

Pateiro-Rodríguez, Carlos; Martín-Bermúdez, Federico; Pateiro-López, Carlos;  
Escourido-Calvo, Manuel

## Article

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Economies

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*Suggested Citation:* Pateiro-Rodríguez, Carlos; Martín-Bermúdez, Federico; Pateiro-López, Carlos; Escourido-Calvo, Manuel (2024) : Universal service regulation and network effects in services of general economic interest in the European Union, *Economies*, ISSN 2227-7099, MDPI, Basel, Vol. 12, Iss. 10, pp. 1-19,  
<https://doi.org/10.3390/economies12100280>

This Version is available at:

<https://hdl.handle.net/10419/329207>

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## Article

# Universal Service Regulation and Network Effects in Services of General Economic Interest in the European Union

Carlos Pateiro-Rodríguez <sup>1</sup>, Federico Martín-Bermúdez <sup>1,\*</sup>, Carlos Pateiro-López <sup>2</sup> and Manuel Escourido-Calvo <sup>3</sup>

<sup>1</sup> Department of Applied Economics, University of A Coruña, 15008 A Coruña, Spain; carlos.pateiro@udc.es

<sup>2</sup> Department of Taxation, Tax and Financial Advisor, 15011 A Coruña, Spain; cpateiroudc@gmail.com

<sup>3</sup> Department of Business, University of A Coruña, 15008 A Coruña, Spain; manuel.escourido@udc.es

\* Correspondence: federico.martin@udc.es

**Abstract:** The process of the liberalisation of services of general economic interest (SGEI) in the EU adopted the universal service (US) regulatory model. The objectives of the process were to strengthen free competition and improve social welfare. SGEIs have the characteristic of networked services and, as such, generate network externalities, as considered by the theory of market failures. This paper analyses the potential of the US in its role as a remedy for network externalities. In the SGEI context, the large number of participants reinforces network externalities, while limiting coordination mechanisms between users. Based on the relevant literature, a theoretical debate arises around the contribution of universal service obligations (USOs) to social welfare. A microeconomic analysis shows that USOs modify consumers' utility functions by shifting from inefficient market equilibria to efficient equilibria, thereby improving social welfare.

**Keywords:** services of general economic interest; universal service; network externalities; social welfare



**Citation:** Pateiro-Rodríguez, Carlos, Federico Martín-Bermúdez, Carlos Pateiro-López, and Manuel Escourido-Calvo. 2024. Universal Service Regulation and Network Effects in Services of General Economic Interest in the European Union. *Economics* 12: 280. <https://doi.org/10.3390/economics12100280>

Academic Editor: Sanzidur Rahman

Received: 19 September 2024

Revised: 11 October 2024

Accepted: 14 October 2024

Published: 17 October 2024



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## 1. Introduction

In the last decade of the 20th century, the European Union began a process of liberalisation of economic services of general interest (SGEIs), following the process initiated in the United States in previous decades. In general, the providers of these services operated under a monopoly regime, mostly of a public nature. Therefore, the basic objective of this liberalisation, according to the respective sectoral directives, is to transfer to the end user the advantages derived from free competition, such as improving consumer surplus, social welfare, or favouring technological progress and the quality of services, among others.

The services included in the SGEI qualification cover a set of essential economic services that are crucial for the development of a modern society. In addition, the SGEI category includes landline, mobile, and internet telephony services, electricity and gas supply, postal services, and passenger transport services.

Faced with the risk that the process of liberalisation of these services at the EU level could generate corporate behaviour capable of preventing or limiting the materialisation of the benefits of competition, regulatory mechanisms were adopted to safeguard users' rights. The regulatory model employed was the establishment of universal service obligations (USOs). Among the regulatory instruments, it is important to highlight the sectoral directives of the European Parliament and the Commission at the European Union level and the national laws transposing these directives in each of the member states.

An essential element of this regulation is the precise definition of the scope of the universal service (US); a concept that will be developed in Section 3. The universal service (US) is understood as a set of basic services provided permanently with the quality intended in the regulations throughout the national territory and at an affordable price for all users. In each SGEI, the scope of the respective US is clearly defined, so that all parties involved

have a clear framework of obligations and rights, while the national regulatory authority (NRA) has the power of control.

This work is oriented towards the analysis of the functions that this tool of the US can fulfil in each of the SGEI. Although the US as an instrument of regulation in SGEIs is the subject of ongoing debate in the legal field, this paper is focused on its economic dimension. Considering that a good part of SGEIs correspond to network activities (or where the network constitutes one of their main elements), the US can contribute to a greater participation in the network, with the consequent reduction in the average costs of providing the service. In terms of regional economic policy, the US has some capacity to guide regional economic policy. In terms of redistribution, both in terms of territorial location and income, the US can be a valuable element for this public policy, especially in terms of inter-regional distribution.

This paper focuses on the role of USOs as a remedy to network externalities, a pervasive phenomenon in SGEI networked services.

The existence of USOs may condition some of the economic policies aimed at strengthening long-term competition in liberalised services listed by [Armstrong and Sappington \(2006\)](#). In particular, the policy of setting adequate access prices, limiting cost shifting from non-liberalised services to competitive services (shifting costs), or reducing switching costs may be affected by the existence of a US area.

The organisation of the work is as follows: After the introduction in Section 2, we will focus on the concept of SGEIs. Section 3 is devoted to the concept of the US, which is evolutionary in nature, and its four defining elements: quality, ubiquity, permanence, and affordable prices. Section 4 discusses the rationale for USOs from a regulatory and positive point of view. Network effects or externalities are discussed in Section 5, which is divided into two sections. Section 6 is devoted to the universal service as a solution-oriented instrument for network externalities. This section is divided into five sub-sections. Sections 6.1–6.4 address the core elements of the universal service, specifically quality, continuity, ubiquity, and affordability. Section 6.5 shapes the social marginal benefit with USOs. Finally, Section 7 presents the discussion and main conclusions.

## 2. On the Concept of SGEI

The EU Treaty does not provide a definition of SGEIs, although article 106 (formerly 86) states that these services must be subject to the rules of competition, except in exceptional cases. A first approach to the concept of SGEIs in European legislation can be found in the [European Commission \(2011\)](#) (COM 2011) document, which contains the quality framework for services of general interest in Europe, and, according to which, “SGEIs are economic activities which produce results for the general public good and which the market would not provide [...] without public intervention”.

Consequently, the concept of SGEIs will be formed on the basis of the academic consensus of social and legal science disciplines. Thus, according to [Laguna de Paz \(2009, p. 34\)](#), these activities are characterised as follows: (i) provision-based, which do not involve the exercise of public powers; (ii) essential, which must be provided even when the market lacks incentives to do so; (iii) economic, whose activity is of a commercial or mercantile nature. According to [Rosado Pacheco \(2019\)](#), the economic, commercial, or mercantile nature of the SGEI initially entails the application of the rules governing the EU internal market. Consequently, freedom of enterprise and freedom of establishment are guaranteed, subject to competition law. In the same vein, as they are business activities, they fall within the scope of application of competition law ([Díez-Picazo 2009](#)).

The general classification of an SGEI activity justifies the use of mechanisms or guarantee techniques, which may exceptionally alter the principles of free competition or, in other words, derogate from the rules that apply to the internal market ([García García 2024](#)). As [Montero Pascual \(2023\)](#) points out, in extreme cases, state rules can eliminate competition in the market, reserving the provision of certain services to the administration (public monopolies).

Along these lines, [Carlón \(2006\)](#) stresses that the essential nature of these activities cannot be neglected by the public authorities, which must maintain basic standards of provision. From this essential nature derives the general interest of their provision. From this perspective, the community concept of SGEIs is a manifestation of the ideology of public service insofar as certain economic activities are essential in relation to the needs of citizens. The failure of the market to guarantee the provision of an SGEI will be the justification for the intervention of public authorities to guarantee access to it for all citizens ([Carlón 2006](#), p. 39).

The liberalisation processes at the end of the 20th century have adopted different techniques of public intervention in each SGEI, without the need to resort to the more classic technique of public service (full public ownership). The application of the most appropriate technique should be based on three fundamental principles emanating from the Treaty: (i) the principle of neutrality between public and private operators; (ii) the principle of proportionality; and (iii) the principle of freedom of states to determine the services and the delimitation thereof.

At the EU level, European bodies define basic standards for each SGEI that are specified in the universal service (US), a concept that we will develop in the following section and which constitutes the specific public service technique for each specific area ([Carlón 2006](#), p. 41).

### 3. On Universal Service in SGEI

In increasingly interconnected and digitised societies, the regulation of SGEIs through the universal service technique constitutes a model supported by the findings of theoretical and empirical research conducted by economists, legislators, policymakers, and experts in the fields of each SGEI. The configuration of the US within the respective SGEI aims to ensure access to essential services for all users, thereby contributing to the reduction in inequality, fostering social and territorial cohesion, and safeguarding equal opportunities. Concurrently, the design of USOs, together with other policy decisions, can act as a counterweight to the potential expansion of corporate power, a trend that is exacerbated in the context of networked activities.

For each SGEI, universal service means a set of basic services provided permanently with the quality intended in the regulations throughout the national territory and at an affordable price for all users. The elements of this definition are common to all SGEIs; although, they take on specificities depending on the nature of the service concerned. The enumeration and delimitation of the services that make up the respective US constitute its content and scope. For example, in the Spanish case, the universal postal service (UPS) includes, among others, ordinary, certified, and insured letters, both national and across the border ([Spanish Parliament 2010](#) (Law 43/2010)); in the telecommunications service, the service of access to broadband internet with a minimum speed of 10 Mbit per second ([Spanish Parliament 2022](#) (Law 11/2022)).

The main characteristics of a US are the following: quality, continuous or permanent provision, nationwide ubiquity, and affordability.

(a) Quality. This shall be as specified in the standards. In this respect, the specific quality of service parameters shall be laid down for each SGEI. In all cases they must be quantified. The measurement methods to be applied shall be publicly available, as shall the content and format of the information, including possible quality certification mechanisms;

(b) On a permanent or continuous basis. The service shall be provided without interruption, except in exceptional cases. Depending on each SGEI, the parameters relating to permanence are set and will also be made public. For example, the UPS requires at least one collection at all access points to the postal network and one delivery to all addresses every working day, Monday to Friday, irrespective of population density and even in rural areas. It is understood that this frequency of collections and deliveries guarantees the permanence of the service. In parallel, all post offices will establish their daily opening hours in accordance with their working calendar;

(c) Ubiquity is one of the central characteristics of the US. Indeed, the US requires the provision of a given SGEI throughout the national territory. The concern for rural and sparsely populated areas is present in the sectoral directives. Thus, the Postal Directive 2008/6 requires Member States to establish sufficient access points to take into account the needs of users in rural and sparsely populated areas. Along the same lines, the preamble of the General Telecommunications Law, in the case of Spain, mentions the deployment of new networks in rural areas, especially in territories with a high population dispersion and complicated orography, as an essential element to enable adequate economic development and to promote entrepreneurship and job creation;

(d) Affordable prices for all users. The prices of the set of basic services that make up the content and extent of the US shall be affordable, transparent and non-discriminatory and shall be oriented to the real costs of the service. Sector-specific regulations generally provide that the competent authority may set maximum and minimum prices for services with USOs<sup>1</sup>. The concept of affordable price is not uncontroversial as the same price set for a particular service may be valued unequally in terms of affordability by different users.

Economic affordability through price coupled with physical accessibility to the service, the latter including for people with different degrees of disability, reinforces the accessibility of the service. As [Carlón \(2006, p. 45\)](#) points out, “[...] the elements of physical accessibility and affordability are at the core of universal service”. Indeed, an affordable price of access reinforces the guarantee of the right to adequate and available service to a broadband internet through an underlying connection at a fixed location, which is one of the elements of the US content in the telecommunications SGEI. In addition, economic affordability can be guaranteed through redistributive public policies, alternative and/or complementary to price affordability.

For the provision of the US, the sectoral directives lay down the fundamental principles of the US: provision to users, under comparable conditions, of an identical service; provision without discrimination of any kind; provision without interruption or suspension, except in cases of force majeure; evolution in line with the technical, economic, and social environment, as well as with the needs of users. The latter gives the US its evolving and dynamic character.

The US, its content and extent, are not static concepts. The regulator will have to take into account technological, economic, and social change in order to modify important aspects of the US in a given SGEI. This modification can occur either positively or negatively (inclusion or exclusion of new services or benefits).

Technological change seems to be the main driver of the evolution of the US. This factor is the determinant of the fact that some services that are now obsolete are excluded from the scope of the US of a specific SGEI, while new services are included. Table 1 shows the content of the US of telecommunications in Spain, resulting from the comparison of the General Telecommunications Laws: [Spanish Parliament \(2003\)](#) (Law 32/2003) and [Spanish Parliament \(2022\)](#) (Law 11/2022). As can be seen, internet access was included as one of the essential elements of the US and subscriber directories and public payphone booths were excluded. The availability of information on the network, as well as the great expansion of the use of mobile phones and an internet accessible from all devices justify the exclusion of both elements, which were once very necessary.

**Table 1.** Evolution of the scope of US in telecommunications in Spain.

Law 32/2003	Law 11/2022
<ol style="list-style-type: none"> <li>1. Access to the public telephone network from a fixed location.</li> <li>2. Provision of the telephone directory service and related directory enquiry service.</li> <li>3. Sufficient supply of public payphone booths.</li> <li>4. Special attention to disabled persons and users with special social needs.</li> </ol>	<ol style="list-style-type: none"> <li>1. Adequate and available broadband internet access service through an underlying connection at a fixed location. The minimum speed for broadband internet access is set at 10 Mbit per second downstream.</li> <li>2. Voice communications services over an underlying connection at a fixed location.</li> </ol>

Own elaboration.



Regarding the evolutionary character of the US, the quoted General Telecommunications Law aims at an increase in speed up to 30 Mbit (depending on the extent of the networks and the state of the art), and the implementation of appropriate measures within one year for the universalisation of a speed of 100 Mbit.

Another element that deserves attention when talking about accessibility to an SGEI is the evolution of the composition of the population in a given territory, both in terms of its age composition and the origin of the users, especially in those contexts where an increasing proportion of the population is of non-EU origin. The first of these aspects can inform about the concentration of potential users in the older age groups, which corresponds to population pyramids typical of some European countries. In such contexts, the digitisation of some of the services, for example, may constitute a barrier to universal accessibility to the service and needs to be taken into account. The second aspect relates to the increased weighting in the population composition of people from outside the EU, with different levels of digital literacy and different languages of origin. The problem that language can pose for access to an SGEI is another element to be considered when adopting measures to ensure universal access. Along with the simplification of requirements, conditions, operating systems, use of forms in different languages, etc., the operator of the particular SGEI will have to reorient the selection of its human factor in order to provide an adequate response to the different aspects of the population structure to which the service is addressed. It cannot be overlooked that the increasing digitalisation of social interrelations faces the risk of digital divides for some groups: the elderly, dispersed population, economic vulnerability, or other social reasons.

Beyond the USOs, the sectoral directives and national legislations impose other obligations of public nature (PNOs) on SGEI operators, for reasons of general interest and of a non-economic nature. These are obligations that aim to guarantee attention to needs or values that are in the general interest, but which refer to elements that are accessory to the service in question and are different from its own content in terms of services. Among the most relevant are the secrecy of postal and electronic communications, the protection of personal data, the safety of network operation in the transport of dangerous substances, the protection of the environment, and regional planning (e.g., [European Parliament and Council 2008](#) (Directive 2008/6/EC, art. 2.19); [European Parliament and Council 2019](#) (Directive 2019/944/EC, art. 9.2)).

Finally, there is another set of public service obligations (PSOs) that Member States may impose on SGEI operators designated for the provision of the respective US, where this is required for reasons of general interest or social or territorial cohesion; improvement in the quality of education and civil protection; safeguarding the normal conduct of electoral processes, where necessary; collaboration to ensure public security or national defence, in extraordinary circumstances (e.g., [Spanish Parliament \(2010\)](#) (Law 43/2010), art. 22.4); protection of vulnerable customers (e.g., Directive 2019/944/EC, art. 58.h.). It should be stressed that the imposition of additional obligations on the US should be subject to compensation.

#### 4. Economic Justifications for Universal Service Obligations

In a normative approach, there are conditions under which it is possible to defend USOs on social welfare considerations ([Cremer et al. 2001](#), p. 13). From a positive approach, USOs can be the result of the multiple interactions of the policy process.

This paper addresses the role of USOs as a remedy to network externalities. There is a clear tendency to strengthen USOs almost everywhere in the world in the vast majority of services organised as network industries ([Garcia-Calvo 2012](#); [Gautier et al. 2024](#)).

As noted above, SGEIs share some of the characteristics of network industries, with this property being stronger in SGEIs providing telecommunications services (landline and mobile telephony), internet, postal services, and passenger transport, in which the presence of network effects or external economies is undeniable. Such network effects constitute the decisive elements for the adoption of public policies of a regulatory nature. In other

services, such as electricity supply, gas supply, drinking water and sanitation, etc., the presence of network effects, although present, does not enjoy a consensus comparable to that of the telecommunications literature.

Among the functions listed in Table 2, as already indicated, in the following section, we address the role of the US as an instrument for the correction of market failures originating in the network externalities of SGEIs. This role of the US is analysed in numerous research papers: [Cremer et al. \(2001\)](#), [Panzar \(2006\)](#), [Armstrong \(2008\)](#), [Jaag \(2014\)](#), [Harker and Kreutzmann-Gallasch \(2016\)](#), [Gautier et al. \(2022, 2024\)](#), [Peitz and Schuett \(2016\)](#), [Garcia-Calvo \(2012\)](#), [Spulber \(2008\)](#), [Kraemer et al. \(2013\)](#), among others.

Table 2. Functions of universal service.

Normative approach
1. As a solution-oriented technique for network externalities
2. As an instrument at the service of regional policy.
3. Means to offering the network itself as a public good.
4. Income redistribution function (by location and by income).
Positive approach
5. The US as a result of the political–economic process (role of policy makers, pressure groups, interest groups, consumer and user organisations, trade unions, etc.).

Own elaboration.

5. Network Effects or Network Externalities

Externalities or external effects of consumption exist when the benefit obtained by one consumer of a good depends on the consumption of another consumer of the same good. These effects can be positive or negative depending on whether they produce an increase or a decrease in utility. Economists exemplify the existence of positive externalities in health care spending to the extent that an individual’s health care spending has a positive impact on his or her own health and, to some extent, on others. Conversely, excessive alcohol consumption by one consumer may cause negative externalities on other consumers.

Within the normative framework, the economic literature studies the existence of external economies as a market failure. Indeed, in the presence of such externalities, the market price system cannot guarantee the efficient level of consumption since the consumer takes into account exclusively his own benefit ([Cremer et al. 2001](#)). In such a context, the level of consumption will be lower than the efficient level if the externality is positive. Conversely, it will be higher than the efficient level if the externality is negative. In other words, this consumer, through the price, does not appropriate the entire benefit or does not pay for the entire harm provided by each unit of the good he consumes and pays for.

This same reasoning applies to network effects or externalities. As indicated above, SGEIs, in general, are examples of network services, notably in landline and mobile telephony, internet, postal services, passenger transport, among others.

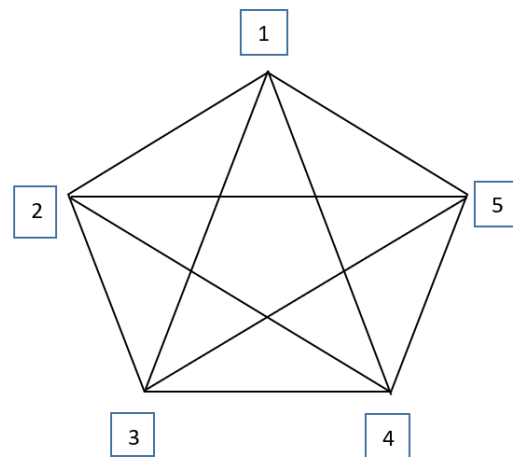
The number of subscribers to a network is a key element in the debate on network effects in this type of SGEI. The increase in subscribers in a network leads to a potential exponential growth of interactions between participants.

In the specific case of a telecommunications network, the number of subscribers determines the potential for possible contacts or inter-relationships. A simple graph can help us to understand the expansive process of these inter-relationships.

Starting from a number of five subscribers, Figure 1 shows that the potential contacts between the five participants in the network are 20. The 10 lines show the connections between each of the participants. When considering connections in both directions, the number of lines will rise to 20. In this case, the number of possible interrelationships (I) is  $I = 5^2 - 5 = 20$ . It can be generalised for n subscribers:

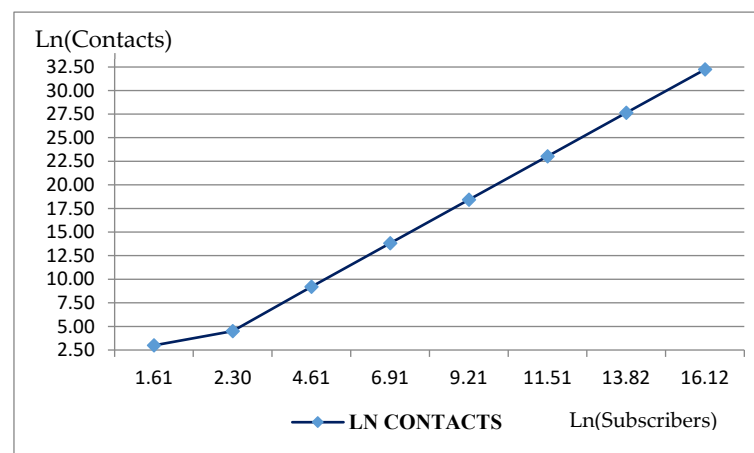
$$I = n^2 - n = n(n - 1)$$

(1)



**Figure 1.** The process of expanding potential network contacts. Own elaboration.

Applying the expression (1), a landline and/or mobile network operator reaching ten million subscribers will have a capacity to generate  $I = 9.999.999 \times 10^{14}$  potential connections. Figure 2, with the data expressed in natural logarithms, shows the exponential evolution of the number of potential contacts. (Note that the antilogarithms of 16.12 and 32.23 are, respectively,  $10^7$  (subscribers) and  $10^{14}$  (potential contacts)).



**Figure 2.** Exponential expansion of potential contacts. Own elaboration.

A more precise approach to the meaning of network effects is to consider them as mutual benefits of consumption (Spulber 2008). As noted, the existence of network effects generates inefficient equilibria in both production and consumption. The search for efficient balances is one of the reasons that vindicates regulatory policies: (1) antitrust legislation; (2) network neutrality (NN); (3) establishment of universal service obligations (USOs).

The most commonly used regulatory policy instruments in the field of SGEIs, being networked services, are NN<sup>2</sup> and OSU. In such contexts, antitrust legislation may be less effective. Antitrust policy based on correcting market inefficiencies arising from network externalities is likely to negatively affect both competition and innovation (Spulber 2008).

### 5.1. Efficient Consumption Level and Social Benefit in the Presence of Network Effects

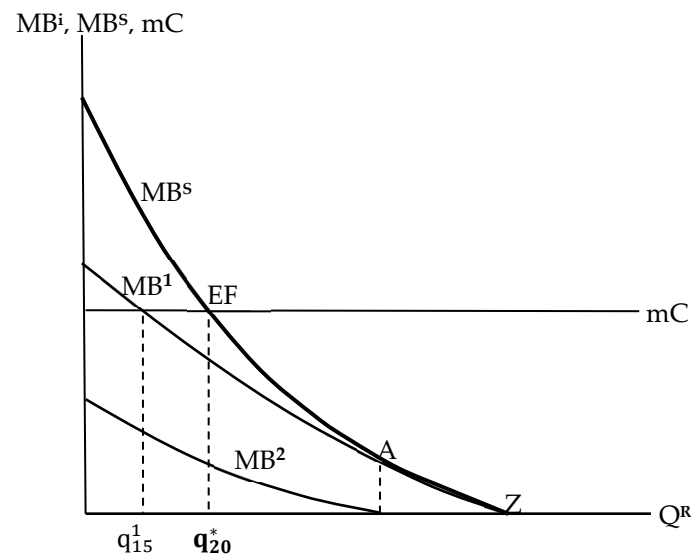
Suppose a network good  $Q^R$  with the capacity to generate positive network effects. Let 1 and 2 be the consumers who demand this good. The quantities  $q^1$  and  $q^2$  are the quantities consumed, respectively, by consumers 1 and 2. For each equilibrium level, the quantity of good  $Q^R$  will satisfy that  $q^1 + q^2 = Q^R$  regardless of whether it is a socially efficient or inefficient level of consumption.



The curves  $MB^1$  and  $MB^2$  in Figure 3 represent the marginal valuation given to the network good  $Q^R$  by consumers 1 and 2, respectively.  $MB^S$  is the social marginal benefit. In consumption microeconomics, both curves  $MB^1$  and  $MB^2$  represent the respective marginal utilities. The utility functions are as follows:

$$U^1 = u^1(q^1, q^2) \text{ with } \frac{\partial U^1}{\partial q^1} > 0; \frac{\partial U^1}{\partial q^2} > 0 \quad (2)$$

$$U^2 = u^2(q^2, q^1) \text{ with } \frac{\partial U^2}{\partial q^2} > 0; \frac{\partial U^2}{\partial q^1} > 0 \quad (3)$$



**Figure 3.** Efficient consumption and social benefit with network effects. Own elaboration.

The positive sign of the partial derivatives of the utility function with respect to the quantity of the good  $Q^R$  consumed by each of the consumers means that the total utility individually perceived by each one increases when both  $q^1$  and  $q^2$  increase. Consequently, the joint utility of both ( $U^1 + U^2$ ) increases. The characteristic of the utility functions in the case of goods whose consumption generates positive externalities is represented by the positive sign of the variation of individual utility with respect to the consumption of the same good by other consumers. In our case:  $\frac{\partial U^1}{\partial q^1} > 0$ ;  $\frac{\partial U^1}{\partial q^2} > 0$  for consumer 1 and  $\frac{\partial U^2}{\partial q^2} > 0$  y  $\frac{\partial U^2}{\partial q^1} > 0$  for consumer 2. On the contrary, in the case that the consumption of the good by one of the consumers generates negative externalities on the other consumer, it will be fulfilled that  $\frac{\partial U^1}{\partial q^2} < 0$  y  $\frac{\partial U^2}{\partial q^1} < 0$ . In what follows, we consider only positive externalities or network effects, as is usual for networked services provided by SGEIs.

Marginal utility, although positive, has a negative slope, which shows the consumer's perception of saturation when the level of consumption exceeds certain subjectively determined limits. For marginalist theories, marginal utility is decreasing (Gossen's first law). The utility that a consumer attaches to each additional unit of a good decreases as he owns or consumes more units of that good. Goods or services with network effects are not exempt from its application. The following expressions represent decreasing positive marginal utilities.

$$\frac{\partial^2 U^1}{\partial^2 q^1} < 0 \text{ y } \frac{\partial^2 U^2}{\partial^2 q^2} < 0.$$

Gossen's second law equates the marginal utilities of different goods, weighted by their respective prices. The rational consumer substitutes the consumption of one good for another that yields a higher increase in utility for each unit of income spent on it.

Equation (4) represents the law of equality of weighted marginal utilities, for consumers 1 and 2.

$$\frac{\frac{\partial U^1}{\partial Q^A}}{p^A} = \frac{\frac{\partial U^1}{\partial Q^B}}{p^B} \quad (4)$$

We assume that both consumers pay a price for each unit of service equal to the marginal cost:  $p = mC$  which, as we know, is the profit maximisation condition for a producer in perfect competition. For simplicity, we assume constant  $mC$ .

Consumers face a price of the network good  $P^A = mC$ . In Figure 3, consumer 1 demands the quantity  $q_{15}^1$  that equals  $MB^1$  at marginal cost. The quantity demanded by consumer 1 satisfies the condition  $mC = p$ . The marginal benefit he obtains from his independent action is the one corresponding to the indicated consumption in his curve  $MB^1$ . Once the quantity of good consumed is established, the total utility (or degree of subjective satisfaction) will be determined in his utility function.

The consumption of a good with network effects by one consumer creates a benefit for other consumers. If the former is not economically compensated for the benefit it generates beyond its own marginal valuation, consumption will be below the efficient level, while the private benefit is lower than the social benefit. The impossibility of recovering through price the benefit it creates for others is the cause of market failure in this context.

The efficient solution, as in the case of a public good, will be that the level of consumption for which the sum of consumers' marginal benefits equals the marginal cost for each quantity of the network good.

In Figure 3, the efficient equilibrium is at the point  $EF^*$  of the  $MB^S$  curve for the quantity of good  $q_{20}^* > q_{15}^1$ . In turn, the social benefit corresponding to the efficient level of consumption  $q_{20}^*$  is greater than that corresponding to the initial quantity. The conditions on the signs of the partial derivatives of the utility functions of each consumer stated above guarantee the superiority of the  $MB^S$  over the  $MB^1$  and over the  $MB^2$ . Consequently, in the efficient equilibrium, the following will be fulfilled:

$$q^* > q^i \text{ y } MB^S > MB^i.$$

Consumer 1 pays for the quantity he demands ( $q_{15}^1$ ) the unit price that equals marginal cost. His expenditure is equal to  $q_{15}^1 * p = q_{15}^1 * mC$ . The MB of this consumer is the one that corresponds to  $MB^1$  (marginal valuation or marginal utility) for that quantity.

Consumer 2, in view of his marginal good valuation curve ( $MB^2$ ), does not demand any quantity of the network good  $Q$  for the marginal cost indicated. However, since it is a non-rival consumption, it can access this good, taking advantage of the network effects generated by the consumption of consumer 1, without any compensation for the generator of the positive externalities. The service is provided free of charge to all other consumers. This is the rationale for the existence of inefficient (lower) consumption and inefficient (lower) individual profit at the efficient equilibrium level.

Although the principle of non-rivalry in consumption is fulfilled, the network good is itself a private good. On the one hand, the provision of one more unit of the service does not have a zero marginal cost, and, on the other hand, the right of exclusion can be exercised, as it is possible to deny access to the network to users who do not pay a subscription to the network.

## 5.2. From Individual Marginal Benefit to Social Marginal Benefit

If the consumption of good  $Q^R$  produces positive network effects on the consumption of another consumer, the utility function of each consumer must internalise the marginal benefits that his consumption causes on the utility of the other consumer. The passage from inefficient quantity and independent marginal benefit to efficient equilibrium quantity and social marginal benefit can be formalised as follows.

Based on the utility functions of each consumer used above, the following is true:

$$U^1 = u^1(q^1, q^2)$$

$$U^2 = u^2(q^2, q^1)$$

the marginal benefits can be expressed, respectively, as follows:

$$\Delta U^1 = \frac{du^1(q^1, q^2)}{d(q^1, q^2)} = mC$$

$$\Delta U^2 = \frac{du^2(q^2, q^1)}{d(q^2, q^1)} = mC$$

The variation in each consumer's utility now depends on the variation in his own consumption and the effects of his consumption on the utility of other consumers.

We refer to the effect that the consumption of the former has on the benefit of the latter as follows:

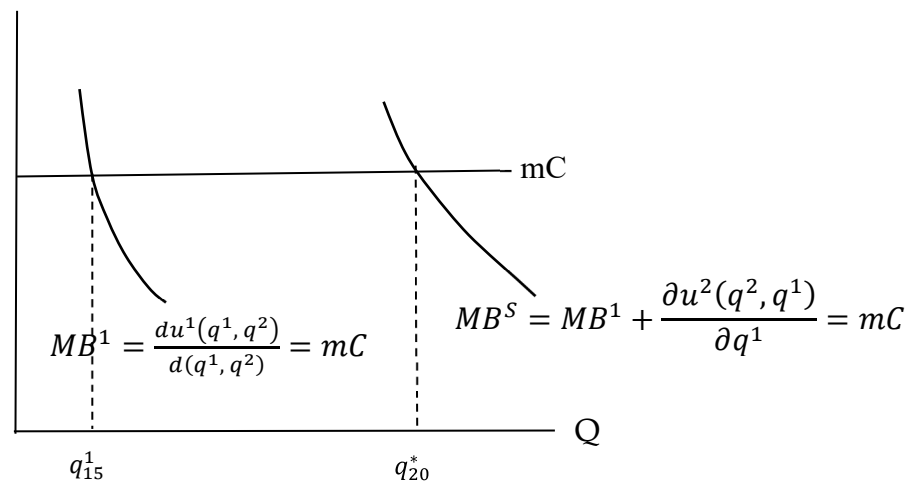
$$\frac{\partial u^2(q^2, q^1)}{\partial q^1}$$

and the effect of the consumption of the latter on the benefit of the former as follows:

$$\frac{\partial u^1(q^1, q^2)}{\partial q^2}$$

The social marginal benefit corresponding to socially optimal consumption is the sum of the individual marginal benefit plus the effect of each individual's consumption on the other's benefit, as shown in Figure 4.

MB, MB<sup>S</sup>, mC



**Figure 4.** From individual marginal benefit to social benefit. Own elaboration.

For the consumer 1:

$$MB^S = \frac{du^1(q^1, q^2)}{d(q^1, q^2)} + \frac{\partial u^2(q^2, q^1)}{\partial q^1} = mC \quad (5)$$

For the consumer 2:

$$MB^S = \frac{du^2(q^2, q^1)}{d(q^2, q^1)} + \frac{\partial u^1(q^1, q^2)}{\partial q^2} = mC \quad (6)$$

## 6. The Universal Service as an Instrument Oriented Towards the Solution of Network Externalities

The phenomenon concerning the existence of network effects arising from the consumption of SGEIs generates an ongoing debate with legal, economic, and technological underpinnings. The alleged market failure derived from network effects is evidenced in the provision of an insufficient or excessive level of service, depending on whether positive or negative externalities are involved, and which, in either case, is inefficient. Its correction recommends the adoption of different forms of regulation, such as universal service or the guarantee of net neutrality (NN), together with other antitrust-oriented measures.

In the European Union, since the 1990s, a process of liberalisation of SGEIs began, some of which had been operating under a quasi-monopoly regime, regardless of whether the ownership regime was mainly public or private. The regulatory system generally adopted is the universal service technique, which, as indicated, aims to guarantee a service of a quality determined by the rules, throughout the territory, on a permanent basis and at an affordable price.

We are particularly interested in the extent to which the establishment of universal service obligations (USOs) in SGEIs can contribute to the correction of market failures in activities that, for the most part, have the characteristics of network services.

The contribution of USOs to the correction of network externalities is analysed through the very elements contained in the universal service definition.

### 6.1. Quality

The various directives, as well as the transposing national laws, set the basic standards for quality in the respective SGEIs. The compliance parameters set at a given point in time are subject to continuous revision, depending on general technological change and technical and process innovation in the specific activity of each SGEI. In postal services, for example, the evolution of surface and air transport infrastructures has contributed to the improvement of quality in time, an aspect of quality that is highly valued by users. In turn, more recently, developments in OCR reading technology and automated sorting have improved quality through the reduction in work processes.

Another element that reinforces the perception of quality is the personal attention to the public at the operator's access points or by telematic means. Personal attention and information are generally provided free of charge. Likewise, the guarantee of secrecy of communications, data protection, information, reliability, security, and continuity are important aspects in the provision of all essential SGEI services.

Regulation through the US technique must seek to adapt the USOs to technological, economic, and social change and to the needs and preferences of users. An improvement in the perception of service quality builds loyalty among current users and encourages the attraction of new consumers, a key factor in the exponential expansion of the network, with private and social benefits.

### 6.2. The Permanence or Continuity of the Service

Both the sectoral directives and the national transposition laws emphasise, within their respective universal services, the requirement for continuity and permanence of service. For example, in Spain, the Electricity Sector Act 24/2013 establishes that the transmission and distribution of energy shall be provided under the conditions of regularity and quality that are enforceable (Art. 43.1). In relation to consumer rights, it establishes that the consumer will receive the service with the levels of safety, regularity, and quality (Art. 44.9h). In terms of penalties, sanctions will be graduated according to the damage caused to the continuity and regularity of supply (Art. 67.4c).

The permanence and continuity of essential services are core requirements for the development of economic activity and social life. In the absence of continuity, vital services such as hospitals, laboratories, the banking system, public administration, e-commerce, education, compatibility of work and home activities, among others, would be impossible

to carry out. All these activities depend on the continuity of services such as telecommunications, electricity or gas supply, etc.

The increasing evolution of technology in all fields and the continuous expansion of its use at all levels of economic and social activity make the absence of interruptions in the provision of these services increasingly essential. As [McMenemy \(2022\)](#) points out, the emergence of new services, such as broadband or mobile telephony, clearly transform society. Any failure to comply with this principle of the US can lead to situations of instability with serious consequences for the normal development of life in all its spheres and expressions.

The obligation of permanence, as an element and principle of the US, constitutes an element of positive valuation of current users, while at the same time acting as a force of attraction for new users. To the extent that externalities are positive, the US, as a regulatory alternative, contributes to the creation of efficient balances in consumption while at the same time reinforcing social welfare.

### *6.3. The Provision of the Service Throughout the National Territory: Ubiquity*

The ubiquity or availability of the service in any part of the territory, including rural or sparsely populated areas, emerges as one of the main elements of the US in SGEIs when this technique is argued as a remedy to network externalities. A network that covers the entire territory, regardless of the degree of concentration or dispersion of potential users (individuals, families, companies, public administration organisation, etc.) increases its capacity in two decisive aspects. Firstly, once the network has been created, its absence no longer constitutes an argument for the user to change location. In addition, the existence of the network allows new businesses to flourish. It stands as an instrument that allows new opportunities to emerge by settling new populations and attracting activities that did not exist before. This property of the US is aimed at avoiding or reducing the digital divide between urban and rural populations, a subject of much debate in the literature.

Postal services extend their network over the entire territory. Their large, automated processing centres and logistics centres are strategically located to provide efficient responses to the sorting, processing, and transport of items. Access points are perfectly coordinated with the transport network. At the destination, distribution units perform pre-delivery tasks. The transport network and delivery units have a capillarity capable of reaching all addresses on a daily basis, regardless of their location. The sectoral regulations guarantee, in particular, the coverage of the service in rural areas. A complex set of specific software ensures the tracking of all registered consignments and financial services from admission to final delivery.

On the other hand, rural and sparsely populated areas face limits to expanding their economies in an increasingly digitised society if they do not have access to a high-speed broadband internet service. Some studies investigate the effects of broadband availability on household income, student earnings, or housing values ([Whitacre and Gallardo 2022](#); [Whitacre and Biedny 2022](#)). Others study the multiple impacts of broadband upgrading at the regional level ([Palmer-Abbs et al. 2021](#)). The work of [Valentín-Sívico et al. \(2023\)](#) finds quality of life benefits, primarily a reduction in frustration linked to faster and higher bandwidth wireless Internet access. The availability of broadband access in small cities competing for residents or employers can be considered in location decisions ([Low et al. 2023](#)). A firm's initial location decision in a particular location also values the availability of broadband access ([Kim and Orazem 2017](#)).

National governments, from a dynamic perspective of the US, must extend the USOs in response to technological progress (as we will see in the following section) and to the needs of the population. The positive economic and social effects derived from the extension and permanent technical updating of the US in the different SGEIs, especially those most closely linked to the evolution of the new digital society, have been widely acknowledged. The integration of the Internet in the field of the US, the extension of the US to broadband, and

the broadening of bandwidth and speed have already been addressed by the governments of several states.

As an example of this concern, the United States government approved a set of federal funds to address the digital divide to improve high-speed broadband in small communities, such as Turney, a small town in Missouri (Valentín-Sívico et al. 2023).

Other initiatives of this nature, based on private collaboration, have proved successful. In this regard, the UK study Cybermoor (n.d.), for example, perfectly exemplifies how broadband connectivity of more than 10 Mbit speed brought economic, educational, and training benefits to the small rural community of Alston Moor in the Pennine Mountains in Scotland.

If the operator providing the US, or other commercial operators, do not respond to the gaps in broadband provision, local communities, as Mandel et al. (2012, p. 142) point out, have the potential to respond to the current uneven broadband market, as they have the capacity to “pool resources, plan together, analyse needs to obtain economies of scale, better services and a stronger community technology infrastructure”. The case of Alston Moor exemplifies the potential of Coasian coordination in small groups.

The mandatory provision of the service throughout the territory is an essential element of regulation through the US. In the postal service, the capillarity of the network is the attribute that reduces the potential urban–rural postal divide. Similarly, in telecommunications, broadband with comprehensive territorial coverage and high quality standards integrates the entire population into the digital society regardless of their location (Philip et al. (2017). Mitigating the urban–rural digital divide is currently one of the objectives of public policies in telecommunications, an objective pursued via regulation through the universal service technique.

Alongside the increase in the number of subscribers and the growing adoption of the service by users with higher consumption volumes, the US can drive a more appropriate architectural structure of the network as a complex structure in which, in addition to the number of adopters, capacity and reliability are of interest (Spulber 2008).

#### 6.4. Affordability

Prices of services with USOs must be affordable for all users. Affordability of the US is referred to above in its two dimensions: physical accessibility and economical affordability. The first refers to ensuring access to network elements (customer service offices, devices, instructions for use, etc.), including people with various physical or sensory limitations. The second focuses on the prices of services.

As a general principle, prices are cost-oriented. As we know, the profit maximisation rule in perfect competition is equality between price and marginal cost. Some of the conditions of USOs, such as ubiquity, permanence, and quality of service collide with the cost orientation to prices. It is assumed that the provision of SGEIs such as postal services, landline and mobile telephony, electricity, or internet are provided under the same conditions in unprofitable areas. The latter are characterised by low population density and dispersed rural areas, as well as isolated mountain areas, where the US provider faces serious problems of investment recovery.

Along with the existence of unprofitable zones, areas, and routes, some US regulations impose price restrictions on the US provider. One of the restrictions is the existence of uniform pricing. Uniform pricing requires the provision of the service at the same price irrespective of whether the user is located in a profitable or unprofitable zone, area, or route. The sectoral directives in the EU do not, as a rule, provide for uniform pricing, although SGEI providers usually apply it at the US level, as the directives themselves provide that US providers in the different SGEIs may agree “...where necessary, to provide such a service at uniform prices...” (Directive 2008/6/CE).

Another price constraint refers to the difficulty or impossibility for the supplier of the US to modify US prices, at least in the early stages of liberalisation. As Armstrong and Sappington (2006) point out, asymmetrically restrictive price regulation that limits the



incumbent supplier's ability to compete against entrants may encourage entry of them. However, even when entry is desirable, the costs of asymmetric regulation may outweigh its benefits. The impossibility of price reductions by the incumbent in response to competitive entry can lead to problems such as the following:

- (a) Market skimming. Entrants, including some inefficient ones, enter profitable areas at lower prices, putting the financial integrity of the US provider at risk. *Cream-skimming* practices deprive the incumbent of part of its business in the most profitable areas or routes, while it cannot neglect the US in unprofitable areas;
- (b) Cross-subsidies may increase industry costs to the extent that a portion of the users are served by inefficient suppliers;
- (c) Market skimming concentrates competition in the profitable part of the market. The benefits of competition are distributed among users in these areas while users in the unprofitable areas do not share in the benefits of competition;
- (d) If the prices of the US provider do not reflect the costs of service provision, the design of network access prices for entrants may be complex.

If asymmetric price regulation is coupled with asymmetric product regulation, the US supplier cannot expand its product portfolio at the same pace as entrants. This regulation leads to higher prices, reduced product variety, and lower innovation and quality.

However, the main problem with the affordable price principle is the financing of the additional cost incurred by the US provider. The justification for financing the net cost of USOs rests on one of the main functions attributed to the US: income distribution by user location and by level of income (Cremer et al. 2001; Pateiro Rodríguez and Rodríguez García 2017). The first is because residents in dispersed and low-density areas, as well as in geographically isolated or difficult orographic areas, would face unaffordable SGEI prices due to the high costs of installation and maintenance of infrastructures. Competitors would not enter this loss-making space of the market. Consequently, the US provider will participate in a compensation fund for the USO, which, depending on the SGEI in question, will be financed by public funds or through the service providers, the users, or a combination of both (Directive 97/67, Art. 7.3; Law 11/2022, Art. 42).

The inter-regional transfer due to the location of the consumer occurs regardless of the consideration of the income levels of individuals, since both in regions with high population density (profitable) and in those with a dispersed population (non-profitable), there are consumers with high and low income levels and, therefore, with different purchasing capacities (Pateiro Rodríguez and Rodríguez García 2017).

If the supplier of the US raises prices in unprofitable areas in order to compensate for the loss of revenue due to cream-skimming in profitable areas, it may also attract entry of competitors in areas of average population concentration closer to the profitable core areas. Such a price-raising strategy by the dominant operator can make areas attractive that were previously unattractive. A persistence in this strategy may lead to a graveyard spiral process, displacing the supplier of the US to isolated and marginal areas (Crew and Kleindorfer 2005; Jonsson and Selander 2006; Prado-Domínguez et al. 2012).

Therefore, it is necessary to directly address the second aspect of redistribution through the universal service (Pateiro Rodríguez and Rodríguez García 2017), which is related to people's income level, regardless of their location in the territory, the analysis of which is not addressed in this paper. At the EU level, the sectoral directives of the different SGEIs and the national laws that transpose them include the fact of vulnerability and the instruments for its attention within the USO. Due to its quantitative and social importance, the regulations relating to electricity, gas, and telephone supply systems stand out. Thus, in order to address situations of vulnerability, in the field of electricity supply in Spain, a social voucher (discount on consumption and other benefits) is created for vulnerable customers and for users in a situation of energy poverty (Spanish Parliament (2013) (Law 24/2013), Art. 45 and 45bis, respectively).

The determination of the net cost of USOs is a complex task. In this paper, we do not address the theoretical, technical, and political problems of determining the net cost of the

USO. We point out, however, that very often the determination of this magnitude in the various SGEIs is the subject of litigation before the relevant courts, with varying results for the disputing parties. There are numerous cases in which the State has had to reimburse the service providers for the funds previously provided by them, following court rulings.

#### 6.5. Social Marginal Benefit with USO

The consideration of the properties of the US developed in the previous section allows the expressions (5) and (6) to be modified, resulting in a higher social marginal benefit.

We rewrite Equation (2) as follows:

$$U^1 = u^1(q^1, q^2, Ql, Co, Ub, Ac) \quad (7)$$

where  $Ql$ ,  $Co$ ,  $Ub$ , and  $Ac$  are, respectively, the attributes of the US: quality, continuity, ubiquity, and physical and economic accessibility. Each of these elements contributes a positive effect to the consumer's utility function 1:

$$\frac{\partial U^1}{\partial Ql} > 0; \frac{\partial U^1}{\partial Co} > 0; \frac{\partial U^1}{\partial Ub} > 0; \frac{\partial U^1}{\partial Ac} > 0$$

The same is true for consumer 2.

If we call  $V$  the joint positive effect of the US attributes ( $Ql$ ,  $Co$ ,  $Ub$ , and  $Ac$ ), we can rewrite the social benefit function of Equations (5) and (6) through Equations (8) and (9), as well as modify Figure 4 where an improvement in social welfare is shown.

For the consumer 1:

$$MB_{uso}^S = \frac{du^1(q^1, q^2, V)}{d(q^1, q^2, V)} + \frac{\partial u^2(q^2, q^1, V)}{\partial q^1} = mC \quad (8)$$

For the consumer 2:

$$MB_{uso}^S = \frac{du^2(q^2, q^1, V)}{d(q^2, q^1, V)} + \frac{\partial u^1(q^1, q^2, V)}{\partial q^2} = mC \quad (9)$$

In Figure 5, the dashed red lines show the new individual marginal benefit of consumer 1 and the new social marginal benefit. Note that both curves are located to the right of the original curves. The new situation reflects the expected positive welfare effects of regulation through the universal service, depending on the appropriate design of the USOs, the degree of their compliance, and their adaptation to technological, economic, and social change.

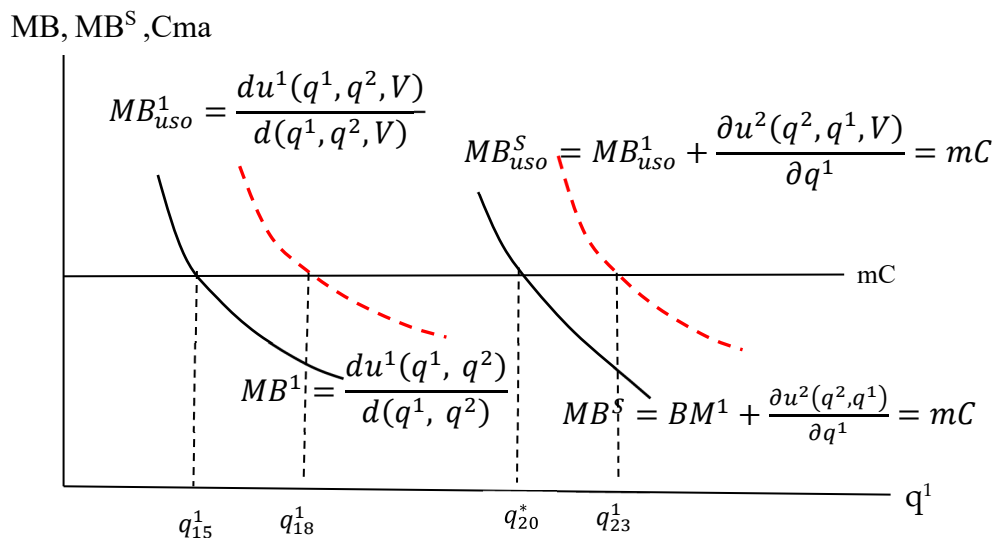


Figure 5. Social welfare with USOs. Own elaboration.

## 7. Discussion and Conclusions

This section discusses the importance of Coasian coordination, driven by consumers in small groups, as well as the importance of spontaneous market order in the Hayekian view of coordination in large groups of consumers. Coordination organised in small groups and spontaneous order can play a valuable role in correcting market failures generated by the existence of network externalities, avoiding some regulatory efforts.

In this sense, Coase (1960) conclusively illustrates how the coordination of consumers and producers in contexts where externalities exist can benefit from coordination through mutual trade-offs. This is the case for small groups where transaction costs are small and coordination is more feasible. Low transaction costs allow the formation of economically efficient informal agreements and formal contracts. While Coase's approach is extensible to the consumption of services with network effects, the consumer groups typical of SGEIs are, in all cases, large. In such contexts, coordination difficulties and high transaction costs may limit the explanatory potential of the analysis.

A more oriented approach to the analysis of coordination in large numbers is that of Hayek (1991). Hayek argues that the spontaneous order of the market can contribute to the solution of market failures originating in network effects. The price system, in principle, is the main informational element for agents; although, he assumes that the price system may not be sufficient to achieve coordination in markets with network effects, where the number of consumers is extraordinarily large (as in the case of SGEIs).

In addition to price, the market has mechanisms capable of emitting more information signals, which contribute to the creation of the "Hayekian spontaneous" order. This set of mechanisms contributes to coordination in large consumer collectives. These mechanisms include mass media, social networks, information, and mass marketing (Spulber 2008).

The debate on the superiority, in terms of social welfare gains, of different regulatory models for networked services does not enjoy consensus in the economic literature. Thus, studies on net neutrality in internet service are oriented in two directions: (i) the internet service provider (ISP) cannot charge content providers (CPs), and (ii) the ISP cannot prioritise paid content. But taken together, these studies compare the effects of NN with the free market. As Gautier et al. (2022) point out, they ignore the fact that, in general, regulation of the US exists.

The separate analysis of NN and USOs is clearly unsatisfactory (Calzada and Tselekounis 2018). Both regulatory models (NN and USOs) share the central objective of network extension, coverage improvement, technological innovation, territorial articulation, and, consequently, social welfare.

The decision to prioritise one regulation over another in terms of improving social welfare depends on multiple factors. For example, regarding the Internet, there is a range of bandwidth that conditions the superiority of one regulatory model over another. For a more detailed analysis of the case, see [Gautier et al. \(2024\)](#).

The generalisation of SGEI regulation in the European Union over the last three decades has contributed significantly to an overall improvement in the quality of services and a significant boost to the network, mainly in the postal sector, telephone services, Internet, passenger transport, and energy services networks (electricity and gas).

In addition to contributing to the correction of network externalities, the US has proven to be an economic policy instrument that, beyond the legal aspects of the regulatory model, has contributed significantly to the reduction in the urban–rural digital divide, to national and international trade, to population settlement policy, and to redistribution for reasons of location and income, among others.

The universal service, regardless of professional and academic debates, has contributed to an improvement in social welfare.

On the other hand, the principal limitation of our work is the lack of perfect synchronisation between the extreme speed of technological change across different SGEIs and the delays in the adaptation of regulatory frameworks to this new reality, particularly within the telecommunications sector. Another limitation arises from the scarcity of homogeneous and comparable data, which may result from differences in technological stages and/or from user groups with varying access capabilities; this is especially pertinent for data concerning populations affected by the digital divide (such as rural–urban disparities, digital literacy, age, etc.).

Finally, future research could be inspired by the treatment of the interaction of USOs and network externalities. The intricate nature of USOs and their interaction with network externalities in the different SGEIs will be the subject of further research. Subsequent new studies, including case analyses, will provide empirical evidence within the framework of SGEIs, particularly concerning telecommunication services. In a second line of research, we propose to further investigate the implementation of public policies aimed at adapting services of general economic interest to the evolving needs of citizens in the current context of spreading digitisation.

**Author Contributions:** Conceptualization, C.P.-R., F.M.-B., C.P.-L. and M.E.-C.; methodology, C.P.-R., F.M.-B., C.P.-L. and M.E.-C.; formal analysis, C.P.-R., F.M.-B., C.P.-L. and M.E.-C.; investigation, C.P.-R., F.M.-B., C.P.-L. and M.E.-C.; resources, C.P.-R., F.M.-B., C.P.-L. and M.E.-C.; writing—original draft preparation, C.P.-R., F.M.-B., C.P.-L. and M.E.-C.; writing—review and editing, C.P.-R., F.M.-B., C.P.-L. and M.E.-C.; supervision, C.P.-R., F.M.-B., C.P.-L. and M.E.-C. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The raw data supporting the conclusions of this article will be made available by the authors on request.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Notes

<sup>1</sup> See for example Article 34 of Law 43/2010 (Spanish Postal Law).

<sup>2</sup> For the concept of Net Neutrality (NN), see e.g., [Kraemer et al. \(2013\)](#), [Gautier et al. \(2024\)](#), [Katz \(2017\)](#).

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