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MOBILE COMMUNICATIONS TECHNOLOGY IN RURAL SOCIETIES OF DEVELOPING COUNTRIES

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ABSTRACT

This paper examines the potentials and pitfalls of Mobile Communication Technology and analyses the factors affecting positively or negatively adoption of the technology. A two-step cluster analysis was employed to explore the strata of mobile communication technology adoption. Data were collected through a survey questionnaire from a cross section of 490 rural residents in the EU-designated Less Favoured Area of Western Macedonia, Greece. Five rural residents' profiles were outlined which differ in terms of several socio-economic characteristics while several potentials - pitfalls of using mobile communication technology were discussed. The stratification of rural population into clusters and the identification of the motives driving them to adopt mobile communication technology or not is suggested as a way of integrating such technologies into rural development policies in Less Favoured Areas of developed countries.

Introduction

During the last two decades, mobile communications technology (MCT) has greatly expanded, especially in urban centres of developed countries. Today, more than ever before, MCT diffuses around the world faster than any other previous technology, becoming a valuable tool to strengthen social networks and to access new business and employment opportunities. Consequently, MCT offers unprecedented possibilities for economic development and progress, especially in developing countries and in underdeveloped regions of developed countries. Mobile phone ownership in most developed countries is currently almost universal among urban people under the age of fifty, while rural residents and farmers are among the least likely to own a mobile phone (Wims, 2007).

There is a growing literature presenting evidence of the important role MCT can play towards economic development, entrepreneurship and social networking in developing countries (Jonathan and Escobar, 2010; Hossain, 2010; Valk *et al*., 2010; Grøtnes, 2009). However, the role of MCT in Less Favoured Areas (LFAs) of developed countries has received little attention in the literature. According to Koutsouris (2006), much of the related literature ignores the '*last mile of connectivity*', namely the fact that on a world-wide scale rural areas are lagging behind in

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terms of access (Paisley and Richardson, 1999). Nevertheless, there is still an important technological and communicational gap between LFAs and the rest of the country, especially for certain groups of rural residents. Moreover, there are several research findings that underline the need to approach the adoption/diffusion of MCT in LFAs with caution. In particular, constraints relating to physical access, such as poor infrastructure and high costs, are quite common. Moreover, recent research results from Asian developing countries (Demiryurek, 2006; Koutsouris, 2009) support the generalisations of diffusion theory, i.e. that there are positive relations between MCT adoption and rural residents' socio-economic characteristics and communication behaviours.

It is well documented that communication is closely linked to one's independence, well-being and quality of life, especially in remote and marginalised areas (Afza and Rashid, 2009). In addition, MCT positively affects agricultural development (Patel, 2010; Zhang *et al*., 2007). In particular, MCT adoption has resulted in increased farm revenue through improved communication with suppliers, buyers, producers and other stakeholders (Hazell and Wood, 2008).

Technologically, MCT offers several advantages for LFAs compared to other communication technologies. According to Wei and Zhang (2008), due to limited computer use in LFAs and ease of network deployment compared to wired communication services, MCT offers benefits that extend its function from an audio telephony device towards a full internet and data communication device. In addition, the lack of wired communications infrastructure and the high cost of such infrastructure deployment provides MCT with a comparative advantage as the most efficient communication technology for remote and uneven terrains (Madden and Coble-Neal, 2008). Evidence from developing countries shows that where wired telephony was never established, MCT quickly became the dominant means of communication, providing a technological leapfrog that makes undeveloped regions competitive in the twenty first century (Al-Khasawneh, 2010; Chong *et al*., 2010; James, 2010). Thus, the adoption of MCT of isolated populations in LFAs of developing countries is an issue of great importance for the economic development of these regions (Akpabio *et al*., 2007).

Specifically for Greece, related research is limited to only three papers addressing the issue of utilisation of communication technology by farmers or rural residents. The first (Alexopoulos *et al*., 2010) aimed at identifying the existence of a 'digital divide' within rural areas in Greece. The second paper (Michailidis et al., 2010) aimed at exploring farmers' use of several information and communication technologies (including MCT) and their views on preferred extension methods, utilising survey data in an LFA. Finally, the third paper (Koutsouris, 2009) aimed at presenting a brief review of the evolution of the '*digital divide*' concept followed by an outline of research findings showing an urban-rural divide.

The main aim of this paper is to analyse the characteristics of rural residents in a LFA of a developed country and employ clustering analysis to segment the rural population in groups based on their MCT adopting behaviour. Using a sample of rural residents from an EU-designated LFA in Northern Greece, we analyse the distinctive characteristics of MCT adopters. The results corroborate Rogers' adoption theory (Rogers, 2003) and draw interesting insights for policymakers. More specifically, the clustering analysis provides a valuable tool to policymakers for designing rural development policies specifically aimed at each cluster. The second aim of this paper is to examine the potentials and pitfalls of MCT development and

to analyse factors positively and negatively affecting the adoption of such technology.

Overall, empirical findings support, to various degrees, Rogers' (2003) socio-economic theory about innovators and early adopters. Nevertheless, taking into account that policy initiatives based on strategies of group segmentation and differentiation might be more effective and less expensive than generic policy measures, further research is needed especially related to the segmentation of rural population in terms of attitudes towards a suite of potentials and pitfalls of MCT as well as to the examination of change drivers in MCT development in rural areas.

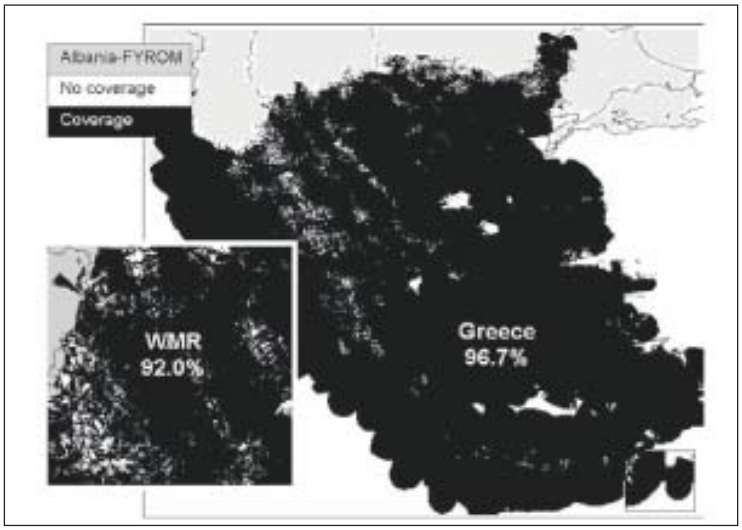
Methodology and Study Area

The region of Western Macedonia (WMR) is one of the thirteen Greek regions that belong to the EU-designated LFAs (European Environmental Agency, 2005). In the European Union, LFA is a term used to describe an area with natural handicaps (lack of water, climate, short crop season and tendencies of depopulation), or that is mountainous or hilly, as defined by its altitude and slope (OECD, 2001). The study area is located in the northwest part of Greek Macedonia (Figure 1) and comprises four Prefectures, Florina, Kastoria, Kozani and Grevena.

Figure 1 : Study Area-Western Macedonian Region

The study area has been selected as it is one of the least developed regions in terms of MCT network coverage. According to the most recent data provided by the three Greek mobile telecommunication companies (Cosmote, 2010; Vodafone, 2010; Wind, 2010), the network coverage for the study area (WMR) approximates 92.0 per cent which is significantly lower compared to 96.7 per cent, the coverage rate for the whole Greek mainland and islands (Figure 2). In addition, the bandwidth in the area is not sufficient and mobile communications are often intermittent and of poor quality. Thus, the study area is not only a LFA but is also one of the most isolated and marginalised Greek regions in terms of mobile communication potentiality.

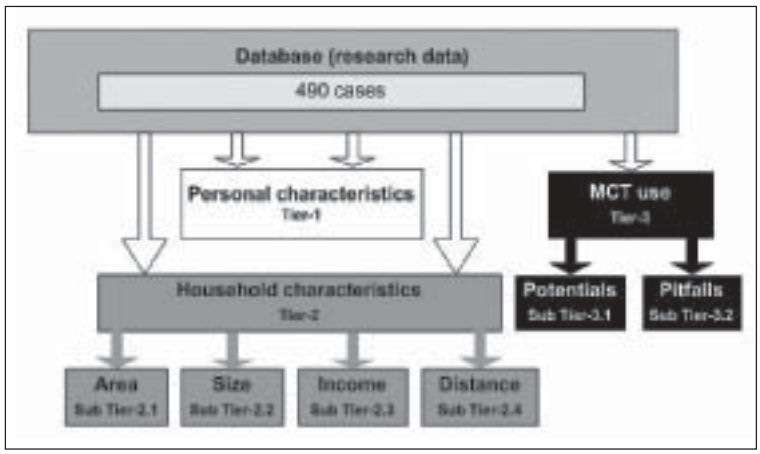
Figure 2 : Network Coverage Map of the Study Area (authors' estimates)



Data were collected through a mail-out/ telephone response questionnaire survey. Initially, all questionnaires were mailed out in batches of 30 per week between June 2007 and February 2008. In the following week after which a batch of questionnaires was mailed, respondents were contacted by telephone and asked if they would like to participate. Respondents could either complete the forms on their own and return them by post, or respond over the telephone. By April 2008, 490 responses had been received from 1,000 questionnaires sent, an overall response rate of 49.0 per cent, and assembled into a database.

From a technical-architectural point of view, the design process of the questionnaire is divided into three levels of functionality (Figure 3). These three levels consist of: (a)

Figure 3 : Database Functionality



the section that provides information about personal or demographic characteristics of the respondents [Tier-1], (b) the section that provides information on household characteristics [Tier-2], including the area section that fractions the research cases according to areas (Prefectures) [Sub Tier-2.1], average size (persons) [Sub Tier-2.2], income (median monthly) [Sub Tier-2.3] and distance from urban centres [Sub Tier-2.4] and (c) the use of MCT [Tier-3], including the prospective potentials [Sub Tier-3.1] and pitfalls [Sub Tier-3.2].

The questionnaire was mainly designed to record issues related to rural life and especially to determine the extent of MCTs' impact on rural development. In particular, some critical questions in the survey were formulated in order to elicit data on respondents' use of MCT and their views on several prospective and desirable changes, following the literature and the special characteristics of the study area. In addition, in order to encourage participation and minimise the cognitive burden on respondents, most questions were framed in *Likert* scale intervals.

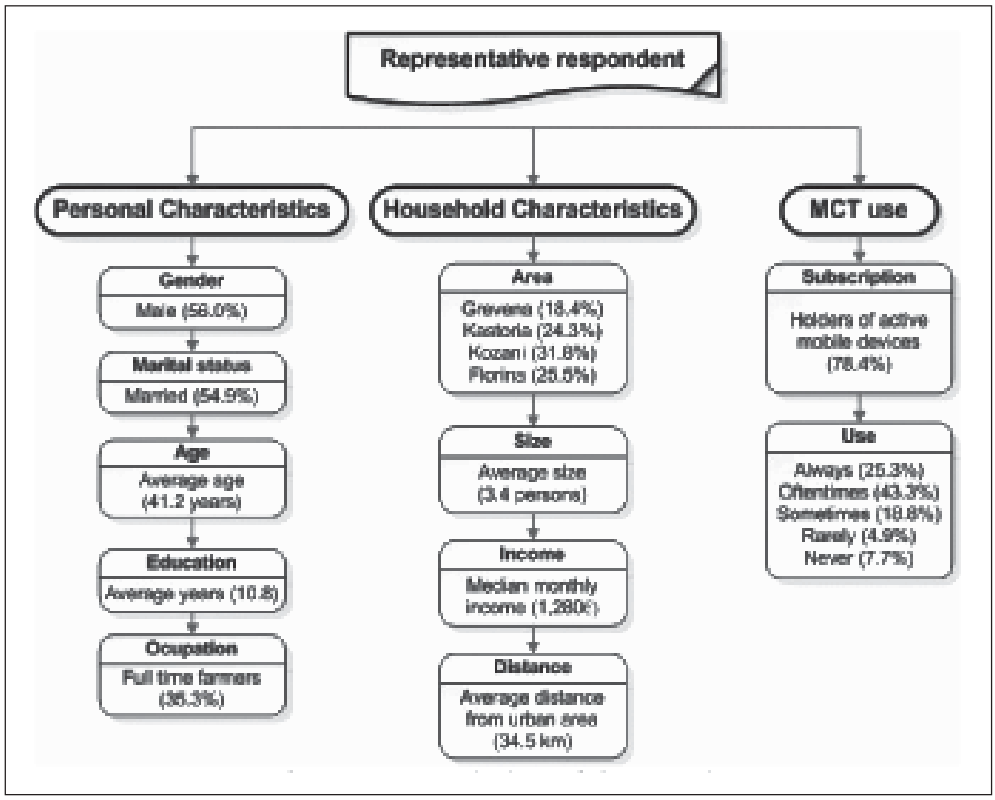
Data were analysed by employing both summary statistics and multivariate techniques. In particular, a two-step cluster analysis was first employed to explore the strata of mobile communication technology adoption and use and a binomial logit model was then employed to explain the variation in adoption rates. The two-step cluster method is a scalable cluster analysis algorithm designed to handle large datasets and categorical variables, as well as attributes. Although it requires only one dataset it follows a two-step procedure: (a) pre-clustering of the cases into many small sub-clusters and (b) clustering of the obtained sub-clusters into the desired number of clusters. However, it can also automatically select the number of clusters. Furthermore, a binomial logit regression was estimated for each stratum to find out possible relations between the levels of MCTs' adoption and a set of selected predictors. The specific version of the applied binomial logit model can be seen as a special case of a general utility maximisation model (Jimenez and Salas-Velasco, 2000; Cramer, 1991; Bishop, 1977; Radner and Miller, 1970).

Data Analysis and Results

According to the sample summary statistics (Figure 4), the representative respondent of the study area is male, 41.2 years old, married, with 10.8 years of primary education who lives in a household with approximately 3.4 members. Most rural residents are part-time farmers, only one-third (35.3 per cent) are full-time farmers, and have a median net monthly income of • 1,280. In addition, majority of respondents come from the prefecture of Kozani (31.8 per cent) while the average households' distance from an urban centre is 34.5 kilometres. Finally, more than two-thirds of the sample members (68.6 per cent) use systematically (often or usually) MCT and 78.4 per cent of them are owners of mobile devices.

Using statistical frequencies, the whole sample is segmented into five representative groups of residents with similar levels of MCT use (Table 1): (a) always or usually, (b) oftentimes, (c) sometimes, (d) rarely and (e) no MCT use. Elaborating the answers further, we found some interesting differences among the five profiles of respondents in terms of income, age and education (Table 1). Younger residents of middle and high income households with more than eleven years of primary education are more likely to use MCT than the older residents of upper income households with less than eleven years of education, while no significant variation was found among residents' profiles in terms of gender and distance from the nearest urban

Figure 4 : Description of the Sample



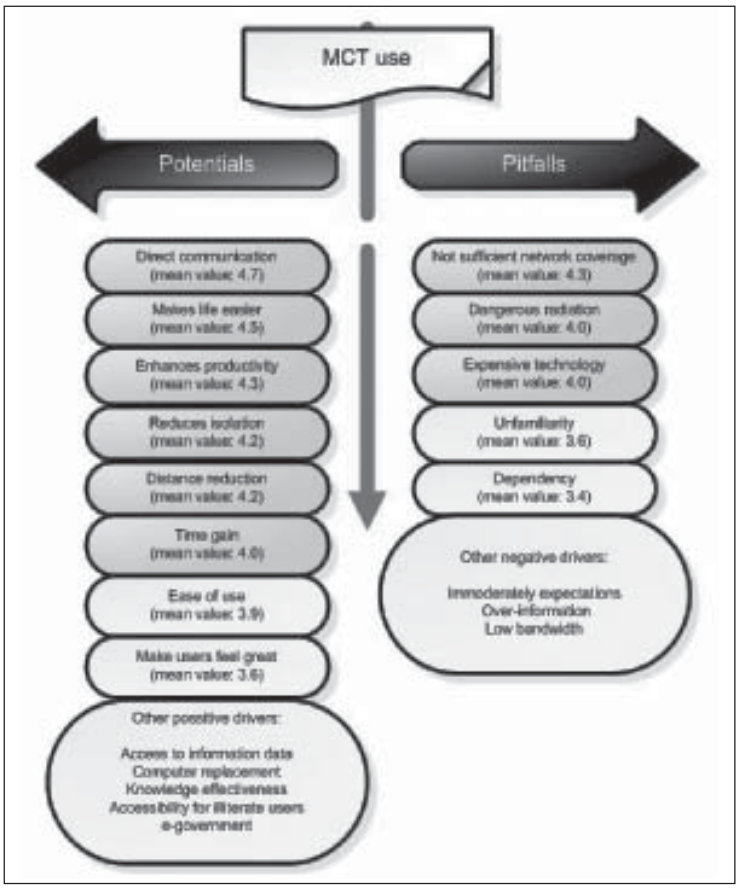
centre. In fact, income differences play a major role in explaining the variations of MCT use among rural areas, more than the area itself, and lower levels of income are consistently shown to be associated with Information and Communication Technologies (ICTs) inequalities in the literature (Verdegem and Verhoset, 2009; Andre *et al*., 2010). What really matters in both rural and urban areas is income, as Bell *et al.* (2004) show, middle and upper income people are more likely to use MCT and ICTs.

Table 1 : Profile of MCT Users

	Never (38 cases)	Rarely (24 cases)	Sometimes (92 cases)	Oftentimes (212 cases)	Usually (124 cases)
Male (%)	59.1	61.2	60.2	54.9	52.7
Household monthly income (•)	950	1,000	1,050	1,350	1,500
Average age (years)	51.4	43.6	42.4	41.2	36.7
Years of education (years)	9.6	9.9	10.2	11.0	11.4
Distance from the nearest urban area (km)	34.1	33.9	34.4	34.6	34.7

However, the relative advantages of using MCT are usually followed by some other absolute disadvantages (Warren, 2007). Towards this statement a paramount finding of this research is the disclosure of several positive drivers of MCT adoption and some other negative drivers of MCT rejection. For this purpose, they selected the previously proposed by Moseley and Owen (2008) drivers of change after the necessary adjustments to the specificities of the study area. Participants were then asked to indicate their level of agreement or disagreement to the selected drivers giving an internal value for each one of them (1=strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree and 5=strongly disagree). Figure 5 quantifies and ranks the major positive drivers of change (potentials) as well as the major negative ones (pitfalls) using the mean value of responses.

Figure 5 : Potentials and Pitfalls of MCT Use



Mean values and rankings clearly demonstrate the potentials of MCT use as there is a strong positive relation between MCT use and six prospective and desirable benefits (mean valuese $\geq$ 4.0) : (a) direct communication, (b) makes life easier, (c) enhances productivity, (d) reduces isolation, (e) reduces distance and (f) time gain. Besides, respondents support that MCT use additionally enforces some secondarily other positive

changes (mean values<4.0). On the other hand, results also demonstrate some pitfalls of MCT use (mean valuese≥4.0): (a) not sufficient network coverage, (b) dangerous radiation and (e) high cost of usage. Among the less significant negative changes are (mean values<4.0): unfamiliarity, dependency, immoderate expectations, over-information and low bandwidth.

Using clustering methodologies it is possible to categorise the rural residents based on their attitudes towards a suite of MCT's adopting reasons (statements). In particular, employing a two-step cluster analysis, based upon the agreement level of the thirteen attributive items of the Table 2 (1=strongly disagree, 2=disagree, 3=neither agree nor disagree, 4=agree and 5=strongly disagree), the respondents were classified in some discernible clusters in order to explore the different levels of MCT's adopting behaviour. SPSS V.17 for Windows (SPSS, 2008) was

Table 2 : Distribution of Observations in Each Cluster

Statements	Adopters			Rejecters	
	1st cluster (34, 6.9%)	2nd cluster (111, 22.6%)	3rd cluster (184, 37.6%)	4th cluster (108, 22.0%)	5th cluster (53, 10.8%)
I believe that MCT improves my life	-	111/197 (56.4%)	-	-	-
I believe that MCT enhances my productivity	-	87/93 (93.5%)	-	-	-
I want to be the first to adopt new technologies	34/46 (73.9%)	-	-	-	-
Others are asking me for advice on new technologies	29/35 (82.8%)	-	-	-	-
I feel very comfortable with new technologies	33/89 (37.1%)	-	-	-	-
MCT reduces the isolation of rural residents	-	107/216 (49.5%)	-	-	-
I want to learn more about MCT	-	-	122/203 (60.1%)	-	5/203 (2.4%)
I don't understand how to use MCT effectively	-	-	56/99 (56.6%)	-	30/99 (30.3%)
MCT is expensive	-	-	-	-	47/83 (56.6%)
I believe that MCT shines dangerous radiation	-	-	-	79/99 (79.8%)	-
I believe that the MCT network bandwidth is not sufficient	-	-	-	32/56 (57.1%)	-
I mainly use my mobile phone to access/ send information (data)	18/34 (52.9%)	-	-	-	-
I use my mobile phone as a computer replacement	24/38 (63.2%)	-	-	-	-

Numbers in parentheses express the ratio of variable's observations in each cluster to the total observations of each variable.

employed for the multivariate statistical analysis of the dataset (490 cases). The two-step cluster method extracted automatically the optimal solution of five clusters. According to Table 2, majority of respondents (184 or 37.6 per cent) were included in the third cluster, 111 of them (22.6 per cent) in the second cluster, 108 of them (22.0 per cent) in the fourth cluster, 53 of them (10.8 per cent) in the fifth cluster and finally 34 of them (6.9 per cent) in the first cluster.

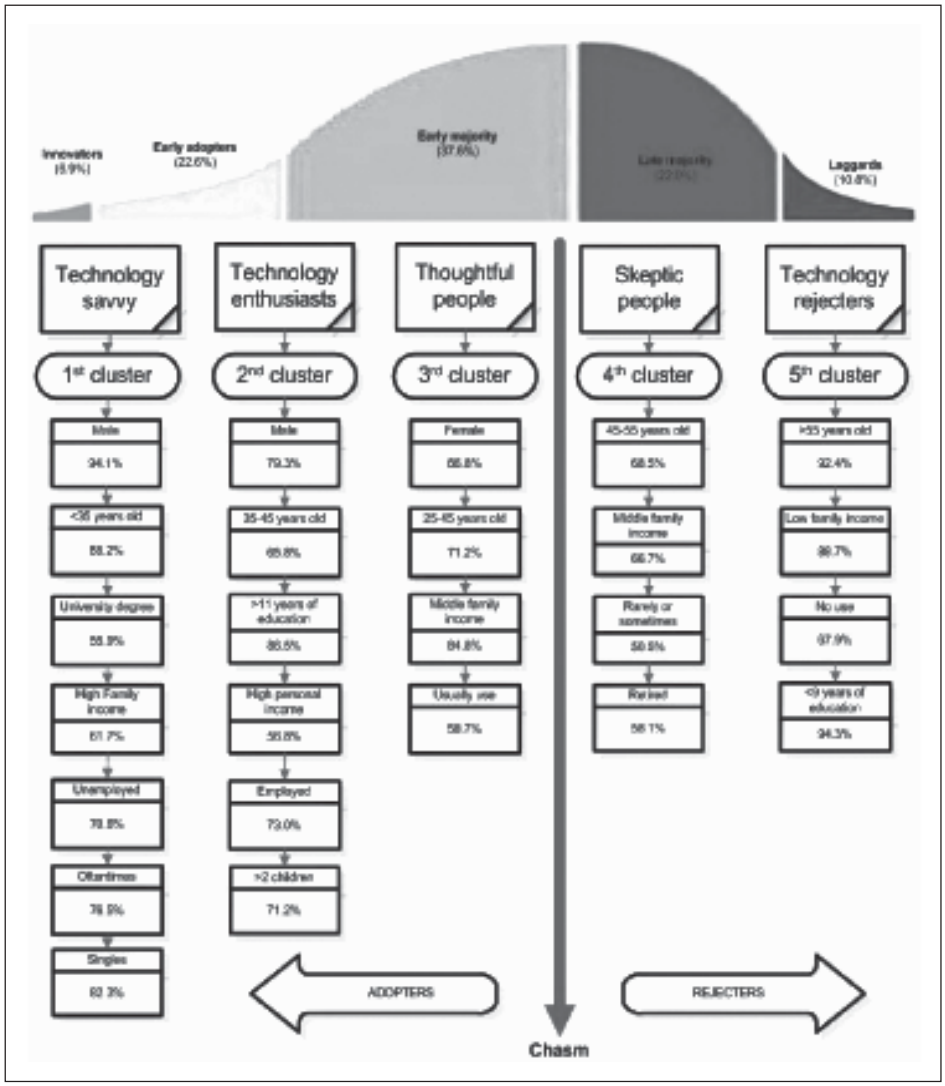
Regarding the distribution of observations in clusters, depending on the reasons of MCT adoption, the first cluster is constituted mainly by "*technology savvies*" who want to be the first to adopt MCTs and other people looking to them for advice about new technologies (Table 2). The "*technology savvy*" segment was very comfortable with new technologies while the "*savvies*" were likely to use their mobile phones to access/ send information (data) or as a computer replacement. The second largest group was identified as "*technology enthusiasts*" and were characterised as being enthusiastic adopters on MCT because it makes life easier, enhances their productivity and reduces the isolation of rural areas/residents. The largest category, "*thoughtful people*", were characterised as recognising that they needed to learn more about MCT because they do not understand how to use MCT effectively. The fourth cluster, the "*sceptic people*", were categorised as being those who believe that MCT shines dangerous radiation while the network bandwidth is not sufficient. The residents of the final cluster were identified as "*technology rejecters*" and were categorised as being those who pretend that MCT is expensive. Although, many of them admitted to not understand new technologies, they showed very little interest in learning about them.

The paramount socio-economic attributive characteristics (PAC) of MCTs' adoption in each cluster were inquired using Kruskal-Wallis and Mann-Whitney tests (Figure 6). The analysis shows that the residents of the first cluster were mainly a youth segment with 88.2 per cent aged less than 35 years and 55.9 per cent of them hold a university degree while the majority of them are singles (82.3 per cent) and unemployed (70.6 per cent). There was quite a strong male bias, as well as a bias in favour of the higher family socio-economic grouping in terms of income. Although, MCTs' subscription was typical of this group, the "*technology savvies*" do not always (or usual) use their mobile phones but just occasionally.

The "*technology enthusiasts*" had also a male bias (79.3 per cent), although smaller than the "*technology savvy*" ones while the majority of them were employed outside agriculture. High personal income, more than eleven years of primary education and more than two children in their household were typical characteristics of this group, as well as a large proportion of this group was aged between 35 and 45 years. The predominant distinguishing characteristic of the "*thoughtful people*" was the high level of mobile phone usage compared to other clusters. In addition, middle family income was a typical feature of this group while a large proportion of the residents of the group were female, aged between 25 and 45 years. "*Sceptic people*" were quite older (45-65 years old), retired (58.1 per cent), with middle family income while this segment is characterised by rather rare use of mobile phones. On the other hand, the "*technology rejecters*" did not tend to use mobile phones or their use was very low. Majority of them were over the age of 55 years, with low family income and less than nine years of primary education.

The segmentation is sufficiently close to Rogers (2003) socio-economic generalisations of adoption/diffusion theory (Figure 6). More specifically, the "*technology savvy*" can be characterised as "*innovators*" (brave people,

Figure 6 : PAC of MCTs' Adoption in Each Cluster



pulling the change), the "*technology enthusiasts*" as "*early adopters*" (respectable people, opinion leaders, try out new ideas but in careful way), the "*thoughtful people*" as "*early majority*" (careful but accepting change more quickly than the average), the "*sceptic people*" as "*late majority*" (will use new ideas or products only when the majority are using it) and finally the "*technology rejecters*" as "*laggards*" (traditional people, caring for the "old ways", are critical towards new ideas and will only accept it if the new idea becomes mainstream or even tradition).

The concept of adopter categories is very important because it shows that all innovations go through a natural, predictable and sometimes lengthy process before becoming widely adopted within a population (Surry and Ely, 2002). However, in our case the

"big scary chasm" is not located between "early adopters" and "early majority" (Cho *et al*., 2009; Moore, 1991) but one step further (Figure 6). Thus, crossing this "chasm" is closely related to the shift from rejection to adoption.

Following the empirical econometric model is employed to relate factors that influence patterns of MCT use by rural residents. This is achieved by using MINITAB for Windows, release 14.1.3 (MINITAB, 2006). MCT use is treated as a separate decision process and it is analysed using a discrete choice model that relates the use probability to the factors of Table 3. In particular, a binomial logit model identifies the importance of determinants of MCT use by sample strata (Madden and Coble-Neal, 2003). More specifically, the dependant variable "use", splits the sample in two sub-groups: (a) MCT users (=1: always, oftentimes or sometimes) and (b) MCT non-subscribers (=0: rarely or never). The selection of the eighteen independent explanatory variables of Table 3 was based on prior analysis of MCT networks while it is adapted to the research area particularities (Madden and Coble-Neal, 2003; Madden *et al*., 2000; Kridel *et al*., 1998; Madden *et al.,* 1998; Rappoport *et al*., 1998).

Table 3 : Model Variables and Description

Variable	Description
Price	Cost of MCT subscribe and use (monthly estimations)
Employment status Family status	1=employed, 0=unemployed1=married, 2=otherwise
Gender	1=male, 0=female
Distance	Distance between respondent residence and the nearest urban centre (in km)
Income	Annual income
Education	Years of general education
Devices	Number of MCT devices used
Persons	Number of persons residing in the households
Tertiary	1=degree qualified, 0=otherwise
Personal computer Internet	1=existence of personal computer, 0=otherwise 1=internet access, 0=no internet access
Young residents	Number of residents aged under 18 years
Age	Respondent's age
Cable telephony	1=existence of cable telephony, 0=otherwise

In order to explore some different drivers of MCTs' use among rural residents the sample has been stratified in three general groups of respondents based on their occupation: (a) farmers, (b) entrepreneurs and (c) other cases. About one-third (35.3 per cent) of the respondents are full time farmers while 11.6 per cent of them manage small enterprises and the rest 53.1 per cent are employees or occupied in several other vocations. The

importance of this sample stratification clearly demonstrated by the model results as the drivers for MCT use are significantly different for these strata (Table 4).

Table 4 : Model Estimates

Model	Variable	Coefficient	t-ratio
Farm model	*Constant*	-0.94	-1.86
	Age	1.39	1.94
	Distance	0.47	0.88
	Cable telephony	1.57	3.21
	Persons	0.41	1.12
	Observations	*173 (35.3%)*	
Rural enterprise model	*Constant*	-1.08	-2.31
	Gender	0.14	0.63
	Tertiary	0.13	0.41
	Employees	0.14	0.78
	Devices	0.93	1.85
	Observations	*57 (11.6%)*	
Rural household model	*Constant*	-0.98	-2.20
	Price	1.44	2.83
	Employment status	0.99	1.76
	Young residents	1.36	2.58
	Income	0.52	1.63
	Observations	*260 (53.1%)*	

More specifically, the *farm model* suggests that MCTs' use is driven mainly by "cable telephony" and "age" variables. In particular, "cable telephony" indicates that the lack of cable communication opportunities works as a driver of MCTs' use whereas "age" demonstrates the different levels of MCTs' use between younger and older farmers. On the other hand, in the *rural enterprise model*, the only significant driver is "devices" which most likely captures the need for mobile communication. The explanation of MCTs' use in the *rural household model* is more complex and related to "price", "employment status" and "young residents" variables. The importance of presence of a resident under eighteen years old implies the increased value of MCT for young population while "price" indicates that low cost communication technologies are most likely to be adopted in households and "employment status" demonstrates the different levels of MCTs' use between employed and unemployed residents.

Conclusions

This paper has described the penetration of MCTs among rural residents in a LFA of rural Greece and has discussed the initiatives to diffuse mobile communication for rural development activities. It is apparent from the study results that considerable strides have been made in MCT in recent years. Actually, rapid MCT "explosion" facilitates access to urban and international markets and has been responsible for a moderate to high degree of rural systems changes. Above all, LFAs have experienced noticeable improvements in the quality of life mainly due to rapid growth of capacity for communication. In addition, MCT reduces "isolation" and "distance" and therefore, helps rural populations improve productivity and time use. On the other hand, the use of MCT is not limited to direct communication but it has expanded to other practical applications of rural extension such as to access/send data or as a computer replacement. However, there is still a widespread concern about the possible effects of MCT use on the health of residents, suggesting that it is an urgent requirement for MCT users to clear up the issue of radiation. Moreover, residents of the study area support that the cost of MCT is still high enough, the network coverage is limited and the bandwidth is not yet satisfied. Unfortunately, without the necessary infrastructural development which includes broadband, rural residents could continue to be marginalised when it comes to MCT adoption.

In Greece and many other developed countries, the driver of MCT coverage has been prioritising access to urban areas that are densely populated and have high economic activity. Thus, the more marginalised rural areas tend to have lower MCT density per capita. While investment in some rural areas has gradually begun to improve MCT access and coverage, in most areas it continues to be limited. So promotion of public policies that support sustained investment, consistent access and wide coverage is necessary. However, development of MCT services must respond and adapt to the special needs of rural people and their communities, while also taking into account individuals' skills to use and take advantage of the services and applications in the field. In this work, two sample stratification efforts were made in the paper based on adoption behaviour and employment of participants. Results clearly demonstrate the importance of sample stratification, as the drivers for MCT use are entirely different among these strata. Thus, the input of new policy measures, in order to encourage or take advantage of the use of MCT, should be specifically targeted towards these segments of the rural population, taking into account the specificities of each group.

The present study has several implications, both theoretical and practical, since its empirical results support the basic argument of the thesis that MCT covers significant needs of rural residents and therefore, causes significant changes in remote and marginalised areas. With growing awareness of mobile telephony in rural areas, the forthcoming technology is expected to reduce costs of information access, to play a role in planning and setting up systems for rural development, to place greater emphasis on rural enterprise and to be used in a more systematic manner to share user-generated multimedia content describing local knowledge. For example, using short messaging services (SMS), policy makers can disseminate information to the rural population more extensively and in a more efficient manner (e.g. news and market prices of agriculture; early warning of conditions and weather threats; and information on disasters and how to mitigate them). In addition, farmers can easily make inquiries and receive updated price data simply by sending a text message. Finally, the latest mobile technologies (Mobile

GPS, MMS, 3G and others) can facilitate the development of innovative services for applications in precision agriculture, geo-traceability, management and control plant and animal health and other areas.

Concluding, we believe that the more detailed analysis of MCT adoption and use sheds light on the structural changes in social and human behaviour between rural areas and cities, but also on the principles and mechanisms that enable these changes. Such results will advance the conceptual framework in the social sciences and economics and may result in new approaches to public policy.

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