

Aravantinos, Elias; Petre, Konstantin; Katsianis, Dimitris; Chipouras, Aris;  
Varoutas, Dimitris

## Conference Paper

# A hedonic approach to estimate the price evolution of FTTH service: evidence from EU

31st European Conference of the International Telecommunications Society (ITS): "Reining in Digital Platforms? Challenging monopolies, promoting competition and developing regulatory regimes", Gothenburg, Sweden, 20th - 21st June 2022

### Provided in Cooperation with:

International Telecommunications Society (ITS)

*Suggested Citation:* Aravantinos, Elias; Petre, Konstantin; Katsianis, Dimitris; Chipouras, Aris; Varoutas, Dimitris (2022) : A hedonic approach to estimate the price evolution of FTTH service: evidence from EU, 31st European Conference of the International Telecommunications Society (ITS): "Reining in Digital Platforms? Challenging monopolies, promoting competition and developing regulatory regimes", Gothenburg, Sweden, 20th - 21st June 2022, International Telecommunications Society (ITS), Calgary

This Version is available at:

<https://hdl.handle.net/10419/265611>

### Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

### Terms of use:

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

## **A hedonic approach to estimate the price evolution of FTTH service: evidence from EU.**

Elias Aravantinos, Konstantin Petre, Dimitris Katsianis, Aris Chipouras and Dimitris Varoutas

Department of Informatics and Telecommunications

National and Kapodistrian University of Athens

Athens, Greece

(eliasara, kpetre, dkats, arischipd.dvaroutas)@di.uoa.gr<sup>1</sup>

### **Abstract**

The price paid today for broadband bundling, is determined by a number of factors, such as broadband speed, premium content, inclusive call allowances, any value-added services, and it is important that people understand their usage requirements so they can identify the one that suits their need. We found strong evidence that bundling proves to have a strong effect on tariffs, a dominant operator's strategy during the study's period, 2014-2020, allowing to allocate fixed costs across a range of services. Download Speed is positively significant to tariffs and increases broadband prices, such as a 10% increase in speed raises broadband prices by around 1.4%. Although broadband prices drop around 6.9%, operators emphasize their efforts to charge higher prices on TV bundles, specifically on plans combining broadband, voice telephony and TV that are 54% more expensive over standalone's plans, compared to the 36% of a previous 2014 study. Incumbents charge higher tariffs, around 20.1% compared to the new entrants, in an effort to pay off the fiber network deployment investments, as coverage continues to grow.

**Keywords:** Hedonic prices, Bundling, Tariffs, Broadband, European Union, Regulation

### **1. Introduction**

The evolution of the new technologies and networks support the consumption of advanced content and entertainment over the Internet that require bandwidth, and high-capacity broadband networks. These are the fundamental ambassadors of the new digital economy. When studying the broadband prices, policymakers can design policies targeting both retail and infrastructure markets. That information is very useful on how retail broadband services are priced and how price, quality and choice of services are changing over time.

Towards this angle, this paper estimates quality-adjusted, internationally comparable prices for residential fixed broadband service across EU countries and how are these affected from their characteristics. Hedonic methods are typically used in international and interarea comparisons to control for product definitions that are imprecise, i.e., differences in products that could be controlled for directly by using more narrowly defined items. Restricting international comparisons to very narrow levels of product definition come at the cost of reducing observations, whereas a hedonic method allows greater coverage of products and fuller use of available data. Owing to the proliferation of bundled telecom service plans and options, hedonic techniques are natural to consider when modeling and summarizing international price differences in residential broadband service.

There is a tremendous preference and buying trend of EU services. The bundling of fixed broadband with other services is widely spread in Europe. Averaging the indicators provided by 21 National Regulator Authorities (NRA), it was concluded that, the average percentage of fixed broadband lines which were sold bundled with other services was 74.1%, those bundled with fixed voice services accounted for 57.5% of the total, and 21.8% were bundled with mobile services.(BEREC, 2018).

The variety of offerings in bundles impact the price, as a result it is more difficult to perform direct comparison. Therefore, researchers often use a hedonic approach to analyze the price of products whose value proposition changes on a regular basis. The hedonic models estimate the demand or value of a good by decomposing its attributes and estimating their implicit prices or contributions to the formation of the good's market price (Rosen, 1974).

## 2. Literature review

(Lyons & Savage, 2013) applied the hedonic regression analysis to the Irish telecommunication market by comparing operators' tariffs and subscriber base. The researchers tried to investigate how much Ireland-based customers are willing to pay for a faster broadband service using the dataset of 743 plans from 19 operators. Their results suggest that the marginal cost of providing high-speed broadband will fall to a very low level because of technological advances. Regarding the interaction between download speed and time, they find a negative and significant relationship.

(Varoutas et al., 2008) aimed to provide a framework for analyzing telecommunication prices over time and study in Greece and how the prices will fluctuate during coming years. It was proved that the application of Sliced Inverse Regression (SIR), was the best fitting model among others and the price of a telecommunications product is related to its characteristics, distance and transmission rate.

(Correa & Crocioni, 2012) used the hedonic approach to construct five regressions – two for the Irish market and three for the Dutch one. By dividing the broadband package prices into different components such as upload speed, download speed, technologies used, the authors tried to understand which operator has pricing power. According to their findings, bundles with satellite technology are usually priced much higher than DSL and cable technology packages. One of the explanations might be that satellite connections can be accessed from thinly populated areas. Therefore, to recover initial investments, operators need to consider both the cost of provision and the satellite's inability to compete with other more advanced technologies in densely populated areas.

(Calzada & Martínez-Santos, 2014) use panel data on a subset of plans in 15 EU countries from 2008 to 2011. They observe a positive relationship between download speed and price (with an elasticity of around 1.3) and they find that services provided by cable modem and fiber are cheaper than those delivered through DSL. Prices are higher when broadband services are bundled with telephony (by about 10%) and television (36%). The study also exploits cross-country variation in market structure and regulatory arrangements to examine the effects of access regulation on prices.

(Wallsten & Riso, 2014) estimate a linear hedonic model on over 25,000 broadband prices drawn from all OECD countries from 2007 to 2009 (2015). They find that broadband speed has a positive marginal effect that declines with speed level (modeled as a quadratic relationship). Data transfer limits, contracts and provision of service through a fiber connection have significant negative associations with service prices, while bundles attract premium prices.

(Lyons & Savage, 2013) estimate a linear hedonic model on data from the Irish residential broadband market, 2006–2011, and include an interaction between download speed and time. They find a negative and significant relationship.

(Lyons & Coyne, 2016) studies the elasticity of price with respect to download speed, concluding that it fell during the sample period, and most significantly for smaller operators, who were not using cable technology and in the earlier part of the period. By the end of the sample period the elasticity is very low. Another important finding is that the fixed line incumbent's retail price premium has fallen significantly since 2007. Bundled services also show a price premium in plans based on digital subscriber line (DSL) technology, but it has

been declining over time. Finally, TV service when included in bundles, adds a significant premium.

(Diaz Pines & Gonzalez Fanfalone, 2015) analyzed triple- and quadruple-play bundles price determinants for telecommunication operators in France, the United Kingdom, and the United States. The researchers also considered the type of technology used by operators as one of the characteristics. One of the advantages of the hedonic approach is the possibility to use non-numeric attributes that are coded by dummy variables (OECD 2011). For example, their results suggest that although internet consumption is steadily increasing, customers still value mobile calls and their inclusion into the bundle increases the price of the bundle by 16-32% depending on the number of calls.

Finally, (Corrado & Ukhaneva, 2016) OECD study, extend and adapt existing hedonic frameworks for international and interarea comparisons and consider the extended country product dummy approach. They have asserted that as bundled products and services in the telecommunication market become more popular and as the service plans among which subscribers can choose become more highly differentiated, the basket-based approach will become increasingly difficult to apply to international price comparisons. The authors presented a hedonic pricing model as an alternative, using a random coefficient model to explain country-level variation in relationships between characteristics of residential fixed broadband services and prices across 34 OECD member countries. They found their model of hedonic functions at the service provider level outperformed the standard models proposed in the previous studies.

### 3. Data

Building on the work of the previous studies, the dataset used in this study consists of tariffs observations, where available, from 28 EU countries for the time-period between 2014 and 2020. The variables and the description are listed in Table 1. The countries included in the analysis used are listed in Appendix A, Table A1. The data used have been collected by the past and latest European Commission available public studies on “Mobile and fixed broadband prices in Europe” (European Commission, 2020).

We use a panel data set of monthly residential retail broadband offers. The dataset contains an overall total of 17376 observations that contain operators’ tariffs, and plans’ characteristics among different EU markets.

#### Types of independent variables:

- Technology (log download speed, DSL, cable, fiber, satellite)
- Contract (years)
- Dummy variables (operator, country)
- Bundle indicators (fixed phone, fixed broadband, TV, mobile, 2-play, 3-play, 4-play)
- Operator Type, ISP Incumbent or new entrant
- VAT
- Time (Year)

*Table 1: Definition of Variables in Broadband Dataset*

Variable	Definition
Tariff	Price of the broadband plan
BB+FixedVoice	Indicator that bundle includes fixed broadband and voice
BB+FixedVoice+Mobile Calls	Indicator that bundle includes fixed broadband and fixed voice with calls to mobile phones
BB+TV	Indicator that bundle includes fixed broadband and TV
BB+FixedVoice+TV	Indicator that bundle includes fixed broadband and fixed voice with TV

BB+FixedVoice+TV+Mobile Calls	Indicator that bundle includes fixed broadband and fixed voice with calls to mobile phones, and with TV
Internet_TechnologyCable	Indicator that broadband is provided via cable
Internet_TechnologyFTTx	Indicator that broadband is provided via fiber
Internet_TechnologySatellite	Indicator that broadband is provided via satellite
Internet_TechnologyxDSL	Indicator that broadband is provided via DSL
DownloadSpeed10-25Mbps	Indicator that download speed is between 10 and 25 Mbps
DownloadSpeed25-50Mbps	Indicator that download speed is between 25 and 50 Mbps
DownloadSpeed50-100 Mbps	Indicator that download speed is between 50 and 100 Mbps
DownloadSpeed 100-300 Mbps	Indicator that download speed is between 100 and 300 Mbps
DownloadSpeed>300 Mbps	Indicator that download speed is greater than 300 Mbps
Contract length >0 and <= 1 Year	Indicator that contract length less than or equal to a year
Contract length >1 and <= 2 Years	Indicator that contract length is more than one and less than 2 years
Operator type	Indicator if the operator is incumbent or new entrant
VAT	Value Added Tax (VAT) of telecommunications services

Table 1 lists and defines the quality metrics (e.g., download speed, contract duration, type of bundle, etc.) that are captured for each broadband plan of the dataset. The definitions of these variables are largely self-explanatory, except for price of tariff. The tariff variable is the monthly price of the broadband plan in Euros.

*Table 2: Residential Broadband Plan by Type in Dataset*

<b>Type of Plan</b>	<b>Number of Plans</b>	<b>Percent of Plans</b>
Standalone	5786	33%
Bundle		
BB+Fixed_Voice	4097	24%
BB_Fixed_Voice+TV	3680	21%
BB+TV	2005	12%
BB+TV+Fixed_voice+Mobile_calls	960	6%
BB+Fixed_Voice+Mobile_Calls	848	5%
<b>Total</b>	<b>17376</b>	<b>100%</b>

The final dataset has a total of 17376 observations of monthly residential fixed broadband plans in EU. Table 2 shows a breakdown of these observations by basic type (standalone, bundle) and bundles by groups of services (broadband plus fixed voice, broadband plus voice and TV, etc.). The most prevalent plan type in the dataset is standalone broadband, followed by broadband bundled with fixed voice. The table also shows that a significant number of residential broadband plans—nearly 39% of the total—include TV service. The former results are similar to (Corrado & Ukhaneva, 2016) OECD study where the TV service plans represent, only a nearly 14% of the OECD markets' plans.

#### 4. Methodology

A hedonic price function treats the price of a good as the sum of the implicit prices of the features of that good. Based largely on the research of (Lyons & Coyne, 2016) and (Rosen, 1974), the idea was to construct a proxy indicator for the value of manufactured products incorporating both quantity and quality. For this research we model the price of a broadband plan as the sum of the values of its characteristics (download speed, access type and contract term, etc.).

Our methodology is based on a classic Hedonic Price Method (HPM), a panel data analysis where usually the dependent variable of the regression is the price. It is commonly used in real estate as a method for estimating the marginal willingness to pay for spatially amenities. Our objective variable of interest would inevitably be the price of monthly fee. That contains a desired consumer's basket for broadband access with additional services such as TV or mobile or fixed telephony. All the explanatory or independent variables will be analyzed and only significant regressors will remain in equation for further analysis

As for the fixed effects variable, in order to capture unobserved heterogeneity, ISP provider or Country will be separately adapted. In addition, download-speed will be captured either as arithmetic variable or as a variable with different speed categories trying to compare results with other studies. Finally, a separate model will regress only incumbent operators hoping to investigate operators with high market shares. In equation 1 we present a general case with all terms but for each of the seven models, defined in Table 3.

The basic hedonic regression model is outlined as follows:

$$\log(\text{Price}) = \log(\text{Download\_Speed}) + \text{Speed\_category} + \text{Contract} + \text{VAT} + \text{Bundle} + \text{Technology} + \text{Operator\_Type} + \text{Year} + \text{Country} + \text{ISP} \quad (1)$$

For example, Model 2's equation is outlined as follows for operator's plan ion year  $t$ :

$$\log(\text{Price}_{it}) = \text{Speed\_category}_{it} + \text{Contract}_{it} + \text{Bundle}_{it} + \text{Technology}_{it} + \text{Operator\_Type}_{it} + \text{Year} + \text{Country} \quad (2)$$

Table3: Models' definition

	log(Download_Speed)	Speed Category	Contract	VAT	Bundle	Technology	Operator Type	Year	Country	ISP
Model 1	√		√		√	√	√	√	√	
Model 2		√	√		√	√	√	√	√	
Model 3	√		√		√	√		√		√
Model 4		√	√		√	√		√		√
Model 5	√		√		√	√		√		√
Model 6		√	√		√	√		√		√
Model 7	√		√	√	√	√	√	√		

There are also some limitations in our methodology as part of the adapted classic hedonic regression:

1. The hedonic model assumes an automatic adjustment in market price due to changes within time in any of the explanatory characteristics. However, there may be a lag related to the change in markets that are not that vibrant or active.
2. The model needs to have a wide variety of assets or properties, not easy to be accurately collected within a study and along the years, to choose from with a mixture of characteristics that a purchaser may require. It means individuals should be able to identify all their desired characteristics in a product.
3. Multicollinearity is possible between VAT, ISPs and countries, as discussed in Model 7.

## 5. Empirical Results

Since all seven models are described on Table 3, Table 4 presents the models' regression results from 1 to 7. The technology proves to be significant as a category no matter the type. The user is interested into technology's performance that covers his needs and less the type. The Download Speed is also significant mainly due to the satellite which remains very expensive and adds to the model. As expected, Download Speed increases broadband prices. Specifically, a 10% increase in speed raises broadband prices by around 1.4% which is comparable to the 1.3% that (Calzada & Martínez-Santos, 2014) reported. However, in another similar result, DSL is strongly and positive significant where it remains more expensive over FTTH, a trend that will continue in the near future. More users tend to move a new technology such as fiber, decreasing the customer base that pays and maintains the operational cost of the DSL technology.

*Table4: Hedonic Regression Results (Models 1-7)*

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
(Intercept)	2.36 *** (0.03)	3.740 *** (0.019)	2.14 *** (0.04)	3.56 *** (0.03)	2.35 *** (0.06)	3.64 *** (0.04)	2.11 *** (0.05)
Log(Download_Speed)	0.159 *** (0.002)		0.163 *** (0.002)		0.147 *** (0.004)		0.164 *** (0.003)
Speed10-25Mbps		0.138 *** (0.009)		0.138 *** (0.008)		0.106 *** (0.014)	
Speed25-50Mbps		0.254 *** (0.009)		0.268 *** (0.008)		0.228 *** (0.015)	
Speed50-100Mbps		0.396 *** (0.009)		0.407 *** (0.009)		0.371 *** (0.017)	
Speed100-300Mbps		0.607 *** (0.011)		0.610 *** (0.011)		0.550 *** (0.021)	
Speed>300Mbps		0.804 *** (0.013)		0.823 *** (0.013)		0.75 *** (0.02)	
Operator_Type	-0.181 *** (0.007)	-0.186 *** (0.007)					-0.178 *** (0.009)
Contract	-0.0056 *** (0.0004)	-0.0042 *** (0.0004)	-0.0059 *** (0.0004)	-0.0046 *** (0.0004)	-0.0070 *** (0.0006)	-0.0051 *** (0.0006)	-0.0192 *** (0.0005)
VAT							0.0052 *** (0.0015)
Bundle Reference = Standalone							
BB+Fixed_Voice+TV	0.431 *** (0.007)	0.438 *** (0.007)	0.429 *** (0.007)	0.436 *** (0.007)	0.385 *** (0.013)	0.394 *** (0.012)	0.459 *** (0.011)
BB+TV	0.181 *** (0.009)	0.192 *** (0.009)	0.188 *** (0.008)	0.199 *** (0.008)	0.121 *** (0.015)	0.132 *** (0.014)	0.121 *** (0.014)
BB+Fixed_Voice	0.245 *** (0.007)	0.250 *** (0.007)	0.250 *** (0.007)	0.253 *** (0.007)	0.225 *** (0.012)	0.229 *** (0.012)	0.346 *** (0.011)
BB+Fixed_Voice+Mobile Calls	0.557 *** (0.013)	0.571 *** (0.013)	0.553 *** (0.013)	0.563 *** (0.013)	0.477 *** (0.024)	0.487 *** (0.024)	0.63 *** (0.02)

BB+TV+Fixed_Voice+MobileCalls	0.716 *** (0.012)	0.721 *** (0.012)	0.703 *** (0.012)	0.707 *** (0.012)	0.66 *** (0.02)	0.67 *** (0.02)	0.768 *** (0.019)
FTTx	-0.037 *** (0.008)	-0.016 * (0.008)	-0.02 * (0.01)	-0.01 (0.01)	-0.01 (0.02)	-0.01 (0.02)	-0.081 *** (0.011)
Plug n Play	0.254 *** (0.022)	0.180 *** (0.022)	0.22 *** (0.02)	0.13 *** (0.02)	0.45*** (0.08)	0.39*** (0.08)	0.9 ** (0.03)
Satellite	0.70 *** (0.05)	0.67 *** (0.04)	0.77 *** (0.04)	0.74 *** (0.04)	0.96 *** (0.05)	0.91 *** (0.05)	0.76 *** (0.07)
xDSL	0.105 *** (0.009)	0.105 *** (0.009)	0.120 *** (0.011)	0.114 *** (0.011)	0.086 *** (0.021)	0.067 ** (0.022)	0.153 *** (0.013)
Year Reference = 2013							
Year2014	-0.047 *** (0.007)	-0.046 *** (0.008)	-0.045 *** (0.007)	-0.042 *** (0.007)	-0.005 (0.012)	-0.003 (0.012)	0.005 (0.012)
Year2015	-0.129 *** (0.007)	-0.128 *** (0.007)	-0.12 *** (0.007)	-0.116 *** (0.007)	-0.125 *** (0.013)	-0.126 *** (0.013)	-0.079 *** (0.011)
Year2017	-0.330 *** (0.011)	-0.334 *** (0.011)	-0.31 *** (0.01)	-0.314 *** (0.010)	-0.280 *** (0.019)	-0.284 *** (0.019)	-0.269 *** (0.016)
Year2018	-0.365 *** (0.011)	-0.375 *** (0.011)	-0.353 *** (0.011)	-0.361 *** (0.011)	-0.298 *** (0.019)	-0.308 *** (0.019)	-0.345 *** (0.017)
Year2019	-0.363 *** (0.018)	-0.376 *** (0.018)	-0.326 *** (0.017)	-0.335 *** (0.017)	-0.31 *** (0.04)	-0.35 *** (0.04)	-0.312 *** (0.028)
Year2020	-0.487 *** (0.016)	-0.516 *** (0.016)	-0.433 *** (0.016)	-0.458 *** (0.017)	-0.57 *** (0.04)	-0.60 *** (0.04)	-0.48 *** (0.03)
<b>Residual</b>	<b>0.3343</b>	<b>0.3348</b>	<b>0.3059</b>	<b>0.3075</b>	<b>0.3053</b>	<b>0.3046</b>	<b>0.5269</b>
<b>R-squared</b>	<b>0.7295</b>	<b>0.7287</b>	<b>0.776</b>	<b>0.7737</b>	<b>0.7219</b>	<b>0.7235</b>	<b>0.3268</b>

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Models 3 and 4 that include the ISPs perform the best data fitness of 77.6% and 77.37% respectively. ISPs explain the model better than the country dummy variable. The model is performing better, when studying each ISP separately, explaining the differences between ISPs and new entrants.

Model 7 includes VAT variable that is positively significant to tariff without including ISP and country variable that create multicollinearity conflicts to the model, weakening the effect. An increase in VAT has a positive effect on all bundling plans as expected, explaining the market dynamics. However, Model 7 has the weakest data fitness, 32%, implying that further research is needed to better clarify the VAT's effect.

Regarding the plan characteristics, the following results are extracted and compared to (Calzada & Martínez-Santos, 2014) results:

- Plans combining broadband and voice telephony and TV are 54% more expensive to standalone's plans, compared to the previous study 36%.



- Plans combining broadband and voice telephony are 28% more expensive to standalone's plans, compared to the previous study 13%.
- Plans combining broadband and TV are 19.8% more expensive to standalone's plans, compared to the previous study 18%.

Bundling remains a dominant technology for operators, emphasizing on a TV and premium content as a driver such as Hulu or Amazon premium services. The ongoing accelerated investments in fiber broadband access network infrastructure across the European region are set to pay off during the next five years with the number of FTTH/B subscribers expected to double by 2026 to 197 million, according to the (*FTTH Council Forecast for Europe - Market Forecasts 2021-2026*). (Aravantinos et al., 2021) studied the EU standalone contracts and showed that as penetration increases, that causes a negative effect to tariffs that tend to drop.

Incumbents' plans are around 20.1% more expensive than entrants' plans compared to the 15% of the previous EU study, which might be explained not only by the formers' dominant position but also due to the ongoing investments to increase coverage. As illustrated in Table 5, when running Model 1 separately for each country, the dominant incumbents in countries such as Netherlands and Cyprus are 69% and 50% (when dividing incumbents' tariffs to the other entrants) the more expensive, respectively. On the other hand, countries such as Poland, Iceland, Norway and Denmark do not experience any serious variation among their tariffs.

*Table5: Incumbents index vs entrants*

Country	index	Incumbents / Other entrants tariffs
Netherlands	-0.523	1.69
Cyprus	-0.406	1.5
<b>Average</b>	-0.184	1.2
Poland	-0.034	1.03
Iceland	0.036	0.96
Norway	0.065	0.94
Denmark	0.079	0.92

When reviewing the current EU market and operators' plans, according to the FTTH Council, Germany, Italy and the UK in particular – are set to experience dramatic increases in FTTH/B subscriber numbers during the coming five years, which of course is encouraging for the networking industry and for the economic welfare of those countries. Despite the expected advances across EU, some developed markets will still lag way behind, such as Portugal and Spain in terms of fiber broadband uptake. That is due to are to a predominance of copper-based technologies and/or cable networks.

Tariffs tend to drop 6.9%, annually, on average across EU during the study's period (2013-2020). The EU average basic plan is 39.8€. Norway and Iceland, which are also ranked in the top five highest penetration FTTH/B markets, illustrate the most expensive basic plans. These are on average are two times higher than the EU average. As operators are investing into fiber networks, tariffs and bundles could be also affected, as well as consumers' willingness to pay for high speed and other bundle's characteristics. Also a previous study has proved that investment is positively correlated with triple-play bundling penetration, which could imply that growing investment could drive triple-play bundling penetration (Díaz-Pinés & Fanfalone, 2017).

Finally, when averaging the fixed effects results of Model 1 and 2 in Table 6, the fixed effects model reveals that countries with the cheapest broadband bundles are Romania, Bulgaria and

Lithuania with a reference country, Norway. On the other hand, the most expensive are NorwayLuxembourg, Iceland, Liechtenstein and Norway. [0.01:0.01], with Romanian FTTH tariffs to remain the cheapest across EU in 2018 at 12.57 Euros per month. Tariffs fall 48% between 2013 and 2018 (from 22.71 to 12.57 Euros).

*Table6: Operators' Fixed Effects index with reference to Norway*

Country	Fixed Effects index	Norway expensive ratio
Romania	-1.26	7.19
Bulgaria	-1.07	5.97
Lithuania	-0.99	5.51
Luxemburg	0.24	1.61
Iceland	0.38	1.4
Liechtenstein	0.46	1.29
Norway	0.71	1

## 6. Discussion

Bundling proves to be a dominant and flexible business model that allows operators to allocate fixed costs across a range of services. They can have beneficial effects for consumers and businesses, such as the convenience of unified billing, new possibilities for innovation and discounts, as well as access to vertical markets such as energy, digital marketing and insurance. Bundling allows operators to gain consumers' trust and loyalty, which are among the fundamentals to maintain strong revenues and customer base. Consumers who bundle fixed and mobile services from the same provider are less likely to churn. Without fixed-mobile bundling the annual churn of fixed broadband consumers would increase from 8.4 to 9.2%. (Grzybowski et al., 2021).

TV services with an emphasis on premium content i.e., exclusive rights on sport events and entertainment continues a trend to the same direction for operators. As expected, plans combining broadband and voice telephony and TV experience the highest increase during the study's period, a 54%, when compared to the 2014 study and the standalone plan (36%). The rise of an 'on-demand' era marked by business models largely driven by subscription fees has produced new types of media and video businesses as well as gaming needs. Having started slowly, established media companies have finally seen the strategic opportunity from streaming distribution and are launching their own competitive digital platforms. However, operators are looking for strategic partnerships, offering high speed broadband service, with these established partners that distribute primarily via broadcast TV affiliates and established pay-TV bundles. The ongoing shift towards streaming is emphasizing on the dominant form of media distribution with even higher prices that users are willing to pay for access to the content. That content is very attractive either with the established pay-TV bundle, with its high prices, or 'all you can eat' pre-programmed content or other exclusive channel offerings. That allows offsetting partly the continuing broadband prices' drop across time that is estimated to be 6.9% on average across EU during the study's period.

## 7. Conclusion

This study has shed some light into the relationships between tariffs and the contracts' characteristics in a specific time period across the EU markets. We found strong evidence that bundling proves to be a dominant operator's strategy during the study's period, 2014-2020, allowing allocating fixed costs across a range of services. Download Speed is positively

significant to tariffs and increases broadband prices, such as a 10% increase in speed raises broadband prices by around 1.4%. Although broadband prices drop around 6.9%, operators emphasize their efforts and higher prices on TV bundles, specifically on plans combining broadband and voice telephony and TV that are 54% more expensive to standalone's plans, over 36% of a previous 2014 study. Incumbents proved to charge 20.1 % higher tariffs compared to new entrants, mainly due to the increasing fiber network deployment investments.

In the future the study aims to include more detailed characteristics regarding premium content, i.e., sports quality, movies quality index. Additionally, it would be useful to consider competition, VAT etc. and explore potential relationships and effects to broadband tariffs. Competition and regulation are essential aspects to gain better understanding to the operators' pricing policy. Syncing with other studies it might be useful to add market's competition (HHI) comparing results and conclusions.

The aim is to satisfy the regulators and policy-makers' needs to overcome some of the challenges, when gaining a greater understanding of consumer needs and of the long-term value when encouraging fiber infrastructure rollouts. Further research could explore if the access regulation at the time may have affected the relative retail prices charged by the incumbent and its rivals, when using access to its DSL or fiber network.

## References

- Aravantinos, E., Petre, K., Katsianis, D., & Varoutas, D. (2021). Determinants of FTTH tariffs evolution in EU: A panel data analysis. *Telecommunications Policy*, 45(10), 102218. <https://doi.org/10.1016/J.TELPOL.2021.102218>
- BEREC. (2018). *European Benchmark of the pricing of bundles – methodology guidelines*. [https://berec.europa.eu/eng/document\\_register/subject\\_matter/berec/regulatory\\_best\\_practices/methodologies/8255-european-benchmark-of-the-pricing-of-bundles-8211-methodology-guidelines](https://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/methodologies/8255-european-benchmark-of-the-pricing-of-bundles-8211-methodology-guidelines)
- Calzada, J., & Martínez-Santos, F. (2014). Broadband prices in the European Union: Competition and commercial strategies. *Information Economics and Policy*, 27(1), 24–38. <https://doi.org/10.1016/j.infoecopol.2014.04.001>
- Corrado, C., & Ukhaneva, O. (2016). Hedonic Prices for Fixed Broadband Services: Estimation across OECD Countries. In *OECD Science, Technology and Industry Policy Papers: Vol. 2016/07*. [https://www.oecd-ilibrary.org/science-and-technology/hedonic-prices-for-fixed-broadband-services\\_5jlp14sgc9hj-en](https://www.oecd-ilibrary.org/science-and-technology/hedonic-prices-for-fixed-broadband-services_5jlp14sgc9hj-en)
- Correa, L., & Crocioni, P. (2012). Can evidence of pricing power help market power assessment? Broadband Internet in Ireland and the Netherlands. *Telecommunications Policy*, 36(5), 419–433. <https://doi.org/10.1016/J.TELPOL.2011.11.014>
- Díaz-Pinés, A., & Fanfalone, A. G. (2017). Analysis of Financial Indicators and their Relationship with Operators' Bundling Strategies. *Communications & Strategies*, 106, 97–120, 209–210. [https://www.dropbox.com/home/new\\_paper?preview=Analysis+of+financial+indicators+and+their+relationship+with+operators%27+bundling+strategies\\_.pdf](https://www.dropbox.com/home/new_paper?preview=Analysis+of+financial+indicators+and+their+relationship+with+operators%27+bundling+strategies_.pdf)
- Díaz Pines, A., & Gonzalez Fanfalone, A. L. (2015). The Role of Triple- and Quadruple-Play Bundles: Hedonic Price Analysis and Industry Performance in France, the United Kingdom and the United States. *SSRN Electronic Journal*. <https://doi.org/10.2139/SSRN.2477821>
- European Commission. (2020). *Shaping Europe's digital future: Broadband Connectivity in the Digital Economy and Society Index*. <https://digital-strategy.ec.europa.eu/en/policies/desi-connectivity>
- FTTH Forecast for Europe - Market forecasts 2021-2026. (n.d.). Retrieved May 31, 2022, from <https://www.ftthcouncil.eu/knowledge-centre/all-publications-and-assets/246/ftth-forecast-for-europe-market-forecasts-2021-2026>
- Grzybowski, L., Liang, J., & Zulehner, C. (2021). Bundling and Consumer Churn in

- Telecommunications Markets. *Review of Network Economics*, 20(1), 35–54.  
<https://doi.org/10.1515/RNE-2021-0032/PDF>
- Lyons, S., & Coyne, B. (2016). The price of broadband quality: tracking the changing valuation of service characteristics.  
<Http://Dx.Doi.Org/10.1080/10438599.2016.1237007>, 26(6), 516–532.  
<https://doi.org/10.1080/10438599.2016.1237007>
- Lyons, S., & Savage, M. (2013). Choice, price and service characteristics in the Irish broadband market. *Int. J. Management and Network Economics*, 3(1).
- Sherwin Rosen. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition on JSTOR. *Journal of Political Economy*, 82(1), 34–55.  
<https://www.jstor.org/stable/1830899>
- Varoutas, D., Deligiorgi, K., Michalakelis, C., & Sphicopoulos, T. (2008). A hedonic approach to estimate price evolution of telecommunication services: evidence from Greece. <Http://Dx.Doi.Org/10.1080/13504850600993648>, 15(14), 1131–1134.  
<https://doi.org/10.1080/13504850600993648>
- Wallsten, S. J., & Riso, J. (2014). How do attributes of broadband plans affect price? *Review of Network Economics*, 13(1), 95–119. <https://doi.org/10.1515/RNE-2012-0006/MACHINEREADABLECITATION/RIS>

## Appendix A

Table A1 lists the countries that have been included in the study.

*Table A1EU Countries included in the dataset*

Austria	Greece	Romania
Bulgaria	Hungary	Slovakia
Belgium	Ireland	Slovenia
Croatia	Italy	Spain
Cyprus	Latvia	Sweden
Czech Republic	Lithuania	United Kingdom
Denmark	Luxembourg	
Estonia	Malta	
Finland	Netherlands	
France	Poland	
Germany	Portugal	

The work described in this article has been funded by the Special Account for Research Grants of the National and Kapodistrian University of Athens (N.K.U.A.).