Competition in the European Telecommunications Industry: 20 Years on from the Liberalisation

Jury	Mémoire présenté par
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Executive summary

Over the last 20 years, the European telecommunications industry has undergone a major transformation, moving from a set of national monopolies characterised by vertically integrated companies to a competitive economic sector where companies from all over the European Union are allowed to compete in any market of this sector.

However, even though the legal framework has been completely redesigned by the liberalisation, this does not automatically entail a radical change in the economic reality of the industry. For this reason, the first objective of this thesis is to take stock of the state of competition in the European telecommunications industry in order to verify whether competition has in fact reached a satisfactory level.

We examined different methods enabling to obtain an overview of the intensity of competition in the industry at issue in each EU country and we came to the conclusion that the profit elasticity indicator is the most suitable both for its solid theoretical foundation and for reasons of data availability. The intuition behind this indicator is that in more competitive markets, firms' profits are more elastic to their efficiency (which is quantified through their marginal cost); therefore, it is possible to measure competition in a specific industry by studying the relation between firms' profits and marginal costs.

The results we obtained by calculating the profit elasticity indicators in 24 EU countries in the 2010 – 2017 period on the basis of firm-level data from thousands of companies show that the intensity of competition in the European telecommunications industry is lower compared to most of the other industries. Moreover, the intensity of competition results to be extremely heterogeneous across EU countries and to have decreased in the majority of them during the period analysed.

In the light of these results, much remains to be done to facilitate competition in this sector, therefore it is crucial to understand what factors have a significative influence on competition levels and what others do not deserve particular attention in terms of policy interventions aimed at boosting competition. This is why the second part of the thesis focuses on testing the relevance of two variables with respect to competition in the telecommunications industry. These variables are the number of mobile network operators active in a country and whether or not the European Commission issued, in previous years, a decision to prohibit an anticompetitive behaviour in the telecommunications industry of a specific country.

After having prepared the needed econometric models to test the relevance of the above-mentioned factors in both a static and a dynamic scenario, by using cross-sectional and panel data, respectively; we estimated them through the use of different methods, including OLS and GLS random effects estimators. The use of a fixed effects model had to be ruled out because of the substantial constancy of the two variables of interest over time.

The results of the regressions performed show that, regardless of the econometric method employed, there is no evidence that either a higher number of mobile network operators or the fact that the European Commission intervened in the telecommunications industry of a specific country play a key role in boosting competition in the sector.

The robustness of the results obtained in both parts of the thesis was checked. As regards the estimation of the profit elasticity indicators, results appear to be plausible in themselves (as they highlight a negative relationship between marginal costs and profits, all other things being equal) and also when compared to a similar research, which obtained similar results when calculating the profit elasticity indicator in several industries both at the Belgian and at the European level. As regards the results of the regressions ran, their robustness is given by the consistency across estimation methods, by the large size of the database employed, by a set of proven control variables used and by the caution used with respect to the heteroskedasticity and serial correlation issues in order to alleviate their effects. In this respect, robust standard errors as well as cluster corrections were employed.

In consideration of these results, we formulated two policy recommendations. First, the European Commission should consider to facilitate the spread of good practices (as it already does in other policy areas) from countries that managed to reach good levels of competition in this industry to countries that are experiencing major difficulties to do so, with a view to harmonising the intensity of competition in the different EU countries upwards. This appears to be particularly urgent due to the declining intensity of competition detected in the majority of the EU countries during the analysed period. Second, governments should not make decisions concerning the number of mobile network operators on the basis of considerations concerning competition, as a higher number of players in this market segment does not result in higher levels of competition. This choice should be made based on different considerations, in particular governments should consider what market structure is the best suited to facilitate investments and stimulate

technological development.

In conclusion, we point out that further research on the effects of the European Commission decisions is desirable, as the elaboration of a counterfactual scenario - while requiring an arduous data collection process – would likely produce more reliable results.

Abstract

What conclusions can be drawn regarding competition in the European telecommunications industry, twenty years after its liberalisation? This thesis measures and compares the levels of competition in this sector across the EU between 2010 and 2017 by calculating the profit elasticity indicator based on firm-level data from thousands of companies. We find that the intensity of competition in this industry is low compared to the majority of the other European industries, that it declined in the majority of the EU countries during the studied period, and that it is extremely heterogeneous across countries, as the profit elasticity indicator ranged between -0.32 (very relaxed competition) in Germany and 2.51 (intense competition) in Ireland. Subsequently, we assess the impact on competition of two variables: (i) the number of mobile network operators active in a country and (ii) a binary variable taking on the value 1 if the European Commission prohibited any anticompetitive behaviour in a specific country's telecommunications industry in previous years. Regardless of the econometric method employed, we find no evidence that either of these two variables has a statistically significant impact on the intensity of competition.

Contents

1 Introduction

The telecommunications industry concerns the transmission of information of any nature (words, sounds, images etc.) over significant distances through technological, electromagnetic means such as wires, radio waves and satellites. This sector – besides being strategic for any economic system due to its importance with respect to business, innovation and education – constitutes an important part of the European economy. Indeed, in 2005, telecommunications services employed one million persons EU-wide and created € 169 billion of value added (i.e. 2.7% of the EU non-financial business economy total) (Eurostat, 2015).

Until 1998, no competition at all was attainable in most of the European countries in this industry, as markets were traditionally monopolies characterised by vertically integrated, national companies.[1] This situation changed radically in the 1980s and 1990s, when the European Commission came to the conclusion that allowing competition was critical to enhance the overall competitiveness of the EU economy and to facilitate the adoption of new technologies. Consequently, between 1988 and 1998, the European telecommunications industry was opened to competition through a step-by-step approach, as a result of several legislative packages adopted at the European Union level. First, the voice telephony and infrastructures were liberalised in 1998. Second, common rules were set through the so-called Open Network Provision to allow new entrants to compete with the ex-monopolists on a fair basis. Third, EU competition rules were applied to the liberalised markets to prohibit anticompetitive agreements and abuses of dominant position (Liikanen, 2001). In particular, rules preventing undertakings from abusing of their dominant position (i.e. Article 102 of the Treaty on the Functioning of the European Union) were applied in several occasions to interrupt anticompetitive behaviours carried out by former monopolists and even Article 101 TFUE had to be mobilised in one occasion to interrupt a non-compete agreement. Annex 9.5 provides a summary of the decisions the European Commission took with respect to violations of competition law in the telecommunications industry, which were mainly centred on cases of margin squeeze and refusal to supply.

Twenty years after the liberalisation, the telecommunication industry of

[1] An exception is represented by the UK, where Mercury Communications was issued with a licence to challenge the incumbent British Telecom in 1982 (Department of Trade & Industry, 2001). - The present thesis is composed of 15,140 words.

each EU country is characterised by competition between the former monopolist, whose market share and market power varies substantially across countries, and a number of new entrants (European Commission, 2017). Nevertheless, much remains to be done and the creation of a Single Digital Market is one of the European Commission's current priorities. The plan set out by the Commission with respect to the telecommunications industry includes "Boosting jobs, competition, investment and innovation in the EU" (Juncker, 2014).

It is, therefore, essential to understand (i) what is the status of competition in the telecommunications industry of the different EU countries twenty years after the liberalisation and (ii) what can be done to improve the current situation. The present thesis focuses on competition aspects and aims, in the first place, at taking stock of the situation of competition in the telecommunications industries of the different EU countries and, secondly, at shading light upon the relevance of two potential determinants of the intensity of competition in this industry.

As regards the former objective, a measure of competition – namely, the profit elasticity indicator introduced by Boone (2000) – is computed for the telecommunications industry in 24 EU countries between 2010 and 2017.[2] This indicator is calculated from firm-level data and estimates the intensity of competition on the basis of the intuition that when competition is fiercer, more efficient firms obtain higher profits and less efficient firms are more heavily penalised, compared to a situation where competition is more relaxed. In other words, the higher the correlation between efficiency and profit, the higher the level of competition estimated by the profit elasticity indicator.

We find that the average profit elasticity in the 24 EU countries considered in this work is 0.96, meaning that if a firm's marginal cost increases by 1%, its profit is expected to decrease by 0.96%, all other things being equal. Furthermore, the situation across EU countries is extremely heterogeneous, with countries where the telecommunications industry is characterised by intense competition and others where competition in the sector is extremely relaxed. In particular, the profit elasticity indicator ranges between -0.32 in Germany and 2.51 in Ireland.

As regards the determinants of competition, the two variables investi-

[2]As explained in more detail in Section 3, Austria, Cyprus, Denmark and Luxembourg were excluded from the calculation of the Boone index due to the insufficiency of available data on companies active in these countries' telecommunications industries.

gated in this research are (i) the number of mobile network operators (i.e. companies that, as a result of a spectrum auction process, control a portion of the electromagnetic spectrum and use it to supply wireless communication services) in each country and (ii) a dummy variable taking on the value 1 in the countries where the European Commission intervened, in previous years, to interrupt an anticompetitive behaviour in the telecommunications industry. Both variables are allowed to vary over time, as during the period considered, (i) two countries have decided to allocate portions of their radio spectrum to a higher number of companies and (ii) the European Commission has intervened in some countries' telecommunications industry where it had not intervened before. Nevertheless, the variability of these two variables across time is extremely limited.

The results previously obtained with respect to profit elasticity are regressed on the two above-mentioned variables to check whether they are relevant to the competition level in the telecommunications industry. This is done by using different econometric models and estimation methods, including OLS, pooled OLS, and GLS random effects. We show that, for both variables and irrespective of the estimation method employed, it is not possible to reject – at a satisfactory level of statistical significance – the null hypothesis that they have no effect on the intensity of competition in the industry at issue.

The remainder of the thesis is structured as follows. Section 2 presents previous research works that introduced or applied methods or theoretical concepts relevant to this thesis. Section 3 illustrates the methods chosen to develop the empirical analysis carried out in this work and elaborates on the rationale behind these choices. Section 4 presents and analyses the results obtained with respect to the profit elasticity indicator and the statistical significance of the two investigated variables on competition levels, while Section 5 discusses the robustness of the results by comparing them to the results obtained a similar studies and by examining issues such as heteroskedasticity and serial correlation, as well as the solutions adopted to alleviate them. Section 6 formulates the consequent policy recommendations, i.e. interventions to harmonise the intensity of competition among EU countries upwards are urgent and the number of mobile network operators should be chosen with a view at facilitating investments and advancing the introduction of new technologies, and Section 7 concludes.

2 Literature review

This thesis belongs to the empirical literature on three interconnected topics, namely the measurement of competition, the effects of the liberalisation of the telecommunications industry in the EU and the determinants of competition in the telecommunications industry.

A number of previous research works are relevant to the methodology employed throughout this thesis. First of all, the profit elasticity (PE) indicator introduced by Boone (2000) is utilised to measure the intensity of competition in the telecommunication industry of the different EU countries analysed. Such an indicator represents an example of the indirect approach to competition measurement, as opposed to indicators proposed by the direct approach, such as market concentration and price cost margins. While indicators based on the direct approach are easier to calculate, the indirect approach proposes indicators that are better grounded to theory. In particular, PE is monotone to competition, while market concentration indexes such as the Herfindahl–Hirschman index are not (Braila, Rayp, & Sanyal, 2010), as we show in Section 3 through an example.

Following Boone's (2000) intuition and the formalisation of his findings, several works have shown how to calculate the PE indicator in different industries and in different contexts (Boone & van Leuvensteijn, 2010; Amador & Soares, 2013; van Leuvensteijn, Bikker, van Rixtel, & Kok Sørensen, 2007). In particular, Braila et al. (2010) provided an example of how the PE indicator can be computed for different industries starting from the 2007 Amadeus DVD (Bureau van Dijk) database. The methodology illustrated in their working paper is essentially followed also in the first part of this research, although some changes have been made in order to make the methodology of this research the most suitable for the available data.

Moreover, previous studies have analysed the level of competition in similar industries and similar geographic areas. For example, Sung (2014) quantified the market concentration of the mobile telecommunications industries of 24 OECD member states between 1998 and 2011.

As regards the general context of this thesis, the liberalisation of the telecommunications industry has been widely studied, not only by economists. Political scientists such as Levi-Faur (2004), for example, argued that the "net impact" of the EU in this process was almost null, as the liberalisation would have taken place in most of the EU countries even in the absence of the European Commission and other agents of supranationalism. Neverthe-

less, it has been proven that the way competition rules are designed crucially influences concentration and prices in the markets for telecommunications. In other words, these rules are the political determinants of competition in the telecommunication sector and, as Faccio and Zingales (2018) showed, pro-competitive rules reduce prices without adversely affecting quality and investments, while rules established to favour politically connected operators result in restricted competition and, consequently, higher prices.

The analysis of non-political determinants of competition includes Porter's (1979) model, according to which the intensity of competition on any profitable market is a function of five forces: customers' bargaining power, suppliers' bargaining power, the threat of potential new entrants, the threat of potential new substitute products or services and rivalry among existing competitors. A similar research was carried out by Shepherd (2004), who defined the three requirements needed to attain a condition of workable competition, that is a market situation that – while not matching the perfect competition paradigm – has "Enough features of perfect competition that government intervention is unnecessary and possibly even counterproductive" (Jamison, 2012). These requirements are (i) at least five reasonably comparable competing firms, (ii) the absence of any dominant player and (iii) the easiness of market entry for potential new competitors.

Very few specific works deal with the non-political determinants of competition in the telecommunications industry, for example Jamison (2012) discusses under what circumstances each of the five forces enumerated by Porter (1979) is relevant to competition in this sector. This thesis aims to contribute to the research on non-political determinants of competition in the telecommunications industry, that is to contribute to determine what market features have a significant impact on competition.

As regards the empirical analysis of the impact of the two variables of interest on competition, a number of previous works suggest a set of proven control variables used for similar regressions in previous research. Among these are Pekarskiene, Bruneckiene, Daugeliene and Lina Peleckiene (2018) and Faccio and Zingales (2018), who employed a number of control variables that we use as well in the empirical part of this thesis.

3 Methodology

The present Section, aimed at presenting the method used to perform the quantitative analyses of this research, is divided into two parts: Subsection 3.1 presents the method employed to measure competition in the telecommunications industry across the EU countries, namely the calculation of the profit elasticity indicator, and explains the rationale behind the choice of this indicator; Subsection 3.2 elaborates on the econometric techniques employed to test the impact and the significance of the two investigated variables on the intensity of competition in the industry at issue.

3.1 Measurement and comparison of competition levels

The intensity of competition can be measured through different methods, the most popular of which include calculating the Lerner index and the Herfindahl-Hirschman index. These indexes are examples of indicators based on the direct approach to competition measurement, i.e. indicators calculated on the basis of variables like concentration, price cost margins, etc. and whose values are relatively easy to calculate once the needed data are available (Braila et al., 2010). An alternative to these indexes is represented by the indirect approach to competition measurement, which proposes indicators requiring more sophisticated calculations, but based on more solid theoretical grounds. The remainder of this Subsection presents the three methods considered to quantify the intensity of competition in the European telecommunications industry, i.e. the Lerner index, the Herfindahl-Hirschman index and the profit elasticity indicator, and explains why the choice fell on the latter.

The intuition behind the Lerner index is that when a market is particularly competitive, firms active in it have a very limited ability to rise prices above the perfectly competitive level. Indeed, in the perfectly competitive paradigm,

$$p = C'$$

where p is the price level in the market at hand and C' is the firm's marginal cost. On the other hand, when competition is severely limited, firms can charge a considerable markup. Therefore, the Lerner index - whose

purpose is to quantify to what extent competition is limited or, in other words, to what extent market power is present in a given market - is defined as

$$L = \frac{p - C'}{p}$$

that is the difference between price and marginal cost as a ratio of the price (Belleflamme & Peitz, 2015).

We observe that, once the necessary data are known, the Lerner index is very easy to calculate. However, this method has a main drawback in our context, given by the peculiarity of the telecommunications industry in terms of marginal costs. This industry is, indeed, characterised by huge initial investments, but nearly zero marginal costs, thus representing an example of what Rifkin (2014) described as "The Zero Marginal Cost Society". This would distort the quantification of competition levels obtained through the Lerner index because in markets where fixed costs are important and the marginal cost is zero,[3] the price cannot also be equal (or close) to zero, otherwise firms active in the industry would make significant losses and would be forced to quit the market. As a consequence, by using the Lerner index, we would end up with very high markups and conclude that competition is extremely limited. On the contrary, these high markups would probably be determined by the necessity to recover the investments and gain a reasonable margin of profit, rather than by firms carrying out anticompetitive behaviours, such as tacit coordination, collusion or abuse of dominance.

Another drawback of the Lerner index is given, in general, by the fact that obtaining data on marginal costs is far from simple, as these figures are kept confidential by most of the companies. Nevertheless, this issue is solved in the following paragraphs by approximating this variable starting from available data. In the light of these considerations, we can conclude that the Lerner index is not an appropriate tool to measure the intensity of competition in the European telecommunications industry.

The Herfindahl-Hirschman index (HHI) represents an alternative to the

[3]This is because, in the telecommunications industry, fixed cost items include, among other things, the establishment of an infrastructure for the transmission of information over long distances. Such an infrastructure might consist of physical media (e.g. cables) or of a network of transmitting and receiving devices for conveying information through the electromagnetic spectrum and requires continuous maintenance, as ensuring the reliability of communications is essential in the telecommunications industry. In addition to this, mobile network operators have also to bear the costs related to spectrum auctions.

Lerner index to measure the intensity of competition and the level of market power in a given market. The HHI measures the level of concentration on the basis of the distribution of market shares among market players. It is defined as the sum of squared market shares for all the firms active in the market at issue:

$$HHI = \sum_{i=1}^{n} \alpha_i^2$$

where n is the number of firms active in the market and α_i is the market share of firm i (Belleflamme & Peitz, 2015). Thus, the HHI takes on quasi-zero values in perfectly competitive markets and takes on the value 10,000 in monopolised markets.[4]

One of the advantages of using this index is that the distribution of market shares is a good way to quantify concentration (and, thus, competition) in any industry. Hence, we would not encounter any problem related to the peculiarities of the telecommunications industry and to its very high fixed costs and very low marginal costs, as it would have been the case if we used the Lerner index. Nevertheless, while the HHI is extremely popular in industrial organisation as a tool to quantify market concentration (Belleflamme & Peitz, 2015, Chapter 2.3.2), it is very rarely calculated in practice due to the difficulty of obtaining reliable data on market shares.[5] This is, first of all, because each firm active in a market has precise knowledge only of its sales figures, while it ignores its rivals'. Therefore, each firm can only have an estimate of market shares, while none of them is able to compute the exact figures. Secondly, each firm regards both its sales figures and the estimates concerning its rivals' sales figures as business secrets. In our case, it is impossible to obtain a dataset featuring the market share of each EU firm active in the telecommunications industry.

Finally, it is worth noting that this research is not focused on one specific market, as it rather concerns the telecommunications industry as a whole,

[4] In the perfectly competitive paradigm, the number of firms in the market is as large as possible because new competitors enter the market until $p = C'$ (Gravelle & Rees, 2004), therefore each of these firms has a very small market share, resulting in a very low value of HHI. On the contrary, when only one firm is active on the market, it inevitably holds a 100% market share. Therefore, in this scenario the HHI equals 10,000 because $HHI = 100^2 = 10,000$.

[5] An example is represented by competition authorities, which calculate HHI and use it – inter alia – in the field of merger control (Petit, 2018). This is possible thanks to public authorities' exclusive possibility to access certain firms' data.

therefore this method should be ruled out even if data on market shares were available. Indeed, the calculation of the HHI is meaningless if a relevant market is not defined. Market definition crucially depends on goods' substitutability (Belleflamme & Peitz, 2015, Chapter 2.3), as Firm A only exerts a competitive constraint on Firm B only if the good produced by the former can substitute the one produced by the latter.[6] The telecommunications industry cannot under any circumstances be considered as a relevant market on the ground of the little or zero substitutability between some services provided within this it, e.g. telephone connections and access to TV broadcasting. Consequently, the HHI index is not suited to the measurement of competition that is performed in this research.

We opted to use an indirect approach to competition measurement, namely the profit elasticity indicator as a consequence of these restrictions and because indicators based on the indirect approach guarantee better theoretical grounds compared to the ones based on the direct approach, even though they involve less straightforward calculations. In order to better illustrate the fallacy of the direct approach to competition measurement in particular circumstances, we consider the following an example. The initial situation in two markets (Market A and Market B) is identical in terms of firms and market shares. Thus, the intensity of competition measured at this stage by using the HHI is identical in the two markets: $HHI_A = HHI_B$. We now assume that the least efficient firm in Market A is forced out of business due to the high intensity of competition in this market, while the least efficient firm in Market B is able to maintain its market share because, while being identical to the least efficient firm in Market A, it is subject to a more relaxed competitive constraint. At this point, the HHI would increase in market A and remain unchanged in market B ($HHI_A > HHI_B$), leading to the conclusion that competition is more intense in market B, which contradicts the scenario described. This kind of estimation errors cannot occur when indicators based on the indirect approach are employed, as it will become clearer after the introduction of the PE indicator below.

The intuition behind the PE indicator is that the least cost-effective firms (i.e. the ones with the highest marginal costs) are heavily penalised in markets where competition is fiercer, while they are relatively better off in mar-

[6]It is important to point out that substitutability is not a one-zero attribute: it may be present in different degrees. Quantitative methods such as the SSNIP test exist to determine whether or not two products should be considered to belong to the same specific market based on their mutual substitutability.

kets where competition is more relaxed. This is because competition in a market has always two effects: first, it increases a firm's profits with respect to the profits of a less efficient firm (reallocation effect); second, when competition becomes more intense, the profits of the least efficient firm in the market decrease (selection effect). Consequently, the intensity of competition within an industry can be estimated by assessing the strength of the correlation between firms' profits and their cost-effectiveness (Braila et al., 2010).

In the above-mentioned example, the PE indicator would correctly report a higher competition level in Market A compared to Market B ($PE_A > PE_B$) due to the stronger correlation between profit and efficiency in Market A compared to market B.

3.1.1 Data

In order to calculate the PE indicator, we used firm-level panel data from the 2019 Orbis Europe dataset (Bureau van Dijk) and considered, in the first instance, all the firms active in the telecommunications industry in 27 EU member states.[7] [8] The database drawn from Obris Europe included 86,809 entries and 17 variables, namely the country in which the firm is active, its yearly turnover in the 2010 – 2017 period and its yearly variable costs in the 2010 – 2017 period. At this stage, the panel was strongly unbalanced and required that data cleaning operations were performed in order to make these data usable to produce reliable results.

Consequently, in a further step, firms for which data are incomplete or implausible were dropped from the sample. More specifically, this data cleaning operation was performed through the removal of any firm for which: (i) at least one yearly turnover figure was missing over the period considered; (ii) at least one yearly cost figure was missing over the period considered; (iii) the turnover increased by more than 500% within one year; (iv) the turnover decreased by more than 80% within one year; (v) the database failed to indicate the country where the firm was active. As a result of the data cleaning, 3,144 firms remained in the sample. Their distribution across countries is

[7]Firms active in the telecommunications industry have been identified following the "NACE Rev. 2" statistical classification of economic activities in the European Community elaborated by Eurostat (2008).

[8]Cyprus was not included in the database due to the unavailability of cost figures concerning firms active in the Cyprian telecommunications industry.

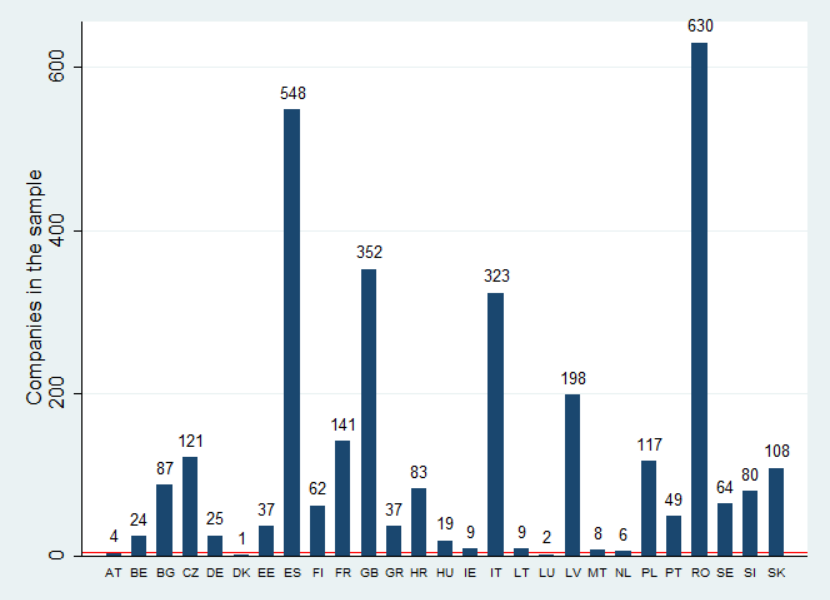
illustrated in Figure 1 below. While this reduction in terms of sample size might seem conspicuous, it is important to note that dropping these entries from the sample is beneficial for the reliability of our results and that it does not in fact represent an excessive reduction of the sample size. This is the case for two reasons.

First, it should be taken into account that the vast majority of the dropped observations are not in fact firms, but rather duplicates of a firms' names without any data.[9]

Second, firms are subject to different obligations in terms of data publications. While the biggest firms are required to publish an important amount of data, the smallest ones do only communicate essential financial figures (Bureau van Dijk, 2010). Therefore, we can assume that companies for which cost figures are unavailable are the smallest ones and that the competitive constraint they exert is very limited due to capacity reasons (Belleflamme & Peitz, 2015, Chapter 3.3.1). Thus, it is more convenient to drop these observations and to include in the sample only firms for which all the data are available, so that it is possible to calculate the profit elasticity for the same period in each of the considered countries. Moreover, as this data-cleaning procedure is performed in the same way for every country, it does not result in any bias or loss of generality of the results.

[9] As an example, the name of the firm is "A1 Telekom Austria Aktiengesellschaft" in 110 observations. Only one of these observations contains the relevant data, while the remaining 109 have missing data for every other variable.

Figure 1: Number of sampled firms in each of the 27 EU countries considered.



Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

We recall that, at this stage, countries are 27 instead of 28 because of the unavailability of cost data concerning firms active in Cyprus. It appears from Figure 1 that, for 3 countries - namely Austria, Denmark and Luxembourg - we have less than 5 firms in the sample (the 5-firm threshold is represented by the red line in the figure). This is particularly problematic because in these countries it was not even possible to include all of the mobile network operators, i.e. the most important players in the industry, in the sample.

Such a low number of firms would not allow us to draw any reliable conclusion with respect to the intensity of competition in the countries at issue, neither would the profit elasticity indicators calculated for these countries be helpful in the second part of the thesis, where the relation between the PE indicators and the two above mentioned variables of interest is investigated. On the contrary, regressing unreliable profit elasticity data on the variables of interest could distort the results obtained. Therefore, the 7 firms active in Austria, Denmark and Luxembourg were dropped from the sample in order to avoid drawing unreliable conclusions on the level of competition in these

countries' telecommunications industries and on the impact of the two investigated variables on the intensity of competition. As a consequence of this choice, the final number of countries in the sample is 24.

3.1.2 Empirical estimation

On the basis of the database described above, the PE index was calculated through the following regression, which reflects Boone's formalisation of his own method (Boone, van Ours, & van der Wiel, 2007):

$$\ln(\pi_{it}) = \alpha_i + \alpha_t - \beta_{it} \ln(C'_{it}) + \varepsilon_{it} \tag{1}$$

where π_{it} is firm i's profit at time t, C'_{it} is firm i's estimated marginal cost at time t, α_i and α_t are the firm fixed effect and the time fixed effect, respectively. The purpose of α_i and α_t is to capture all unobserved, constant factors that affect $\ln(\pi_{it})$ in order to obtain unbiased estimators of the coefficient β, which quantifies the intensity of competition. (Wooldridge, 2014).

In other terms, we regress, for each firm in our database, its profit on its marginal cost. The econometric model is specified in the log-log form and estimated through the use of panel data and by using fixed effects.

We recall that the concept of elasticity is related to the log-log form of the model. Indeed, since both profits and marginal costs appear in Equation 1 in their logarithmic form, the coefficient β has to be interpreted as the percentage change of the profit when the estimated marginal cost changes by 1%.

While the annual turnover figures are directly available in the database, the estimation of annual profits and marginal costs required some preliminary calculations before the model presented in Equation 1 could be estimated.[10] These calculations were performed following different methods depending on data availability, as the next paragraphs illustrate.

For companies active in 17 out of the 24 countries of the database,[11] annual data on turnovers, material costs and costs of the employees are available. Therefore, we follow the methodology adopted by Braila et al. (2010) and described in the following paragraphs.

[10] The preliminary calculations were performed prior to the data cleaning operations.

[11] Namely, Belgium, Bulgaria, Czech Republic, Germany, Estonia, Spain, Finland, France, Croatia, Hungary, Italy, Poland, Portugal, Romania, Sweden, Slovenia and Slovakia.

First, an estimate of variable costs is calculated as the sum of material costs and costs of employees for each firm and each year. Then, the approximation of the marginal cost is defined as the ratio between variable costs and the operating turnover:

$$C'_{it} = \frac{MC_{it} + EC_{it}}{R_{it}} \tag{2}$$

where MC_{it} is the material cost of firm i at time t, EC_{it} is the cost of employees of firm i at time t and R_{it} is the operating revenue of firm i at time t.

As regards profits, they are simply estimated, for each firm in each year, as the difference between the operating revenues drawn from the database and the variable costs approximated as the sum of the material cost and the costs of the employees:

$$\pi_{it} = R_{it} - MC_{it} - EC_{it} \tag{3}$$

For the remaining 7 countries in the database,[12] data on companies' turnovers are available, but data on material costs and costs of the employees are missing in the vast majority of cases. In order to remedy the lack of these data without losing important observations and further reducing the number of analysed countries, we identify a variable provided in the Orbis Europe database, namely "Cost of the goods sold" which can be used as a proxy of the sum between material costs and costs of the employees, as it represents an approximation of the variable costs.

Consequently, for this subset of countries, firms' marginal cost is not approximated as in Equation 2, but rather as the ratio between the newly introduced variable and the operating turnover:

$$C'_{it} = \frac{CGS_{it}}{R_{it}}$$

where CGS_{it} is the cost of goods sold by firm i at time t.

Likewise, profits achieved by firms active in these 7 countries are not calculated as in Equation 3, but rather as the difference between each firm's operating revenue and its cost of goods sold:

[12]Namely, the United Kingdom, Greece, Ireland, Lithuania, Latvia, Malta and the Netherlands.

$$\pi_{it} = \frac{R_{it}}{CGS_{it}}$$

After having calculated each firm's profit and marginal cost in each year of the considered period, we run the regression presented in Equation 1 to obtain the estimation concerning the PE indicator. This indicator is computed, at the country level, in each of the 24 EU member states present in the final sample as well as at the EU level. Moreover, as regards the time dimension, the indicator is calculated: (i) over the entire 2010 – 2017 period in order to measure and compare the levels of competition across the EU obtained on the basis of a large, balanced panel; (ii) over the 2010 – 2013 and the 2014 – 2017 periods in order to assess the evolution of the intensity of competition in the industry within each of the countries in the sample and (iii) for each year included in the considered period in order to obtain – in the second part of the thesis – an estimated effect of the two investigated variables by regressing these results on the data concerning the variables of interest as well as a set of control variables. The results obtained with respect to the PE indicator in each of the above-mentioned time intervals are presented and discussed in depth in Section 4.

3.2 Assessment of the impact of the investigated variables on competition

This subsection presents the methods employed to explore the causal relation between the intensity of competition in the telecommunications industry of a given country and two variables of interest, namely (i) the number of mobile network operators active in that country and (ii) a dummy variable taking on the value 1 if the European Commission intervened to interrupt an anticompetitive behaviour in that country in previous years and 0 otherwise. First, we briefly present the two variables of interest and the motivation to explore their causal effect on the intensity of competition; then the following Subsections 3.2.1, 3.2.2 and 3.2.3 introduce the econometric methods employed in order to do so.

In general, we chose the two above mentioned variables as variables of interest because one could reasonably expect that they have a significant effect on competition, therefore confirming or rejecting this expectation leads to relevant policy conclusions with a view at boosting competition in the telecommunications sector. Each of the two variables of interest is briefly

presented in the next paragraphs and discussed in more detail in Subsection 4.2.1.

As regards the number of mobile network operators, it is important to recall that these companies are, in every country included in the sample, the most important market players in the analysed industry in terms of operating revenues, profits, and number of employees. Mobile network operators supply wireless communication services, such as broadband internet access and mobile phone coverage, through a portion of the electromagnetic spectrum that they control. These markets are oligopolistic in all the sampled countries, as governments auction off spectrum rights to a limited number of firms, ranging between 3 and 5.

The investigated variable "number of mobile network operators" (MNO) is expected to have an unambiguous effect on competition: as this number increases, the related market becomes less concentrated and competition should become fiercer. Since the market segment concerning the supply of wireless communication services is the largest in the telecommunications industry, the expected increase in competition resulting from a higher number of mobile network operators should be reflected by a higher level of competition in the entire industry and, thus, by a higher value of the PE indicator.

On the contrary, the fact that the Commission intervened in a given country has an expected effect on the PE indicator that is more complex and not easy to predict. On the one hand, the Commission's intervention should have boosted competition by interrupting an anticompetitive behaviour and by causing a deterrent effect on all market players (expected pro-competitive effect). This is because, since the Commission proved to pay special attention to a market, players active in that market will likely be more cautious and avoid engaging in anticompetitive agreements or abusing their dominant position. On the other hand, the fact that an anticompetitive behaviour took place in a given country, sometimes lasting for years, should have reduced the competition level measured by PE (expected "anticompetitive" effect).

Furthermore, the timing of the European Commission's intervention has a fundamental effect on the net effect of the above-mentioned effects. For example, if the Commission's intervention took place before the beginning of the period considered in this research (i.e. before 2010), then only the expected pro-competitive effect of the dummy variable should be taken into account. This is because, while the Commission interrupted an anticompetitive behaviour and caused a deterrent effect on all market players, the anticompetitive behaviour did not take place in the period considered and,

therefore, did not influence the measurements taken through the PE indicator. On the contrary, if the Commission intervened at the end of the period considered (e.g. in 2017), then only the "anticompetitive" effect of the dummy variable should be taken into account, as the infringement took place during the 2010 - 2017 period, likely influencing the values of the PE indicator and the results of the deterrent effect will likely occur when the PE indicators we calculated do not detect them anymore. As it is explained in the next Subsections, we adopted methods to take the decisions' timing into due account when estimating the different econometric models aiming at investigating causal effects.

We used the PE indicators obtained through the methods illustrated in Section 3.2 in order to quantify the intensity of competition in the telecommunications industry of each of the 24 countries in the sample and employed different econometric models and estimation methods to explore the existence of causal relationships between the level of competition and the two investigated variables.

Besides data concerning competition, we used data concerning the investigated variables, namely the number of mobile network operators in each studied country and data on the countries concerned by Commission's decisions along with the dates of such decisions.

Finally, we used a set of control variables to make sure that the statistical significance of the investigated variables is not overestimated and that their estimated effect on competition is correct when other factors influencing competition are equal. Control variables include GDP, GDP per capita, the $Indexofeconomicfreedom$ and the rate of market growth. Data on GDP and GDP per capita are retrieved from the Eurostat (2019) databases; the Index of economic freedom is retrieved form the website of the Heritage Foundation (2019), which created it along with The Wall Street Journal;[13] while market growth is computed as follows, based on the yearly data on firms' operating turnover:

[13]This index attributes to each country an overall score covering 12 quantitative and qualitative factors, namely property rights, government integrity, judicial effectiveness, government spending, tax burden, fiscal health, business freedom, labour freedom, monetary freedom, trade freedom, investment freedom, and financial freedom. We consider this index to be a relevant control variable, as a higher level of economic freedom is expected to facilitate competition.

$$MG_{ct} = \frac{\sum_{i=1}^{n} R_{it} - \sum_{i=1}^{n} R_{it-1}}{\sum_{i=1}^{n} R_{it-1}} \tag{4}$$

where MG_{ct} is the rate of growth of the market of country c during the year t, $\sum_{i=1}^{n} R_{it}$ is the sum of the operating revenues of all the firms active in country c in the year t and $\sum_{i=1}^{n} R_{it-1}$ is the operating revenues of the same firms in the previous year. This control variable is particularly relevant, as it is a well-established notion in competition economics that competition tends to become fiercer in declining markets, while it tends to be more relaxed in growing markets.

A detailed description and a summary statistic of every variable are provided in Annexes 9.1 and 9.2, respectively.

3.2.1 The cross-sectional benchmark

The first method employed is the estimation of the following linear model through the use of cross-sectional data:

$$PE_i = \beta_0 + \beta_1 MNO_i + \beta_2 EC_i + \beta_3 GDP_i + \beta_4 GDPpc_i + \beta_5 IEF_i + \beta_6 MG_i + \varepsilon_i \tag{5}$$

where PE_i is the calculated profit elasticity of country i's telecommunications industry throughout the 2010 – 2017 period, MNO_i is the number of mobile network operators active in country i during the period under examination, EC_i is a variable taking into account whether the European Commission prohibited any anticompetitive behaviour in country i, GDP_i is the average gross domestic product at current market prices produced by country i in the considered period, $GDPpc_i$ is the average GDP per capita at current market prices produced by country i in the considered period, IEF_i is the average Index of Economic Freedom attributed to country i through the considered period and MG_i is the total rate of growth of the telecommunications industry between 2010 and 2017, calculated as in Equation 4.

As mentioned above, taking into account the timing of the European Commission decisions is crucial to correctly assess the effect of these antitrust interventions. This is why, in order to take into due account the expected pro-competitive and "anticompetitive" effects mentioned above, we defined the dummy variable EC_{it} for each year and each country as follows. EC_{it} takes on the value 1 if, at the beginning of year t the European Commission

had already intervened in country i and 0 otherwise. Thus, as the European Commission intervened in Germany in 2003, the dummy variable takes on the value 1 for Germany in each of the years considered; while in Portugal – where the commission intervened in 2013 – takes on the value 1 only for the last four years of the considered period, i.e. 2014 – 2017.

As regards the independent variable EC_i in Model 5,[14] the value it takes on is the average value of EC_{it} throughout the 2010 - 2017 period, that is:

$$EC_i = \frac{\sum_{t=2010}^{2} 017 EC_{it}}{8}$$

so that this variable will take on the value 1 for Germany and 0.5 for Portugal.

As regards the variable MNO_i in Model 5,[15] we adopted a similar approach:

$$MNO_i = \frac{\sum_{t=2010}^{2} 017 MNO_{it}}{8}$$

so that, for example, in Italy where the number of mobile network operators increased from 3 to 4 in 2016, MNO_i takes on the value

$$MNO_i = \frac{3 * 6 + 4 * 2}{8} = 3.25$$

3.3 The pooled OLS benchmark

After having obtained a first benchmark through the OLS regression displayed in Model 5, we turn to considering panel data. Indeed, we collected data for each of the variables included in this research in every year of the period considered in all the studied countries.

In order to obtain another benchmark, this time on the basis of panel data, we pool the 8 cross sections (one for each year of the considered period). We expect this method to produce more precise estimators and to allow us to test statistics with more power because, by pooling the cross sections, we

[14]The variable EC_{it} is used in models estimated on the basis of panel data, while EC_i is an adaptation of the former variable used in models estimated on the basis of cross-sectional data.

[15]The variable MNO_{it} is used in models estimated on the basis of panel data, while MNO_i is an adaptation of the former variable used in models estimated on the basis of cross-sectional data.

increase the sample size in a very significant manner: from 24 observations to $24 * 7 = 168$ observations.[16] Moreover, this model allows the intercept to differ across years by including dummy variables for every year, except for 2010, which is chosen as the base year. Moreover, these dummy variables provide us with an indication of how the general level of competition evolved in the studied countries during the studied period.

Therefore, the model estimated through pooled OLS is the following:

$$\begin{aligned} PE_i = \beta_0 + \beta_1 MNO_i + \beta_2 EC_i + \beta_3 GDP_i + \beta_4 GDPpc_i + \beta_5 IEF_i + \\ \beta_6 MG_i + \delta_7 y11i + \delta_8 y12i + \cdots + \delta_1 3y17i + \varepsilon_i \end{aligned} \tag{6}$$

where the dummy variables y11i, y12i, ..., y17i are equal to 1 when the observation comes from 2011, 2012, ..., 2017, respectively. The results of the estimation are discussed in Subsection 4.2.3.

3.3.1 The GLS random effects model

The last model we employed to test and quantify the causal effect of the two investigated variables on the intensity of competition within the 24 countries in the sample is the following:

$$PE_i = \beta_0 + \beta_1 MNO_{it} + \beta_2 EC_{it} + \beta_3 GDP_{it} + \beta_4 GDPpc_{it} + \beta_5 IEF_{it} + \beta_6 MG_{it} + \varepsilon_i \tag{7}$$

In general, fixed effects models are a more convincing tool for policy analysis because they allow arbitrary correlations between unobserved effects and independent variables (Wooldridge, 2014). However, in this specific case, the choice fell on the use of a random effects model. Such a choice was determined by the very scarce variance of the two investigated variables across time. More specifically, MNO takes on the same value in all 8 years of the studied period in 22 out of 24 sampled countries, while EC takes on the same value in all 8 years of the studied period in 21 countries out of 24. As a consequence, the employment of a fixed-effect or a first-difference model was ruled out.

[16] The number of observations is obtained by multiplying the number of countries in the sample by 7 (and not by 8, even though the analysed period is composed of 8 years) because the rate of market growth could not be calculated for the first year in the period.

The results of this GLS random effects estimation are presented in Section 4.2.4, while Section 5 discusses the relevant robustness issues, including heteroskedasticity and serial correlation.

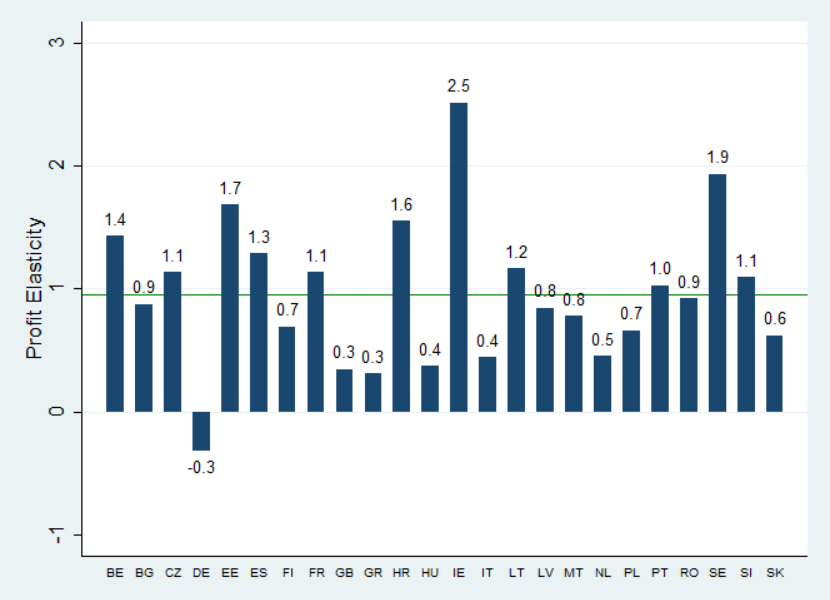
4 Analysis

4.1 Competition levels in the analysed countries' telecommunication industries

As discussed in detail in Subsection 3.1, we computed the competition level in the telecommunications industries of 24 EU countries by using the PE indicator, which was ultimately estimated by computing the OLS estimators presented in Model 5.

We present, first of all, these OLS estimators, which represent the profit elasticity recorded in each industry and referred to the entire period from 2010 to 2017. Results are shown in Figure 2 below for the 24 studied countries, while Annex 9.3 provides the same results with greater precision.

Figure 2: PE indicator in the 24 analysed countries' telecommunication industries (2010 - 2017).



Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

At this point, it is important to notice that a positive value of the PE indicator denotes an inverse relationship between the estimated profit and the estimated marginal cost (i.e. profit increases when the marginal cost decreases and vice versa). This is because $\beta_t \ln(C'_{it})$ has a negative sign in Equation 1, therefore an increase in $\ln(C'_{it})$ corresponds to a decrease in $\ln(\pi_{it})$.

The first fact we observe from these results is that the coefficient β_t has the expected sign for all of the considered countries, except for Germany. Such a result is not necessarily at odds with reality, as it simply means that less efficient firms were relatively more profitable compared to more efficient ones. The result indicates a situation where competition is extremely relaxed in Germany, which could be due to several factors, such as barriers to entry, consumer inertia, etc. This could indicate the presence of significant market power, such that the dominant players can increase their profits even when their efficiency is reducing. However, a thorough analysis of the reasons of such a low level of competition is beyond the scope of this thesis.

As regards the quantitative interpretation of these results, we can state – for example – that a Belgian telecommunications firm whose marginal cost is 1% lower than the marginal cost of a rival will have, all else being equal, a higher profit than its rival by 1.4%.

The average value of the PE indicator across the whole sample is 0.957 (cf. Appendix 9.3). While it is not possible to draw conclusions on this result, as to do so it would be necessary to have data on the PE indicator in comparable geopolitical entities, we can state that this industry is not one of the most competitive within the European Union by comparing the above mentioned average value with the results obtained by Braila et al. (2010) and showing that the profit elasticity of industries in the "EU-6" ranges between 3.06 in the industry of wood and 0.63 in the industry of electricity, gas and water supply.[17] In addition, the average PE obtained for the EU in this thesis is lower than 19 out of 21 PE indicators calculated by Braila et al. (2010) for different industries in the "EU-6". Even though these data are not perfectly comparable due to differences in the sample of studied countries, we can conclude that the level of competition in the telecommunications industry is

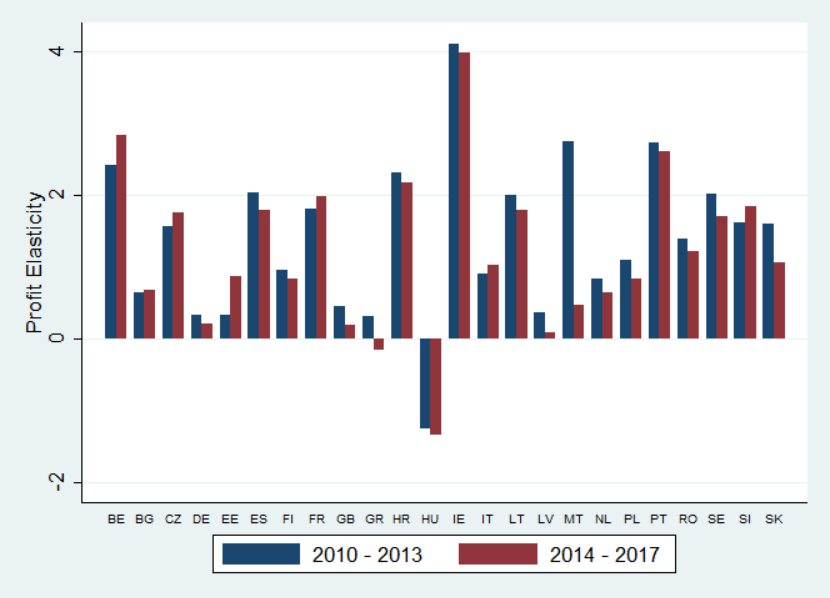
[17]The "EU-6" is defined, within Braila et al.'s (2010) paper, as Finland, France, Italy, Spain, Sweden and the United Kingdom.

low compared to other industries in the EU.

We note that the PE indicator displays an important variance across the studied countries, ranging between 2.514 in Ireland, which results to be the country where competition is the most intense, and -0.317 in Germany, which is the analysed country where competition results to be more relaxed. To better appreciate the measure of this variance, we refer to Braila et al.'s (2010) again to point out that when they computed the PE indicator for each industry of the Belgian economy, results ranged between 3.19 (Transport equipment) and 0.57 (financial intermediation).

In order to have a first overview of the trend followed across time by the telecommunications industry's competition levels, we calculated – in each country – not only the PE index for the overall 2010 - 2017 period, but also for two subperiods, namely 2010 – 2013 and 2014 – 2017. Results of these calculations are presented in the Figure 3 below.

Figure 3: Comparison between the PE indicators calculated it two subperiods in the 24 analysed countries' telecommunication industries.



Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

First of all, we notice that – by changing the timeframe of PE indicator's

calculations – the results change substantially. It is, therefore, worth noting that the results previously obtained with respect to the entire 2010 -2017 period and summarised in Figure2 are not comparable with these ones. As mentioned in Section 3, the former ones are more reliable because they are computed on the basis of a broader database and of a longer period of time. Nevertheless, data presented in Figure 3 are still useful to have an idea of how the intensity of competition evolved in each of the 24 studied industries.

We observe that competition became more intense in the second four-year period compared to the first one in 7 countries out of 24, while it became more relaxed in 17 cases; meaning that the vast majority of the studied countries are experiencing a reduction in the level of competition of their telecommunications industry.

4.2 Impact of the investigated variables on competition

This Subsection presents the results of the regressions aimed at investigating and quantifying the existence of any causal relation between the intensity of competition in the telecommunications industry and the two variables of interest of this study.

The presentation is divided into four part. First, Subsection 4.2.1 introduces the investigated variables. Second, Subsection 4.2.2 considers the benchmark consisting of an OLS regression of cross-sectional data. Third, Subsection 4.2.3 evaluates the results of the pooled OLS benchmark, which is based on panel data and does also allow us to test how the overall competition level in the EU telecommunications industry evolved over time. Forth, we propose a GLS random effects estimation in Subsection 4.2.4 whose results have to be regarded as the most reliable ones because of the method employed and the data considered.

4.2.1 Variables of interest

We are interested in the impact on the intensity of competition of (i) the number of mobile network operators active in a country and (ii) a binary variable taking on the value 1 if the European Commission prohibited any anticompetitive behaviour in a country in previous years and 0 otherwise.

Mobile network operators are companies active in the market segment of wireless voice and data communications services. Examples of these compa-

nies are represented by Proximus, T-Mobile, and Telefónica. They manage a complete telecommunications infrastructure composed of transmitters, receivers, and a part of the radio spectrum; the latter being the crucial element differencing a mobile network operator from any other company in the industry.

Each country, indeed, exercises its sovereignty on the radio spectrum within its borders, just like it does with respect to territorial waters, mineral gas, etc. (Ryan, 2005) and decides (normally through an auction process) what companies have access to it to provide wireless communications services. Mobile network operators pay a lump sum whose amount depends on the bids and the rules of the specific spectrum auction and obtain, in exchange, the licence to transmit signal over a specific band (Cave, Majumdar & Vogelsang, 2001). Since governments allocate these rights only to a limited number of market players (ranging between 3 and 5 in the EU countries), mobile network operators always compete in an oligopolistic market. Moreover, these players have a particular importance because they are the most important companies in this industry, creating a yearly € 139.4 billion value added (European Telecommunications Network Operators' Association, 2019).

For these reasons, it is reasonable to expect that a change in the number of mobile network operators, that is a change in market concentration in this segment, has an effect on the intensity of competition in the entire industry. Therefore, we decided to use the number of mobile network operators as a variable of interest in this thesis. Such a variable is used both in the regression based on cross-sectional data (MNO_i) and in the ones based on panel data (MNO_{it}). In the latter case, we have 192 observations (24 countries over 8 years), value ranges between 3 and 5 with an average of 3.609. In the former case, the average value of the variable MNO_{it} over the 2010 - 2017 period was considered for each country. The range and the average value are the same and the only countries having non-integer values for this variable are Italy and Finland, as in these countries the number of mobile network operators changed during the studied period.

The European Commission is entrusted to monitoring compliance with competition rules at the EU level. One of the most important tools it has at its disposal is the imposition of fines under article 23 of the Council regulation (EC) No 1/2003: fines imposed to firms violating Article 101 of the Treaty on the Functioning of the European Union (TFUE) by engaging in anticompetitive agreements or Article 102 TFUE by abusing their dominant position in the market may amount up to 10% of the firm's global turnover in

the preceding business year. Such a high threshold set for these fines is aimed at discouraging any competition law violation. In particular, in the telecommunications industry, the application of competition law was a crucial step to implement the liberalisation into practice.

We consider that when the European Commission issues a decision in a given industry of a specific country, it could exert an important effect of deterrence on all the players active in the national industry at issue. Therefore, this thesis uses a dummy variable taking on, in each year, the value 1 if the European Commission previously issued a prohibition decision in a specific industry and 0 otherwise.

In the telecommunications industry, fines were issued in reason of infringements of Article 101 or 102 in 8 occasions, involving 9 companies in 6 countries. 7 decisions were issued under article 102, and the remaining one under Article 101. The first infringements were committed by Deutsche Telekom, which was fined in 3 different occasions, including the "Price squeeze local loop Germany" case, centred on an abuse of dominant position consisting in the German incumbent charging its competitors prices to access its fixed telephony network that were so high to in fact prevent them to compete on the final prices charged on customers. As a consequence of this abuse the Commission levied a fine of € 12.6 million in 2003, which was later confirmed by the Court of Justice of the European Union.

The case based on Article 101 regards an agreement made by incumbent operators Telefónica and Portugal Telecom, who engaged not to compete on each other's home market (i.e. Spain and Portugal, respectively): this led to the imposition of a € 66.9 million fine on Telefónica and a € 12.3 million fine on Portugal Telecom in 2013. While the Court of Justice of the European Union confirmed that the agreement is unlawful, it decided that the European Commission should redetermine the entity of the fines imposed on the two companies. Additional information on competition cases in this industry can be found in the summary proposed in Annex 9.5.

Before presenting the results obtained from the regressions, it is, in our view, important to anticipate that all the estimations are robust to heteroskedasticity and serial correlation, as Section 5 discusses in more detail. Each estimation is based on the relevant model presented by Equations 5, 6, and 7. The estimated coefficients are presented in tables in each of the following subsections.

4.2.2 The cross-sectional benchmark

The OLS estimators of the linear model based on cross-sectional data take on the expected sign with respect to the control variables concerning the index of economic freedom (IEF) and the rate of market growth. Indeed, a greater economic freedom is expected to facilitate competition, while an increasing size of the industry is expected to result in more relaxed competition. The latter control variable ($marketgrowth$) does also result to be statistically significant at the 5% level, while IEF is not significant even at the 15% level.

As regards the other variables considered in the model, we find that none of their p-values is low enough to reject the null hypothesis according to which they have no effect on the expected value of the dependent variable, namely PE. Moreover, we note that the coefficients concerning the variables of interest (MNO and EC) have negative signs: -0.081 and -0.483, respectively. On the contrary, one would have expected that, consistently with the theory presented in Section 3, a higher number of mobile network operators in the industry facilitates competition, as well as an intervention of the European Commission aimed at interrupting an anticompetitive behaviour in a given country. The results of the regression are presented in more detail in Table 1 below. Standard errors are robust to heteroskedasticity, as discussed in Section 5.

Table 1: Results of the regression based on cross-sectional data (Model 5).

	(1)	
	PE (avg)	
Number of MNO (avg)	-0.0810	(-0.31)
EC (avg, dummy)	-0.483	(-0.79)
GDP (avg)	-0.000134	(-0.45)
GDP per capita (avg)	0.000151	(0.48)
IEF (avg, index)	0.0383	(1.09)
Market growth (%)	-0.000604*	(-2.15)
Constant	-1.428	(-0.53)
Observations	24	

t statistics in parentheses

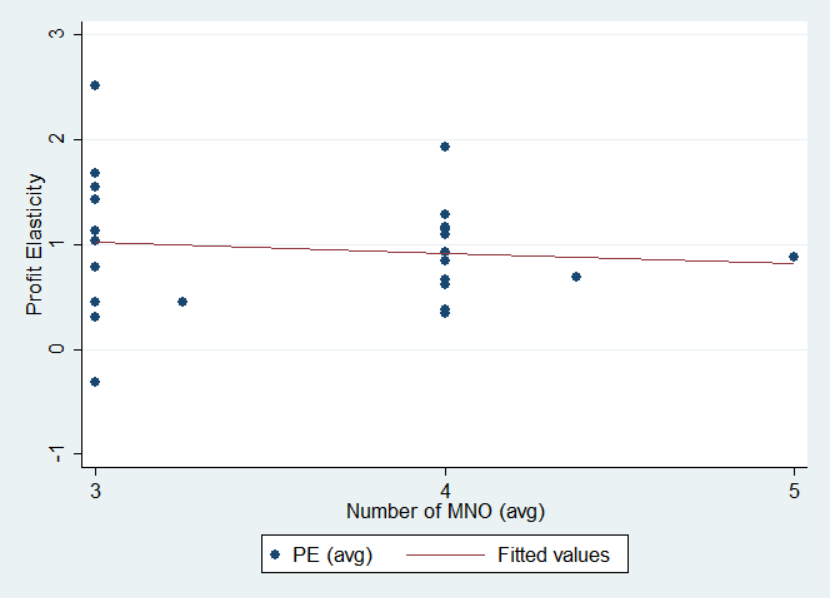
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

Due to the very limited size of the sample used to run this regression on the basis of cross-sectional data (24 observations), it is not possible to regard these results as exact. Nonetheless, they provide a useful benchmark that can be compared with the results obtained from the regressions presented in the next Subsections in order to draw conclusions with respect to their robustness and consistency.

Finally, on the basis of the cross-sectional data, we graphically compare the fitted values (i.e. the level of the PE indicator predicted by the model for each value assumed by the investigated variables) with the actual values of the PE indicator observed in the data. Such a comparison is presented in Figure 4 below with respect to the number of mobile network operators in each industry.

Figure 4: Comparison between fitted values and actual values of the PE indicator, given the number of mobile network operators. (2010 - 2017). Estimated through OLS on the basis of cross-sectional data.



Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

The negative slope of the line representing the fitted values shows that the model predicts a decrease in the PE indicator (i.e. in the intensity of

competition) when the number of mobile network operators increases; as we observed from the negative value taken on by the estimator of MNO's coefficient (cf. Table 1). Most importantly, the vast variance of the dependent variable can be observed when MNO equals 3 and 4. Such a variance makes estimating the effect of this variable difficult. This is the reason why MNO does not result to have a significant impact on the PE indicator from the results obtained by estimating this model.

In this graph, it is also possible to notice that 2 observations do not correspond to an integer number of mobile network operators: they represent the two countries (namely, Italy and Finland) that decided to increase the number of these players during the analysed period.

Similar considerations apply to the comparison between fitted values and observed values when the considered independent variable is EC instead of MNO. The relevant graph is reproduced in Annex 9.4.

4.2.3 The pooled OLS benchmark

We now turn to the estimation of econometric models based on panel data. The results obtained in these cases have to be regarded as more reliable compared to the ones obtained on the basis of cross-sectional data. In the case of the pooled OLS estimation (Model 6), this is because of the bigger size of the sample (which increases from 24 to 168 observations).

In this model, we included dummy variables for every year, except for the base year (2010) in order to allow the intercept to differ across years. The presence of these dummy variables also enables us to draw conclusions on the evolution of the general level of competition in the analysed countries. While the variable y11 is omitted because of collinearity, we observe that the estimated coefficient of these dummy variables decreases over time, from -0.106 for 2012 to -0.291 in 2017. This means that the value of the PE indicator tends to decrease, or – in other words – that the level of competition in the EU telecommunications industry declined over the analysed period. This finding is consistent with the analysis carried out in Subsection 4.1 by comparing the values of the PE indicator in the first part of the analysed period against the second part of the period in each studied country (cf. Figure 3).

The OLS estimators based on this model substantially confirm the results provided by the previous model: the only statistically significant variable at the 5% level is the rate of market growth, whose effect on competition is

negative. None of the other variables is statistically significant at the 15% level.

As regards the investigated variables, MNO is relatively close to the 15% threshold of statistical significance, yet its sign is negative, indicating that the theory according to which a larger number of mobile network operators stimulates competition in the industry at issue is not supported by the market data. The dummy variable EC has a positive sign; however, its elevated p-value does not allow us to reject the null hypothesis that EC has no effect on the value of the profit elasticity indicator even at the 80% level. The results of the regression are presented in more detail in Table 2 below. The cluster correction was employed to estimate this model, as discussed in Section 5.

Table 2: Estimators of Model 6 based on pooled OLS.

	(1)	
	PE	
Number of MNOs	-0.421	(-1.35)
EC (dummy)	0.137	(0.25)
gdp	0.0000135	(0.10)
GDP per capita	0.0000126	(0.08)
IEF (index)	-0.00389	(-0.09)
Market growth (%)	-0.00840*	(-2.36)
t11	0	(.)
t12	-0.106	(-0.95)
t13	-0.238	(-1.55)
t14	-0.292	(-1.42)
t15	-0.279	(-1.09)
t16	-0.348	(-1.17)
t17	-0.291	(-1.00)
Constant	2.728	(0.84)
Observations	168	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

4.2.4 The GLS random effects model

We now come to the presentation of the most important results of this research: the estimators obtained through the GLS random effects model

(Equation 7) have to be regarded as the most reliable ones in the light of the sample size and of the method employed. Indeed, this kind of estimation method – based on the assumption of the existence of an unobserved effect uncorrelated with each explanatory variable – aims at eliminating these unobserved effects prior to estimation (Wooldridge, 2014).

In this case, the estimators take on different values compared to the previous regressions, yet the conclusions we can draw from them are consistent with the ones discussed with respect to the benchmarks.

The results obtained from this GLS estimation confirm that the two variables of interest do not play the expected role in facilitating competition in the telecommunications industry. In particular, the number of mobile network operators does not have a statistically significant impact on the PE indicator even at the 35% level and we note that its estimated coefficient is negative. The dummy variable EC results to be statistically significant at the 1% level and the negative coefficient indicates that its effect on the intensity of competition is negative. This shows that the "anticompetitive" effect discussed in Section 3.2 with respect to this dummy variable prevails over the procompetitive effect. In other words, the negative effect on competition determined by anticompetitive behaviours and recorded by the PE indicator is quantitatively more important than the positive effect on the PE indicator determined by the effect of deterrence related to the European Commission's intervention.

As regards the control variables employed in this model, none of them is statistically significant at the 15% level and we note that the estimated coefficients of IEF and Market growth take on the expected sign. Table 3 below presents the results of the regression. Here too, the cluster correction was employed in order to alleviate the issues related to heteroskedasticity and serial correlation.

Table 3: Estimators of Model 7 based on GLS random effects.

	(1) PE	
Number of MNOs	-0.128	(-0.89)
EC (dummy)	-0.264**	(-2.88)
gdp	-0.0000428	(-0.85)
GDP per capita	0.0000452	(0.82)
IEF (index)	0.00342	(0.21)
Market growth (%)	-0.00232	(-1.18)
Constant	1.585	(1.13)
Observations	168	

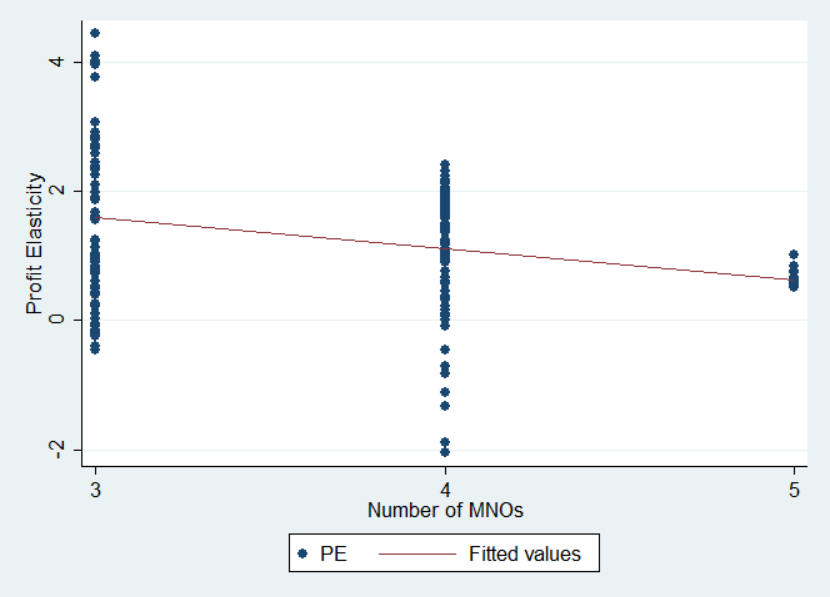
t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

Figure 5 below presents a graphical comparison between the observed values of the PE indicator and the fitted values of this indicator based on the number of mobile network operators.

Figure 5: Comparison between fitted values and actual values of the PE indicator, given the number of mobile network operators. (2010 - 2017). Estimated through GLS on the basis of panel data.



Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

The graph confirms the conclusions we have drawn from the graphical comparison displayed in Figure 4 and from the regressions analysed in the previous paragraphs. It is not possible to verify that a change in the number of mobile network operators corresponds to a precise effect in terms of intensity of competition. More precisely, and contrary to what one would expect, we can rule out that countries which auctioned off spectrum rights to 4 players instead of 3 achieved the effect to obtain a higher intensity of competition in the telecommunications industry.

While, as it was the case in Figure 4, we observe a high variance of the profit elasticity indicator when the number of mobile network operators equals 3 or 4; in the present case we also observe that the PE indicator tends to be lower when MNO is 4, which provides a further argument to reject the hypothesis that a lower concentration in this market segment boosts competition in the industry at issue.

Similar considerations apply to the comparison between fitted values and observed values when the considered independent variable is EC instead of MNO. The relevant graph is reproduced in Annex 9.4.

5 Robustness checks

This Section aims at pointing out the issues encountered with respect to the data and the estimation methods employed, as well as at presenting the steps taken in order to alleviate these problems and to check that the obtained results are reliable.

5.1 Measurement of competition levels

As regards the first part of this thesis, the robustness of results obtained with respect to the PE indicator was tested in two ways: by checking whether they are plausible in absolute terms and, secondly, by comparing them against the PE indicators obtained by Braila et al. (2010) in a similar research.

First, the plausibility of the estimated PE indicators displayed in Figure 2 and, in more detail, in Annex 9.3 is proven by their sign. Indeed, we find that in 23 out of 24 analysed countries the indicator is positive, meaning that an increase in marginal costs (i.e. a decrease in efficiency) leads to a decrease

in profits, all else being equal. Such a result is compatible with competitive industries, such as the ones considered in this thesis. As regards the country for which the estimated PE indicator is negative, the result is unexpected, yet we consider plausible that – over an 8-year period – relatively less efficient firms were able to gain relatively higher profit. Therefore, we regard this result as correct and conclude that competition in the telecommunications industry of this country was extremely relaxed in the analysed period.

Second, the results obtained are consistent with the ones published by Braila et al. (2010): in this case, the Belgian post and telecommunications industry was estimated to have a 1.22 profit elasticity over the 1997 – 2004 period (compared to the 1.43 profit elasticity found by this research over the 2010 – 2017 period), while the same industry was estimated to have a 1.35 profit elasticity over the same period at the "EU-6" level (compared to the 0.97 profit elasticity found, on average, in the same countries by this research).[18]

Moreover, in the same paper we find a negative value of the PE estimator, which shows that – in particular circumstances and over limited periods of time – it is possible to find a positive relation between firms' marginal costs and their profits (Braila et al., 2010, p. 26).

5.2 Assessment of the impact of the investigated variables on competition

As regards the second part of the thesis, the robustness of the results was ensured by appropriately dealing with heteroskedasticity and serial correlation and confirmed by the consistency of the results obtained through all estimation methods. First of all, we tested whether the homoskedasticity assumption holds for our models. Such an assumptions states that the unobserved error, conditional on the explanatory variables, is constant (Wooldridge, 2014). Whenever the variance of the unobserved factors is correlated with one or more of the independent variables, heteroskedasticity is present and – while it does not affect the unbiasedness and consistency of OLS estimators – it requires that statistics employed for statistical inference are calculated with specific methods, known as heteroskedasticity-robust procedures.

We tested whether heteroskedasticity is present in our data, given the de-

[18]The "EU-6" is defined, within this paper, as Finland, France, Italy, Spain, Sweden and the United Kingdom.

pendent and independent variables we had chosen. This was done by using the Breusch–Pagan test, which tests the null hypothesis that the homoskedasticity assumption holds.

Since the Breusch–Pagan test statistic has a p-value equal to 0.02, we can reject the null hypothesis (homoskedasticity) at the 5% level of statistical significance and conclude that we have to keep heteroskedasticity into account when performing statistical inferences.

Secondly, when panel data are used, additional assumptions need to hold in order to obtain the best linear unbiased estimators. In particular, in this context, the error terms in different time periods need to be uncorrelated conditional on the set of independent variables. We tested for serial correlation by using the test introduced by Wooldridge (2000).

The above-mentioned test diagnosed serial correlation, as the tested null hypothesis is the absence of first-order autocorrelation and the obtained p-value is 0.10, meaning that we can reject the null hypothesis at the 10% level of statistical significance. Consequently, we have to take serial correlation into account and to adopt the needed corrections when analysing panel data.

In the light of the above, we employed heteroskedasticity-robust standard errors when regressing Model 5 on the basis of cross-sectional data. This enabled us to draw reliable conclusions with respect to the statistical significance of the independent variables, even in the presence of heteroskedasticity. Moreover, we included cluster corrections when estimating Models 6 and 7 on the basis of panel data, as this kind of correction takes into account the violation of both the homoskedasticity assumption and the no serial correlation assumption. This enables us to obtain consistent estimators and to draw reliable conclusions in terms of statistical inference, even in the presence of the above-mentioned issues.

As regards the robustness of results concerning the effect of (i) the number of mobile network operators and (ii) the intervention of the European Commission in a country's telecommunications industry to interrupt an anticompetitive behaviour in previous years, we observe that the conclusions drawn from each of the estimated models are consistent: in every case we observe that neither a higher number of mobile network operators nor a European Commission intervention (significantly) increase the level of competition in the telecommunications industry.

To conclude this section, we point out that a number of incongruities were found in the database. In particular, some of the companies are registered in countries that do not correspond to the country where the company earns

(the majority of) their incomes. This fact is likely due to the different fiscal obligations imposed by the EU countries; therefore, we cannot assume that this kind of "errors" are randomly or equally distributed across countries. Nonetheless, thanks to the large amount of firm-level data we employed, we can reasonably expect that these misplacements of firms do not affect the reliability of the results obtained with respect to the PE indicator and employed to assess the causal effect of the two variables of interest on competition.

A further limitation is represented by the fact that, while infringements to competition law were accounted for through the dummy variable EC, cases of tacit coordination could not be detected and accounted for. This is particularly problematic because the market segment concerning the supply of wireless services has many of the characteristics facilitating the establishment of tacit coordination among market players: a low number of firms having similar sizes and interdependent interests, price transparency, barriers to entry and switching costs (Competition Commission, 2012).

6 Policy recommendations

It is possible to draw a number of policy conclusions based on the results obtained in this thesis, in particular on the extreme heterogeneity of the intensity of competition in the telecommunications industry across the EU and on the regressions' estimators.

First of all, much remains to be done to reach a satisfactory degree of competition in every EU country: in spite of the European Commission's efforts to unify the "Digital market" at EU level, situations remain very different across countries in terms of competition. This goal could be achieved by facilitating the spread of good practices from countries that managed to obtain a good level of competition in this industry to countries that are experiencing major difficulties and should boost competition at a higher level. The European Commission is already engaged in similar activities in other policy areas, for example it monitors good practices in the fields of employment end social rights (European Commission, 2016). Most importantly, such an intervention appears to have the character of urgency because the intensity of competition has been declining in the majority of the EU countries in the analysed period.

In the light of the results obtained, we can also exclude that reducing the concentration in the market segment of wireless telecommunications services

by auctioning off spectrum rights to a higher number of mobile network operators is a viable solution to achieve the goal of a higher intensity of competition. Indeed, the variable concerning the number of mobile network operators resulted to be statistically insignificant in all the estimated models and, in addition, the PE indicator resulted to be generally lower when the number of mobile network operators was 4 compared to when it was 3.

As suggested by Belleflamme and Peitz (2015), this market segment is an example of natural monopoly, therefore governments should not fear market concentration, as it is not necessarily harmful to consumers, neither it appears to impede competition. On the contrary, strategical choices concerning the number of mobile network operators should be driven by other considerations, in particular governments should consider what market structure is the best suited to facilitate investments and stimulate technological development.

7 Conclusion

This thesis focused on competition in the European telecommunications industry, aiming at describing the situation 20 years after the liberalisation of this sector and at exploring the impact of the number of mobile network operators and of the European Commission decisions on the level of competition recorded in each analysed country.

As regards the current state of the competition in this industry, the profit elasticity indicators calculated for each analysed country in the first part of the thesis show that the intensity of competition in the telecommunications industry is low compared to other European industries and that it decreased, during the studied period, in 17 out of 24 analysed countries. Moreover, the high degree of dispersion of the results indicates that the situation in extremely heterogeneous across EU countries.

As regards the causal effects investigated in the second part of the thesis, we found no evidence that the number of mobile network operators active in an industry affects the intensity of competition, while the profit elasticity recorded in countries where the European Commission intervened in previous years with a prohibition decision resulted to be lower compared to other countries, all other thigs being equal.

The robustness of the results obtained is confirmed by various factors. As regards the first part of the thesis, the data have been carefully cleaned, the

calculations relied on a proven methodology and the results are reasonable both in themselves and when compared with the ones obtained in a similar work. In the second part of the thesis, steps were taken to deal with heteroskedasticity and serial correlation so that the statistical inference can be considered robust to these issues. However, a number of limits of this research have to be taken into account as well, including a number of incongruences spotted in the database and the impossibility to keep into account the effect of potential phenomena of tacit coordination.

Further research is needed to evaluate the "net effect" of the EC variable through the elaboration of a counterfactual scenario, so that keeping into account the "anticompetitive" effect of this variable would not be necessary anymore. However, this kind of work requires specific data that are normally kept secret.

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9 Annexes

9.1 Variables definitions

Variable name	Definition and data source
Log profit	Logarithm of the profit gained by the firm at issue in a given year. Source: own analysis of data retrieved from Orbis Europe (Bureau van Dijk).
Log marginal cost	Logarithm of the marginal cost of the firm at issue in a given year. Source: own analysis of data retrieved from Orbis Europe (Bureau van Dijk).
Number of MNO	Number of mobile network operators in the country at issue in a given year. Source: list of mobile network operators in Europe, retrieved from https://en.wikipedia.org/wiki/List_of_mobile_network_operators_of_Europe
Number of MNO (avg)	Average number of mobile network operators in the country at issue in the 2010 – 2017 period. Calculated as the sum of the number of mobile network operators in each year and divided by 8. Source: list of mobile network operators in Europe, retrieved from https://en.wikipedia.org/wiki/List_of_mobile_network_operators_of_Europe
EC (dummy)	Dummy variable taking on the value 1 if the European Commission intervened in previous years in the country at issue with a prohibition decision interrupting an anticompetitive behaviour in the telecommunications industry. Source: European Commission's Search competition cases tool, http://ec.europa.eu/competition/elojade/isef/
EC (avg, dummy)	Average value of the dummy variable *EC* over the 2010 – 2017 period. Calculated as the sum of the values of *EC* in each year and divided by 8. Source: European Commission's Search competition cases tool, http://ec.europa.eu/competition/elojade/isef/
GDP	Gross domestic product at market prices (thousands of euro) of the country at issue in a given year. Source: Eurostat, retrieved from https://ec.europa.eu/eurostat/databrowser/view/tec00001/default/table?lang=en
GDP (avg)	Average gross domestic product at market prices (thousands of euro) of the country at issue over the 2010 – 2017 period. Calculated as the sum of the values of *GDP* in each year and divided by 8. Source: Eurostat, retrieved from https://ec.europa.eu/eurostat/databrowser/view/tec00001/default/table?lang=en
GDP per capita	Ratio of real GDP to the average population of a specific year in the country at issue (euro). Source: Eurostat, retrieved form https://ec.europa.eu/eurostat/databrowser/view/sdg_08_10/default/table?lang=en
GDP per capita (avg)	Average ratio of real GDP to the average population of a specific year in the country at issue (euro). Calculated as the sum of the values of *GDP per capita* in each year and divided by 8. Source: Eurostat, retrieved form https://ec.europa.eu/eurostat/databrowser/view/sdg_08_10/default/table?lang=en
IEF (index)	Overall score of "economic freedom" attributed to the country at issue in a given year. The index reflects 12 quantitative and qualitative factors: property rights, government integrity, judicial effectiveness, government spending, tax burden, fiscal health, business freedom, labour freedom, monetary freedom, trade freedom, investment freedom, and financial freedom. Source: The Heritage Foundation, retrieved from: https://www.heritage.org/index/explore?view=by-region-country-year&u=637012113661120504
IEF (avg, index)	Average score of "economic freedom" attributed to the country at issue over the 2010 – 2017 period. Calculated as the sum of the values of *IEF* in each year and divided by 8. Source: The Heritage Foundation, retrieved from: https://www.heritage.org/index/explore?view=by-region-country-year&u=637012113661120504
Market growth (%)	Rate of growth of the telecommunications industry in the country at issue in a given year, computed as the ratio between (i) the difference between the total turnout of the country's telecommunications companies in the given year and in the previous one and (ii) the total turnout of the country's telecommunications companies in the previous year. Source: own analysis of data retrieved from Orbis Europe (Bureau van Dijk).

Variable name	Definition and data source
Total market growth (%)	Rate of growth of the telecommunications industry in the country at issue over the 2010 – 2017 period, computed as the ratio between (i) the difference between the total turnout of the country's telecommunications companies in 2017 and 2010 and (ii) the total turnout of the country's telecommunications companies in 2010. Source: own analysis of data retrieved from Orbis Europe (Bureau van Dijk).
y11, y12, …, y17 (dummies)	Dummy variables taking on the value 1 if the observation at issue comes from the relevant year. Source: own analysis of data retrieved from Orbis Europe (Bureau van Dijk).

Source: summary of own elaboration

9.2 Summary statistics

Variable	No. Obs	Mean	Std. dev.	Min	Max
Log profit	23,810	5.951	2.681	0	17.271
Log marginal cost	24,705	-0.767	0.788	-8.443	5.665
Number of MNO	192	3.609	0.595	3	5
Number of MNO (avg)	24	3.609	0.591	3	5
EC (dummy)	192	0.192	0.395	0	1
EC (avg, dummy)	24	0.193	0.364	0	1
GDP	192	22,617.71	12,534.15	5,100	61,900
GDP (avg)	24	22,617.71	12,502.63	6,062.5	46,012.5
GDP per capita	192	21,435.42	11,557.84	5,100	54,200
GDP per capita (avg)	24	21,435.42	11,653.16	5,575	42,700
IEF (index)	192	68.246	5.591	53.2	81.3
IEF (avg, index)	24	68.246	5.472	56.462	77.425
Market growth (%)	168	5.058	23.512	-17.994	218.993
Total market growth (%)	24	107.859	443.574	-25.948	2182.081
y11, y12, …, y17 (dummies)	192	0.125	0.331	0	1

Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk), Wikipedia, European Commission, Eurostat and The Heritage Foundation.

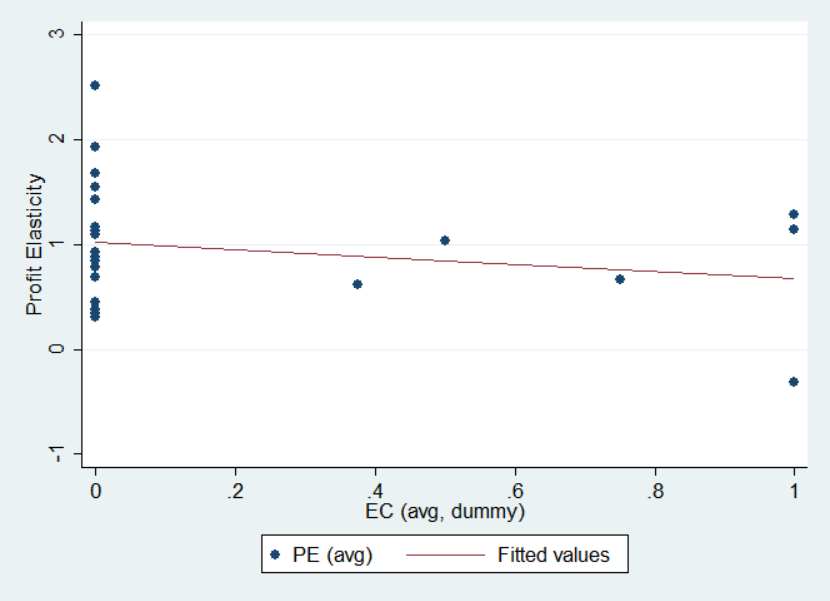
9.3 Profit elasticity results

Country	Profit elasticity 2010 - 2017	Profit elasticity 2010 - 2013	Profit elasticity 2014 - 2017
Ireland	2.514	2.417	2.834
Sweden	1.932	0.643	0.671
Estonia	1.681	1.560	1.754
Croatia	1.551	0.321	0.209
Belgium	1.430	0.334	0.872
Spain	1.290	2.041	1.782
France	1.137	0.962	0.830
Czech Republic	1.133	1.812	1.978
Lithuania	1.165	0.444	0.180
Slovenia	1.096	0.307	-0.159
Portugal	1.030	2.306	2.172
Sample's average	*0.957*	*1.386*	*1.209*
Romania	0.924	-1.258	-1.345
Bulgaria	0.874	4.111	3.988
Latvia	0.844	0.906	1.030
Malta	0.781	2.000	1.787
Finland	0.692	0.362	.0788
Poland	0.662	2.756	0.457
Slovakia	0.622	0.827	0.638
Netherlands	0.455	1.097	0.829
Italy	0.446	2.722	2.600
Hungary	0.374	1.392	1.206
United Kingdom	0.348	2.009	1.711
Greece	0.311	1.609	1.850
Germany	-0.317	1.596	1.063

Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

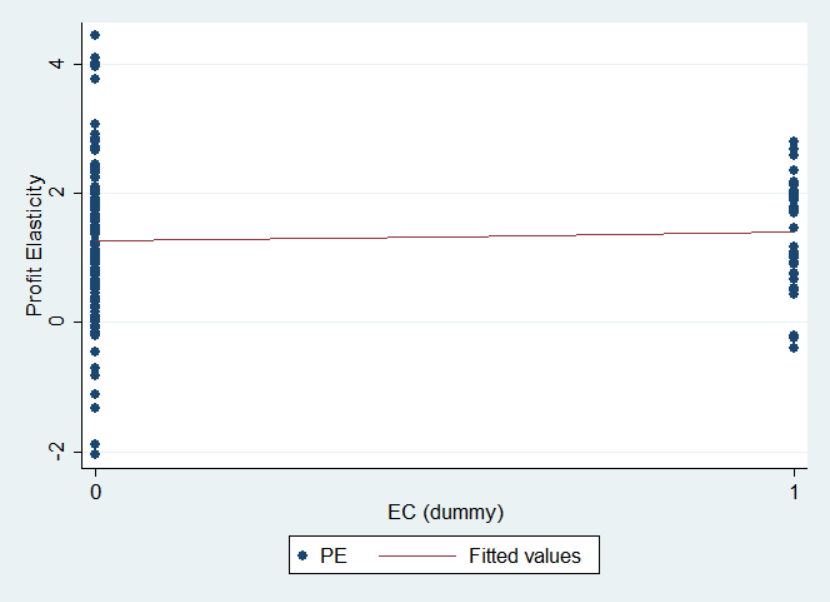
9.4 Additional figures

Figure 6: Comparison between fitted values and actual values of the PE indicator, given the average value of the dummy variable *EC* (2010 - 2017). Estimated through OLS on the basis of cross-sectional data.



Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

Figure 7: Comparison between fitted values and actual values of the PE indicator, given the values of the dummy variable *EC* (2010 - 2017). Estimated through GLS on the basis of panel data.



Source: Own analysis of data drawn from Orbis Europe (Bureau van Dijk).

9.5 Summary of competition cases in the EU telecommunications industry

Case number	Case name	Decision date	Infringement	Country
37451	Price squeeze local loop Germany	21 May 2003	Margin squeeze	Germany
37578	TeleBel+7/DT+Deutschland	21 May 2003	Anti-competitive tariffs for access to local networks	Germany
37579	Ewe Tel+5/DT+Deutschland	21 May 2003	Anti-competitive tariffs for access to local networks	Germany
38233	Wanadoo	16 July 2003	Predatory pricing	France
38784	Telefonica S.A. (broadband)	4 July 2007	Margin squeeze	Spain
39523	Slovak Telekom	15 October 2014	Margin squeeze and refuse to supply	Slovakia
39525	Telekomunikacja Polska	22 June 2011	Refuse to supply	Poland
39839	Telefónica and Portugal Telecom	23 January 2013	Non-compete agreement	Spain and Portugal

Source: European Commission (search engine for competition cases).