Increasing economic growth through dynamic radio spectrum management policies

GEORGE MASTORAKIS
Department of Commerce and Marketing
Technological Educational Institute of Crete
Kakridi and Palama Street, Ierapetra, 72200, Crete
GREECE
gmastorakis@staff.teicrete.gr

Abstract: - The current global move to switch from analogue to digital terrestrial television technology has opened up an opportunity for the re-allocation of valuable radio spectrum resources. In one way, radio spectrum once used for analogue television will be completely cleared and in another way, digital terrestrial television technology geographically interleaves parts of radio spectrum to avoid interference between neighbouring TV base stations. This process liberalizes valuable TV radio spectrum, introducing the notion of digital dividend and leaving space for deploying new wireless networks services by small telecommunications players. In this context, this paper studies dynamic radio spectrum management policies and investigates new radio spectrum opportunities, as well as the economic potential and business strategies, towards leveraging entrepreneurship. Following this study, secondary markets for radio spectrum trading are examined and incentives of both primary and secondary telecommunications players are analyzed.

Key-Words: - Economic growth policies, radio spectrum management

1 Introduction
Information and Communication Technology (ICT) markets throughout the world economy are characterized by a high level of economic and technological dynamics. Sophisticated digital technologies have created large markets in which data, voice, video and audio are transmitted through wireless and wired networking infrastructures. ICT economic dynamics received a boost after market liberalization of fixed-line telecommunications and mobile networks technologies, while the growing development of ICT products contributed to a higher economic growth [1], expanding the Internet and reinforcing international trade and growth in many countries [2]. From the European Union’s (EU) perspective, the Lisbon Strategy [3] envisions towards the provision of ubiquitous mobile broadband multimedia services and Internet access for all European citizens, even in the most dispersed locations.

Moreover, there is a global move to switchover from analogue to digital terrestrial television, namely digital switchover (i.e. DSO) process. Although DSO is underway in the EU, this process is differently completed from country to country, depending on the configuration of the market. It is predictable that the request by the European Commission for completion of DSO process in 2012 will be difficult to achieve in a number of EU countries. Due to the efficiency of digital terrestrial television, radio spectrum (i.e. range of frequencies) used for analogue television will be totally cleared and made available for usage by other wireless networks. Additionally, spectrum allocation in digital terrestrial television networks is such that a number of additional frequencies (i.e. geographically interleaved spectrum) remain unused in given geographical locations, so as to avoid causing interference between neighbouring transmission stations. The cleared spectrum and the unused geographically interleaved spectrum (i.e. digital dividend), provide a unique opportunity to deploy sophisticated wireless networks. For the European Commission, digital dividend [4] is a great opportunity to achieve important objectives of the EU Lisbon strategy [3], especially regarding the provision of ubiquitous mobile broadband Internet services.

Market analysis proves that digital dividend is a unique opportunity to realize economic and social benefits, leveraging entrepreneurship and maintaining competitiveness across EU countries, while initiatives of small business secondary markets in ICT sector lag behind in Europe in comparison to the rest of the developed world. A very little progress has been in developing
frameworks for secondary usage of ICT resources (e.g. radio spectrum), enabling trading between primary and secondary wireless network systems at European level. Additionally, digital dividend could be valuably employed by cognitive radio (CR) networks [5], which are a key enabler for real-time spectrum trading markets [6], established among licensed (i.e. primary network operators) and unlicensed (i.e. secondary network operators) spectrum wireless network systems (e.g. small businesses). Secondary CR network operators dynamically gain access to unused spectrum, through a trading process, established between primary network systems and then operate in a non-interference basis, at time intervals and locations when and where it is possible for them to transmit, while achieving optimum quality of services provided to end users. Currently CR networks are intensively investigated for proper access to TV White Spaces (TVWS) [7], which become available in a geographical basis, after the digital switchover. Moreover, Radio Spectrum Policy Group (RSPG) released a report [8] that makes clear comments on the possibility of supporting spectrum trading mechanisms for CR networks. This report elaborates on vertical and horizontal policies, regarding trading of spectrum among primary and secondary market players. At a global level, the active secondary trading of spectrum is still more a concept than a reality. There are a number of landmarks that could mark the start of secondary trading of radio spectrum worldwide. Specifically, New Zealand started spectrum trading in 1987, Guatemala in 1996, Australia commenced in 1997 and both the Federal Communications Commission (i.e. FCC) [9] and Ofcom [10] adopted regulations for spectrum trading in 2004. However, very little progress has been achieved in the economic/business and regulatory development of an active secondary trading environment between primary and secondary ICT market players, which might be considered in TVWS. The development of secondary trading systems in EU countries has been slowed, in comparison to other developed countries. In this case, research activities envision, bridging this gap by investigating mechanisms for secondary spectrum trading and proposing relevant means to allow a secondary treatment for the spectrum in European context.

For the successful development of dynamic spectrum trading mechanisms and market policies for wireless network services in TVWS, the intersection of influences from regulatory, technology and market potential aspects, is needed to be analyzed and studied. For this purpose, this paper elaborates to investigate the economic potential of digital dividend, towards leveraging/boosting entrepreneurship of small business players in ICT sector, by exploiting a dynamic radio spectrum management policy. Following this introductory section, the following sections elaborate on the entrepreneurship potential of digital dividend for small businesses and investigate secondary markets for spectrum trading, while the last section concludes the paper by elaborating on fields for future research.

2 Leveraging Entrepreneurship Potential of Digital Dividend

Digital dividend has been studied over the last years, especially regarding the opportunity to introduce new wireless network technologies (e.g. CR networks) and services [11], [8], [12]. The economic potential and the resulting social dimension in Europe, stemming from a wise management of digital dividend, has been also highlighted [13], [14] and a number of its possible uses by small business players, such as local digital terrestrial television networks, mobile TV systems, wireless broadband network, public safety and cognitive radio systems, have been identified. Due to the differences and particularities of each European country, the demand for each of these potential digital dividend uses can vary considerably. For instance, it is expected that the exploitation of digital dividend for the provision of digital terrestrial television services, will generate € 750 bn to € 850 bn in net present value (NPV) for the European economy. Furthermore, the optimum coverage and features of the wireless networks, operating on digital dividend, are undoubtedly of great interest to key stakeholders in ICT market and will require a common approach and harmonization of actions, in European countries. In this respect, the conservative trend in Europe is to allocate a portion of digital dividend to mobile telephony networks, estimating to generate from € 63 bn to € 232 bn NPV and evaluating benefits for a period of 20 years. A further extension is likely to be evaluated at a second stage, after the reassessment of the market, considering data regarding the demand, market development and technological innovations.

In a broader perspective, the market can be analyzed under different scenarios (e.g., pessimistic, conservative and optimistic), in which the main key drivers are the digital terrestrial television, the wireless broadband services demand and the relationship between them. These parameters are then interpreted into financials figures, considering
a specific allocation of digital dividend for each possible uses of technology. In order to quantify the prediction of growth and demand for wireless broadband services, towards interpreting direct and indirect economic benefits, the models are using measurable key activities, such as video (i.e. streaming and downloading data in minutes per month), navigation (i.e. pages per month), music (i.e. tracks per month), e-mail (i.e. number of messages per month), mobile TV (i.e. minutes of data per month) and other business applications. The direct benefits are those, resulting from direct consumption of mobile broadband services and are divided into the cost/benefits, due to the producers and those due to consumers. For producers of mobile broadband services, directly benefits mainly result from the reduction of network costs. If these cost savings were retained by operators or their shareholders, this would add to the producer surplus. However, since this market is very competitive, it can safely assume that almost 100% of the cost savings are ultimately passed on in price changes. Reduced prices for mobile broadband services will facilitate the increased use of consumer services and the incremental benefit to consumers or consumer surplus is the additional use in conjunction with lower prices for the current year. Indirect benefits result from the indirect effects of the market for those services have on other product markets and, consequently, may further increase total surplus of consumers and producers. For instance, some of the additional revenues from mobile broadband services could be derived from marketing or incensement of electronic commerce and not only by the subscribers. However, especially for the marketing revenues, they do not represent an economic benefit but a financial flow or an expense by the advertiser as part of his marketing strategy, which leads to higher sales and profits for producers in other parallel markets. Externalities are the wider economic benefits for society as a whole, and not taken into account by the consumer or producer when selling the product or service. These will include increased productivity of workers, since small business applications will be available easier and more efficient ways to produce additional jobs will exist, strengthening the related industries, etc. Furthermore, as a further social adds on, the improvement of quality of service can be considered as well as the enhancement of the safety and security related applications that promote a better quality of life for citizens.

3 Digital Dividend Markets for Cognitive Radio Networks

3.1 Secondary market spectrum trading

The active secondary trading of spectrum is still more a concept than a reality and there are several milestones that mark the inception of secondary spectrum trading in the global context. FCC [9] and Ofcom [10] adopted spectrum trading regulations in 2004, while a very little progress has been achieved in the economic/business and regulatory development of an active secondary spectrum trading environment for micro trades in TVWS context. The most schemes in existence include spectrum licenses that are issued in the form of spectrum rights, in terms of geographic scope, network resources availability and duration. These licenses are partitionable or fragmentable in terms of space, spectrum allocation and time. In many cases, change of use is allowed so long as it does not cause interference to the existing neighboring licenses. Even it may be acknowledged that these initiatives mark a step change in the way, in which spectrum is traded from the preceding 80 years of "command and control" style regulation, they still fall well short of what can be considered an active or liquid market for spectrum, especially regarding small business participation.

Australia has been a leader in liberalization of spectrum regulation and the promotion of market-based systems for assignment of spectrum licenses. The Australian secondary market has manifested itself, as an after-market that allows for the correction of initial offerings of spectrum. Thus, economic efficiencies can be realized, when unused or under-used spectrum is made available to other ICT players (e.g. small businesses) and uses without regulatory intervention. This market among primary and secondary ICT players, is very much based on bilateral spectrum trading. In this context, in order all possible gains to be achieved from trade (e.g. gains such as spectral and/or economic efficiency), mechanisms must be introduced that will allow spectrum trading parties to interact with each other on a multilateral basis with low transaction costs. In May 2007, Google proposed to FCC what it called a "real-time airwaves auction model", which would allow a spectrum license holder to auction off unused spectrum to bidders on a wholesale basis. This model is based on Google online advertising auction, in which enterprises bid on the placement of their ads on Google's search engine based on how much they are willing to pay per user click through to their websites. A real-time auction policy will
allow small enterprises to enter in spectrum market, have access to TVWS and be charged based on spectrum utilization [15]. However, no real-time systems have been introduced, accommodating micro trades (i.e. trades of licenses that cover small geographical areas such as a TVWS area or which cover durations of less than a day).

A competitive secondary market enables participants to discover the price of spectrum at the required grade or quality of service. Several solutions have been proposed for the dynamic internal pricing of spectrum, such that wireless network resources usage is maximized with regard to the demand placed by end-users [16]. Furthermore, the notion of a spectrum broker, which manages the allocation of spectrum, according to price in mobile telephony networks, has been presented as a policy, which can maximize the value extracted from a licensed part of spectrum [17]. Presently, the secondary market is one that consists of notification to the regulators, approval or denial of requests to trade and the transfer of ownership of physical assets (e.g. network infrastructure) when a trade occurs. However, with CR networks, the rate of change of ownership of rights will continually increase, demanding a more nimble rights management system. Mechanisms for searching, conveying, deciding and then enforcing and monitoring policy have already received much attention and many are suited to the application for the modalities of a trading scheme.

3.2 Secondary Spectrum Markets Initiatives in Europe

Secondary spectrum markets initiatives in Europe generally lag the rest of the developed world since there has been very little progress in the development of comprehensive frameworks for secondary trading of spectrum at European level. There does not appear to be any active industrial engagement with secondary markets. However, the EU, through its various agencies, has made some basic progress in laying the initial regulatory groundwork for secondary markets in the Member States and the RSPG has also begun to address the concept of spectrum trading for CR networks.

Also, EU Commission issued a communication to the Council and Parliament [18], referring to the aims of the revised Lisbon agenda, namely that the vision of the community is one a “common and coordinated removal of restrictions” which would help to promote an “open and competitive digital economy”. The broad framework for the secondary trading of licensed spectrum, which falls along the lines, mirroring the implementations of the FCC, would generally allow for the re-sale or lease of licenses, in whole or in part, subject to certain restrictions.

Furthermore, RSPG was of the opinion that European harmonization of spectrum trading rules should not be introduced until the Member States of EU have greater experience of secondary spectrum trading [19]. These experiences should be notified to, and shared with, the EU community. In essence, the RPSG call for more local experimentation and trialing of market-based initiatives, before there is any attempt at full European harmonization.

Furthermore, the UK’s Ofcom has been to the fore in leading the development and trialing of spectrum trading initiatives, which generally mirror the approach undertaken by the FCC. Recent data released by Ofcom shows that between 2007 and 2009, the number of trades had risen from near-zero to over 600, whilst the number of tradable licenses had risen from near-zero also to just over 200 [20]. In this latest consultation document, Ofcom has begun to explore regulatory changes that will be necessary to facilitate a more nimble and liquid spectrum market. It should be noted that spectrum leases are generally given by a license to a sub-license for a limited period after which the rights revert to the original license. In essence, it is reducing the transaction costs for the traders. Whilst still at an early stage of consultation, Ofcom foresee the possibility of entities, called band managers, which would allow a license to commercially exploit its spectrum holding through spectrum trading. As such, the responsibilities of the band manager could include: planning the use of the licensed spectrum (or the TVWS), packaging the spectrum for disposal through trading, engaging with the market to trade the spectrum and acting at the first point of contact for dispute and interference resolution.

The implications of trading are now also pervading discussions of emerging technologies, such as CR networks. The RSPG published a draft of a report on CR technologies [8], which makes explicit comment on the possibility of supporting trading mechanisms for CR technologies. This report describes two policies for the licensed sharing of spectrum; vertical and horizontal. The vertical policy, envisages the licensed user (i.e. the digital terrestrial television broadcaster), allowing secondary usage of its spectrum at locations and times that it is not used. This description closely corresponds to TVWS. The RSPG does not foresee the need for any significant regulatory intervention, supporting a vertical sharing regime beyond actually making the spectrum tradable and making the usage conditions
flexible, such that they allow uses not necessarily covered by the primary license. More specifically, the report considers that the important aspects of any negotiations, for both the primary licensee and the cognitive radio, are issues of guaranteed access and quality of service parameters for both parties. The horizontal policy, on the other hand, involves the pooling of the all parts of spectrum held by a group of licenses, such they can then access that spectrum according to their given demand profiles. This type of trading regime allows primary licenses to release spectrum that is underused to others for a payment, or to top up on their existing holding when experiencing excess demand. This policy would only seem to be of interest in areas in which the primary licensee experiences fluctuations in demand for its spectrum/services which is not the case in digital terrestrial television networks. The exception to this may occur under mobile broadcasting scenarios (i.e. mobile TV broadcasts), when a broadcaster is catering for a large irregular event, such as a major sporting event, and requires extra spectrum to deliver more temporary channels. Additionally, the RSPG in the European Regulators Group (ERG) has undertaken a study on possible competition issues that may arise in a liberalized spectrum regime, which allows for spectrum trading, considering that when spectrum markets are more fully liberalized, the prospect of success for anti-competitive action is diminished. Basically, the more spectrum that is made tradable and flexible, the more expensive it is for any individual or group of enterprises to hoard spectrum, such that they can dominate the price and range of services on offer. TVWS offers another avenue, by which anti-competitive trends can be achieved. If TVWS can be exploited as tradable and flexible spectrum, then it further expands the range of spectrum available over which key services can be provided. In turn, this increases the difficulty of for large players to dominate a market or develop market-abusive strategies. Moreover, in spite of the lack of specific regulatory clarity surrounding the development of trading initiatives in the TVWS, the existing WAPECS directive [21], which underpins regulatory developments in the member countries for a number of spectrum parts, provides a clear framework for the development of technology and service neutral licensing of spectrum. Such licensing is a fundamental building block for any trading system on which a secondary market will be developed.

4 Conclusion

Currently, there is a global move to switch from analogue to digital terrestrial television technology, opening up an opportunity for the re-allocation of valuable radio spectrum resources. Due to the efficiency of digital terrestrial television systems, parts of TV radio spectrum once used for analogue television will be completely cleared or geographically interleaved, liberalizing valuable radio spectrum resources (i.e. digital dividend) and leaving space for deploying new wireless networks services by small telecommunications players. Digital dividend has a great potential, towards leveraging small business entrepreneurship and acts as a unique opportunity for Europe to meet the growing demands for spectrum, particularly regarding the provision of wireless network services in rural areas and dispersed locations. Therefore, it can contribute significantly to achieve targets on increasing competitiveness, economic growth, as well as boosting small business development, satisfying some of the important social, cultural and economic needs of EU citizens. In this context, this paper studies digital dividend and liberalized TV radio spectrum availability, elaborates on its exploitation under a dynamic management approach and investigates the economic potential and business strategies, towards leveraging entrepreneurship. Following this study, secondary markets for spectrum trading are also investigated.

References:


