrier	Yes	16 (8.8%)
	No	165 (91.2%)
Understanding/knowledge of internet as a barrier	Yes	45 (24.9%)
	No	136 (75.1%)

Table III. Barrier variables responses

the sample. In total, 74.6 percent were manufacturing companies and the rest 25.4 percent were wholesalers. All firms implemented B2B sales while 22.1 percent of them replied to combine B2B and B2C. In total, 53 percent of the companies declared of targeting to both local and foreign customers and 47 percent that their sales were delimited to the local market. Most firms (66.9 percent) procure from both Greek and foreign suppliers, 24.3 percent only from Greek and 8.8 percent only from suppliers abroad.

Sample responses indicate that none of the three barriers measured constitutes a major problem toward internet adoption. 94.5 percent of the firms stated that enabling technology (infrastructure) is easy to find from the available providers, while cost of buying such products or services is affordable for the vast majority (91.2 percent). The three-quarters (75.1 percent) believe that they are relevant to internet and understand its benefits demonstrating that the lack of knowledge is a barrier to a slightly higher volume of respondents in comparison to the previous two issues.

Table IV summarizes the figures generated by responses with regard to the non-clustering variables including internet access, web site availability and frequency of internet use. Additionally, the same table lists the corresponding descriptive of Greek and European enterprises for the purpose of a brief comparison. Since Eurostat does not provide data with regard to very small enterprises, small firms (< 50 employees) and SMEs (< 250 employees) are used as benchmarks.

Table V presents the descriptive statistics of the ten internet activities measured in our study.

The percentage of companies possessing an active internet connection approached 80.7 percent. This figure falls slightly when compared to the 86 percent of small Greek firms being online indicating that internet penetration in cross-size Greek enterprises is rather similar. However, given that 96 percent of EU small firms have internet access, both very small and small Greek are significantly lower internet adopters. 82.2 percent of firms online utilize internet every day and 15 percent two to three times per week, mainly to support simple information-based activities such as e-mail (93.2 percent), business information search (90.4 percent) and data exchange with business partners (63 percent). Lower participation was presented to non-commercial transactions such as e-Banking and public sector transactions as 47.9 and 42.5 percent of firms with an

Sample descriptive statistics			Greek and EU 2013 descriptive statistics			
Variables	Freq.	% of sample	% of Greek small firms	% of EU 28 small firms	% of Greek SMEs	% of EU 28 SMEs
Internet access	146	80.7	86[a]	96[a]	87[a]	96[a]
Web site availability	66	36.5	58[b]	70[b]	60[b]	72[b]
Frequency of internet use (for the 146 firms with internet access)			Every day	2-3 times/week	2-3 times/month	Never
Frequency			120	22	2	2
% of sample			66.3	12.2	1.1	1.1
% of firms with internet access (firms online)			82.2	15.1	1.4	1.4

Notes: [a]Data from: Eurostat information society statistics database: enterprises – level of internet access (NACE Rev. 2); [b]data from: Eurostat information society statistics database: enterprises – computers: devices and communication systems (NACE Rev. 2)
Source: Eurostat (2013b, c)

Table IV.
Internet access and web site availability

Information-based activities	Frequency	% of total sample	% of firms online
E-mail	136	75.1	93.2
Business information search	132	72.9	90.4
Data exchange with partners	92	50.8	63
Non-commercial transactions	Frequency	% of total sample	% of firms online
e-Banking	70	38.7	47.9
Public sector transactions	62	34.3	42.5
Web site features	Frequency	% of total sample	% of firms with a web site
Product promotion	64	35.4	97
Visitor communication	50	27.6	75.8
After sales services	8	4.4	12.1
Commercial transactions	Frequency	% of total sample	% of firms online
e-Procurement	28	15.5	19.2
e-Sales	20	11	13.7 or 30.3 of firms with a web site

Table V.
Descriptive statistics of internet activities adoption

active internet connection declared adoption correspondingly. In total, 66 companies (36.5 percent of the total sample) replied that they maintain a web site. In contrast to internet access figures, it is observed that in the case of web site availability, very small Greek firms lag behind both domestic (58 percent) and European (70 percent) small firms and thus business size seems to act as an important disabler. These firms utilize their web site mainly to promote their products (97 percent) and to facilitate communication with visitors (75.8 percent). In total, 20 of these firms responded to have incorporated e-Sales mechanisms (30.3 percent) while only eight (12.1 percent) offer electronic after sales services to their clients. Finally, e-Procurement is undertaken by 15.5 percent of the total sample (or 19.2 percent of firms online).

5.2 Cluster construction

Given that the primary aim of the study was to examine whether groups of firms presenting similar internet adoption characteristics could be inductively extracted, cluster analysis (CA) was the most convenient technique to use. CA is a statistical technique that sorts observations into similar sets or groups (Ketchen and Shook, 1996). In the case of this study, CA aimed at grouping firms into coherent groups according to the adoption of the ten internet activities (Table I variables).

The clusters produced were afterwards cross-tabulated to relevant variables and in cases submitted to significance tests in order to evaluate the research hypotheses. The statistical methodology followed is presented in Figure 2.

Before proceeding to CA, original variables were submitted to multiple correspondence analysis (MCA) which is an alternative of principal component analysis or factor analysis when the data are categorical (Abdi and Valentin, 2007). MCA enabled the transformation of the binary variables to quantified measurements (namely dimensions) which is the prerequisite type of CA input (Jain and Dubes, 1988) and eliminated possible multicollinearity issues as any undesired high correlations were removed from the resultant dimension scores (Punj and Stewart, 1983). MCA led to a two-dimension solution with a mean Cronbach's $\alpha = 0.742$ and eigenvalues greater than 1.596, indications of a respectable level of reliability (DeVellis, 1991).

CA was implemented in a two-step procedure as proposed by relevant literature (Hair *et al.*, 1992; Punj and Stewart, 1983). To the first step MCA dimension scores were submitted to hierarchical CA according to Ward's minimum variance method, resulting to an optimum three clusters solution. This outcome remained consistent and

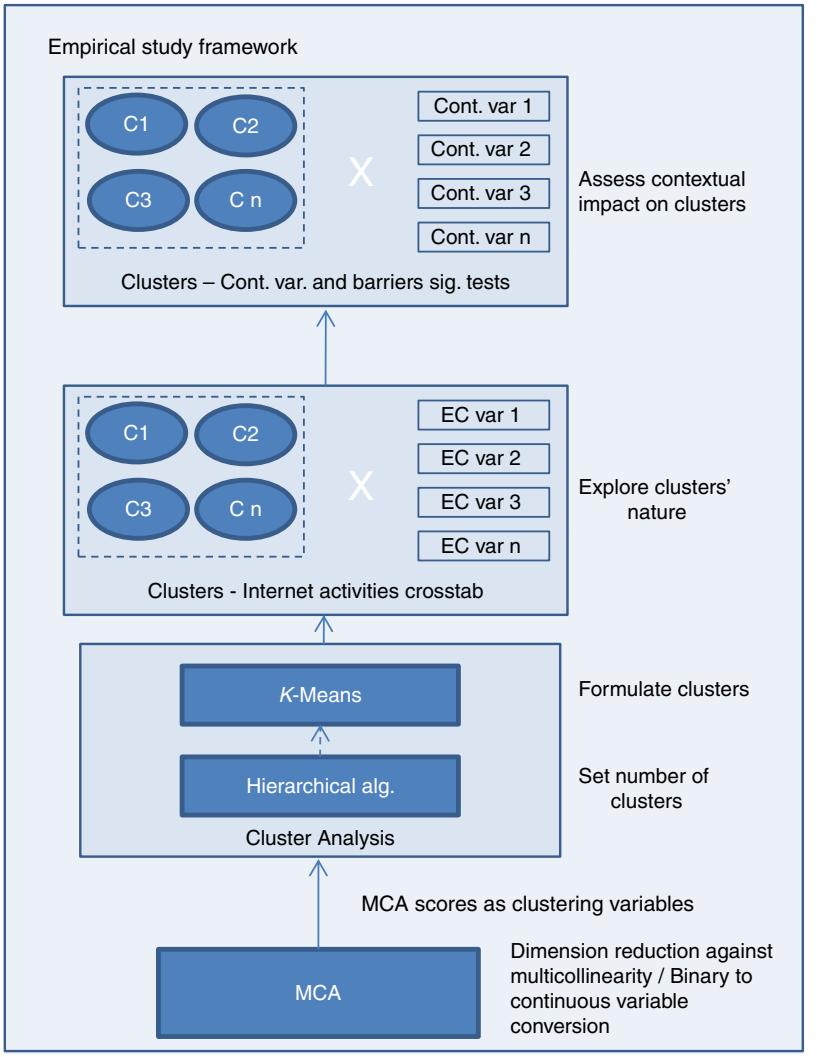

Figure 2.
Statistical methodology

therefore reliable when the methods of "average linkage (between groups)" and "average linkage (within groups)" were used instead of Ward linkage (Hair *et al.*, 1992). To the second step, *K*-means was used in order to classify the 181 sample cases to the three clusters by applying to them a cluster membership variable.

After constructing the clusters, a cross-tabulation between the membership variable and the original internet application variables revealed the three clusters' characteristics, which are presented in Table VI.

The "Uninvolved" first cluster consists of 47 firms (26 percent of the sample) that hardly incorporate any of the activities under examination. This group contains 35 firms with no internet connection and 12 firms that, despite being online, present extremely limited or no internet use. In fact only four activity questions were answered

Cluster	1 (Uninvolved)		2 (Involved)		3 (Evolved)	
Frequency	47		116		18	
% of total	26		64.1		9.9	
	Freq.	% of Cl. 1	Freq.	% of Cl. 2	Freq.	% of Cl. 3
Internet connection availability	12	25.5	116	100	18	100
Every day internet users	4	8.5	100	86.2	16	88.9
Web site availability	4	8.5	44	37.9	18	100
Clustering variables						
Information-based activities						
1 E-mail	4	8.5	114	98.3	18	100
2 Business information search	4	8.5	110	94.8	18	100
3 Data exchange with partners	0	0	76	65.5	16	88.9
Non-commercial transactions						
4 e-Banking	0	0	52	44.8	18	100
5 Public sector transactions	0	0	46	39.7	16	88.9
Web site features						
6 Product promotion	4	8.5	42	36.2	18	100
7 Visitor communication	4	8.5	28	24.1	18	100
8 After sales services	0	0	0	0	8	44.4
Commercial transactions						
9 e-Procurement	0	0	14	12.1	14	77.8
10 e-Sales	0	0	2	1.7	18	100
Applications applied to cluster	4		9		10	
Min/max no. of adopted applications per firm	0/3		2/8		6/10	
Mean applications per firm (SD)	0.34 (0.760)		4.21 (1.623)		8.44 (1.381)	

Table VI.
Cluster composition

positively by four firms in each case. Out of the 12 companies with internet access, only four declared of being every day users.

The second cluster, namely "Involved," comprising of 116 companies (64.1 percent) is the largest of the sample. This cluster consists of frequent web users: 86.2 percent of the firms connect to internet every day and the rest two to three times per week. It appears that these firms' main orientation is to exploit the internet as a communication mean: the most popular activity is e-mail (98.3 percent), followed by business information search (94.8 percent) and data exchange with business partners (65.5 percent). There is also a considerable participation into non-commercial transactions such as e-Banking (44.8 percent) and public sector transactions (39.7 percent).In total, 44 firms (37.9 percent) maintain a web site, mainly to promote their products (36.2 percent), as well as to facilitate communication with visitors (24.1 percent). Implementation of commercial transactions is low with regard to e-Procurement (12.1 percent) and extremely rare (1.7 percent) when considering e-Sales.

In total, 18 companies are assigned to the third cluster (9.9 percent of the sample) which appears to be the most active on the web, and is entitled as "Evolved." All cluster's firms have internet access and maintain a web site for commercial reasons. Moreover, 88.9 percent of the respondents declared to use internet every day. Firms here make extensive use of e-mail (100 percent), business information search (100 percent), data exchange with business partners (88.9 percent), e-Banking (100 percent), public sector transactions (88.9 percent) and e-Procurement (77.8 percent). All companies utilize their web sites to promote and sale their products and to provide communication channels to visitors and almost half of them (44.4 percent) to offer after sales services to their customers.

A simple comparison between firms of the three clusters demonstrates a high differentiation in terms of internet adoption. Cluster 1 firms are mainly non-adopters, firms of cluster 2 can be characterized as frequent internet users when considering simple information-based activities but less frequent or even non-adopters of more complicated applications and finally companies assigned to the third cluster are advanced internet adopters.

Since CA revealed coherent groups of firms, we argue that internet adoption among micro-B2B firms of the jewellery industry can be approached as a model of clusters, each one of them currying unique operational characteristics.

Justification of whether the formulated clusters can be approached as stages of growth should be made after monitoring the actual progress of firms through time in the internet context. Since no such evidence is available, no valid conclusions can be drawn from this study concerning the staged/contingent nature of the model produced.

However, analysis of data in hand reflects in a gradual increase in the use of internet applications when moving up the cluster chain: mean values of activities undertaken per firm are 0.34 (SD = 0.760), 4.21 (SD = 1.623) and 8.44 (SD = 1.391) for clusters 1 to 3 accordingly. Firms of the "Uninvolved" cluster have adopted up to three applications, firms of the intermediate "Involved" cluster between 2 and 8 and companies of the "Evolved" cluster have adopted from six up to the total number of applications under examination. As mentioned by Daniel *et al.* (2002), when considering staged maturity models of internet adoption it is hypothesized that firms of each cluster are expected to have adopted all previous cluster's applications plus some extra, an indication which is presented by the model established. Given the verification of this basic linearity assumption, it can be argued that the three clusters bear a resemblance to stages of growth, even though the migration process has not been explored.

The outcomes of statistical analysis so far, allow expressing the first, tentative, hypothesis of this research:

H1. Internet adoption of micro-sized B2B enterprises can be approached by a pattern, which classifies firms into three clusters ranging from no internet use to relatively intensive web exploitation in a gradual manner.

5.3 Contextual variables and barriers

The exploration of demographic characteristics and barriers impact on firms' clustering position was facilitated by the use of significance tests (χ^2 and Kruskal-Wallis H for categorical and continuous measurements correspondingly). In that manner, tests used aimed at revealing if any of the contextual/barrier variables provided a significant contribution to the cluster assignment. Table VII lists descriptive figures of these variables per cluster, as well as indications of significant correlations.

As recorded, six demographic variables were found to be significantly correlated to the cluster membership: the firms' size in terms of employees and annual revenue, the business type, suppliers and customers' origin.

In the case of business size variables, tests disclosed a linear to linear association with clusters; as the values of personnel and annual revenue increase so does the cluster to which a firm is more likely to belong. So, even within the micro-context, a firm's size is a highly important factor of internet adoption. Moreover, it should be stressed out that the observed deviations are larger when comparing the first cluster to the other two, than this between clusters 2 and 3. Under this perspective, it can be

Issues under examination Contextual variables		Cluster responses 1 (Uninvolved), %	2 (Involved), %	3 (Evolved), %
Employees**	Mean (SD)	1.96 (1.122)	3.98 (2.374)	5.50 (2.854)
Size (⩽2)**	⩽2 employees	87.2	36.2	22.2
	> 2 employees	12.8	63.8	77.8
Annual revenue**	< €150K	85.1	41.4	33.3
	€150K-€500K	14.9	42.2	33.3
	> €500K	0.0	16.4	33.3
Region	Athens	63.8	53.4	44.4
	Thessaloniki	8.5	25.9	22.2
	Other	27.7	20.7	33.3
Business type*	Manufacturing	87.2	73.3	50
	Wholesaling	12.8	26.7	50
Sales strategy	B2B	83.00	74.1	88.9
	B2B and B2C	17.00	25.9	11.1
Customers origin*	Greece	57.4	44.8	33.3
	Greece and abroad	42.6	55.2	66.7
Suppliers origin**	Greece	51.1	15.5	11.1
	Abroad	0.00	10.3	22.2
	Greece and abroad	48.9	74.1	66.7
Possible barriers				
Infrastructure availability is an issue	Yes	6.4	5.2	5.6
	No	93.6	94.8	94.4
Cost is an issue	Yes	8.5	4.3	5.6
	No	91.5	95.7	94.4
Knowledge of internet is an issue**	Yes	63.8	12.9	0
	No	36.2	87.1	100

Notes: *,**Significant at the 0.05 and 0.01 level, respectively

Table VII.
Contextual variables and barriers by cluster

suggested that the extremely small size of a company with an average occupation of two people and annual revenue that does not exceed €150K, implies a major barrier toward internet adoption. As the size increases, a firm is more likely to progress to some kind of web exploitation. Still, it is not safe to argue that an isolated examination of the business size can provide robust evidence of different level of adoption among micro-firms that have already incorporated internet applications.

An aspect of this study that might strengthen the understanding of contextual characteristics effect on internet adoption is that of business type. Even though a significant increase in the percentage of non-productive (wholesale) companies occurs as the cluster category moves from 1 to 3, the substantial differentiation is observed when comparing cluster 3 to the previous two clusters rather than this between clusters 1 and 2. In that case, the enhanced commercial profile of a non-productive company seems to force its managers into implementing a larger number of the available web applications.

With regards to the last significant contributions of contextual variables, more than half of Uninvolved firms responded as cooperating solely with local suppliers and buyers while the observed international cooperation of the other two groups is relatively high. Even though the correlation between the use of the internet and the cooperation with

remote businesses is expectable, what is intriguing is that this association was statistically stronger in the case of supplies than in the case of sales. Still this study is limited to the elaboration of the cause and effect dimension of this phenomenon, as it is not clarified whether cooperation with foreign organizations forces micro-firms to undertake internet activities in order to facilitate communication and transaction or vice versa ICT supports the location of remote suppliers and buyers offering better commercial terms.

Out of the three possible barriers included in the survey, only knowledge with regards to internet issues is following a significantly different distribution of values. Despite the fact that the vast majority of Involved firms (87.1 percent) and all of the Evolved firms stated that are familiar with internet and its benefits, 63.8 percent of Uninvolved firms proved to be unaware of how internet can help them improve their performance in any manner.

As a result, the analysis of demographics' impact on firms' internet adoption leads to the conclusion that the cluster of adoption currently reached by a firm is affected by specific contextual characteristics. Additionally, different degrees of internet utilization are associated with different perceptions of inherent barriers and thus, there is enough argumentation toward expressing the second hypothesis of this study:

H2. The cluster of internet adoption currently reached by a micro-B2B firm depends heavily on its size, importing activity and awareness of web's value proposition and to a lesser extent on its type and exports.

5.4 Comparison to previous SMEs' and large firms' exploratory models

The adoption model produced was submitted to a comparison with four earlier models retrieved from literature. In order for this benchmark to be as thorough as possible all studies use samples drawn from different enterprise size/type/origin populations. In accordance to ours, the studies are inductive and the adoption patterns have been generated by analyzing internet applications utilization under a similar statistical approach. The first study provides a reference with regards to the North American SME B2B firms (Sila and Dobni, 2012) while the second targets pan-European cross-size B2B companies (Caniato *et al.*, 2009). The third model chosen is that of Daniel *et al.* (2002) as a good representative of earlier research on the field of SMEs' internet adoption patterns. Finally, the selection of the fourth study (Papastathopoulou and Avlonitis, 2009) aimed to facilitate the understanding at the national level, by comparing the patterns of the Greek smallest and largest firms, respectively. Consolidated data of the five models is presented in Table VIII.

Micro- and larger firms B2B patterns present similar scaling structure consisting of three clusters ranging from low, to medium, to high level of adoption. Given that the three studies concerning B2B firms are relatively recent (2014, 2012 and 2009), it can be argued that modern B2B internet adopters can be classified into these three groups no matter of their size or place to which they are established. However a substantial differentiation regards the proportion of firms positioned in the upper level: while a percentage of approximately 40 percent of larger firms (SMEs and large) seem to have fully adopted internet and e-Commerce, only a mere 9.9 percent of micros has incorporated internet activities to a relatively wide range of operations. The immaturity of the micro-sized firms also emerges from the lowest adoption group. Despite presenting almost identical concentration when compared to the European B2B population (27 and 26 percent, respectively), it constitutes from companies that are actually disconnected from the internet, rather than low adopters. The same conclusions arise when comparing the results of our study to the corresponding values of Daniel's research. What is intriguing in

Dimension	Model				
	Panayiotou and Katimertzoglou	Sila and Dobni (2012)	Caniato *et al.* (2009)	Daniel *et al.* (2002)	Papastathopoulou and Avlonitis (2009)
Sampling					
Firm size[a]	Micro (EU recommendation)	US SMEs (< 500)	Small (< 250) Medium (< 500) Large (> 500)	SMEs (EU recommendation)	Medium and large (EU recommendation)
Firm type	Jewellery industry/B2B	B2B	Manufacturing B2B	Cross-type	Cross-type
Location	Greece	North America	Europe (13 countries)	UK	Greece
Adoption model construction					
Clustering variables	10	7	8	16	14
Type of pattern	Staged[b]	Staged[b]	Staged[b]	Staged	Hybrid (staged/contingent)
Clusters formulated/ concentration of values	Uninvolved: 26% Involved: 64.1% Evolved: 9.9%	E-laggard: 16.2% E-limiteds: 47.6% E-leaders: 36.2%	Low adopters: 27% Partial adopters: 33% High adopters: 40%	Developers: 6.7% Communicators: 23.1% Web presence: 34.7% Transactors: 35.6%	WWW Experimentalists: 23.8% E-transaction Adopters: 13.6% E-purchasers: 10.3% Information seekers: 37.9% E-merchants: 14.4%
Affecting factors (statistically significant)					
	Size, extroversion, business type, internet knowledge	Network reliability, scalability, top management support, firm-trading partner trust, pressure from competition, complexity, hostility	None (Variables tested include industry, company size, and position in the supply chain No factor found to affect the choice of e-business adoption strategy)	Percentage of B2B/ B2C sales, percentage of sales in the UK/ exported	Market characteristics (demand uncertainty, intensity of competition), organizational characteristics (process formalization degree, employees' commitment to change), demographic characteristics (industry, size)

Notes: [a]As defined by the EU recommendation or by authors, in terms of employee; [b]the staged type results from the gradually increasing adoption of internet applications between clusters. It is not stated by authors that future adoption will follow a linear path

Table VIII.
Internet adoption models comparison

this pair is that even though UK SMEs were measured more than a decade before, their adoption levels seem to be a step forward than these of nowadays' Greek micros. The observed digital divide might be explained by the combination of the Greek market immaturity when compared to the British firms' entrepreneurship and the general "e-lag" of ultra small firms against larger corporations.

Focussing in the Greek context, large firms' as-is adoption strategies are more complicated than this of micros as they comprise of two more types and combine the maturity and the contingent orientation in a hybrid manner. Still, the percentages of firms assigned to the low, medium and higher classes, respectively, present only a minor deflection and thus the overall distribution is rather common. These two indications are leading us to the conclusion that despite the different internet adoption strategies followed by domestic large and small firms, the total Greek enterprise population does not align to international firms' adoption.

Internet adoption affecting factors examined by each study are conceptually scattered and therefore it is not possible to assess their impact across the five different populations. However, discussion over the issues measured in our study concludes to the following:

- Business size is a significant factor only in the cases of the two Greek studies, while Caniato *et al.* (2009) and Daniel *et al.* (2002) found no significant contribution of this measure on the positioning of firms.
- In any form reported, business extroversion (exports/imports) boosts internet adoption for either micros or SMEs (assessed by Daniel *et al.*, 2002).
- Business type and industry are affecting the Greek firms more than they do to the European or the UK populations (assessed by Caniato *et al.*, 2009; Daniel *et al.*, 2002).
- Internet knowledge was measured only in our study. However, larger firms are expected to maintain an IT department or person handling all relative issues and therefore it is assumed that they are more familiar than micros.

6. Conclusions

6.1 Concluding remarks

This is one of a very few studies that focus on exploring the internet business initiatives of very small B2B firms. The important role of micro-firms in the Greek and the European market in general as well as the high potential benefits that these firms can achieve through the use of web technologies were the main driving forces for the accomplishment of the research. Despite its preliminary nature, the results of this study set the basis of future attempts toward the understanding of micro-firms' internet adoption and in particular with regard to B2B companies of traditional handcraft industries.

The responses of a sample drawn from the Greek jewellers industry were analyzed and a model which classifies firms on the basis of their current internet application adoption was empirically constructed. The three clusters emerged present gradually increased exploitation ranging from no internet use to the implementation of relatively advanced applications. In that sense, our findings seem to confirm the staged approached, even though monitoring of the actual migration process is an objective of future research.

The structure of the model is consistent to previous models that target larger B2B companies' internet adoption, but different from these of large domestic enterprises and cross-type SMEs. However, as the overall adoption of enabling technology is low and, in most cases, limited to the simplest of available applications, it is argued that

traditional micro-firms do not fully take advantage of the opportunities internet offers and thus these firms do not seem to keep up with the larger companies.

An extra point that might differentiate micros from larger corporations emerges from the sequence in which supply chain transactions are adopted. In the case of SMEs and large firms, e-Procurement and e-Sales are either indiscriminately implemented or they serve a specific up/downstream strategic focus. In contrast, it is observed that micro-firms initiate their engagement to web-enabled commercial transactions from e-Procurement before proceeding to the adoption of e-Sales mechanisms. This phenomenon can be partially explained by the enhanced power of the larger suppliers over the micro-firms and their ability to "motivate" them to use their existing electronic trading channels. Additionally, buying online is an easier task since it usually does not require any infrastructure investment or special knowledge on the buyer side. So, assuming the linear progression of internet adoption as valid, we expect micro-firms to start purchasing over internet, probably from their existing foreign suppliers, and as their familiarity with web transactions increases to develop their own downstream channels.

Factors found to apply a significant effect on the firms' current adoption include company size and type as well as cooperation with foreign businesses. Firms that do not implement internet activities are mainly manufacturing organizations employing two people in average that operate within the domestic market, while advance adopters are significantly larger companies presenting higher levels of cooperation with international partners. It is interesting that even the "Uninvolved" firms did not mention cost as a barrier and thus all micro-companies seem to be financially capable of acquiring the necessary infrastructure. However, the smaller firms seem to lack the necessary knowledge with regards to how internet tools can facilitate their operations. What can be assumed here is that the smaller the firm, the less likely is for this owner-centered type of organization to be experienced enough to identify, select and implement the supporting technology. It is our belief that government bodies and trade associations maintain a key role in shifting the entrepreneurial culture and business environment toward the digital economy by informing small business owners and encouraging more forward thinking in this regard.

6.2 Research implications

In accordance with previous authors suggesting that there is a significant impact of business size on internet adoption, we believe that micro-firms should be distinguished from SMEs in general when researching relevant issues. Despite the plethora of research that focusses on SMEs' internet adoption, there is a significant literature lack with regards to empirical studies that interpret adoption issues of the smallest business size. Trying to address this gap, this is the first study that provides an inductive internet adoption model for micro-B2B firms and one of a very few field studies that focus on this business size. Despite its limitations, the research undertaken contributes to the understanding of micro-firms' internet exploitation with regards to which web applications are currently adopted and to what degree, what types of firms are the most/least active adopters and finally, how these two research dimensions combine to give a comprehensive model of internet adoption.

In more detail, this study contributes to the continuous academic discussion of the process that companies follow when adopting the internet. At this moment, the model constructed provides a valid as-is classification scheme rather than an accurate maturity model of adoption progress. However, the constitution of the groups in terms of the observed applications per cluster tends to resemble the staged approach similarly to previous adoption patterns that target cross-size B2B firms. Should this assumption be

correct, further progression of micro-firms can be approximately predicted as firms are expected to follow a linear internet adoption path.

Out of the vast volume of contextual variables that have been measured as adoption causes, our study assesses only a few of the most common ones. Still, significant impacts have been highlighted with regards to most of the measurements, indicating that the overall organizational/operating context of micro-firms forms a major factor toward web adoption and therefore it should be included in relevant analyses. Moreover, as the typical web inactive profile of a B2B micro-firm constitutes of an ultra small size organization (≈2 employees) that operates in the domestic market, it is our belief that future studies aiming to enhance internet adoption should elaborate around the proposition of possible ways that could enable self-employed firms engage in internet initiatives.

6.3 Practical implications

As already mentioned, very small firms are rarely the focal business segment of academic interest, probably due to the simplicity of their operations. Despite the preliminary nature of our study, we address this issue and produce information that, we believe, is usable and will set the basis of future research attempts.

Given that the sample was drawn from one industry sector, the most robust practical implications emerge arguably for this very business sector. Taking into account the overall similarity of the jewellery industry when compared to other handcraft sectors, it is rather safe to argue that the model established is very likely to provide an adequate abstraction of other Greek handcraft industries that mainly consist of micro-B2B firms.

Moreover, our internet adoption model provides a conceptual tool that might assist the aims of both business owners and public authorities, each one in a different manner. Business owners can position their firms to one of the groups of adoption and act correspondingly. Those of the lowest group (Uninvolved), may understand that firms being more active have gained benefits from internet initiatives. Involved firms can plan their future adoption by taking into account what next level firms have already implemented. Finally, given the similarity of the adoption patterns developed for cross-size B2B companies, Evolved firms may get ahead and follow the paths established by larger SMEs by implementing more sophisticated, e-Commerce applications. Concerning all cases, the adoption of internet might provide access to new markets and thus to help micro-firms to increase their revenue or lower their costs.

Finally, we have highlighted a major barrier toward internet adoption that can be confronted by public authorities: this of the lack of knowledge with regards to the internet and its benefits. Despite the fact that the necessary infrastructure is available and affordable, business owners are not aware of the value that internet can offer. Relevant governmental initiatives should be planned in order to properly inform micro-firms aiming to increase penetration and the value-added for both businesses and the state. Additionally, our study provides statistics that are not available to either the Greek or the European statistical authority, since micro-firms are excluded from official surveys.

6.4 Further research

As a following stage of our current research, firms that participated in the current survey will be re-contacted in order for their actual progress in the cluster chain to be evaluated. This information will facilitate the assessment of model's linearity and therefore will verify (or not) its staged nature. After completing the second part of the

research, the pattern established should be validated by taking into consideration its current sampling limitations, such as the industry-specific focus and the regional distribution of firms.

Other future research should also attempt to enhance the model by increasing the volume of variables used in order to construct the model and by including more contextual and organizational characteristics that may interpret firms' decisions with regard to internet adoption. It is noted that the above-mentioned research activities might subject the current model to changes with regard to the number of adoption clusters and the activities found in each one of them.

Finally, a comprehensive multidimensional framework is yet to be developed, containing additional factors that determine firms' adoption, such as benefits currently realized by firms of each cluster, benefits expected and barriers encountered when undertaking more sophisticated internet activities.

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