UNIVERSIDADE CATÓLICA PORTUGUESA

# Common-Ownership in the Communications Industry

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by

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# Resumo

O objectivo desta tese passa por tentar compreender se a existência de accionistas com posições em múltiplas empresas de comunicações portuguesas (*common-ownership*) afecta ou não o preço que aquelas praticam aos seus clientes. Se o gestor de cada empresa procurar maximizar o retorno dos seus accionistas e existirem accionistas com posições em múltiplas empresas concorrentes, o gestor não irá procurar maximizar o lucro da empresa. Em concreto, o gestor deparar-se-á com um potencial conflito de objetivos que poderá influenciar negativamente o funcionamento do mercado. Para responder a esta questão foi visto o impacto de um indicador de concentração, que capta a *common-ownership* (MHHI), sobre os preços praticados por cada empresa da indústria. Apesar de algumas análises preliminares o indicarem, os resultados obtidos demonstram não haver uma ligação entre preço e a concentração de *common-ownership* no mercado de telecomunicações portuguesas.

Palavras-chave: *Common-ownership*, concentração de mercado, telecomunicações, Portugal.

Abstract

The objective of this thesis is to try to understand if the existence of shareholders with positions in multiple Portuguese communication firms (common-ownership) affects or not the price practiced to their clients. If the manager of each firm seeks to maximize the return of their shareholders and there are shareholders with multiple positions in competing firms, the manager will not seek to maximize the firm's profit. In particular, the manager will come across a potential conflict of objectives which might influence negatively the normal functioning of the market. To answer this question, it was seen the impact of a concentration index, which captures common-ownership (MHHI), over the prices practiced in each firm in the market. Despite a few preliminary analyses indicates, the obtained results demonstrate no link between price and the concentration of common-ownership on the Portuguese communications market.

Key Words: Common-ownership, Market Concentration, Telecommunications, Portugal.

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# 1 Introduction

This paper is the first, to my knowledge, to examine the impact of common-ownership on the Portuguese communications industry. The existence of common shareholders among companies, a fact very frequent in today's world, can raise a few questions concerning the transparency on how these common owned companies conduct business and competition works (Schmalz, 2017). This can happen because there could be a conflict of interests between shareholders with and without stakes on competing firms of the same industry, forcing the manager to weight their different objectives. As a consequence, the goal of the manager would be to maximize the value of the portfolio of the firm's shareholders more than the value of the firm (Antón et al., 2017).

Common-ownership is becoming a growing problem given that there's been a significant growth in private equity investment companies that typically invest in more than one firm within specific industries (Brito, Ribeiro & Vasconcelos, 2017). Some of those companies and funds hold an increasing vast list of assets under management (e.g. BlackRock, Vanguard, Norge Bank, etc.), making this a concerning issue for almost all industries (Azar, Raina & Schmalz, 2016).

In order to illustrate this issue, consider that, instead of undiversified owners, two firms in the same industry have common shareholders. If these two firms are the only firms active in the market, will they actively compete? If the manager of each firm maximizes their corresponding shareholder's returns, as advocated in the literature, they will not have an incentive to compete, as it may reduce overall industry profit. This occurs with the investment funds mentioned above, which own an extensive amount of positions in multiple firms within the same industry. This is particularly visible in US industries (Schmalz, 2017). It is less evident in Portuguese industries, where the existence of shareholders with large positions is more frequent than in the U.S.. In family owned publicly traded companies or in any other publicly traded companies where there is a majority position in a single undiversified investor, similar to a large portion of Portuguese firms, the risk is significantly lower. The risk is lower because the actual control rights and influence power of a smaller investor, when there's a majority position established by someone else, is inferior.

The objective of this thesis is to examine if these situations are visible, through regression, on the Portuguese communication industry similarly to the U.S. and if so what are the consequent impacts. For this thesis it was necessary to gather a great deal of information, the data collected is consisted of market specifics, ownership information on firms and additional complementary information, mainly comprised of statistics. To examine the impact on price, the delta of a common-ownership index, named MMHI, was brought to the regression which together with other variables created the equation. The estimation results reveal that, despite common-ownership being present in a small scale through the studied firms, there is no effect of common-ownership on the price practiced.

This thesis is organized as it follows: chapter 2 reviews the literature, chapter 3 presents the theoretical model, chapter 4 describes the empirical application and presents the estimation results, and chapter 5 concludes.

# 2 Literature Review

This thesis lays its fundamentals on previous papers done essential in the U.S.A. and the purpose of this chapter is to present these different opinions and concepts originated from distint authors and papers with the purpose of demonstrating the theoretical and empirical foundations for this work.

There's been an increase in concern regarding whether common-ownership in competing firms affects the normal functioning of a market or not. The idea and the concern appear to be simple: market competition shrinks prices which hurt profits and, consequently, owners. If a single owner is diversified on different concurrent companies, then there is an interest and a possibility on improving margins and increasing prices (Schmalz, 2017). Thus investors have incentives to acquire positions in multiple firms in an industry to achieve increasingly monopoly benefits (Rubinstein & Yaari, 1983), motivations to diversify their portfolio by maximizing industry profits instead of individual firm profits (Gordon, 2003).

Common-ownership was first introduced by Bresnahan & Salop, (1986) and then developed by Salop & O'Brien, (2000), which referred to this as a conflict of objectives which forces the manager to maximize a weighted average of the profits where the shareholders have rights. They also estabilish that it's possible to relate price with the concentration index throught the Cournot model.

One of the most used indicators to check anti-competitive effects and market concentration is in fact the Herfindahl Hirschman Index (Brito et al., 2017).

## 2.1 Theoretical Literature

HHI or Herfindahl Hirschman Index, as described in Calkins (1983), is a method used to measure the concentration of an industry. It is computed as the sum of the squared market shares of each firm in the industry and it ranges from almost 0 to 10.000 (the closest to zero, the less concentrated is the market and the more it resembles perfect competition).

The HHI can be related to the average price in the industry as follows: the higher the HHI, the more monopolistic is the market and, as a consequence, the higher the price (since economic theory postulates that prices tend to be higher in less competitive markets). This implies that HHI should have a positive correlation with the prices of the industry. This relationship between prices and the HHI can be formally derived under the Cournot model of quantity competition and some models of ordered bargaining (Brito et al., 2017).[1,2]

However, this relationship between industry prices and the HHI is derived assuming that each firm in the industry maximizes its own profit. O'Brien & Salop (2000) show that, under common-ownership, this relationship changes. They show that when firms are Cournot competitors, industry prices are not related to the HHI but, instead, to a modified version, named modified Herfindahl Hirschman index (MHHI). The MHHI considers not only the market shares of the firms in the industry, but also the weighting of the shareholders returns by the manager of each firm, computed from the voting and financial ownership stakes of the shareholders in the different firms. The difference between the MHHI and the HHI captures the concentration due to common-ownership.

[1] Cournot model of competition was an economical model, developed by Augustin Cournot, which described an industry of homogeneous products where the firms could only choose quantities and the prices varied accordingly.

[2] The HHI was introduced on the U.S. justice department in 1982, complementing former measures like concentration ratios.

## 2.2 Empirical Literature

The empirical impact of common-ownership on industry prices is not unanimous, with some authors establishing and quantifying a statistically significant relation between industry prices and common-ownership and some authors finding no such relationship. On this sub-chapter, I will first describe the literature that establishes the common-ownership/price relationship, and then the literature that finds no such relationship.

Azar, Schmalz & Tecu (2017) were among the first to examine the impact of common-ownership on firm's objectives and market outcomes. To do so they focus on the U.S.A. airline industry. This industry was chosen because (i) it has a good amount of available data that enables each route to function like a separate market, therefore limiting potential concerns regarding the results found and (ii) for the substantial amount of common-ownership that occure in this industry.

The data used by Azar, Schmalz & Tecu (2017) was obtained via three different sources: (i) Department of Transportation's Airline Origin and Destination Survey (DB1B) database for information regarding flights and passengers on quarterly basis with the purpose of obtaining information on prices (the explained variable) and quantities (to compute market shares, an input of the MHHI), (ii) Bureau of Economic Analysis for population statistics to construct control variables like population and income per capita and (iii) Thomson-Reuters Spectrum dataset on 13F filings to obtain the ownership (voting and financial) information required to construct the weighting scheme of the manager of each firm (another input of the MHHI). The final data consisted of over a million observations on a market-carrier level for a subset of 16 quarters between 2011 and 2014. In order to examine if common-onership impacted industry prices, Azar, Schmalz & Tecu (2017) performed a OLS regression of the log of the average price per airline carrier at a specific time and route on the difference between MHHI and HHI (delta of MHHI, which reflects common-ownership ), the HHI, a high number of controls (log of flight distance, non-stop carriers operating in a route, low-cost carriers operating on the route, geometric average of per capita income in the two endpoints in the route, the geometric average of population in the two endpoints in the route and the share of passengers who use connecting flights), and year and market-time-carrier fixed effects. The equation is represented as follows:

$$\log(p_{rjt}) = \beta \; MHHI \; delta_{rt} + \gamma \; HHI_{tr} + \boldsymbol{\theta} \, \mathbf{X}_{rjt} + \alpha_t + \vartheta_{rj} + \varepsilon_{rjt},$$

where the $p_{rjt}$ stands for the average price for carrier $j$ in route $r$ at quarter $t$, $MHHI \; delta_{rt}$ is the difference between MHHI and HHI as explained above in route $r$ at quarter $t$, $\mathbf{X}_{rjt}$ is a vector of the controls mentioned above, $\alpha_t$ are quarterly time fixed effects and $\vartheta_{rj}$ is route/carrier fixed effects.

Azar, Schmalz & Tecu (2017) show that the coefficient of the MHHI delta is positive and statistically significant even with all the controls accounting for possible differences in price. These results display that an increase in the MHHI's delta can lead to an increase of average fares by 4%. Despite being, by their understanding, not totally conclusive, these findings prove a link between prices and who controls the firms, in this case the carriers, on each of the specific routes. Azar, Schmalz & Tecu (2017) aim, with their investigation, raise awareness for the fact that common-ownership should be taken serious for market concentration calculations and that can indeed influence the competitiveness of an industry.

Azar et al. (2016) also examined the effects of common-ownership (and cross-ownership) on industry prices[3]. To do so, they focus on the US banking industry

[3] Cross-Ownership is similar to common-ownership except that the first relates to firms owning directly other firms instead of investors having positions in multiple firms.

and use a different estimation strategy. Instead of using the MHHI delta as explanatory variable, like in Azar, Schmalz & Tecu (2017), they use the MHHI individually and compare the estimation results with the ones that result from using the HHI, which incorrectly assumes that each company is owned by undiversified investors. Azar et al. (2016)'s idea is to examine whether banking fees and deposit rates are affected by shareholders having several positions in competitors within the same market. The idea rose from the fact that, despite having more competitors and a lower HHI, banks from New York and California area have higher banking fees and lower deposit rates compared to banks from different areas of the USA.

The data used by Azar et al. (2016) was obtained via three main sources: (i) RateWatch for branch level bank rates and fees which represent the prices they seek to explain, (ii) FDIC's Summary of Deposits for branch level deposit rates in order to calculate market shares (an input of the MHHI), and (iii) Thomson Reuters 13f to obtain the ownership (voting and financial) required to construct the weighting scheme of the manager of each firm (another input of the MHHI). The final data consisted of over 60 million branch-county-year observations. In order to examine if common-ownership impacted industry prices, Azar et al. (2016) used three different methods: an OLS regression, an instrumental variables regression, and a difference-in-differences regression. The main one was the OLS regression while the others were robustness checks. In the OLS regression, they explain the price of banking services as a function of the HHI or the MHHI and controls like the log of the county's median household income, the log of the county's population, the bank's market capitalization, as well as branch and year fixed effects. The estimated equation was as follows:

$$R_{ijbt} = \beta \text{ Concentration Index}_{it} + \boldsymbol{\theta}\, \boldsymbol{X}_{it} + \mathcal{E}\, Q_{bt} + \upsilon_j + \zeta_t + \varepsilon_{ijbt},$$

where the concentration index variable denotes HHI and MHHI separately in each regression in county $i$ and year $t$, $R_{ijbt}$ stands for prices (various fees, fee thresholds, and deposit interest rate spreads) in branch $j$ of bank $b$ in county $i$ and year $t$, $\boldsymbol{X}_{it}$ includes the log median household income and log population used as controls for county $i$ and year $t$, $Q_{bt}$ represents the market capitalization of bank $b$ in year $t$, $\upsilon_j$ is a branch indicator variable and $\zeta_t$ is time indicator variable.

Azar et al. (2016) show that, in fact, who owns the bank has an impact on industry prices, impliying that, at least to some extent, managers maximize shareholder's returns. The comparation between the results obtained from measure industry concentration via the HHI or MHHI indicates that the HHI is insufficient to address market concentration issues in some areas where common-ownership exists. As a consequence, Azar et al. (2016) raise the issue of regulatory and anti-trust laws to protect and prevent common-ownership acquisitions that lessen the market ability to function normally.

To examine thoroughly the issue of common-ownership, it is necessary to review also non-concordant literature since it provides a different insight into the issue and highlights the potential weaknesses of the previous, concordant, literature.

Kennedy et al. (2017) criticize the approach of Azar, Schmalz & Tecu (2017) and Azar et al. (2016) for examining the relationship between industry prices and the MHHI. They argue that previous results and estimations may suffer from an endogeneity problem (i.e. price shocks may also change the concentration index) and that it depends too heavily on key assumptions that may or may not hold, especially the one that assumes that any shareholder who holds an ownership stake (no matter how small it is) in a firm may influence its manager. As a consequence, Kennedy et al. (2017) question if common-ownership justifies regulatory action like mergers do. In particular, they argue that common institutional owners bring benefits to the market, which could be affected and reduced by the introduction of regulatory constraints. The fact that common institutional owners fund firms is positive to the economy since it creates growth. Thus, Kennedy et al. (2017) argue that regulators should not apply regulatory actions if not necessary, and that such actions will only harm firms' performance.

Kennedy et al. (2017) propose to estimate the effects of common-ownership by introducing oligopoly theory into O'Brien & Salop (2000)'s theory of partial ownership. They apply their framework to Azar, Schmalz & Tecu, (2017) common-ownership airline ticket price setting. The data used was a subset of 16 quarters (ranging from 2011 to 2014) and markets with the geometric mean of population > than 2 million in the fourth quarter of 2014, from four sources: (i) Airline Origin and Destination Survey (DB1B) for complete airline information containing ticket prices, passengers together with flight origin and destination, (ii) Air Carrier Statistics (T-100) database as a complementary source for the same information as the previous, (iii) Equity Ownership Current and Historical Americas by Thompson Reuters for quarterly information on voting and non-voting shareholders, and (iv) population and income data from the Bureau of Labor Statistics (BLS) as controls. The complete data produced 137,461 observations. The estimation that greater contributed to their findings was the IV estimation of the following structural demand and supply model:

*Demand-side*

$$\ln(\mathrm{s}_{jrt}) - \ln(\mathrm{s}_{0rt}) = \mathbf{X}_{jrt}\boldsymbol{\theta} + \alpha\, p_{jrt} + \sigma \ln\left(s_{\frac{jrt}{g}}\right) + \varepsilon_{jrt},$$

*Supply-side*

$$mc_{rt} = p_{rt} - b_{rt}(s_{rt}, C_t, \alpha, \sigma) = \mathrm{X}_{jrt}\omega + \mu_{rt},$$

where $\mathbf{X}_{jrt}$ represents controls like the log of the average flight distance by rival carriers, the number of rival carriers, and the number of rival carriers offering non-stop flight on a specific carrier $j$ in each route $r$ in quarter $t$, $mc_{rt}$ represents the marginal cost in route $r$ in quarter $t$, $p_{jrt}$ denotes the price of carrier $j$ in route $r$ in quarter $t$, $s_{\frac{jrt}{g}}$ denote the within-market share of carrier $j$ in route $r$ in quarter $t$, and $b_{rt}(s_{rt}, C_t, \alpha, \sigma)$ stands for a vector of carriers price-cost margins in route $r$ in quarter $t$. The estimation of this structural model involves three endogenous variables: the price, the common-ownership incentive term and the within-market share.

Although reduced-form price regressions show that common-ownership is correlated to industry prices, with positive and negative [4] effects being statistically significant, the estimation of the structural model suggests the parameter that scales the common-ownership incentive term as not statistically significant, meaning that it has no effect on industry prices. Furthermore, Kennedy et al. (2017) argue that previous literature, based on modified versions of HHI have equations that are not derived from economic theory and can have multiple interpretations. As a consequence, they argue that common-ownership does not require any sort of regulatory policy as it is not proved to affect industry prices and market normal functions.

Gramlich & Grundl (2017) also advocate an alternative approach to MHHI to quantify the impact of common-ownership on industry prices. In particular, they focus on the weighting of the shareholders returns by the manager of each firm. This approach, in their opinion, has three main advantages: (i) it is more consistent to a wider range of competition models, (ii) it requires less data to estimate, and (iii) reduces endogeneity concerns.

Gramlich & Grundl (2017) apply their proposal to the US banking industry. In particular, they use an OLS regression to examine the relationship between price (rates of deposits) and quantities (deposits) to the weights that the manager of a

[4] Results achieved using OLS found positive effects of common-ownership on price while the IV regression found the opposite, negative correlation.

firm places on own-profit and the weight that places on its competitors profits. As controls, the two equations have fixed effects of bank-time and market-time. This approach differs from Azar et al. (2016)'s approach in the sense it relies on the weighting scheme of the manager but not on the vector of market shares, claiming that the MHHI approach could confuse the interpretation of results. The data used came from three different sources: (i) SEC 13f fillings to obtain the ownership data to construct the weighting scheme of the manager of each firm, (ii) RateWatch to obtain the rates and fees, one of the outcome variables, and (iii) Summary of deposits to obtain the quantity data, the other outcome variable.

Gramlich & Grundl (2017) developed two estimation equations, one for the price and another for the quantity variable:

$$p_{ibt} = \theta_1 w_{bbt} + \theta_2 \overline{w}_{kbt} + \boldsymbol{\Theta_p X_{ibt}} + \varepsilon_{ibt},$$
$$q_{ibt} = \theta_3 w_{bbt} + \theta_4 \overline{w}_{kbt} + \boldsymbol{\tau_p X_{ibt}} + \varepsilon_{ibt},$$

where $p_{ibt}$ is the "price" (deposit rate) paid by bank $b$ in county $i$ and quarter $t$, $q_{ibt}$ is the "quantity" (deposits) on bank $b$ in county $i$ and quarter $t$, $w_{bbt}$ is the weight that bank $b$ places on its own-profit in quarter $t$, $\overline{w}_{kbt}$ is the average weight that themarket competitors place on the profit of bank $b$ in quarter $t$, and $\boldsymbol{X}_{ibt}$ are bank-quarter and county-time fixed effects as controls.

In contrast with Azar et al. (2016), Gramlich & Grundl (2017) results are mixed: (i) as for short-term products (CD's < 3 months), the estimated coefficients $\theta_1$ and $\theta_2$ are positive, suggesting that the weights have indeed an effect on price and quantity, (ii) as for bigger maturities, the magnitude of the same coefficients is estimated to be smaller, meaning that the weights have a very small effect on the price, also they found that at least one of the coefficients is estimated to be negative. Gramlich & Grundl (2017) aimed at developing a different approach to tackle the existing common-ownership issue. To some intent, their results are consistent with the correlation between industry prices and common-ownership found in Azar, Schmalz & Tecu (2017) and Azar et al. (2016), but lacked significant implied magnitudes, meaning that large movements on the weights will only produce very small changes to the prices and quantities.

# 3 Theoretical Model

The focus of this dissertation is to answer the question of whether common-ownership affects industry prices or not. It has been established in the literature that competition usually improves customer prices at the expense of firm profit, since firms will sacrifice price to improve market share and to drive competition out. This argument is supported by the Cournot model for imperfect competition under homogeneous products. Let $p(Q)$ denote the demand function in which industry price responds negatively to aggregate quantity. Under the model above, the manager of firm $j = 1, \dots, N$ solves the following profit maximization problem:

$$\max_{q_j} \pi_j = p(Q)q_j - c_j(q_j),$$

where $p(Q)$ denotes the industry price, $q_j$ denotes the quantity of firm $j$, $c_j(q_j)$ the cost of firm $j$, which is a function of the quantity of the firm, and $Q$ denotes the industry quantity, which aggregates the quantities of the different firms.

This maximization problem has the following first order condition, obtained by taking the derivative of profit with respect to $q_j$:

$$0 = \frac{\partial \pi_j}{\partial q_j} = p(Q) + p'(Q)q_j - c_j'(q_j).$$

Rewriting the first order condition obtained above, it is possible to obtain an expression for the price-cost margin of firm *j*:

$$\frac{p(Q)-c_j'(q_j)}{p(Q)}=-\frac{p'(Q)q_j}{p(Q)}=-\frac{Qp'(Q)}{p(Q)}\frac{q_j}{Q}=\frac{s_j}{\eta},$$

with $s_j$ being the market share for firm *j* and $\eta$ the price elasticity.

If, after this rearrangement, we multiply the expression by the market share of firm *j* and sum across all *N* firms in the industry:

$$\sum_{j=1}^{N}\frac{p(Q)-c_j'(q_j)}{p(Q)}s_j=\sum_{j=1}^{N}\frac{s_j}{\eta}s_j=\frac{1}{\eta}\sum_{j=1}^{N}s_j^2=\frac{1}{\eta}HHI,$$

we obtain the relationship between the HHI (computed as the sum of the squared market shares of each firm in that specific industry) and industry prices. The lower the price elasticity and the greater the concentration of the industry, the least competitive the market is and vice versa. With that in mind, measuring market concentration (using the HHI) is important to identify potential situations where anti-trust or regulatory policies should be pursued.

What if firms are not owned by undiversifed owners? Will the relationship above still arise? The answer is no. The relationship between industry prices and the HHI arises with undiversified owners, but not in face of common-ownership. In order to see why this is the case, consider the following illustration in which a set of owners have stakes in a single firm and a set of owners have stakes in two competing firms. The owners with stakes in both firms will wish that the competition between the firms should be less aggressive than the owners with stakes in a single firm. Therefore, when firms are owned by diversified investors, managers must weight a possible conflict of interest. The manager of firm *j* will not maximize own-profit but a weighted average of the owners returns, as follows:

$$\max_{q_j} \sum_{i=1}^{M} \gamma_{ij} R_i = \sum_{i=1}^{M} \gamma_{ij} (\sum_{k=1}^{N} \beta_{ik} \pi_k) = \sum_{k=1}^{N} \underbrace{(\sum_{i=1}^{M} \gamma_{ij} \beta_{ik})}_{l_{jk}} \pi_k,$$

where $\gamma_{ij}$ represents the voting rights of owner $i = 1, \dots, M$ in firm $j$, $R_i$ denotes the return of investor $i$, $\beta_{ik}$ denotes the financial rights of owner $i$ in firm $k$ and $l_{jk}$ denotes the weight that the manager of firm $j$ allocates to the profit of firm $k$, which will be a function of the voting rights of the owners of firm $j$ in the firm and of the financial rights of the owners of firm $j$ in firm $k$.

Dividing the maximization problem by $l_{jj}$ and rearranging the first order condition in the way it was done for the HHI, uncovers a relationship between industry prices and the MHHI:

$$\sum_{j=1}^{N} \frac{P(Q) - C_j'(q_j)}{P(Q)} s_j = \frac{1}{\eta} \sum_{j=1}^{N} \sum_{k=1}^{N} \left(\frac{l_{jk}}{l_{jj}}\right) s_j s_k = \frac{1}{\eta} \underbrace{\sum_{j=1}^{N} \sum_{k=1}^{N} w_{jk}\, s_j s_k}_{MHHI},$$

where $w_{jk}$ denotes the (normalized) weight that that the manager of firm $j$ allocates to the profit of firm $k$, which reduces to $w_{jk} = 0$ for $j \neq k$ if no common-ownership is present in the industry, yielding MHHI=HHI.

In vector notation, we can compute the MHHI as follows:

$$MHHI = \mathbf{s}^T \mathbf{W}\, \mathbf{s} = \mathrm{HHI} + \underbrace{\mathbf{s}^T (\mathbf{W} - \mathbf{I}_N)\, \mathbf{s}}_{MHHI\ Delta},$$

where the $\mathbf{s}$ denotes a *N*x*1* vector of market shares of each firm, $\mathbf{I}_N$ denotes the identity matrix and $\mathbf{W}$ denotes the normalized weight *N*x*N* matrix which captures, as discussed above, the weight of each firm imposes on itself and others. This latter matrix can be computed in vectore notation, as follows:

$$\mathbf{W} = diag\,(\mathbf{C}^{\mathrm{T}}\,\mathbf{F})^{-1}\mathbf{C}^{\mathrm{T}}\,\mathbf{F},$$

where $\mathbf{C}$ represents a $M$x$N$ matrix of the voting rights and $\mathbf{F}$ represents a $M$x$N$ matrix of the financial rights, with the following structure:

$$\boldsymbol{F}_{(\boldsymbol{MxN})} = \begin{bmatrix} \beta_{11} & \cdots & \beta_{1N} \\ \vdots & \ddots & \vdots \\ \beta_{M1} & \cdots & \beta_{MN} \end{bmatrix}, \boldsymbol{W}_{(\boldsymbol{N\,x\,N})} = \begin{bmatrix} 1 & \dots & W_{1N} \\ \vdots & 1 & \vdots \\ W_{N1} & \dots & 1 \end{bmatrix}, \boldsymbol{C}_{(\boldsymbol{MxN})} = \begin{bmatrix} \gamma_{11} & \cdots & \gamma_{1N} \\ \vdots & \ddots & \vdots \\ \gamma_{M1} & \cdots & \gamma_{MN} \end{bmatrix}.$$

## 3.1 Empirical Hypotheses and Empirical Methodology

The empirical question of whether common-ownership affects prices in the Portuguese communications industry or not can be stated as the following hypothesis:

*H0: The existence of common-ownership influences industry prices.*

There is also the possibility of this hypothesis being rejected even if common-ownership does affect price, this can happen if the effect on price is erratic or has a negative correlation. Also important is which concentration index is better at predicting prices, if HHI is a better predictor of prices than MHHI this will indicate that common-ownership diminish the significance of variable HHI. This is a fact because the only difference, in this case, between MHHI and the HHI is the normalized weight matrix **W** which is what provides the common-ownership effect.

In order to examine this hypothesis, I propose to estimate the following equation based on the reviewed literature:

$$\log(price_{tfs}) = \vartheta\, HHI_{ts} + \beta\, MHHI\ delta_{ts} + \boldsymbol{\theta}\, \boldsymbol{X}_t + \alpha_f + \upsilon_t + \varrho_s + \varepsilon_{tfs}$$

where $price_{tfs}$ is the price of service $s$ from firm $f$ in quarter $t$, $MHHI\ delta_{ts}$ represents the difference of the concentration in service $s$ and quarter $t$ as measured by the MHHI and the HHI, $HHI_{ts}$ is the concentration in service $s$ and quarter $t$ as measured by the HHI, $\boldsymbol{X}_t$ is a vector of controls that includes the log of the GDP per capita of Portugal and the log of population, and $\alpha_t$, $\upsilon_t$ and $\varrho_s$ denote firm, quarter and service-fixed effects, respectively. The $MHHI\ delta_{ts}$, $HHI_{ts}$ and $\log(price_{tfs})$ are based in Azar, Schmalz & Tecu (2017) whereas the controls (per capita GDP and population) are derived from Azar et al. (2016).

An alternative approach could be Kennedy et al. (2017)'s structural model, however such model is beyond the scope of this master's thesis. Gramlich & Grundl (2017) model while corrected and, to my knowledge, uncontested on offering a different approach to the topic, lacks background literature explaining and backing their empirical methodology, especially, when compared to the approaches of Azar, Schmalz & Tecu (2017) and Azar et al. (2016). This fact proved to be significant on electing the equation for this thesis, eventually overcoming their model better ability to reduce endogeneity problems.

Ultimately, the choice of the estimation equation was based in Azar, Schmalz & Tecu (2017) and Azar et al. (2016). The outcome variable, price, was transformed into a logarithm as, in my opinion, the impact of common-ownership on industry prices is not linear. For the main explanatory variable, the literature suggests two options: (i) using both the HHI and the MHHI delta as in Azar, Schmalz & Tecu (2017) in a single equation or (ii) using the HHI and the MHHI in two equations as in Azar, Schmalz & Tecu (2017). I opted for the first option as it allows to capture the effects in a single estimation, plus it allows to separate the common-ownership effect from the HHI with the MHHI delta. Regarding the control variables, I adopted the control variables from the literature that could be adapted to this different industry. I thus control for the effects of economic growth and population changes to industry prices. Finally, I followed the literature and also included fixed effects to the equation. In particular, I included firm, segment and quarter indicator variables with the purpose of reducing possible correlations with the error term, known as endogeneity problems.

# 4 Empirical Application

## 4.1 Data Description

The resources gathered for this dissertation are comprised of three core sources of information: (i) the data collected from the Portuguese communication regulator regarding prices, market shares, products, revenues and users, (ii) ownership details about financial and voting rights of the different firms, collected from Thompson Reuters and (iii) country statistics from OECD to obtain population and GDP per capita.

The first part of the dataset was gathered from the Portuguese communications regulator, ANACOM, which publicly provides quarterly reports[5] containing major information about the industry and its key players. With access to this, I was able to extract: market shares of users and revenues, revenues and users for each specific firm and quarter compiling a full dataset of ten quarters, starting from 2015:Q1 to 2017:Q2. All this information was extracted for the following five different segments of activity: (i) mobile, (ii) fixed services, (iii) double play, (iv) triple play, and (v) quadruple/quintuple play. In most quarters and segments there are five players mentioned: MEO, NOS, Vodafone,

[5] "Factos e Números"

Cabovisão (which includes Oni) and "others". In some cases, the number of market players is lower than five as, for example, in the Quadruple/Quintuple play segment in 2015:Q1 there were only MEO, NOS and Vodafone operating.

The second part of the dataset was obtained via Thomson Reuters historical ownership tab that provides information on a large part of the listed companies shareholders: on this case Vodafone Group PLC, Pharol SGPS (former PT SGPS) and NOS SGPS SA. The data was collected for the same ten quarters from 2015:Q1 to 2017:Q2. Thompson Reuters retrieves its information directly from the companies and/or from the stock exchanges mandatory disclosure laws. It is also worth reporting that Altice bought MEO from PT SGPS in June 2015 and kept Cabovisão until regulators imposed a sale which eventually happened in September 2015. This implies that Altice controlled both firms in the second quarter of 2015 which is reflected in the calculations. Altice later sold Cabovisão to two French private equity funds, which are not listed in any stock exchange, making it impossible to determine any ownership details. From the third quarter of 2015 forward Cabovisão and "others" are represented by a single fictious investor which owns 100% of the capital.

The third and final part of the dataset, the complementary data, was collected to obtain the controls variables referent to the Portuguese GDP per capita and population. Information was extracted from the Organization for Economical Co-operation and Development (OECD) website via the dataset of quarterly national accounts. Furthermore, the data was collected for the same quarterly periods as the other data in U.S. dollars and in thousands of individuals, respectively. In order to convert US Dollars into Euros, I used the correspondent closing forex rate, for each ending quarter's day (when impossible to use the exact date due to lack of rate, the immediately preceding date was used).

The sample collected is thus a panel and contains information from different firms and segments over ten quarters. Concerning units of measure: prices and

GDP per capita are measured in euros, population is in thousands of individuals and the MHHI delta and HHI are represented by indexes points which range from close from 0 to 10.000. The remaining data is either in percentage points (i.e. market shares, ownership) or in users (people, mobile phones active, fixed land line telephones, etc.). Regarding units of observation: price is by firm-segment-quarter, HHI and MHHI delta is by segment-quarter and the controls are only by quarter. This data is composed by fifty observations of fixed services and double play, forty-four observations of mobile services, thirty-nine of triple play and thirty-two of quadruple/quintuple play, adding up to two hundred and fifteen total.

Alongside the more complex calculations done and explained through the theoretical model chapter, there were other steps that were made to treat the information gathered in order to fill this thesis needs. This was specially the case of ANACOM's collected data, as it was detailed in the data description, the information provided was with a raw format.

One of those examples is the price. The price variable was not directly extracted from ANACOM's reports as it was not available. Revenues and users per firm and per segment was what was accessible, so I computed the price variable by dividing revenues with quantities (users). The actual partition of users and revenues per firm was also not directly reported. In order to obtain this data, segment-quarter revenues and users were multiplied with revenues market shares and user market shares, respectively.

The Portuguese communication industry, composed by the above described five firms, ended 2017:Q2 with revenues of 905,071,441€ and had total number of accumulated users of 27,519,137[6].While there is no clear market leader in all services, MEO stands off as the most influential player by having the biggest market share in four out of the five services (Quadruple – Quintuple (45.5%),

[6] The sum of users for every service in 2017:Q2.

Double play (40.6%), fixed (41.3%) and mobile (43.9%)). MEO is followed close by NOS and Vodafone with the first being a market leader in Triple play (36.5%). Cabovisão and "others" represent smaller market players, focused on more traditional services, with even no activity in some services at this thesis time window. As an example of common-ownership present in 2017:Q2, the Norge Bank owned positions in three out of the five operating companies with 1.44% in Altice, 2.11% in NOS and 2.14% in Vodafone. The same can be said for The Vanguard Group with 1.14% in Altice, 0.97% in NOS and 2.42% in Vodafone. But these funds are not the only ones who are diversified in the Portuguese communications industry. A few more examples are: BlackRock, T. Rowe Price, Artemis Investment Management and Capital International Investors. This implies that the MHHI would be different than the HHI and that the MHHI delta would have positive values.

Table 1 provides some summary statistics of the final dataset with 215 observations:

| | **Mean** | **Median** | **Std Deviation** | **Minimum** | **Maximum** |
|---|---|---|---|---|---|
| Price | 76.92000 | 72.46000 | 57.61000 | 2.66000 | 225.31000 |
| HHI | 3 498.40000 | 3 472.82000 | 437.81000 | 2 965.50000 | 4 565.94000 |
| MHHI Delta | 318.15000 | 300.41000 | 129.66000 | 93.34000 | 660.93000 |
| GDPpp | 27 568.37000 | 27 394.20000 | 1 086.80000 | 26 431.90000 | 29 565.03000 |
| Population | 10 333.02000 | 10 329.47000 | 21.38000 | 10 304.51000 | 10 372.97000 |

*Table 1 - Table of descriptive statistics of equation variables.*

The results suggest (i) that median firm has a price of 72.46€ per segment and quarter, (ii) that the concentration, as measured by the HHI, of the median segment is of 3,472.82 index points per quarter, representing a highly concentrated market accordingly to the U.S. Department of Justice, (iii) that common-ownership increases the concentration, as measured by the MHHI delta, of the meadian segment by 300.41 index points per quarter, (iv) that in the median quarter the per capita annual GDP is of 27,568.37€, and (v) that in the median quarter the population is of 10,329,470 individuals.

As we can see from the Table 1, while population and per capita GDP don't vary much due to the short period of time of the observations, the other variables, on the other hand, do vary quite considerably. HHI is generally a stable index when there are no large market changes. In particular, there were some significant variations into the market shares when Altice bought MEO and kept Cabovisão which significantly increased market concentration and consequently lead to a regulator decision, despite that, overall there has not much variation. The MHHI delta, on the other hand, does have a larger variation with the standard deviation being roughly ½ of the median, indicating large changes in ownership. Prices also vary greatly from segment to segment and from firm to firm while the MHHI delta does seems to have larger values in more recent years implying more common-ownership. These differences are also amplified since the different segment were combined in the table.

## 4.2 Data Limitations

The process of gathering information contemplated difficulties that consequently originated in a few data limitations. First, the multiple adaptations and changes made to the statistics provided by ANACOM, due to the normal evolutions of this technological industry, created a very narrow time window for this thesis sample. This meant that it was only possible to start this analysis in 2015:Q1 for three segments (different revenue data display) and 2015:Q2 for the triple and quadruple/quintuple play services (share market data by service was combined for this services) resulting in a small number of observations.

Second, fixed service part of the information, reported by ANACOM, was including all fixed services provided (phone, internet and cable television), standalone and in package. Since the package details are also presented in this study, the users and the revenues were calculated by subtracting package values to the values displayed in total, originating the fixed services amounts individually.

Third, there were some differences regarding the data provided from ANACOM's different reports. For the purpose of this thesis, only the market shares and revenues shares were extracted from the quarterly PDF's versions of "Factos e números", everything else was collected through excel version of "FactosNumerosHistorico2T2017".

Fourth, it is contemplated, in the calculations done, the changes that occurred between market players. On June 2nd 2015 Altice acquired PT segment of communications MEO meaning that, for ownership purposes, it was used PT SGPS ownership on previous dates and Altice NV for quarters after the date. Due to regulatory rules on September 15th 2015, Altice sold its Cabovisão and Oni participation to a French private equity named Apax France, also changing ownership calculations.

Fifth, regarding ownership data, it was installed a floor on stakes lower than 0,10%, meaning that lower participations weren't regarded for this study and consequently it was assumed that there is no common-ownership among the excluded values.

## 4.3 Preliminary Analysis

Three main figures were constructed with the purpose of having a better understanding of the relations between the concentration variables and industry prices. The results provided are still inconclusive but help to have a grasp on the subject.


*Figure 1- Relation between Price and HHI in all segment.*

Figure 1 shows an increasing slope regarding price when the market concentration index (HHI) grows. The information displayed is this figure is aligned with the theoretical model, indicating a positive correlation between the profit maximizing prices (under Cournot) and the HHI.

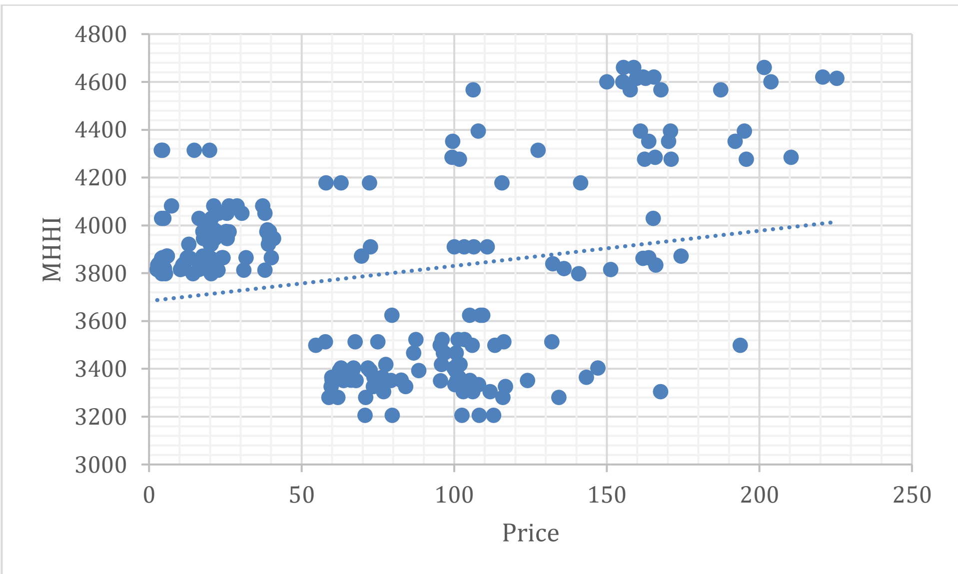


*Figure 2 - Relation between Price and MHHI in all segments.*

Figure 2 displays a positive slope between the MHHI and industry prices, suggesting that indeed common-ownership is influencing the overall prices of communications. Similarly, this figure also appears aligned with the theoretical model when joined by diversified investors. Appendix A presents a more detailed analysis, discriminated by segment.

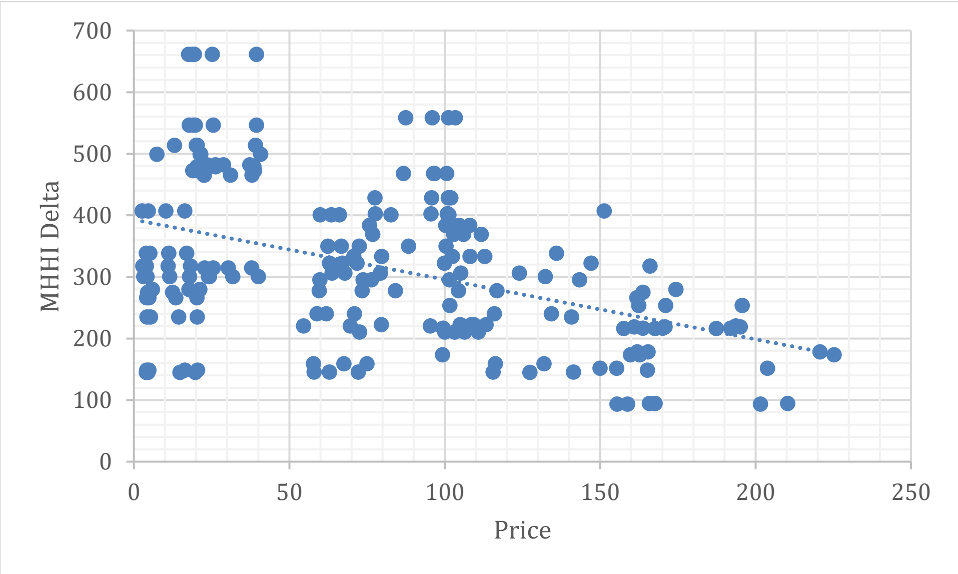


*Figure 3 - Relation between Price and MHHI delta in all segments.*

Figure 3 displays, strangely, an opposite relationship between the MHHI delta and industry prices, in contrast with the two figures above. This suggests that the difference between MHHI and the HHI (capturing the concentration due to common-ownership) has a negative impact of industry prices.

Despite the above results, it is not possible to draw final conclusions with just the preliminary results as it only uses the concentration measures, without any controls.

## 4.4 Estimation Results

Table 2 presents the OLS estimation results of three specifications produced with 215 observations, which vary in the controls used, of the equation described in the theoretical model chapter.

| | (1) | (2) | (3) |
|---|---|---|---|
| **HHI** | -0.00026 | -0.00004 | 0.00247 |
| | (0.00020) | (0.00025) | (0.01905) |
| **MHHI Delta** | -0.00349*** | 0.00065 | 0.07255 |
| | (0.00074) | (0.00085) | (0.10037) |
| **Ln(GDPpp)** | -0.77352 | 0.23165 | - |
| | (2.53205) | (1.36385) | |
| **Ln(Population)** | -104.28500** | 49.03209 | - |
| | (52.05620) | (41.80005) | |
| Firm Fixed Effects | | ✔ | ✔ |
| Segment Fixed Effects | | ✔ | ✔ |
| Quarterly Fixed Effects | | | ✔ |
| R-squared | 0.09800 | 0.74960 | 0.77600 |

*Table 2 - Results from OLS regression.*

* With significance of 10%
** With significance of 5%
*** With significance of 1%
The values displayed in the parentheses correspond to the standard errors.

Specification (1) regresses the log of prices on the HHI, the MHHI delta and the GDP and population controls, without any fixed effects. The results suggest that (i) the HHI appears to have no impact on price; (ii) the MHHI delta, on the contrary, presents a statically significant coefficient with a negative effect on price, with an oddly decrease in 34.9% on price with an increase of 100 points in the MHHI delta; (iii) the per capita GDP has no impact on price, and (iv) the population appears to have a massive unexplained negative effect on price by decreasing it by roughly 104% with a 1% increase in population. The first regression bears a low R-squared of 0.09800 and the results are somehow unexpected, suggesting that further efforts to increase the quality of the regression are required.

Specification (2) regresses the log of prices on the same explanatory and control variables but including firm and segment fized-effects to reduce possible endogeneity problems (HHI or MHHI delta correlation with the error term) of the first specification and, thus, improve overall results. The results suggest the following: (i) the HHI continues to have no impact on price, similar to the first regression above; (ii) the MHHI delta loses its effect on prices; (iii) the per capita GDP continues to have no impact on price, and (iv) the population also looses the effect exhibited previously. This regression displays no effect on price by any of its variables, despite being more complete than the (1) with the introducing of the fixed-effects and having a greater R-squared (0.74960).

Despite improvements to the equation, it is still possible to decrease the possibility of endogeneity problems, in addition to previous specifications. Specification (3) adds quarterly fixed effects to produce the most complete regression done. Per capita GDP and population variables were dropped due to the fact that vary only by quarter, the same as the indicator variables added, inducing collinearity problems. The results suggest the following: (i) the HHI keeps on having no impact on price, similar to the specifications above and (ii) the MHHI delta also continues to have no effect on price. This regression had a R-squared of 0.77600, representing the highest one of the three.

Using the final specification has the preferred one to draw the conclusions, since it is the most complete when compared to the others, the hypothesis formulated on this thesis must be rejected: the MHHI delta does not seem to influence industry prices. This result contradicts the findings in Azar, Schmalz & Tecu (2017) and Azar et al. (2016), who find clear links relating common-ownership with industry prices. In contrast, this result (i) is aligned with the findings in Gramlich & Grundl (2017), who find mixed results regarding the impact of common-ownership on industry prices and (ii) is similar in a way to Kennedy et al. (2017) opinion of common-ownership.

# 5 Conclusion

The theory behind this subject and multiple potential issues, brought by several discussed authors, about common-ownership do tend to be plausible and, in my opinion, should continue to be debated and developed. Regardless of the importance of this topic, overall the results do not suggest a strong and robust relationship between common-ownership and industry prices. In contrast to Azar, Schmalz & Tecu (2017) and Azar et al. (2016), they actually suggest that there is no effect of common-ownership on the prices charged by Portuguese communications firms and, therefore, this thesis, shares some of the conclusions of Gramlich & Grundl, (2017) and possible of Kennedy et al. (2017).

The Portuguese communications market is not comparable in size to the US industries examined in the literature. Further, and most importantly, the firms competing in this industry do not have a striking evidence of common-ownership when compared to the US airline and banking industries, with multiple owners having large positions in competing firms. In this specific case only a few funds have a significant yet small positions in multiple firms (i.e. Norges Bank and BlackRock), making this issue less of a concern.

Based on this thesis, additional anti-trust and regulatory actions should not be pursued as the implicit benefits discussed brought by funds should overcome potential situations of conflict of objectives with owners.

Additional efforts on this subject can be useful if performed on a different industry and specially with a larger time window to be able to have a superior observation data. Furthermore, the use of instrumental variable techniques might prove useful to deal with endogeneity issues.

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# Appendix

Figure A1 suggests that mobile services segment does appear to have an opposite relation to what would be the expected outcome: prices tend to be lower when MHHI is higher. Prices varies between close to 7€ to more than 40€ while MHHI starts at near 3,800 points and go to close to 4,100 points.


*Figure A1 - Relation between Price and MHHI in mobile services segment.*

Figure A2 shows a different situation if you ignore the spike resulting of Altice acquisition: it appears rather stable. The fact that fixed services is considered a mature segment with settled market players helps explaining the small variation, where prices vary from as small as 2€ till 22€ and MHHI goes from near 3,300 points to the peak of 4,200 points.

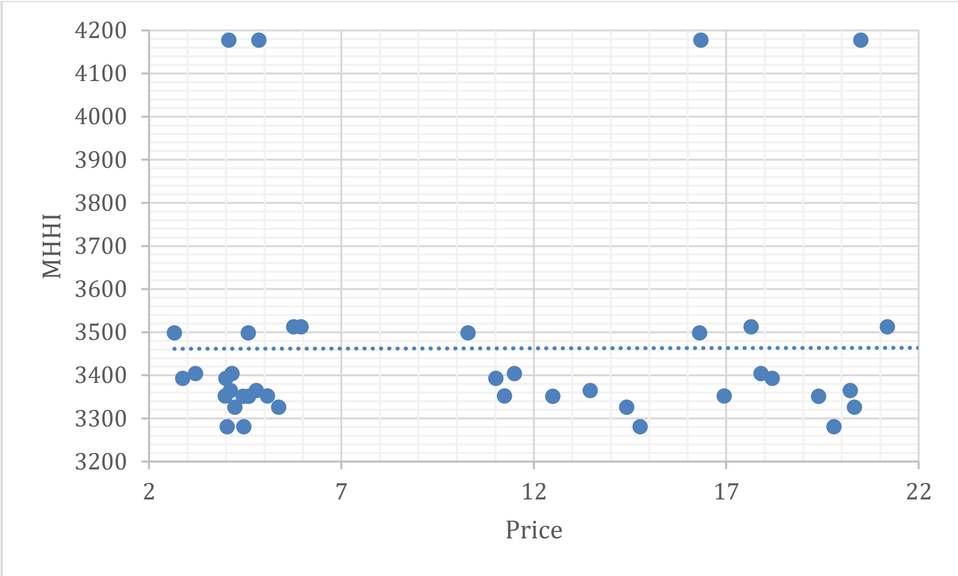


*Figure A2 - Relation between Price and MHHI in fixed services segment.*

Figure A3 gives the same impression as Figure A2: the relation is also not clear despite the slope on this one being slightly more positive. Price on double play starts close to 55€ and goes to almost 110€ where MHHI varies from roughly from 3,250 points to more than 3,500 points.

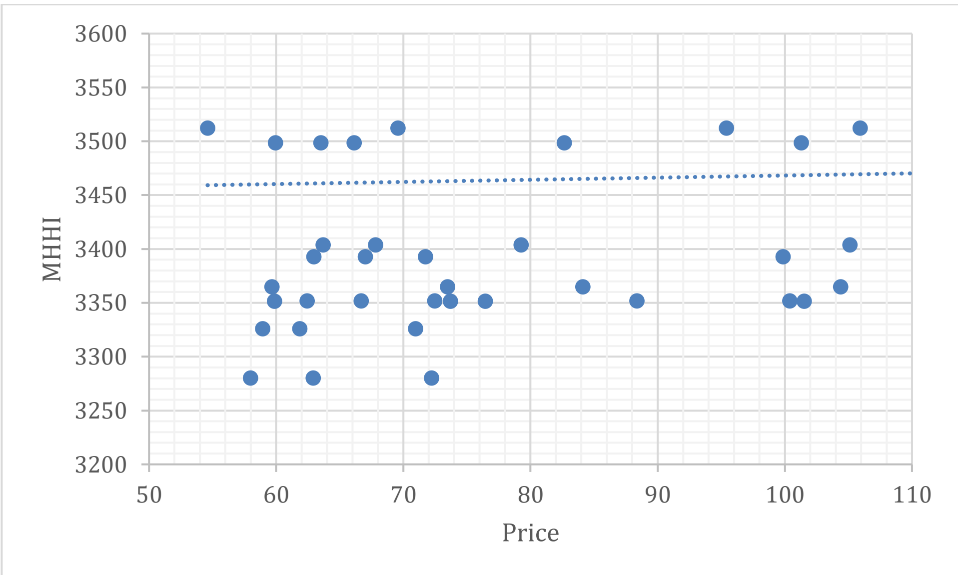


*Figure A3 - Relation between Price and MHHI in double play segment.*

Figure A4 also displays a small positive slope on the linear line proving the economic theory behind this topic. It is also visible the impact of Altice acquisition on triple play market concentration with a peak reaching approximately 3,900 points where the lowest was around 3,200 points. Price is greater than previous one, establishing from about 70€ till roughly 115€.

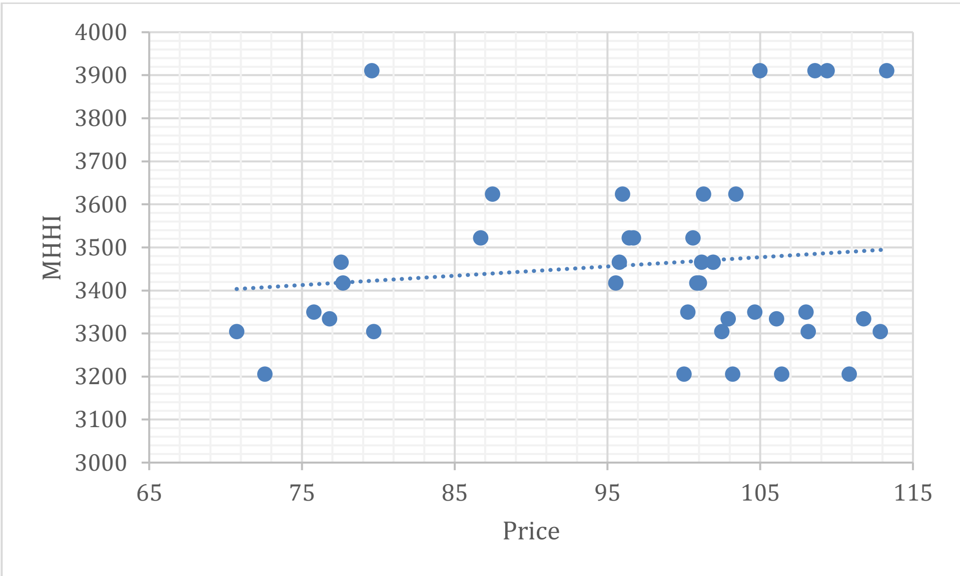


*Figure A4 - Relation between Price and MHHI in triple play segment.*

The results on the last segment presented, quadruple/quintuple play, are more significant than previous ones with a much larger slope. This is a relatively new segment where there are currently only three firms operating. Alongside having a greater HHI due to the number of competitors, the MHHI is also larger due to the three firms present are listed are have common-ownership. MHHI varies from more than 4,250 points till almost 4,700 points and the price from near 100€ till 245€.

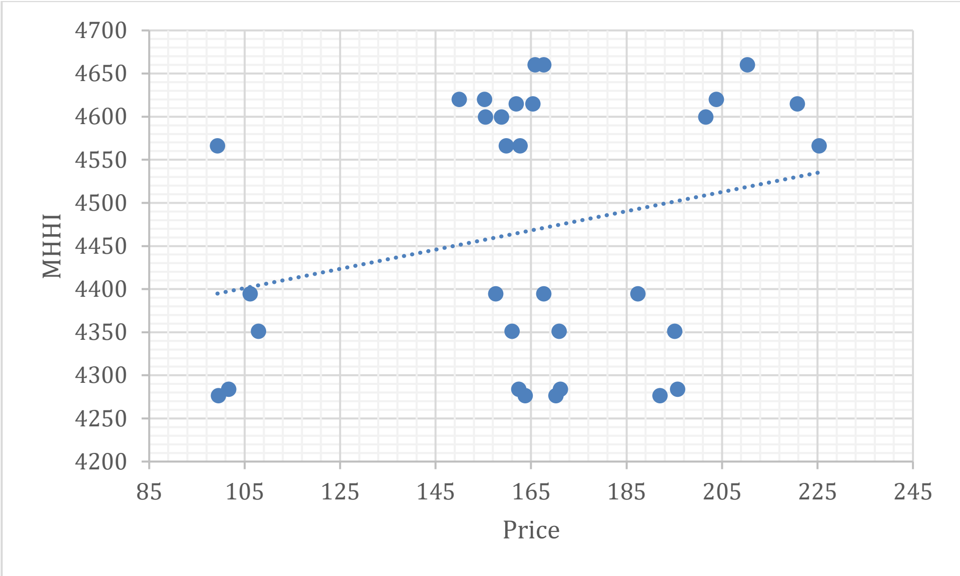


*Figure A5 - Relation between Price and MHHI in quadruple/quintuple play segment.*