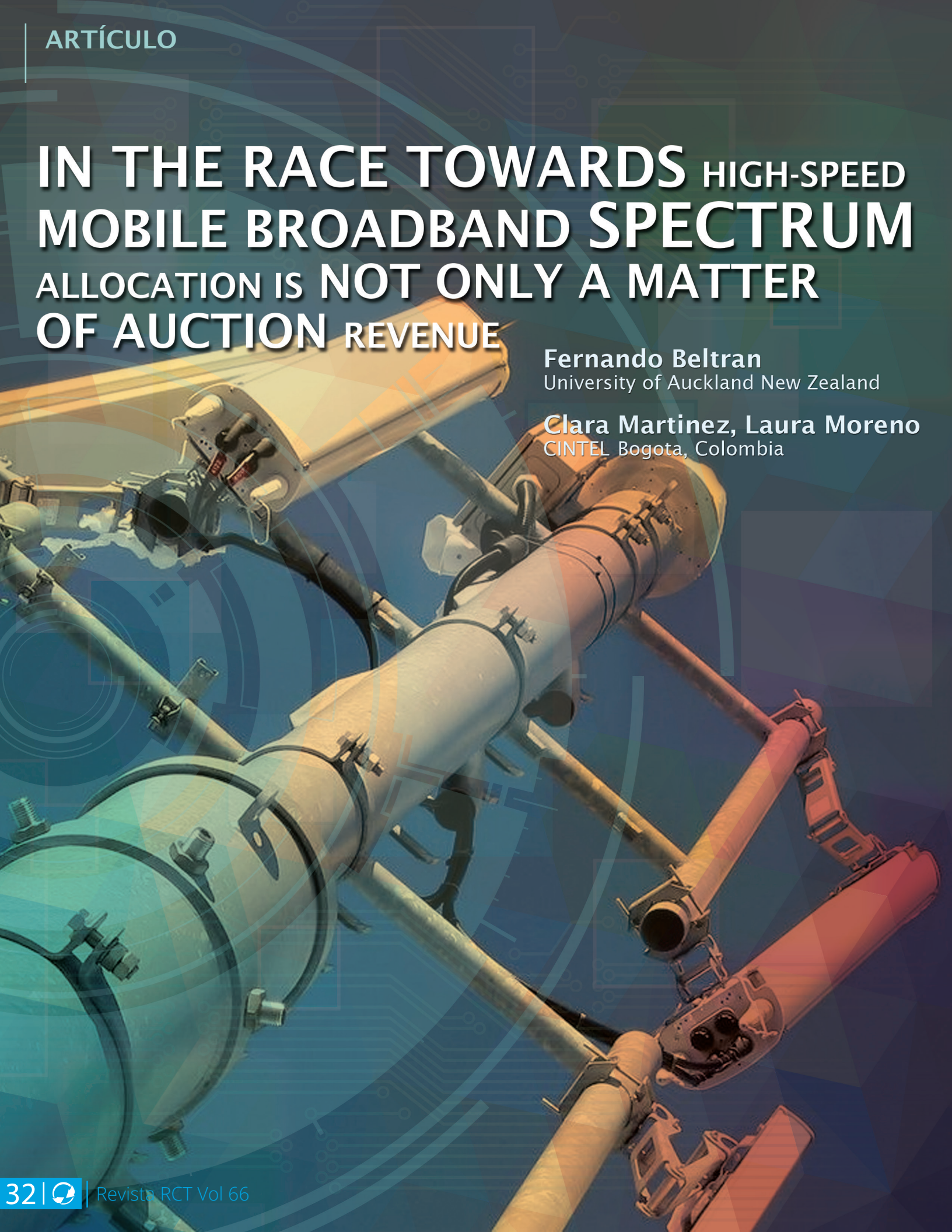
IN THE RACE TOWARDS HIGH-SPEED MOBILE BROADBAND SPECTRUM ALLOCATION IS NOT ONLY A MATTER OF AUCTION REVENUE

Fernando Beltran
University of Auckland New Zealand

Clara Martinez, Laura Moreno
CINTEL Bogota, Colombia



Abstract

Inspired by the Colombian mobile telecommunications market, this paper reviews the process by which a government's spectrum agency decides on the allocation of new spectrum bands to the mobile communications markets, including 4G and mobile broadband. It discusses the elements the spectrum agency needs to consider in order to build an analytical framework that helps assess the most important issues that may have a potential impact on the efficient allocation of spectrum and, consequently, on future market development.

1.Introduction

Traditionally there has been a quasi-prescriptive approach to spectrum allocation (Cave, Doyle and Webb, 2010), by which the regulator decides on the use of a band maintaining control and ensuring interference is minimized. This can be achieved because the regulator can design the license terms appropriately.

One of the principles of the spectrum allocation and assignment problem is that it must be efficient. Efficiency can refer to how the allocation can maximize the ability of the spectrum to accommodate technically similar services in adjacent bands, which allows fitting more users into a given amount of spectrum. The latter is known as technical efficiency. On the other hand, efficiency can refer to the regulatory objective of maximizing the benefits that society obtains from assigning the spectrum; this is known as economic efficiency (Cave, Doyle and Webb, 2010).

The most popular mechanism for assigning spectrum bands is the auction. Efficiency equates to deeming winners those who can make best use of the spectrum. When the auction is over and results are known, an ex -post interpretation would argue that the bidder who paid the largest amount for the bands is that who can effectively make better use of them. Compared to its alternatives, the auction may more transparently reflect that the winner is the one who should bring the resource to its best use.
A modern vision of the role of the spectrum agency as stated by Ofcom (2013) regards the role of the agency as being guided by the following set of principles:

– The spectrum usage rights should be clear and unambiguous, and as flexible as possible while respecting the rights of others.

– Spectrum users should be able to transfer the rights to use it in a simple and fast way, unless there is strong evidence of adverse effects on competition.

– There should be incentives for users to use the spectrum efficiently such as a price mechanism based on the opportunity cost that its use imposes on others.

– The spectrum should be released as soon as possible.

Ofcom's position indicates that an initial allocation of spectrum with a set of clearly defined property rights can be achieved with an auction, the best mechanism for such effect. This is essentially the observation of Ronald Coase in his now famous 1959 article (Coase, 1959).

Property rights on spectrum result from a combination that includes the limits of power levels and transmission band masks. This approach to spectrum management invokes the ability of market-based methods to be more efficient in allocating and assigning the resource. In particular, under this view, the licenses must be traded for commercial transactions between private agents, with assistance from the authority of the spectrum when it considers inappropriate. Similarly a property rights approach allows, and possibly encourages, the leasing of spectrum use by licensees without having to inform the authority or a permit.

2. A framework for the analysis of spectrum allocation

This section describes the elements that should be considered in the process of allocating spectrum for mobile broadband services. If a property rights approach is adopted, such allocation process can be understood as an initial allocation.

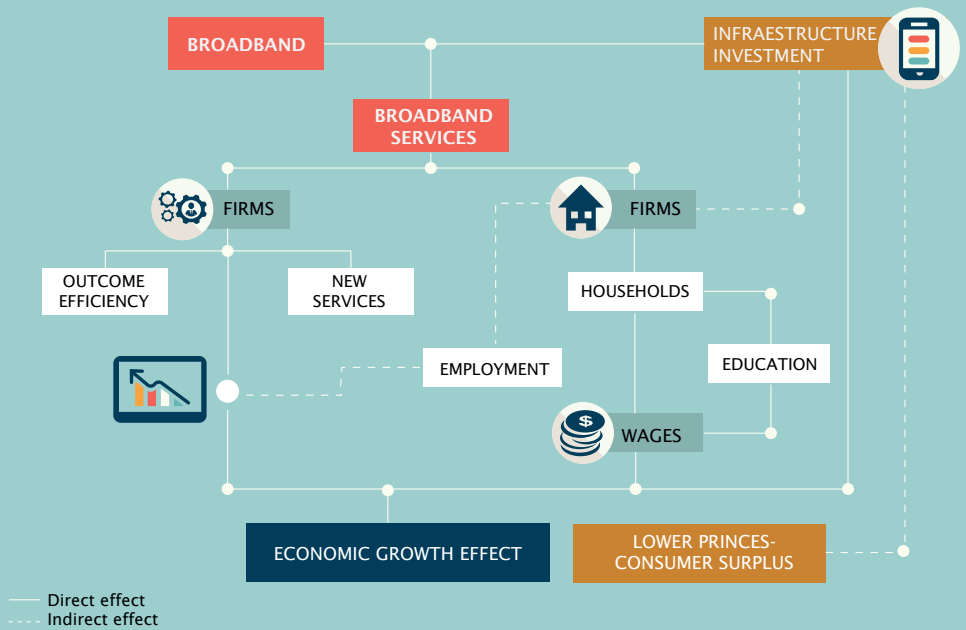
The spectrum agency's (SA) decision process encompasses issues such as how much spectrum to allocate, how often to do so, and the allocation mechanism to be used. Those must be correctly determined in order to stimulate competition in the market and minimize any adverse effects. To do so, the agency needs to consider and balance at least the following aspects:

- Market's need for access to new spectrum bands.
- Technological developments that change the way spectrum is used.
- The rules and design of the allocation and assignment mechanism.
- Local legislation and international spectrum harmonization norms.

It is important to identify points in the current process where improved decisions can be made that result in benefits such as an increased efficiency in the eventual assignment, or a reduction of the harmful effects on competition brought about by inefficient decisions.

Market forces and technology are driving technology producers and service providers to develop sophisticated ways to exploit the potential of spectrum to be shared (Werbach & Mehta, 2014). New technologies such as cognitive radio, CR, and ultra-wideband, UWB will increasingly allow using the spectrum in non-traditional ways. Fundamentally, these are techniques that facilitate spectrum sharing allowing multiple users to share a spectrum band on conditions and terms defined by the technology and must be seriously considered by the SA in the near future. In particular, the SA should develop ways to incorporate the expected impact of sharing (made possible through the above mentioned new technologies) into the policy decisions regarding amount of spectrum to auction, timing of the auction(s) and the anticipated tension between expected auction revenue and the social benefit derived from the assignment.

Figure 1: Broadband impact on economic growth and consumer surplus Source: Inspired by ITU, 2012.



Decisions on spectrum allocation, the incentive scheme built into a spectrum auction, and its outcome help shape the markets for wireless broadband access and the services therein provided. A wireless broadband infrastructure serves as a platform for business and society in general to advance many disparate goals, among them contributing to economic growth.
In our view what matters are the benefits accrued by an effective spectrum policy. An assessment of the potential benefits brought about by wireless broadband deployment can be inspired by a model to assess the impact of broadband in the economy as presented in (ITU, 2012).

Figure 1 illustrates how the impact of broadband construction and deployment on firms and households. Positive effects on the economy are revealed by separately analyzing how an undertaking

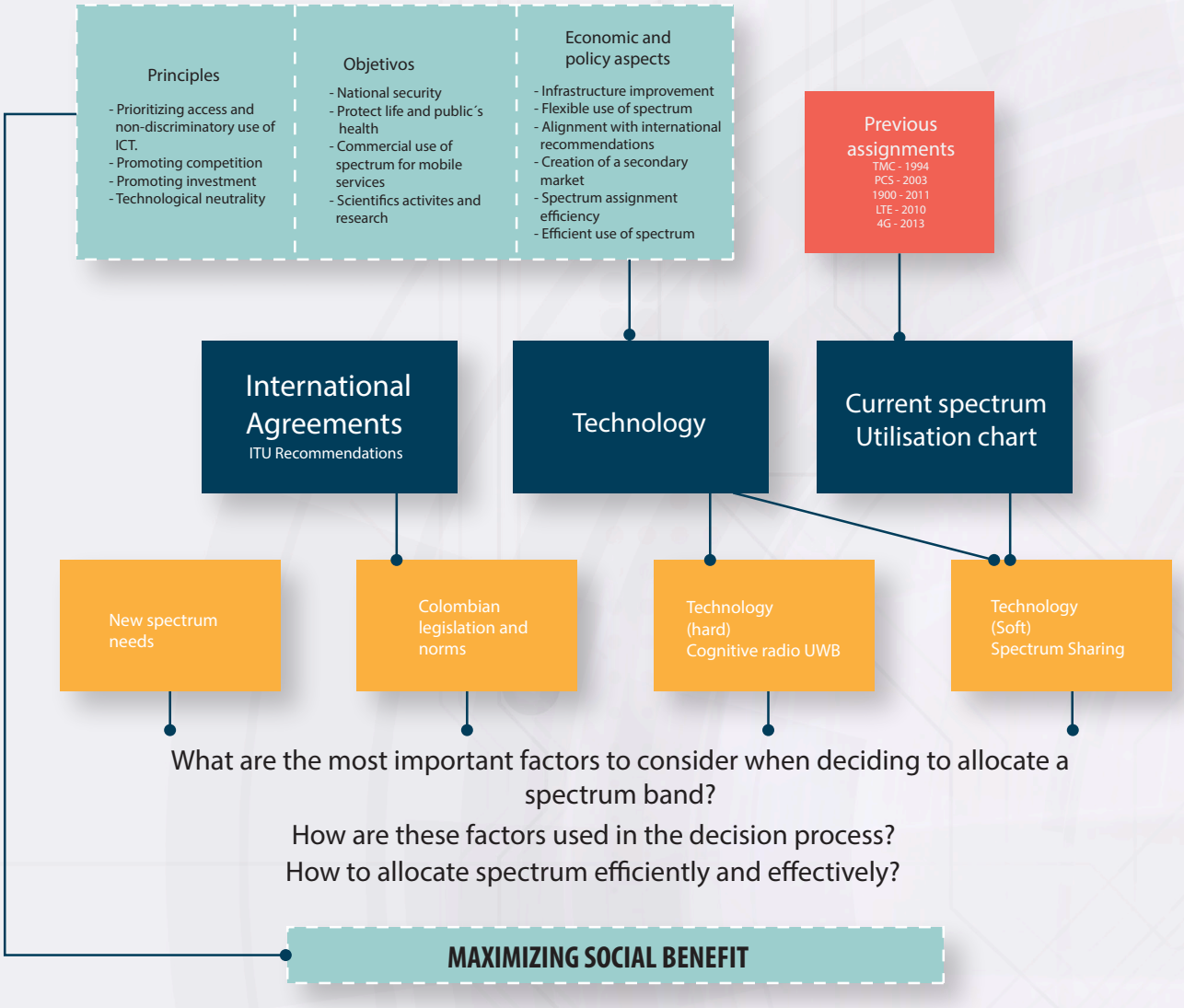


Figure 2. Elements to consider in formulating a process of optimal allocation of spectrum

to build or expand broadband leads to investment in infrastructure, on one hand, and to the provision of broadband-based services, on the other. ITU (2012b) model makes explicit the effect on growth (as measured by GDP growth) by linking the construction of broadband infrastructure (such as an optical fibre network to the home) to direct benefits on residential consumers and business, affecting the income of the former and the productivity of the latter, both contributing to GDP growth. In addition, consumer surplus is also affected by the effect of the service provided over the infrastructure and the expected reduction in the access price. A third effect is job creation while infrastructure is being built.

If mobile telephony introduced practices and behaviours that would make highly attractive in comparison with fixed telephony, it can be argued that mobile broadband has potential to replicate the same situation, albeit with its own features, that would probably make it highly attractive to consumers. This is in fact what occurs with 3G services in many developed countries. The social benefits of mobile broadband can then be traced over the same model of Figure 1, but further insights are needed to understand what the differences are with respect to fixed broadband.

3.The Colombian case

As seen in Figure 2 in Colombia spectrum management principles guide the spectrum assignment and allocation processes. The spectrum administrator must ensure that national security and the protection of life and health precede any allocation of spectrum to commercial use. Within the scope of any allocation scheme, for instance after the announcement that a given spectrum band has been set for a specific use, policy and economic aspects determine the SA's scope for action.

With rising demand for spectrum for wireless broadband access the SA must quantify the amount of spectrum needed over time and decide how much to assign and when to do so. Conventionally the SA would design a process for the competitive assignment of a determined amount of spectrum aiming to maximise the efficiency of the assignment. Question arises as to whether the SA can manage to maximise the social benefit derived as well. Hazlett, Muñoz, & Avanzini (2012) argue that deeming an auction successful on the basis of the amount of revenue raised does not necessarily mean that the auction assignment is doing its best.

4. Balancing revenue generation and social welfare.

Public scrutiny of an auction outcome has fixated on the amount of revenue raised. As argued above the SA is also mandated to protect and promote the public's interest. This section proposes and discusses a definition of social utility function derived from the allocation of spectrum bands for mobile broadband services and operation of associated services.

When conducting an auction the SA seeks to assign H MHz spectrum; assuming that eventually a fraction h ($0 < h < 1$) of the offered spectrum is actually sold, the social utility function W(h) is an additive function of four components :

R, revenue generated by the auction;
V, the social benefit;
C, administrative cost of running the assignment process, and, CO, the opportunity cost of the spectrum not awarded.

The function is then expressed as

$$W(h) = R(h) + V(h) - C - CO(1-h)$$

The resources generated by an auction are linked to the value of the spectrum. Variables affecting R can be divided into two types: variables that would occur or realize after the auction is run and variables occurring or performed before the auction. For example, the value of the spectrum is related to the present value of future cash flows from the gains on the commercial exploitation of the purchased spectrum. The value of the spectrum could also be estimated based on the results of previously conducted similar auctions in the same jurisdiction or other countries (Bazelon and McHenry 2013). In either case the spectrum value obtained is most likely used by auction participants in their strategic bids.

Qualitatively, R can be affected by a number of variables. The number of operators interested in acquiring spectrum under relatively standard conditions has been known to influence the revenue of an auction. Conditions imposed by the right to exploit the assigned bands to the winners of the auction which must be met when the service is rolled out; these conditions seek to provide benefits that would not be possible if a winner would simply acquire the right to exploit the spectrum . The amount of recently allocated spectrum for IMT services and the time elapsed since its assignment; incumbent operators and other potential bidders may need a reasonable time to be able to compete for new spectrum.

The social benefit V is a result of the effect in the short, medium and long-term of using the spectrum and can be interpreted as the direct

and indirect impact on consumers having access to mobile broadband.

5. Conclusions

Meeting seemingly conflicting goals characterizes the SA's spectrum allocation and assignment problem. This paper aligns with recent literature that argues that auction revenue alone cannot be regarded as the only indicator of the success of a spectrum allocation and assignment process. However, if such is the case, then the size and complexity of the SA's problem is in effect larger. Not only has the SA to assure an efficient competitive bidding process that aims to maximise the efficiency of the assignment also it has to attend to other decision variables such as the perceived social benefit derived from the assignment of spectrum and later exploitation of services, timing of auction processes, policy goals expressed in terms of incentives, bidding thresholds and market structure

Restating the SA's problem by identifying a broader objective, the social utility function W( ) helps guide the process by which, once identified, a spectrum band for wireless broadband access will be sold. Revenue, R, and social benefit, V, could antagonise as revealed by a trade-off between expecting high revenues and delivering high benefits to consumers. The characteristics of such trade-off are worth discussing. Some hypothesis can be put forward as a matter of concluding this paper.
If the SA is only focused on short-term efficiency its actions and the results of the auction will be assessed by the ability of the process to raise revenue. Arguably this has been the case in many jurisdictions. If a spectrum exploitation policy is to deliver benefits on tiers of the population for whom mobile broadband access may take a long time to reach them, if they are reached at all, the SA should then consider including an expression of the social benefit, V, within its objective. V could mean the inclusion of mandated goals on coverage under time constraints, for instance. The latter has been used in past assignments of spectrum for mobile services.

Acknowledgement: This paper has been prepared under financial support of a grant from the Colombian Research Funding Agency, Colciencias (Contrato RC. No. 0687- 2012).

6. References

- Bazelon, C. and McHenry, G. (2013). The economics of spectrum sharing. Telecommunications Policy Research Conference, September.
- Cave, M., Doyle, C. and Webb, W. (2010) Essentials of modern spectrum management. Cambridge University Press.
- Coase, R. (1959). The Federal Communications Commission. Journal of Law and Economics, Vol. 2., pp. 1-40.
- Hazlett, T.W., Muñoz, R. & Avanzini, (2012). What really matters in auction design. Northwestern Journal of Technology and Intellectual Property. 10,3: 93-123.
- ITU – International Telecommunications Union (2012). The Impact of Broadband on the Economy: Research to Date and Policy Issues. Broadband Series. April. http://www.itu.int/broadband
- Ofcom (2013). Spectrum management strategy. Consultation document. October.
- Werbach, K. & Mehta, A. (2014). International Journal of Communication. 8:128–149.