Contemporary Engineering Sciences, Vol. 10, 2017, no. 24, 1181 - 1193
HIKARI Ltd, www.m-hikari.com
https://doi.org/10.12988/ces.2017.710144

Evaluation of Net Neutrality Scenarios

Using Game Theory

Sthefania Moreno Reina

Universidad Nacional de Colombia, sede Bogotá
Bogotá, Colombia

Octavio José Salcedo Parra

Universidad Distrital "Francisco José de Caldas"
Universidad Nacional de Colombia, sede Bogotá
Bogotá, Colombia

Lewys Correa Sánchez

Universidad Distrital "Francisco José de Caldas"
Bogotá, Colombia

Copyright © 2017 Sthefania Moreno Reina, Octavio José Salcedo Parra and Lewys Correa Sánchez. This article is distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

This paper presents a brief introduction on the net neutrality debate. Then, documentation is presented referring to the main works with two-sided models and scenarios of network neutrality. At the end, a two-sided model is developed and analyzed through game theory, which shows the case of neutrality in front of multiple non-neutrality cases, analyzing the participation and effects on the main players.

Keywords: Network Neutrality, game theory, internet service provider (ISP), content provider (CP), consumers, quality of service, access rate

1 Introduction

According to the constitution "The administrative function is at the service of the

general interests and is developed in the principles of equality, morality, efficiency, economy, impartiality and publicity"[1]. And it is here, in search of protecting the rights of society where the net neutrality debate arises. Network neutrality is understood as the concept that defines the freedom and equal access for all users to content, applications or Internet services, regardless of their origin, destination or content [2]. However, many discussions and controversies have been generated in the face of the issue, where the positive and negative arguments are exalted by the main actors: Users and service providers and Internet service providers (ISPs). Where users are looking for a neutral network that allows them free access with the goal to ensure the Internet as an engine for innovation, free development and economic growth, ISPs, driven by an economic factor expose the complications of blocking, privacy and network congestion [3].

2 Net Neutrality

A UN study in 2009 stresses that "technological neutrality is of particular importance given the rapidity of technological innovation and helps to ensure that legislation can continue to accommodate future developments and is not outdated very soon [...] technology neutrality allows organizations and parties to use technology that fits their needs [4].

Illescas Ortiz in [5] considers technological neutrality as that aptitude that must prevail in the new disciplinary rules of electronic commerce.

Ibanez Parra and Rincón Cárdenas in [6] say that technological neutrality is a principle that "tends, because the rules of e-commerce, can cover ... technologies that are developing and are yet to be developed, taking into account a realistic interpretation that allows it to be developed according to the specific facts and situations, so that the legislation is in line with the constant development of new technologies".

In Colombia, technological neutrality is to ensure that an operator can provide telecommunication services, regardless of the technology used. [7]. Thus, technological neutrality is understood as freedom over the technology to be used and free competition between them [8].

The new telecommunications networks allow the coexistence of different technologies and the transmission to different types of terminal or end user without privileging or discriminating contents or formats. This is known as network neutrality (OFCOM, 2005) [8]. It is evident that the principle of technological neutrality is a broader concept than that of net neutrality, which refers to the logical and economic infrastructure of computer services and products [9].

3 The current debate and the actors

There are two major positions regarding the debate on technological neutrality. The first are the Openists, these hold the need to maintain the fundamental feature of the internet from end to end. Where, according to this, planned and centralized innovation is rejected [10]. The second is that of the deregulationists, claiming that

communications networks represent costly investments and the business sector will invest in them by gaining some benefit where regulatory revenue could slow investments. [10]
In this way, the discussions about regulation in net neutrality cover how the regulation on ISPs should be implemented as intermediary entities from operators to users. The main players in the debate [10] are Internet access service providers, Internet service providers and applications, Content providers, Equipment manufacturers and terminals.

4 Background

4.1 Challenges

The advances in regulation of different countries were evaluated, detecting the problems and challenges that arise when forming a regulatory framework of net neutrality.
1. Traffic control: Network neutrality runs counter to the need for an administration that manages traffic, as traffic grows as the network expands and more users connect to it. However, there is the risk of unfair traffic management practices and lack of transparency [3, 10].
2. Blocking: filtering and blocking of content where users are denied access to certain specific content is contrary to the freedom of content exposed in Network neutrality, where a degradation of the service may also occur [3, 11]
3. Security: ISPs have the ability to know the content of packets that circulate through their network, which is contrary to users' rights of privacy and freedom of expression [10].
4. Competition: ISPs can affect the competition of markets and services using policies of discrimination and preference to certain contents of the network. Market competition is necessary insofar as it gives the user free choice and freedom of choice [11].
I.1. Models: Two sides of the Market
Cheng in [13] develops a model one has a monopolistic supplier of Internet services that serves consumers. Two options are considered: where the ISP charges the CPs for the preferential treatment of the packages and where it does not charge. Neutrality and non-neutrality are analyzed. The results show that, for the ISP, net neutrality is preferable and favorable. This same scenario is unfavorable for CPs. End-consumers do not differ much from benefits except in the case where a CP is clearly better than the other does.
Njoroge in [14] propose a model where two interconnected ISPs compete for the quality and prices of heterogeneous content providers (CPs) and heterogeneous consumers. In the neutral regime, a CP has access to all consumers connecting to a single ISP. In the non-neutral regime, a CP has to pay access to the ISP to access the users of each ISP.
Chamorro [15] Establishes non-neutrality when ISPs can generate charge rates at CPs and charge CPs to prioritize their packages over others. In net neutrality, ISPs

decide on the rate of Internet access and consumers choose CPs. Chamorro [15] finds that in both scenarios the beneficiaries are the ISPs who have the ability to define the access prices, the CPs decide whether to pay for QoS and the users would benefit in a framework of neutrality with free access.
Economides and Ta˚g [16] consider two models, one monopolist and one duopolistic model of ISPs, where they charge by subscription to final consumers and an access tariff to CPs. In both models CPs are considered as monopolists who depend on the income per consumer. The demand for content depends on the number of consumers. Economides and Ta˚g [16] allows ISPs to charge positive rates to CPs [16]. They demonstrate that there are parameters that do not allow ISPs to charge positive rates to the CPs and still give the IPS a surplus state. They are even demonstrated in the duopoly model where the neutrality of the network is justified even if there is competition in the IPS markets.
Reggiani and Valletti [17] analyze a model that shows the heterogeneity of CPs in the market, including ISPs and consumers. They study the case of a monopolistic ISP that offers consumers two CPs, one large and one small. Proposes the prioritization of access to the network as a tool in the interface. The results show that the regulation of neutrality protects the innovation made by small content providers. Prioritization, on the other hand, can give an increase in infrastructure investment only if the CPs provide enough innovation.

5 Model

5.1 Players

In this, models will be considered 3 types of players:
1. A duopoly of ISPs, which provide Internet access to end users and are responsible for managing the delivery of services provided by service providers to end users.
2. Two content providers that are competing in the service provider market and deliver content to end users.
3. End users who choose their service providers according to their preferences and who pay a fee for Internet access to an ISP of their choice.

5.2 No Net Neutrality

1. Case 1: NN1: ISPs charge CPs for traffic management and packet preference with CPs having access to all consumers. Case where ISPs define equal QoS rates.
2. Case 2: NN2: ISPs charge consortium access fees to CPs but do not charge Qo rate.
3. Case 3: NN3: Not extreme neutrality in which ISPs charge fees for Qos and for access to consumers. (Case 1 + Case 2).

5.3 Net Neutrality

Network neutrality will be assessed when ISPs do not charge CPs for packet preference treatment and CPs have access to all consumers.

5.4 The rules

This model consists of two interconnected ISPs competing in prices, both CPs and consumers. Content providers compete for content quality, access to users and provide various content, customers choose the content provider according to their personal preference.

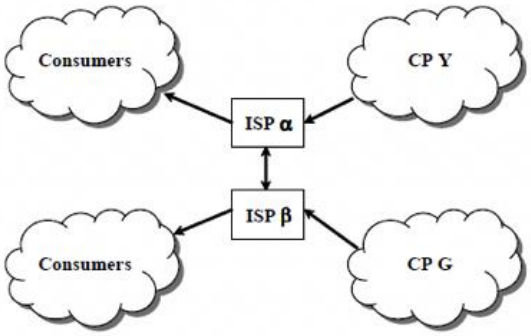

Fig. 1: Market model with two interconnected ISPs and two CPs. Source: [14].

In this model, we consider a model with two ISPs denoted by α and β, two providers of contents Y and G and a mass of clients normalized to zero where clients $x \in [0,1]$. By normalizing the total mass to 1, consumers are distributed in a straight line from 0 to 1 where at the ends of the line are found content providers [15]. At the right end the content provider Y is located at point 0, while the content provider G is located to the far left of the line at point 1 (Figure 2). The average consumer is represented by x, so the market share for content providers are represented by the following functions:

$$Y(x) = x \tag{1}$$

$$G(x) = 1 - x \tag{2}$$

This completely covers consumer demand and achieves complete market coverage.

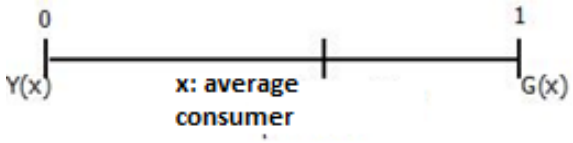

Fig. 2: Normalization of mass of clients to 1 for CPs. Source: Authors

The same normalization can be applied to the mass of ISP customers, considering that the two ISPs form a duopoly, the total consumer market is distributed. Thus, we have to:

$$\alpha(x) = x \tag{3}$$

$$\beta(x) = 1 - x \tag{4}$$

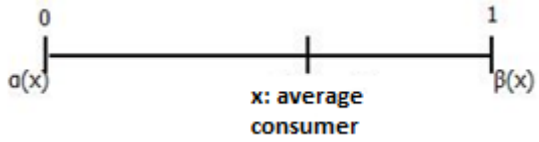

Fig. 3: Mass normalization of clients to 1 for ISPs. Source: Authors

6 Non-Net Neutral Model

6.1 NN1 case

For the first case of non-neutrality, ISPs charge a fee for preferential package delivery to content providers. The following terms will be used from now on as follows: Quality of service QoS, which corresponds to the preferential payment for handling of traffic and packages; Best-Effort (BE) where there is no traffic management in the network. To carry out the analysis it was assumed that the price charged by α and β by QoS is equal to z.
Once ISPs define the price of the QoS rate, CPs must make the decision: Pay for preferential treatment or not pay. Since this decision of the CPs directly affects the consumers and their own decisions on the chosen content, an indicator I, that represents the status of the CPs with respect to the decision on QoS will be used. you can define the indicators for each provider how [15]:

$$I_Y = \begin{Bmatrix} 0 \; if \; Y \; not \; pay \; Z \\ 1 \quad if \; Y \; pay \; Z \end{Bmatrix} \tag{5}$$

$$I_G = \begin{Bmatrix} 0 \; if \; G \; not \; pay \; Z \\ 1 \quad if \; G \; pay \; Z \end{Bmatrix} \tag{6}$$

Thus, the demand for content suppliers $X(I_Y , I_G)$ and $1\text{-}X(I_Y , I_G)$ depends on the decision taken I_Y and I_G.

6.2 NN2 case

For this non-neutral case, ISPs charge a fee to the CPs for access to the users of each ISP. In non-neutrality, the content provider Y has access to consumers connected to the ISP α. However, it does not have access to consumers connected to the ISP β. In the same way it happens for the content provider G, which has access to the users of β but not of α.
In this case, ISPs charge an access price to their users u. In response, content providers decide whether to pay user access or not to pay. Thus the indicator A for content providers in this case is:

$$A_Y = \begin{Bmatrix} 0\ if\ Y\ noy\ pay\ u \\ 1 \quad if\ Y\ pay\ u \end{Bmatrix} \tag{7}$$

$$A_G = \begin{Bmatrix} 0\ if\ G\ not\ pay\ u \\ 1 \quad if\ G\ pay\ u \end{Bmatrix} \tag{8}$$

This CP decision affects consumers so that if Y decides to pay and G decides not to pay, consumer demand for ISP α cannot be fully covered since G will not have access to the entire mass of consumers.

The title of the paper must be centered at the top of the page; it has to be Times New Roman 16 pts not typed in capital letter. Leave two line spaces of 10 pts. and give the name(s) of the author(s). The font size of the authors is 12 pts. The authors' affiliation should appear at end of the paper.

6.3 NN3 case

In this case, of extreme net non-neutrality, the two cases mentioned above are considered. Both when the ISP charges for the QoS rate and when the ISP charges for the access fee to consumers. In this way, we have two fees that are charged by the ISP:

Z: QoS rate.
u: Consumer access tariff.

In this case, content providers must make two decisions. Decide whether to pay the consumer access fee and Decide whether to pay the fee for QoS. We will call the sum of the two tariffs (z + u) as the complete tariff (TF) and its associated indicator as TCPs.
In this way, the demand indicators for content providers are arranged as follows. For the content provider Y you have to:

$$T_Y = \begin{Bmatrix} 0\ \ if\ A_Y = 0\ and\ A_Y = 0 \\ 1\ \ if\ A_Y = 0\ and\ A_Y = 1 \\ 1\ \ if\ A_Y = 1\ and\ A_Y = 0 \\ 2\ \ if\ A_Y = 1\ and\ A_Y = 1 \end{Bmatrix} \tag{9}$$

In the same way for the provider of content G has:

$$T_G = \begin{Bmatrix} 0\ \ if\ A_G = 0\ and\ A_G = 0 \\ 1\ \ if\ A_G = 0\ and\ A_G = 1 \\ 1\ \ if\ A_G = 1\ and\ A_G = 0 \\ 2\ \ if\ A_G = 1\ and\ A_G = 1 \end{Bmatrix} \tag{10}$$

7 Net neutrality model

In the case of network neutrality, ISPs put a network access fee, from which consumers choose ISP and content provider. In this case, the content providers have no decision to make since they have access to all users and will have the same package treatment.

8 Decision Making: Net Neutrality

8.1 Internet rate pricing decisions by ISPs

By doing an analysis of the mass of consumers, a market analysis and a projection to the actions of consumers and content providers, ISPs define the internet access rate seeking the highest profit margin. In this case two options can be given:

- Equal Rates: ISPs define an Internet access fee S.
- Different rates: Each ISP sets different access fees. A for α and B for β.

8.2 Internet Decision for Consumers

Equal tariffs: Where the two ISPs, SY = SG = S, consumers make the choice between ISPs independently and / or randomly, the marginal consumer is x. In this case, the consumers of α, Cα are located in the segment [0, x] and those of β, Cβ, in [x, 1]. This indicates that the market share under these circumstances is equal for both providers with a value of x = 1/2.

Different rates: If the ISPs α and β have different internet access rates where A> B, the market shares in the same way will be xα> xβ.

8.3 Content decision for consumers

The content decision for consumers is not affected by ISPs' Internet access fees because they are interconnected and consumers have both access to content AND access to content G. The consumer mass represented by x is the same for both content providers Y = G = x = 1/2.

9 Decision Making: No Network Neutrality

All cases of non-net neutrality will be evaluated under the condition that ISPs define the same Internet access tariff, i.e. S.

9.1 NN1 case

ISPs QoS Rate Decision: ISPs allocate the tariff after valuing consumer and CP decisions to be competitive in the market.

Consumer content decisions: According to the decision of the CPs regarding payment or non-payment of the QoS rate, there are the following cases:

- Case 1: IY = IG = 1: When Y and G decide to pay the QoS rate. In this case, both content providers will be under the same circumstances to reach consumers. The market share and marginal consumer for each CP corresponds to x1 = 1/2.
- Case 2: IY = 1, IG = 0: When Y decides to pay and G no. In this case, the Y packets

will be handled with QoS and G packets with BE. This will allow the Y packets to have priority in the network traffic on the G packets. The marginal consumer will choose Y over G because Y can provide a higher quality of service, which reduces their waiting time and increases their satisfaction level. Thus, in case 2, x2> 1/2. This indicates that the content provider Y obtains a market share greater than the market share that corresponds to G (1 - x2 <1/2).
- Case 3: IY = 0, IG = 1: Who decides to pay the fee is G and Y is not. The G-packets will take precedence over the Y-packets and this will raise the market share of G to 1-x3> 1/2 and lower the share from Y to x3 <1/2.
- Case 4: IY = 0, IG = 0: None of the CPs pay the QoS rate. The two will send their packets with BE and both packets will have to face the traffic of the network, without disposing advantages one over the other. This reduces the market share to equal terms for Y and G, with x4 = 1/2.

9.2 NN2 case

ISPs consumer access tariff decision: It is defined by ISPs after an analysis, with the objective that this tariff allows market competitiveness while achieving a higher profit margin.
Consumer Content Decisions: Consumers are directly affected by decisions taken by CPs over the access tariff. In this way, we have the following possible cases:
- Case 1: AY = 0, AG = 0: None of the CPs pay the access tariff to the consumers of the other ISPs The content provider Y, connected directly to the ISP α only has access to the users of α, Cα and the same form, the CP G, connected to the ISP β, only has access to the users of β, Cβ.
Considering that net non-neutrality establishes that the internet access tariff for α and β equal to S (equal rates), the market is balanced in equal parts for ISPs and therefore, the marginal consumer will be x = 1/2 and the market share for the two CPs Y and G will be equivalent.
- Case 2: AY = 1, AG = 0: Provider Y decides to pay the access fee to users while provider G does not pay. In addition, it has access to the total mass of consumers, ie Cα + Cβ. On the contrary, G, which is directly connected to β, only has access to consumers of β, Cβ. This means that the market share for Y x2> 1/2 will be higher at the market rate for G 1 - x2 <1/2. This is x2> 1 - x2.
- Case 3: AY = 0, AG = 1: Y does not pay the access fee to users while G if it pays the fee. The provider that is directly connected to the ISP α, only has access to the users of the ISP α. In contrast, content provider G, who paid the user access fee, can deliver content to ISP β users and ISP α users. The content provider that pays the tariff, in this case G, has a greater coverage of the demand in the market, and this causes the market rate for G 1-x 3> 1/2 to be greater than the market share for Y x3 <1/2. This is x3 <1-x3.
- Case 4: AY = 1, AG = 1: Both Y and G decide to pay the user access fee. Both have access to the full mass of consumers. In which case the access quota for Y and G corresponds to x4 = 1/2.

9.3 NN3 case

Consumer Content Decision: Considering that for extreme non-neutrality (NN3) a greater number of possible cases arise, the cases will be exposed in one direction and in view of the fact that some cases will be repeated from the NN1 and NN2 scenarios, alone will be explained briefly and will be studied in the particular cases belonging to the NN3 scenario and which have not been presented in the previous scenarios.

- Case 1: TY = 2, TG = 2: In this case, AY = 1, IY = 1 for Y and AG = 1, IG = 1 For G. Paying both CPs both rates, both content providers have access to all the users and are in the same conditions of handling of packages in the network. This is reduced to an equal market rate for both CPs corresponding to x1 = 1/2.

In this case, AY = 1, IY = 1 for Y and AG = 1, IG = 0 for G. Moreover, it has access to all consumers and has QoS, whereas G has access to all users, but you send your packages by BE. Same as case 2 for NN1, x2> 1 / 2y for G is 1 - x2 <1/2.

- Case 2: TY=2, TG=1 where AG=1: In this case, AY = 1, IY = 1 for Y and AG = 1, IG = 0 for G. In addition, it has access to all consumers and has QoS, while G has access to all users, but you send your packages by BE. Same as case 2 for NN1, x2> 1 / 2y for G is 1 - x2 <1/2.
- Case 3: TY = 2, TG = 1 Where IG = 1: In this case, AY = 1, IY = 1 for Y and AG = 0, IG = 1 for G. Here, Y has access to all users and QoS , while G does not have access to all users but has QoS. In these circumstances, the supply of content for users of β is equal, since both CPs have QoS, however, for users of α only the CP Y can provide content. Being Cα indifferent to the supply of G. This leads to x3> 1/2 and therefore the market share for Y is greater than the market share for G.
- Case 4: TY = 2, TG = 0: In this case, AY = 1, IY = 1 for Y and AG = 0, IG = 0. CP And pay the user access fee and the QoS rate, provider G does not pay any fee. This case presents a great disadvantage for the CP that decides not to pay, G, not having access to all users and above not being able to offer QoS. Moreover, as a service provider can better meet the demand of consumers at a high level of difference, so the average consumer will be represented by x4 >> 1/2. The market rate for Y increases drastically and in the same way decreases for G.
- Case 5: TY = 1 Where AY = 1, TG = 1 Where AG = 1: In this case, AY = 1, IY = 0 for Y and AG = 1, IG = 0. Here, both Y and G pay consumer access fees and both use BE. Under the same conditions, the consumer is x5 = 1/2 where the market rates are equal x5 = 1-x5 = 1/2.
- Case 6: TY=1 where AY=1, TG=1 where IG=1: In this case, AY = 1, IY = 0 for Y and AG = 0, IG = 1. Here, provider Y has access to all users; however, it does not offer QoS. Vendor G only has access to Cβ consumers but can offer QoS. In this case, the consumer and the market share for Y will correspond to x6> 1/2. However, it is important to note that this mass of consumers x6 <x2 and x3.
- Case 7: TY = 1 Where AY = 1, TG = 0: In this case, AY = 1, IY = 0 for Y and AG = 0, IG = 0 for G. Here, provider Y pays access to consumers but does not offer QoS, and G does not pay any fees. Hence x6> 1/2 where the market rate for G is 1-x2 <1/2.
- Case 8: TY =1 where IY=1,TG=1 where IG=1 : In this case, AY = 0, IY = 1 for

Y and AG = 0, IG = 1 for G. Here, no provider pays user access fee but both pay QoS rate. So for both CPs x8 = 1/2.
- Case 9: TY =1 where IY =1, TG =0: In this case, AY = 0, IY = I for Y and AG = 0, IG = 0 for G. No CP pays consumer access and only Y pays QoS. Seeing that each CP only has access to the consumers of the ISP to which they are connected, the payment of QoS Y does not affect the market rate that is distributed equally for Y and G as x9 = 1/2.
- Case 10: TY = 0, TG = 0: In this case, AY = 0, IY = 0 for Y and AG = 0, IG = 0 for G. No provider pays any fee so x10 = 1/2 for Y and G.

10 Discussion of results

The clear strategic advantage of ISPs over consumers and content providers is obvious. Consumers rely directly on content providers and ISPs. Content providers depend on ISPs, who define rates and prices. It can be seen that in all non-net neutrality scenarios, ISPs are not affected by consumer decisions, regardless of the choice of content they make; they will still be connected to their ISPs. Thus, since ISPs have two revenue platforms and the infrastructure for the provision of telecommunications services that allow them to set and define the tariffs for services, they are the least affected and most favored in one or more scenarios of non-net neutrality.
The different scenarios presented namely case NN1, NN2, NN3, show the different ways in which net neutrality can affect the consumer. In NN3, the proposed extreme non-neutrality affects consumers to such an extent that, in a certain case, they are not even offered a versatility of content and / or quality of service. The negative effect of network non-neutrality on the satisfaction of users or end consumers with respect to the social benefits they obtain in a Neutrality scenario is evident, where neutrality offers them a high social benefit, with free access to content, and the ability to freely choose between them, non-neutrality reduces all of this in a drastic way.
As well as the favorable nature of network non-neutrality for ISPs, it is also possible to see that these same scenarios are highly unfavorable from the point of view of CPs. Those who can only improve their status as well as the social welfare of the consumers when accessing the payment of access tariffs defined by ISPs.
Similar results to Cheng in [13] are presented here, where for NN1 the ISPs benefit from the access tariff to QoS, in the NN2 scenario, by the access tariff to consumers and NN3 both by the tariff of access to QoS as the user access rate. In addition, social welfare is defined by the payment of access fee by the CP, when a CP pays in respect of one that does not pay and remains constant when paying both CPs the Rate. Here only the possibility of improving social welfare through the payment of tariffs by CPs is considered, Unlike Cheng, where this may be greater when considering an increase in the rate of access to consumers.
Njoroge, Ozdaglar, Stier-Moses and Y. Weintraub in [14], contrary to what is obtained in this model, find that the payment of tariffs by CPs to consumers can positively impact the incentives to generate investment that can help improve and

upgrade the network infrastructure.
With regard to the Chamorro model [15], the results obtained for the case of net neutrality and the case of non-neutrality of network 1 (NN1) are the same, since in net neutrality with ISPs generating internet access tariffs the same behavior occurs in CPs and in consumers.

11 Conclusions

It is evident the advantage in which the ISPs are in the scenarios of non-net neutrality. From the perspective of the CPs, the best cases are within the net neutrality scenario. Finally, from the perspective of consumers, and considering the social welfare that each case can offer them, it is evident that this social welfare is higher in the case of neutrality.

References

[1] Constitución política de Colombia. Artículo 209. [Online]. Accessed February 6, 2017. Available in: http://www.constitucioncolombia.com/titulo-7/capitulo-5/articulo-209.

[2] COLNODO. Neutralidad de la red en Colombia. De la 2015. Bogotá. Colombia. 2016.

[3] M. David Ramirez, Luces y sombras de la neutralidad de la red. March 11th. 2015.

[4] Universidad de los Andes. Nuevas tendencias del derecho administrativo. Bogota. Colombia. 2016.

[5] Oscar Ibañez Parra, Erick Rincón Cardenas, El acto administrativo electrónico y las nuevas tecnologías de la información. [Online]. Retrieved April 22, 2017. Available in: http://repository.usergioarboleda.edu.co/bitstream/handle/11232/257/CienciasSocialesyHumanas471.pdf?sequence=1

[6] Ana Yasmín Torres Torres, Principios de la contratación Electro´nica Principles of e-procurement, Revista principia iuris, No. 13, 2010.

[7] Congreso de Colombia. Ley 1341 de 2009 Por La Cual Se Definen Principios Y Conceptos Sobre La Sociedad De La Información y la Organización de las Tecnologías de la Información y las Comunicaciones – TIC -, Se Crea La Agencia Nacional De Espectro Y Se dictan Otras Disposiciones, 2009.

[8] Ana T. Aldana J., Azucena Vallejo C., Telecomunicaciones, convergencia y regulación, *Revista De Economía Institucional*, **12** (2010), no. 23, 165-197.

[9] Carles Alonso Espinosa, La información en la red y el principio de neutralidad Tecnológica: la libertad de expresión y la difusión de información administrativa, *Revista Derecho Del Estado*, no. 22, (2009).

[10] Bernadette Califano, Políticas de Internet: la neutralidad de la red y los desafíos para su regulación, Argentina. 2013.

[11] Internet Society. Neutralidad de la red. [Online].Consultado el 04 de marzo 2017. Available in: https://www.internetsociety.org/

[12] Jorge Pérez. Martinez, Neutralidad de Red: Aportaciones al debate, Editorial Ariel, Madrid España. 2011.

[13] Hsing K. Cheng, Subhajyoti Bandyopadhyay, Hong Guo, The Debate on Net Neutrality: A Policy Perspective. Universidad de Florida, 2011.

[14] Paul Njoroge, Asuman Ozdaglar, Nicolás E. Stier-Moses, Gabriel Weintraub, Investment in Two Sided Markets and the Net Neutrality Debate, 2010.

[15] Jhonatan Chamorro C., Teoría de Juegos en Neutralidad de la Red, Universidad Nacional de Colombia.

[16] Nicholas Economides, Joacim Tág, Network neutrality on the Internet: A two-sided market analysis, *Information Economics and Policy*, **24** (2012), 91–104. https://doi.org/10.1016/j.infoecopol.2012.01.001

[17] Carlo Reggiani, Tommaso Valletti, Net neutrality and innovation at the core and at the edge, *International Journal of Industrial Organization*, **45** (2016), 16–27. https://doi.org/10.1016/j.ijindorg.2015.12.005

Received: October 29, 2017; Published: November 21, 2017