EFFECTS OF DIGITAL TRANSFORMATION AND NETWORK EXTERNALITIES IN THE TELECOMMUNICATION MARKETS

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ABSTRACT

The main purpose of the paper is to address the effects of digital transformation in the telecommunications markets which are characterized by network externalities. By acknowledging disruptive effects of digital transformation age, the paper highlights challenges which were created by advancement of technological capabilities. The specific aim of the paper is to present a methodological framework for measuring the information society. The research will be based on an analysis of the number of subscribers by types of telecommunication services, in developed and developing countries, in the last two decades. In this regard, increasing the number of subscribers leads to higher value of the selected network. We expect confirmation of both hypotheses respectively (H1: Digital transformation affects the simultaneously continuous growth of the number of subscribers and the continuous decline in prices of telecommunication services; H2: There are similar trends in developed and developing countries, which are related to the number of the telecommunication services subscribers). Therefore, digital transformation and the effect of network externalities contribute to increasing the number of subscribers, reducing the number of networks (distortion of the market competition) and reducing the prices of telecommunication services.

INTRODUCTION

Network effects are a very often discussed phenomenon in the literature. Despite strong empirical support on network effects generally, there is a need to measure, evaluate their influence and operationalization in digital environments where customer satisfaction and new revenue streams driving digital transformation. Thanks to digital transformation, networks are becoming increasingly complex, as well as the services delivered by them. Subscribers expect a network which will meet their needs and offer innovative digital services. 5G is expected to play a key role in digital environments, enhancing citizens' life experiences and creating new business opportunities. The high speeds and low latency promised by 5G will accelerate companies into a new age of the Internet of Things (Table 1).

Table 1. Evolution of Mobile Networks

	1G	2G	3G	4G	5G
Approximate deployment date	1980s	1990s	2000s	2010s	2020s
Theoretical download speed	2kbit/s	384kbit/s	56Mbit/s	1Gbit/s	10Gbit/s
Latency	N/A	629 ms	212 ms	60-98 ms	< 1 ms

Source: [1, p. 6]

In the electronic communications markets, such as telecommunications, digital changes are encouraged by rapid technological progress. The rapid development of the mobile networks of the fourth generation (4G), was marked the electronic communications market in the first and the second decade of the 21st century. The fifth generation (5G) networks will be characteristic for the post 2020 period.

Variations in the adoption of new technology by companies operating in a network-based industry, such as telecommunications, could be explained as a function of three network effects: 1. the conversion effect (driven by operations-related increasing returns to scale); 2. the consumption effect (driven by demand-side increasing returns to scale); and 3. an imitative effect. Some authors expect that the conversion effect is more strongly during earlier phases of a technology's evolution[2].

According to[3], ten guiding principles of a digital transformation are:

Stage 1 Defining value: 1. Secure senior management commitment; 2. Set clear, ambitious targets; 3. Secure investment

Stage 2 Launch and acceleration: 4. Start with lighthouse projects; 5. Appoint a high-caliber launch team; 6. Organize to promote new, agile ways of working; 7. Nurture a digital culture

Stage 3 Scaling up: 8. Sequence initiative for quick returns; 9. Build capabilities; 10. Adopt a new operating model.

Network externalities present the effects on a user of a product (service) of others using the same or compatible products (services). If the benefits or marginal utility are an increasing function of the number of other users, there are positive network externalities. On the other hand, if the benefits are a decreasing function of the number of other users, there are negative network externalities.

The concept of network externalities can be presented graphically. If the economic agents behave rationally, they choose the amount of services which will maximize their profits by equlizing the marginal costs to marginal benefits. In the absence of externalities, the optimizing quantity corresponds to the lower equlibrium price. The total marginal beneft received by the network subscriber is higher than this level. Every subscriber that joins the network receives additional benefits created by other subscribers, including future subscribers. The distance AB shows the value of additional benefits generated by the network externalities (Figure 1).

Figure 1. Network Externalities and the Battle for Critical Mass
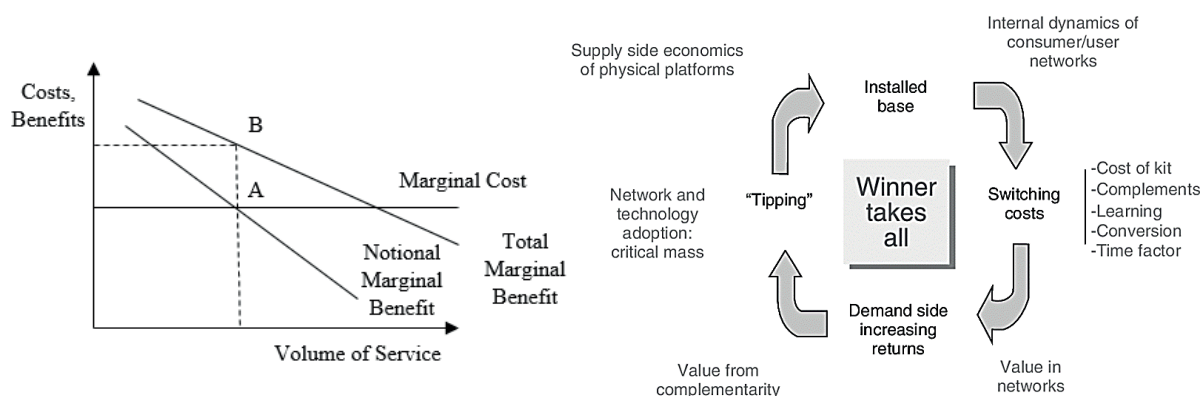
Source:[4]

In the digital economy, value comes from plenty: if something is more demanded and more expected to be demanded, it becomes more valuable. Expectations are so important in driving demand, so a point where the momentum is so overwhelming that success becomes a runaway event is known as a "winner-takes-all" phenomenon (Figure 1).

The electronic communications market is crucial infrastructure sector which directly or indirectly, affects the development of all other sectors in one national economy. This sector includes: mobile telecommunications market, fixed telecommunication market, internet market, and media market, which refers to the distribution of media contents. Some of the main characteristics of these markets are: large fixed costs and very low, close zero, marginal costs, large capital investments, constant innovation in supply side, and shorter life cycle of service. Investing in the development of this markets can accelerate the development of society as a whole, regardless it is a developed country or a developing country[5, p. 226-227].

The paper is organized as follows. This introductory section will be followed by a Section on the literature review and the Section on the research methodology. It sets the scene for the research results and discussion the key trends over time. The last Section provides the conclusions and gives recommendations for further research in this field.

1. LITERATURE REVIEW

One of the most commonly used measure for digital transformation is the Digitalisation Index, proposed by Sabbagh[6] and Katz and Koutroumpis[7]. It is created in order to measure the cumulative, holistic impact of discrete information and communication technologies. This index consists of sixteen indicators divided into six groups of digitalization categories: affordability, infrastructure reliability, network access, capacity, use, and human capital.

Some empirical studies explore the multiplicative effects of digital transformation on business environments. In this regard, one comprehensive measure of digital convergence is consructed (Weighted Digital Convergence Indicator, WDCI). The speed of digital convergence and the size of the digital gap depend on many factors including the degree of the development of information society, the regulatory framework, the political context and the general business environment[8].

Network externalities play a central role in digital environment. In an effort to describe the demand for new networks, the critical mass phenomena, that characterize network externalities, should be especially emphasized[9]. Network externality has been defined as a change in the benefit, or surplus, that an agent derives from a good when the number of other agents consuming the same kind of good changes. This allows, in principle, the value received by consumers to be separated into two parts: the value generated by the product even if there are no other users, and the additional value derived from being able to interact with other users of the product. This latter value that is the

essence of network effects[10]. Bental and Spiegel[11, p. 197] proposed "the model identifies the quality of a network product with the number of consumers using it. Hence the producer cannot unilaterally control the quality of his product. If producers can enter the market freely, market coverage with non-compatible networks will be larger. However, if there is no free entry, market coverage is larger with a single industry-wide standard".

The Table 2 gives an overview positive and negative network effects for information goods, distinguished between content and software. It can be stated that network effects are omnipresent with all information goods, but the degree or intensity of network effects differs by information good.

Table 2. Positive and Negative Network Effects for Information Goods

Information Good / Network Effects	Direct Network Effects	Indirect Network Effects
Software	Positive: Data transfer, cooperation, troubleshooting Possibly negative: Congestion	Positive: hardware, additional programs Possibly negative: Viruses
Content	Positive: Communication advantages Negative: Undesirable distribution of exclusive information	Positive: e.g. end devices, complementary content online Negative: advertising, fraudulent
Product features that support network effects	Integrated technologies Integrated communication applications	File formats System interfaces Source code access (open source)
Network effects	Data exchange, Information exchange Mutual support, Product evaluations	Media reviews, Additional applications and content Software suppliers Accessories, Professional trainings

Source: Adapted from[12, p. 59; 13]

We have identified the following product features that encourage and support network effects: integrated technologies, integrated communication applications, file formats, system interfaces and source code access. In addition to the product features that encourage and support network effects, the following indicators specify and describe direct network effects: Data exchange, Information exchange, mutual support and product evaluations. Media reviews, additional applications and software suppliers, accessories and professional trainings are further operationalizing indirect network effects.

In theory the telecommunications sector has two sector-specific characteristics: network externalities and discriminatory pricing. The estimated demand function based on a discreet consumer choice model indicates that termination-based discriminatory pricing can facilitate network expansion. Therefore, price liberalization could acelerate the development of the telecommunications network led by the private sector[14].

Chung and Yoo[15] analyse the effect of government policy on the diffusion of mobile telecommunication services in member countries of the Organization for Economic Cooperation and Development (OECD). They examine how the competition in and standard policies of each country affect cellular diffusion through interactions with positive and negative network externalities. The obtained results show that the positive effects dominate the negative effects

initially, the negative network externality effects become larger and outweigh the positive externality effects after a certain level of diffusion rate has been achieved. In particular, a single standard policy and the speed of technological innovation combined with the penetration rate generate a positive network externality on the diffusion of mobile telecommunications. However, a competition policy increases the rate of new subscriptions but does not generate any interacting effects[15].

The latest research in this field deals with issues related to externalities between on-line contents drive telecom operators' incentives to provide quality open internet through neutral network[16]. Also, some papers explore the role of network effects in the consumer's choice. This contributes to the existing literature by taking a new approach which allows to analyse the impact that the immediate social network has on consumer choice in network markets. There is some evidence that individual choice of operator is influenced by the total number of subscribers for each operator, but a much stronger effect is the operator choice of other household members[17].

Trifunovic, Mitrovic, and Ristic[18] have determined that users of the network with the largest market share benefit the most from call externalities. In addition, one network does not price discriminate between outgoing and incoming roaming calls, which implies that users of this network have higher level pecuniary externalities in roaming compared to users of price discriminating networks[18].

The existence of positive externalities between contents and applications available on Internet and their effects on the incentives of network operators to provide neutral access, emphasize the importance of regulating this area. Net neutrality is the principle that internet service providers treat all data on the internet the same, without discrimination, which could be blocking, throttling or paid prioritization. Jaunaux and Lebourges[16] compare the economic foundations of net neutrality regulation to the actual practices of internet service providers and their incentives to discriminate or the contrary to preserve an open and neutral internet[16].

The impact of policy and regulatory frameworks on the growth of markets for digital services and applications should not be ignored. Considering that the growth of digitization is primarily driven by the private sector, we point out that policy and regulatory variables are important factors and drivers of growth in the digital economy[25].

2. RESEARCH METHODOLOGY

This Section presents an overview of methodological framework, based on data collected by the International Telecommunication Union (ITU) in the period from 2001 to 2018. The following indicators were especially analyzed: Fixed-telephone subscriptions per 100 inhabitants; Mobile-cellular subscriptions per 100 inhabitants; Individuals using the Internet per 100 inhabitants. This set of indicators cover different aspects of information society. Data will be presented at the global and regional level by development status of the country. The research is based on an analysis of the number of subscribers by types of services in developed and developing countries in the last two decades.

Having in mind the context of the research, the basic hypothesis are defined as follows:

H1: Digital transformation affects the simultaneously continuous growth of the number of subscribers and the continuous decline in prices of telecommunication services;

H2: There are similar trends in developed and developing countries, which are related to the number of the telecommunication services subscribers.

The mobile-cellular subbasket refers to the price of a standard basket of mobile monthly usage for 30 outgoing calls per month (on-net/off-net to a fixed line and for peak and off-peak times) in predetermined ratios, plus 100 SMS messages. It is calculated as a percentage of a country's average monthly GNI per capita. The mobile-cellular subbasket is based on prepaid prices, although postpaid prices are used for countries where prepaid subscriptions make up less than two per cent of all mobile-cellular subscriptions.

The fixed-broadband subbasket refers to the price of a monthly subscription to an entrylevel fixed-broadband plan. It is calculated as a percentage of a country's average monthly GNI per capita for the least develop countries (LDCs). For comparability reasons, the fixed-broadband subbasket is based on a monthly data usage of (a minimum of) 1 GB. For plans that limit the monthly amount of data transferred by including data volume caps below 1 GB, the cost for the additional bytes is added to the subbasket. The minimum speed of a broadband connection is 256 kbit/s.

Some authors developed[23] and implemented[24] econometric models which consist of four equations: an aggregate production function and, subsequently, three functions: demand, supply and output. In the case of mobile telecommunications, the econometric specification of the model can be presented as follows:

the aggregate production function (GDP is linked to the fixed stock of capital, labour and the mobile infrastructure proxied by mobile penetration):

the demand function (links mobile penetration to the average consumption propensity of individuals proxied by GDP per capita, the price of a mobile service proxied by ARPU (average revenue per user), the per cent rural population, and the level of competitive intensity in the mobile market measured by the HHI (Herfindahl Hirschman) index;

 the supply function (which links aggregate mobile revenues to mobile price levels proxied by ARPU, the industry concentration index of the mobile market (HHI), and GDP per capita);

and the output equation links annual change in mobile penetration to mobile revenues, used as a proxy of the capital invested in a country in the same year.

3. RESEARCH RESULTS AND DISCUSSION

The results of the World Bank survey show that the significance of the telecommunication markets, which are characterized by network externalities, in the less developed countries is large and that the increase in penetration of broadband access (ie the number of subscribers per 100 inhabitants) of 10% leads to economic growth measured by growth rate of gross domestic product for 1.38%. This increase is significantly higher than developed countries can counted (1.21%)[19].

Firstly, there is upward trend in the access to and use of Information and Communication Technologies (ICT). Except for fixed-telephone subscriptions, all indicators have consistently been increasing. More importantly, penetration rates are approaching saturation levels, especially in the developed countries.

Figure 2. Global ICT Developments
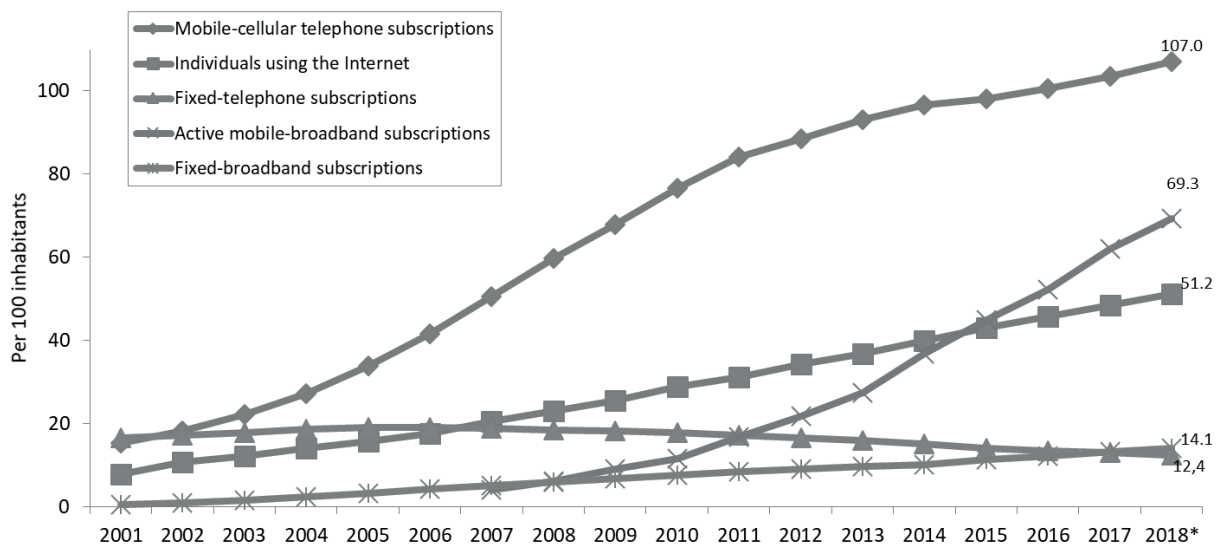
Note: * Estimation

Source: Authors' presentation according to[20]

Secondly, broadband access continues to grow strongly. In particular, the number of active mobile-broadband subscriptions keeps growing. With the global penetration rate standing at 69.3 per cent at the end of 2018, there is still plenty of room for further growth in the next period. In this regard, the fixed-broadband penetration rate also grew rapidly.

Figure 3. Number of Users per 100 Subscriptions (inhabitants) by Type of Services in Developed and Developing Countries
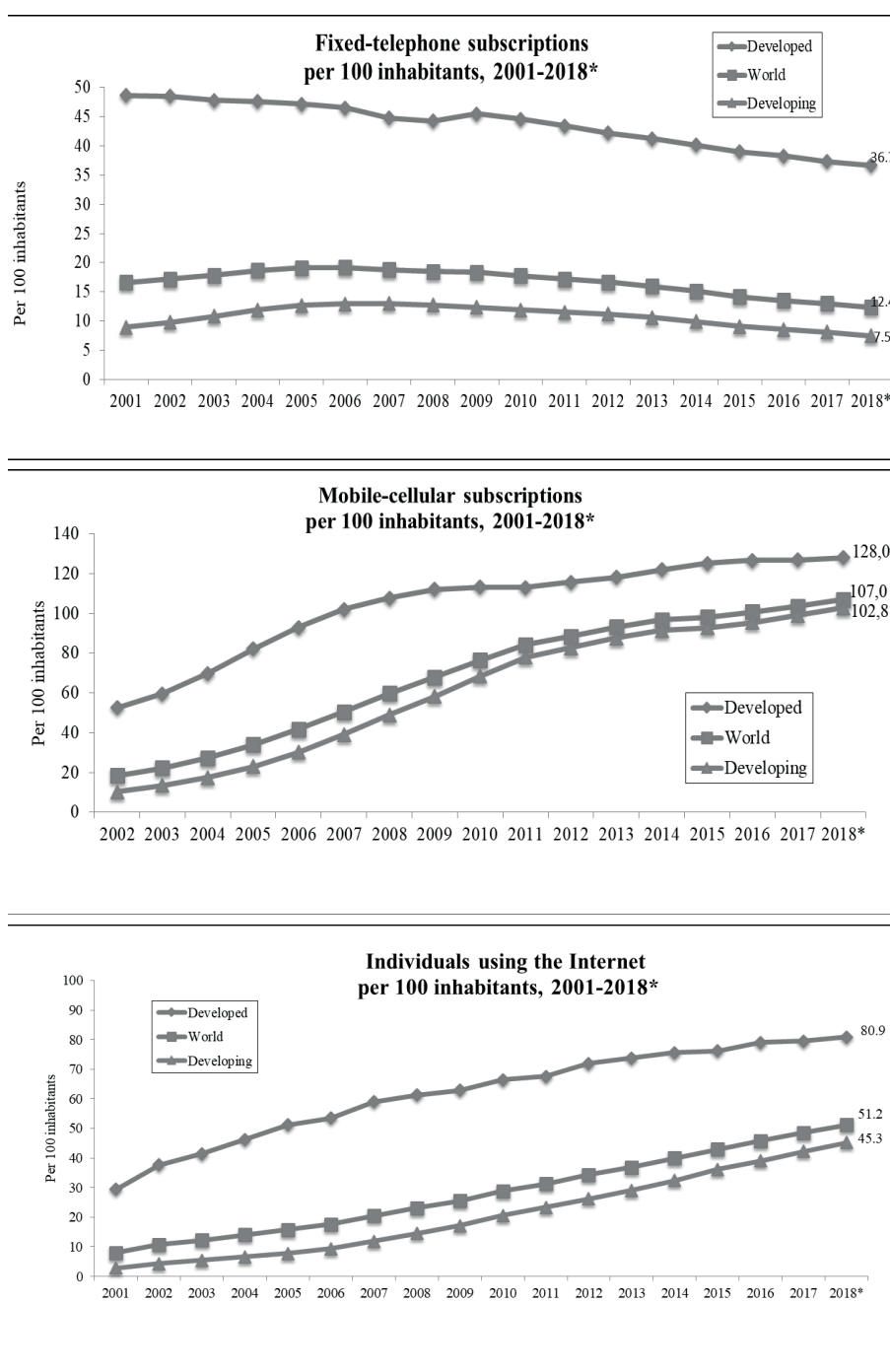

Notes: * Estimation. The developed/developing country classifications are based on the UN M49[21]

Source: Authors' presentation according to[20]

Thirdly, mobile access is becoming ever more predominant. Fixed-telephone subscriptions have been in decline for a long time, while mobilecellular telephone subscriptions keep growing, even when there are already more subscriptions than people on Earth. The world has crossed the halfway line in 2018 in terms of Internet use, with 51.2 per cent of the world population using the Internet. Nevertheless, growth rates for selected indicators have been more modest in recent years compared to the first decade of the century.

This part of the paper is devoted to the latest ICT price data and affordability of three key ICT services (mobile-cellular, fixed-broadband and mobilebroadband), as well as, to the highlighting key trends over time. Information and communication technology prices have dropped globally in the last decade, in parallel with the increase in access to and use of ICT services. It is worth mentioning that improved regulation and policy-making have played a pivotal role in creating the conditions for the reduction of prices in the period 2008–2017.

Figure 4. Global Fixed-Broadband Price Basket (left axis) and Fixed-Broadband Subscriptions per 100 inhabitants (right axis)
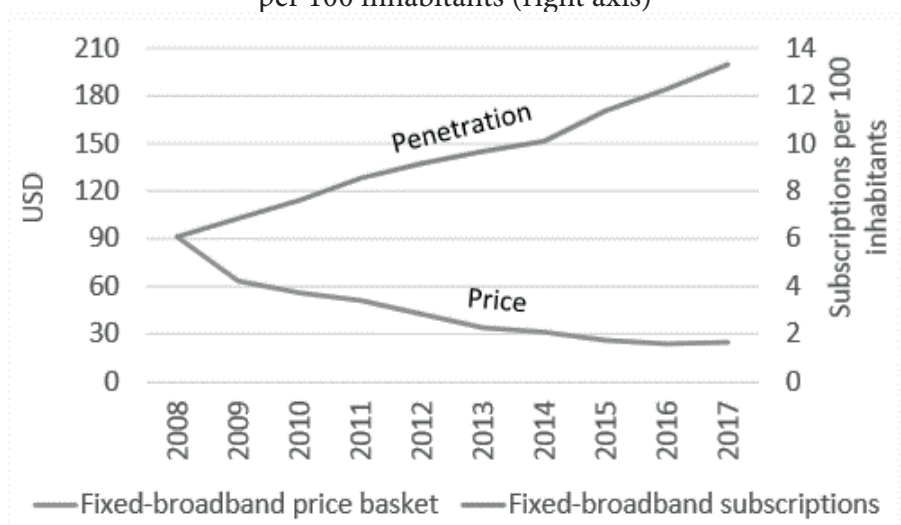
Source:[22, p. 97]

The two vertical axes are scaled proportionally based on the 2008 values. It means that a 10 per cent increase in subscription penetration takes the same range as a 10 per cent decrease in proces.

Figure 5. Global Mobile-Cellular Price Basket (left axis) and Mobile-Cellular Subscriptions per 100 inhabitants (right axis)
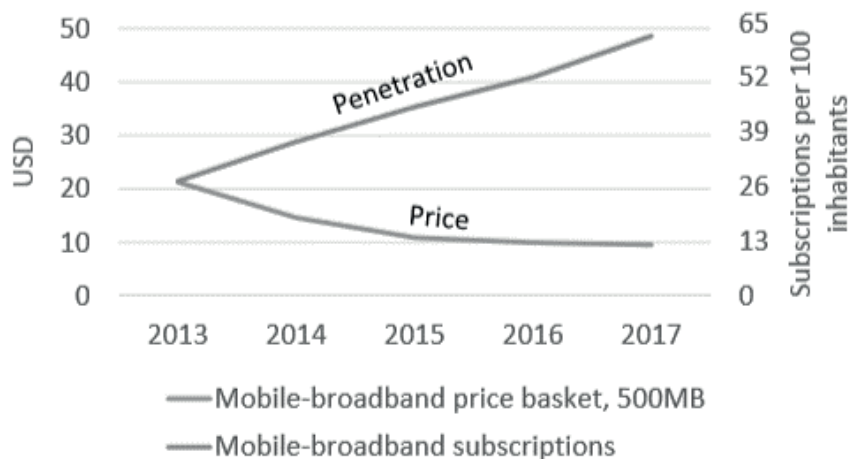

Source:[22, p. 97]

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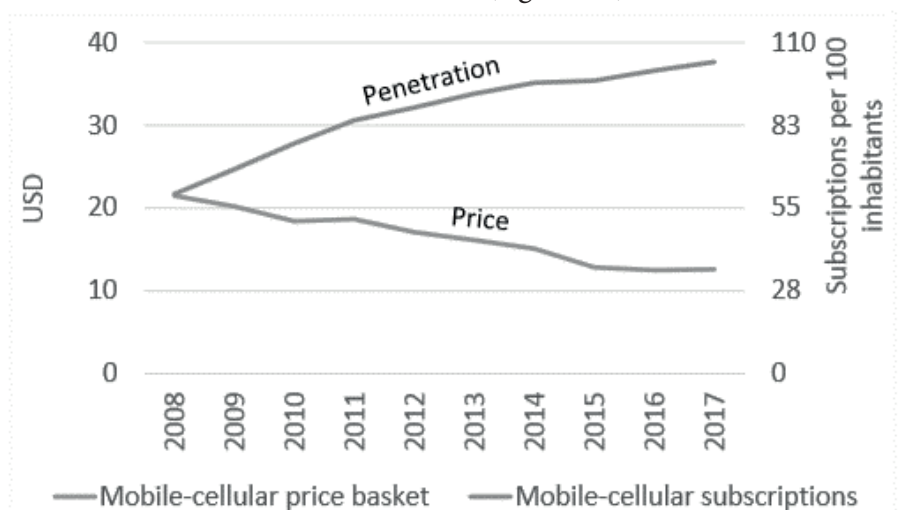
Mobile-cellular prices has a sustained decreasing trend in the period from 2008 to 2015. From 2015, mobilecellular prices have been higher and the mobile-cellular basket (51 minutes and 100 SMS messages per month) cost on average USD 12.5 per month at the end of 2017, which is half of the average price of the fixed-broadband basket, and 35 per cent higher than the average for the handset-based mobile-broadband basket. Taking into account the above, it can be concluded that there is still room for lower mobile-cellular prices.

Figure 6. Global Mobile-Broadband Price Basket, Prepaid Handset-based 500 MB (left axis) and Mobile-Broadband Subscriptions per 100 inhabitants (right axis)

Source:[22, p. 98]

The price of a handset-based mobile-broadband basket including 500 MB per month followed a decreasing trend worldwide in the period 2013–2016. The global average was driven down by strong reductions in prices in developing countries. The price of a computer-based mobile-broadband basket including 1 GB per month followed a similar trend as the handset-based mobile-broadband basket. Despite the sustained decrease in prices in developing countries, average data allowances continued to increase.

In 2017, almost all developed countries had computer-based mobile-broadband prices corresponding to less than 2 per cent of Gross National Income per capita The economic commitment that an average family in the developing world need to face to connect to the Internet at home is larger than the average share of budget allocated to ICTs in most countries (household expenditure on ICT as a percentage of total household expenditure is below 8%)[22].

CONCLUSION

Numerous studies have confirmed evidence of a direct network effect in a digital environment. Conducted research shed light on the number of subscribers of digital services and the prices trends, particularly with respect to national development levels. The paper shows that a total network size, measured by number of subscribers, is an important network externality factor affecting the success of a network. However, consumer' satisfaction with network services and consumers' surplus are additional network externality determinants. The significance of this research arises from the current debate whether digital transformation and network externalities could increase consumer welfare in telecommunications markets.

Finally, the conducted research confirmed the Hypothesis 1: Digital transformation affects the simultaneously continuous growth of the number of subscribers and the continuous decline in prices of telecommunication services, as well as Hypothesis 2: There are similar trends in developed and developing countries, which are related to the number of the telecommunication services subscribers.

On the one hand, digital transformation and the effect of network externalities contribute to: increasing the number of subscribers, reducing the number of networks (distortion of the market competition), and reducing the prices of telecommunication services. On the other hand, increasing the number of subscribers increases the value of the selected network.

This paper summarises relevant theoretical and practical evidence about the effects of digital transformation in the telecommunications markets which are characterized by network externalities. Obtained results give a good basis for further research due to taking into account the state analysis and determines key trends in this area. In addition, it offers suggestions for measuring the information society in national economies. Finally, it suggests companies to take into account a planty digital transformation opportunities in order to increase the value of their networks.

It is noted that the impact of regulatory framework on the growth of telecommunication markets is significant, so this analysis provided base for further evidence of the importance of the regulatory and institutional variable in driving digital ecosystem growth. Future research might be focused on the development of the model which examines the interplay between digital transformation and network externalities. In this sense, it would be possible to use selected variables in order to adequately describe the analyzed interdependence. Since further changes in network based sectors is expected, the issue of effects of the digital transformation will be topical in the next period.

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