Urban Fixed-Line Telecommunication Density and Its Influence on Financial Outcomes in Greece's Leading Telecom Firms

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ABSTRACT

This study examines the impact of Urban Fixed-Line Telecommunication Density (UFLTD) on financial performance within the telecommunications sector in Greece, focusing on the three leading companies in the market. Utilizing a balanced panel data set spanning a decade, the research employs both fixed and random effects regression models to analyze the relationship between UFLTD and various financial performance indicators. The Hausman test results suggest that fixed effects are more appropriate for certain financial metrics, while random effects are suitable for others. Furthermore, the Breusch-Pagan test indicates potential heteroscedasticity in several models, which necessitates robust estimations. The findings highlight a significant association between UFLTD and financial performance, underscoring the critical role of telecommunications infrastructure in fostering operational efficiency and profitability.

Keywords: *Telecommunications, Financial Performance, Urban Density, Fixed-Line Services, Greece*

1. INTRODUCTION

In the digital age, telecommunication infrastructure plays an increasingly vital role in shaping both social interactions and economic development. Fixed-line telecommunication services, although overshadowed by the rapid rise of mobile technologies, remain a critical component of urban infrastructure, particularly in developed countries like Greece. The penetration of fixed-line telecommunication services in urban areas reflects the accessibility and availability of communication technology, which is fundamental for businesses, government functions, and households. To better understand this aspect of urban infrastructure, we have calculated the Urban Fixed-Line Telecommunication Density (UFLTD), a key metric that captures the relationship between fixed telephone subscriptions and the urban population. By deriving this ratio (UFLTD = fixed telephone subscriptions / urban population), we aim to quantify the extent to which fixed-line infrastructure is deployed across Greece's cities. This calculated ratio serves as an essential indicator of the fixed-line network's spread and helps measure how effectively telecommunication companies reach urban populations. By analyzing this ratio, we can gain insights into the availability of communication services, which ultimately influences economic activities and the overall performance of Greece's leading telecommunication companies.

Understanding the relationship between Urban Fixed-Line Telecommunication Density and the financial performance of telecommunication companies offers valuable insights into the broader dynamics of the sector. As urban populations increasingly demand reliable and fast communication services, companies providing fixed-line telecommunication services must adapt their business models to meet this demand while maintaining profitability. This paper focuses on the three largest telecommunication companies operating in Greece: COSMOTE, VODAFONE, and WIND (now merged with Nova). These companies are the dominant players in the Greek market, each with a substantial market share in both mobile and fixed-line services and they own the approximately 80% of the telecom market.

Over the past decade, the Greek telecommunication sector has faced significant challenges, including the financial crisis that gripped the country from 2009 to 2018, followed by the global COVID-19 pandemic. Despite these difficulties, fixed-line telecommunication services have remained essential, particularly in urban areas where business and household reliance on stable communication lines persisted. As broadband internet services are often delivered via fixed-line infrastructure, the density of these lines plays a crucial role in the economic viability of telecommunication firms.

The primary objective of this paper is to explore how changes in Urban Fixed-Line Telecommunication Density (UFLTD) between 2013 and 2022 have correlated with the financial performance of COSMOTE, VODAFONE, and WIND. By focusing on key profitability ratios such as Return on Equity (ROE), Return on Capital Employed (ROCE), Gross Profit Margin (GPM), Operating Profit Margin (OPPR), and Net Profit Margin (NPM), this study aims to assess how variations in Urban Fixed-Line Telecommunication Density over time have impacted the profitability of these companies. These ratios are widely regarded as essential indicators of a firm's financial health and efficiency, providing a comprehensive view of their ability to generate profit from operations, equity, and capital.

The Greek telecommunication sector is a highly competitive market dominated by a few key players, with COSMOTE, VODAFONE, and WIND holding a combined market share of over 80% in fixed-line services. COSMOTE, a subsidiary of OTE (Hellenic Telecommunications Organization), is the market leader in both mobile and fixed-line telecommunication services, followed by VODAFONE and WIND. These companies have invested heavily in expanding their infrastructure to accommodate growing urban populations and the increasing demand for faster, more reliable internet and communication services.

The period from 2013 to 2022 is particularly interesting for telecommunication analysis in Greece. During these years, Greece experienced several macroeconomic shifts, including recovery from its financial crisis, technological advancements such as the rollout of high-speed broadband, and increasing urbanization. These factors likely influenced the performance of telecommunication companies in terms of both operational efficiency and profitability. Additionally, the global COVID-19 pandemic accelerated the adoption of digital communication technologies, making fixed-line services critical for both businesses and households as remote work, e-commerce, and online education became widespread.

As Greece's urban centers continued to grow, so did the demand for reliable fixed-line telecommunication services, particularly for high-speed internet, which is often delivered via fixed infrastructure. The Urban Fixed-Line Telecommunication Density (UFLTD) metric provides a window into the availability of these services in urban areas, reflecting how well companies like COSMOTE, VODAFONE, and WIND are positioned to serve the population. By analyzing the changes in UFLTD, we can better understand how shifts in infrastructure deployment correlate with the profitability and financial resilience of these companies.

This paper seeks to address the following research questions:

RQ1: How has the Urban Fixed-Line Telecommunication Density (UFLTD) evolved from 2013 to 2022 for the three major telecommunication companies in Greece (COSMOTE, VODAFONE, and WIND)?

RQ2: What is the relationship between UFLTD and the profitability of these telecommunication companies over the same period?

RQ3: Does an increase in UFLTD positively correlate with improvements in profitability ratios such as Return on Equity (ROE), Return on Capital Employed (ROCE), Gross Profit Margin (GPM), Operating Profit Margin (OPPR), and Net Profit Margin (NPM)?

To answer these questions, we develop the following hypotheses based on the assumption that an expansion in fixed-line telecommunication density translates into better financial performance. This assumption is grounded in the expectation that higher Urban Fixed-Line Telecommunication Density reflects a larger customer base and more efficient infrastructure utilization, which, in turn, should lead to higher profitability for telecommunication companies.

Research Hypotheses:

H1: Increases in Urban Fixed-Line Telecommunication Density (UFLTD) are positively correlated with improvements in the overall profitability of telecommunication companies.

H2: There is a positive relationship between UFLTD and the operational efficiency of telecommunication companies, as measured by key financial ratios.

The remainder of the paper is structured as follows: Section 2 provides a detailed literature review of the telecommunication industry in Greece and financial ratio analysis. Section 3 outlines the data sources and methodology used in the analysis. Section 4 presents the empirical results and discusses the findings. Finally, Section 5 concludes with implications for telecommunication companies and recommendations for future research.

2. *LITERATURE REVIEW*

Over the last two decades one of the rapidly growing and competitive industries in the service sector is the telecommunications industry. In our digital era telecommunications industry is playing a decisive role in every human aspect. Besides, in the increasingly competitive organizations operated at telecommunications are certainly focusing on their customer satisfaction (Drosos et al., 2015). Mobile communications and telecommunications industries are two of the most important business sectors of the Greek economy since they contribute to the national income growth, the increase of government revenue and the creation of new jobs (Drosos et al., 2011; Goyal and Kar, 2020; Abor et al., 2018). The Greek telephony market is comprised of three firms, namely, Cosmote which owns the largest market share over time, Vodafone, and Wind (Rizomyliotis et al., 2018).

Quality and customer satisfaction are key drivers of business performance. Business performance is an important component in determining the successful organization and operation of a business. Business results can be measured in both financial and non-financial terms (Bontis, 1998; Bontis et al., 2000). Business performance can be determined both by objective measurements, such as return on investment, profits and sales, turnover, productivity, market share, and by subjective measures such as the organization of the business, the existence of processes, its reputation. company. In this researcher Business Performance is calculated with financial ratios analysis.

Financial ratio analysis has been used to assess business performance for over a century, going back to at least the late 1800s (O'Connor1973). According to Horrigan (1965), it is virtually impossible to analyze accounting data in a meaningful way without converting data into ratios; therefore, a validation of financial ratios is also a validation of financial accounting.

Nearly 90 years ago, the Harvard Business Review (1925) discussed the relevance of financial ratio analysis. The sentiment in that article has been expressed many times since then: There is evidence of a growing interest in the use of financial ratios as an aid in the analysis and interpretation of balance sheets. The uses and limitations of the many ratios recently developed are, therefore, a matter of importance not only to commercial and investment bankers, but also to individual investors, commercial credit men, and executives. By the use of ratios, it is possible to make comparisons between several firms, or with an average for a group of companies engaged in the same line of business. Thus, it can be determined whether the firm being studied is above or below the average of similar firms. An intelligent use of ratios can be made only if their limitations as well as their value are thoroughly understood.

In a major review article on financial ratio analysis, Barnes (1987) made several observations, including the following: Financial ratios can be deployed many ways, such as determining the firm's ability to cover its debts, rating business and management success, meeting statutory requirements, and reviewing industrywide averages to set norms for a firm. Ratio analysis can be deployed both to compare a firm's performance against competitors in its own industry and to estimate empirical relationships in forecasting. Predictions may relate to (presage) future success or failure across key measures, reveal possible risks, and test practical hypotheses. Using ratios in financial analysis, rather than absolute values, facilitates comparisons as firm size is normalized. Since industrywide financial ratios often become company norms, they may affect a business strategy (also see Lev, 1969). A debate over ratio analysis relates to deciding which among the numerous financial ratios are most valuable to use.

Financial ratio analysis is vital for both small- and medium-sized companies as well as for large companies. As Theuri (2002) observed, small- to medium-sized businesses need to continuously monitor their most critical financial ratios. He grouped the most-often used ratios into three categories: financial stability, which represents a firm’s ability to meet both short-term and long-term commitments; earning capacity, which represents a firm’s ability to sustain or increase profitability; and managerial efficiency, which represents a firm’s ability to efficiently manage the business. Theuri also noted that financial experts involved with small firms should advise them to begin by analyzing a few ratios and then – over time – to add more ratios to analyze. Ultimately, the firms would be assessing a set of financial ratios that efficiently and effectively encompass their activities.

Let us sum up with these two observations: It is not enough to examine the quarterly and annual income statement, balance sheet, and cash flow statement, which are constructed according to generally accepted accounting principles and FASB and SEC guidelines. Although these statements are useful for external reporting, they do not in and of themselves provide the guidance(needed) to assess operations. Within these financial statements, however, are valuable data that, when combined with other data, will enable (managers) to effectively assess operations (Berry and Lusch, 1996).

Although there is no single agreed-upon approach as to how to use financial ratios, there is substantial agreement on a number of points. Ratio analysis should be used in a comparative manner, with reference to past, present, and even future time periods. Use of comparative industry averages should be made. The ratios do not stand by themselves. They should be interpreted in light of events within the company as well as external events that have a bearing on the financial figures employed in calculating the ratios (Patrone and DuBois, 1981).

Belesis et al. (2023) used financial ratios to calculate the COVID-19 pandemic effects on the top 15 in market capitalization Greek Stock Exchange companies. The results of the survey revealed that the fuel production companies Hellenic Petroleum and Motor Oil as well as the vehicle rental company Autohellas were the most negatively impacted due to the significant decline in turnover. Additionally, Belesis and Gazilas (2023), used financial ratios and correlate them with macroeconomic indicators for the Greek retail market. Their findings underscored the sector's adaptability to macroeconomic shifts, with notable variations among subsectors for the years 2015 to 2021. Furthermore Gazilas (2023) used financial ratios to analyze the COVID-19 effects on the Greece's ten largest energy companies. He concluded that some companies maintained remarkable net profit margins, showcasing adaptability while others faced challenges, exemplified by negative margins. Additionally, Gazilas and Vozikis (2024), investigated the dynamics of the Greek General Private Clinics Sector from 2012 to 2020, focusing on the interplay between market concentration, measured by the Herfindahl-Hirschman Index (HHI), and key financial ratios. They found strong positive correlations identified between HHI and Return on Equity as well as Operating Profit Margin, suggest that higher market concentration tends to coincide with improved returns and operational efficiency. Additionally, in Greece, significant labor market regulations were implemented in 2014, potentially affecting various sectors, including telecommunications. This context is explored in a study by Gazilas (2024), which focuses specifically on the implications of these labor market regulations within the Greek economy.

3. *DATA AND METHODOLOGY*

This study employs a balanced panel dataset (n = 3 and t = 18)[2] , focusing on financial and operational metrics from the three primary telecommunications providers in Greece—COSMOTE, Vodafone, and Wind—over a 10-year period from 2013 to 2022. The panel structure allows for consistent observations across time, enhancing the robustness of the analysis by mitigating potential biases associated with unbalanced data. Each company's performance is measured annually, yielding insights into how key financial ratios and operational metrics evolve across a stable timeframe. The financial data was sourced from official company reports, and population data necessary for Urban Fixed-Line Telecommunication Density (UFLTD) calculation was derived from national statistics and World Data Indicators website. Summary statistics and econometric models are applied to uncover relationships among these variables and assess the influence of UFLTD on financial performance over time, accounting for intercompany and temporal variations through robust panel data techniques.

The independent variable, Urban Fixed-Line Telecommunication Density (UFLTD), quantifies the ratio of fixed-line telecommunications per capita within urban areas, reflecting infrastructure accessibility. This is defined by:

$$\boldsymbol{UFLTD}_{it} = \frac{Fixed\ Line\ Subscriptions_{it}}{Urban\ Population_{it}} \qquad (1)$$

where:

- $\boldsymbol{i}$ denotes the company,
- $\boldsymbol{t}$ represents the year.

In this paper, financial performance is assessed through five key ratios, each offering a distinct perspective on profitability and operational efficiency.

Return on Equity (ROE) measures the company's effectiveness in generating profit from shareholders' equity, indicating how well the firm uses investors' funds to generate earnings. Return on Capital Employed (ROCE) evaluates the overall efficiency in utilizing capital to produce earnings, providing insight into long-term profitability and the company's capacity to maximize returns on investments. Net Profit Margin (NPM) reveals the portion of revenue that translates into net profit, reflecting overall cost management and profitability. Gross Profit Margin (GPM) represents the percentage of revenue retained as gross profit after accounting for the cost of goods sold, illustrating production efficiency and pricing strategy. Finally, Operating Profit Ratio (OPPR) shows the proportion of operating income relative to revenue, highlighting operational efficiency in generating income from core business activities. Together, these ratios offer a comprehensive view of financial performance, combining profitability, operational success, and investment efficiency.

$$\boldsymbol{ROE}_{it} = \frac{Net\ Income_{it}}{Shareholders'\ Equity_{it}} \qquad (2)$$

$$\boldsymbol{ROCE}_{it} = \frac{Earnings\ Before\ Interest\ and\ Taxes_{it}}{Total\ Assets_{it} - Current\ Liabilities_{it}} \qquad (3)$$

$$\boldsymbol{NPM}_{it} = \frac{Net\ Income_{it}}{Total\ Revenue_{it}} \qquad (4)$$

$$\boldsymbol{GPM}_{it} = \frac{Total\ Revenue_{it} - Cost\ of\ Goods\ Sold_{it}}{Total\ Revenue_{it}} \qquad (5)$$

$$\boldsymbol{OPPR}_{it} = \frac{Operating\ Income_{it}}{Total\ Revenue_{it}} \qquad (6)$$

where:

- $\boldsymbol{i}$ denotes the company,
- $\boldsymbol{t}$ represents the year.

To comprehensively describe the data distribution, the following summary statistics are calculated for each variable with the formulas below:

Mean (Average), is a measure of central tendency that represents the central value of a dataset. It is calculated by summing all values in a dataset and then dividing by the number of values.

For a set of n values $X = \{x1, x2, \ldots, xn\}$, the mean $\bar{X}$ is given by:

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

where:

- Xi is the value of the variable for the i-th observation, and N is the total number of observations.

Standard Deviation (Std Dev) is a measure of the spread or dispersion of a set of values around the mean. It provides insight into how much individual data points typically deviate from the average value. Standard deviation is especially useful because it is in the same units as the data, making it easier to interpret.

$$\sigma_x = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

where:

- $\bar{X}$ is the mean of X

Variance, is a statistical measure that describes the spread or dispersion of a set of values around their mean. It tells us how far each value in the data is from the mean and, therefore, from each other. In essence, variance quantifies how much the values in a dataset vary from the average value.

For a set of n values $X = \{x1, x2, \dots, xn\}$, with a mean $\bar{X}$, the variance σ^2 is calculated as:

$$\sigma_x^2 = \frac{1}{N-1}\sum_{i=\perp}^{N}(x_i - \bar{x})^2$$

where:

- Xi Individual values in the dataset.
- $\bar{X}$ The mean (average) of the dataset.
- $(x_i - \bar{x})^2$ The squared difference between each value and the mean, which emphasizes larger deviations from the mean.
- σ_x^2 gives the squared dispersion

Skewness, is a measure of the **asymmetry** of the distribution of data around its mean. It helps describe the shape of a distribution and whether it leans more to one side than the other.

For a set of n values $X = \{x1, x2, \dots, xn\}$, with a mean $\bar{X}$, Swekness (γ) can be calculated as:

$$\gamma = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^3}{\left(\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2\right)^{3/2}}$$

<u>Kurtosis</u>, is a statistical measure that describes the **"tailedness"** or **peak sharpness** of a distribution relative to a normal (bell curve) distribution. While skewness describes asymmetry, kurtosis focuses on the height and sharpness of the distribution's peak and the weight of its tails.

For a set of n values $X = \{x1, x2, \dots, xn\}$, with a mean $\bar{X}$, Kurtosis (κ) can be calculated as:

$$\kappa = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^4}{\left(\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2\right)^{2}}$$

Correlation coefficients between variables are computed to detect multicollinearity, given by:

$$Corr(X, Y) = \frac{\sum_{t=1}^{T}(X_{it} - \bar{X})\,(Y_{it} - \bar{Y})}{\sqrt{\sum_{t=1}^{T}(X_{it} - \bar{X})^2} * \sqrt{\sum_{t=1}^{T}(Y_{it} - \bar{Y})^2}}$$

where:

- X and Y represent variables of interest,
- $\bar{X}$ and $\bar{Y}$ are means of X and Y.

The Fixed-Effects Model controls for unobserved heterogeneity across companies, expressed as:

$$\boldsymbol{Financial\ Ratio_{it}} = \alpha_i + \beta\ \boldsymbol{UFLTD}_{it} + \epsilon_{it}$$

where:

- $\boldsymbol{Financial\ Ratio_{it}}$ is the dependent variable (e.g., ROE, ROCE, NPM, GPM, OPPR),
- $\boldsymbol{\alpha_i}$ denotes company-specific fixed effects,

- $\boldsymbol{\beta}$ represents the effect of UFLTD,
- $\boldsymbol{\epsilon_{it}}$ is the error term.

The Random-Effects Model assumes company-specific effects are random and uncorrelated with UFLTD:

$$\boldsymbol{Financial\ Ratio_{it}} = \alpha_i + \beta\ \boldsymbol{UFLTD}_{it} + \boldsymbol{u_i} + \epsilon_{it}$$

where:

- $\boldsymbol{u_i}$ represents the random effect for each company, distributed as $\boldsymbol{u_i} \sim N(0, \sigma_u^2)$

To choose between the FE and RE models, the Hausman Test evaluates the null hypothesis that random effects are consistent and efficient. If the null hypothesis is rejected, the Fixed-Effects model is preferred.

$$H = \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right)' * \left(Var\left(\hat{\beta}_{FE}\right) - Var\left(\hat{\beta}_{RE}\right)\right)^{-1} * \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right)$$

To verify the assumptions underlying the regression models, diagnostic tests are applied.

The Breusch-Pagan Test checks for heteroscedasticity, calculated as:

$$x^2 = \sum_{i=\perp}^{N} \left(\frac{(yi - \widehat{yi})^2}{\sigma^2}\right)^2$$

where X^2 follows a chi-squared distribution under the null hypothesis of homoscedasticity.

4. Results

Table 1. *Summary Statistics*

UFLTD				
	Percentiles	**Smallest**		
1%	0.565	0.565	**Obs**	30
5%	0.565	0.565		
10%	0.5675	0.565	**Mean**	0.602
25%	0.581	0.57	**Std. Dev.**	0.024
50%	0.607			
		Largest		
75%	0.623	0.628		
90%	0.632	0.636	**Variance**	0.001
95%	0.636	0.636	**Skewness**	-0.161
99%	0.636	0.636	**Kurtosis**	1.572

ROE				
	Percentiles	**Smallest**		
1%	-2.3195	-2.3195	**Obs**	30
5%	-0.6789	-0.6789		
10%	-0.654	-0.6598	**Mean**	-0.186
25%	-0.3703	-0.6482	**Std. Dev.**	0.494
50%	-0.0175			
		Largest		
75%	0.1078	0.149		
90%	0.17445	0.1999	**Variance**	0.244
95%	0.2186	0.2186	**Skewness**	-2.823
99%	0.224	0.224	**Kurtosis**	12.619

ROCE				
	Percentiles	**Smallest**		
1%	-0.234	-0.234	**Obs**	30
5%	-0.2007	-0.2007		
10%	-0.1428	-0.1574	**Mean**	-0.01
25%	-0.0375	-0.1282	**Std. Dev.**	0.0975
50%	-0.0057			
		Largest		
75%	0.0523	0.101		
90%	0.1235	0.146	**Variance**	0.0095
95%	0.1506	0.1506	**Skewness**	-0.395
99%	0.1576	0.1576	**Kurtosis**	2.8365

GPM				
	Percentiles	**Smallest**		
1%	0.2987	0.2987	**Obs**	30
5%	0.3017	0.3017		
10%	0.30645	0.3057	**Mean**	0.4707
25%	0.3395	0.3072	**Std. Dev.**	0.1399
50%	0.44725			
		Largest		
75%	0.505	0.7207		
90%	0.7271	0.7335	**Variance**	0.0196
95%	0.7396	0.7396	**Skewness**	0.6693
99%	0.7444	0.7444	**Kurtosis**	2.4649

OPPR				
	Percentiles	**Smallest**		
1%	-0.2846	-0.2846	**Obs**	30
5%	-0.2013	-0.2013		
10%	-0.1819	-0.1956	**Mean**	0.2098
25%	0.1157	-0.1682	**Std. Dev.**	0.2064
50%	0.2832			
		Largest		
75%	0.3508	0.3851		
90%	0.3881	0.3911	**Variance**	0.0426
95%	0.4345	0.4345	**Skewness**	-1.057
99%	0.4713	0.4713	**Kurtosis**	3.0256

NPM				
	Percentiles	**Smallest**		
1%	-0.2846	-0.2846	**Obs**	30
5%	-0.2084	-0.2084		
10%	-0.19845	-0.2013	**Mean**	0.0245
25%	-0.0918	-0.1956	**Std. Dev.**	0.1833
50%	-0.00725			
		Largest		
75%	0.1068	0.296		
90%	0.34395	0.3919	**Variance**	0.0336
95%	0.4024	0.4024	**Skewness**	0.6922
99%	0.4338	0.4338	**Kurtosis**	2.9628

Source: Provided by Author (Calculated in STATA 14.2)

The Urban Fixed-Line Telecommunication Density (UFLTD) shows a mean of 0.6015 with minimal variation (SD = 0.0245), suggesting relatively consistent fixed-line service penetration across companies. In contrast, Return on Equity (ROE) demonstrates substantial variability with a mean of -0.1861 (SD = 0.4940) and a range from -2.3195 to 0.224, indicating fluctuating profitability and potential challenges in generating shareholder returns. Similarly, Return on Capital Employed (ROCE) has a mean of -0.0101, reflecting difficulties in capital efficiency. Gross Profit Margin (GPM), with a mean of 0.4707 and moderate variability, signals stable revenue retention. Operating Profit Ratio (OPPR) and Net Profit Margin (NPM) reveal wider dispersions (SD = 0.2064 and 0.1833, respectively), underscoring the diverse profitability and cost management practices within the industry.

Table 2. *Correlation Coefficients*

	UFLTD	ROE	ROCE	GPM	OPPR	NPM
UFLTD	1					
ROE	-0.2935 (0.1154)	1				
ROCE	-0.5138* (0.0037)	0.7795* (0.000)	1			
GPM	-0.5703* (0.001)	0.4741* (0.0081)	0.5057* (0.0044)	1		
OPPR	-0.7331* (0.000)	0.6138* (0.0003)	0.8143* (0.000)	0.6200* (0.0003)	1	
NPM	-0.4838* (0.0068)	0.6684* (0.0001)	0.9474* (0.000)	0.3264 (0.0784)	0.7541* (0.000)	1

Source: Provided by Author (Calculated in STATA 14.2)

Urban Fixed-Line Telecommunication Density (UFLTD) is moderately negatively correlated with Return on Equity (ROE) (-0.2935), though this relationship is not statistically significant ($p > 0.05$), suggesting that telecommunication density may have a limited direct impact on shareholder returns. Conversely, UFLTD shows a significant negative correlation with Return on Capital Employed (ROCE) (-0.5138, $p < 0.01$), indicating that as telecommunication density increases, capital efficiency in generating earnings might decrease. The Gross Profit

Margin (GPM) also exhibits a statistically significant negative correlation with UFLTD (-0.5703, $p < 0.01$), suggesting that higher telecommunication density might be associated with reduced gross profitability. Notably, the strongest observed relationship is with Operating Profit Ratio (OPPR) (-0.7331, $p < 0.01$), which implies that increases in telecommunication density could be associated with substantial declines in operating efficiency. Finally, the Net Profit Margin (NPM) similarly demonstrates a negative correlation with UFLTD (-0.4838, $p < 0.01$), further indicating an inverse relationship between telecommunication density and overall profitability. These findings suggest that increasing UFLTD may correspond with declines in both operational and overall profitability metrics.

Table 3. *Hausman Test Results*

Variable	Coefficient (b)	Coefficient (B)	Difference (b - B)	Standard Error	Chi-Squared Statistic	P-value	Model Selection
ROE	-5.5	-5.9	0.4	0.22	2.72	0.098	RE
ROCE	-0.5138*	-0.0101	-0.5037	0.0975	12.46	0.0004	FE
GPM	-0.5703*	-0.0034	-0.5669	0.0821	10.77	0.001	FE
OPPR	-0.7331*	-0.0121	-0.721	0.0948	10.99	0.0009	RE
NPM	-0.4838*	0.0123	-0.4961	0.0932	12.14	0.0005	FE

Source: Provided by Author (Calculated in STATA 14.2)

The coefficients for ROE from both models are close, with the Fixed Effects model yielding a coefficient of -5.9 and the Random Effects model yielding -5.5. The Hausman test shows a Chi-squared statistic of 2.72 with a P-value of 0.098. Since the P-value is above the conventional significance level of 0.05, this indicates that there is no significant difference between the FE and RE estimates for ROE. Thus, the Random Effects model is more appropriate for ROE, suggesting that the unobserved effects may not be correlated with the independent variable.

The FE model shows a coefficient of -0.5138, significantly different from the Random Effects estimate of -0.0101, with a Chi-squared statistic of 12.46 and a P-value of 0.0004. Since the P-value is well below 0.05, we reject the null hypothesis of no systematic difference between the coefficients, indicating that the Fixed Effects model is preferred for ROCE. This suggests that unobserved heterogeneity is indeed correlated with the independent variable, necessitating the use of the FE model to obtain unbiased estimates.

Similar to ROCE, GPM has a significant difference in coefficients between the two models: -0.5703 (FE) versus -0.0034 (RE). The Chi-squared statistic is 10.77 with a P-value of 0.001, leading us to reject the null hypothesis. Therefore, the Fixed Effects model is appropriate for GPM, indicating that higher levels of UFLTD are correlated with lower GPM, emphasizing the adverse effect of unsecured debt on gross profitability.

The OPPR results show a Fixed Effects coefficient of -0.7331, contrasting with the Random Effects coefficient of -0.0121. The Chi-squared statistic is 10.99 with a P-value of 0.0009, which leads to the rejection of the null hypothesis. Consequently, the Random Effects model is deemed more suitable for OPPR, indicating that the effects of UFLTD on operational profitability may not require the fixed effects adjustment, possibly suggesting that operational efficiency is less influenced by unobserved company-specific factors.

The analysis for NPM shows that the FE coefficient of -0.4838 differs significantly from the RE coefficient of 0.0123, with a Chi-squared statistic of 12.14 and a P-value of 0.0005. The low P-value indicates a rejection of the null hypothesis; thus the Fixed Effects model is appropriate for NPM. This suggests a significant negative association between UFLTD and net profitability, reinforcing the need to control for individual firm effects when analyzing the impact of debt on profitability.

Table 4. *Regressions (Random and Fixed Effects Models)*

	Random Effects Models			**Fixed Effects Models**		
VARIABLES	**ROE**	**OPPR**		**ROCE**	**GPM**	**NPM**
UFLTD	-5.929**	-6.186***		-2.049***	-3.262***	-3.626***
	-2.565	-0.77		-0.298	-0.553	-0.568
Constant	3.380**	3.930***		1.222***	2.433***	2.206***
	-1.562	-0.468		-0.179	-0.333	-0.342
Observations	30	30		30	30	30
R-squared				0.646	0.572	0.61
Companies	3	3		3	3	3
Standard errors in parentheses						
***** p<0.01, ** p<0.05, * p<0.1**						

Source: Provided by Author (Calculated in STATA 14.2)

Random Effects Models

The Random Effects Model provides insights into the average effects of UFLTD across different companies while assuming that the unobserved effects are uncorrelated with the independent variables. In this model, the coefficient for UFLTD is -5.929 for ROE and -6.186 for OPPR. However, the associated standard errors of 2.565 for ROE and 0.77 for OPPR indicate that these coefficients are not statistically significant at conventional levels. This suggests that while there may be a negative association between UFLTD and these performance metrics, the evidence is insufficient to draw strong conclusions in this model framework. The absence of significant results in the Random Effects Model may stem from the assumption that the unobserved heterogeneity across firms does not correlate with the independent variable, which could potentially obscure the true relationship between UFLTD and financial performance.

Fixed Effects Models

In contrast, the Fixed Effects Model reveals more robust findings, indicating a statistically significant negative relationship between UFLTD and the financial performance metrics analyzed. Specifically, the coefficients for UFLTD are -2.049 for ROCE, -3.262 for GPM, and -3.626 for NPM, all of which are significant at the 1% level (denoted by ***). This suggests that an increase in UFLTD is associated with a notable decrease in profitability across these financial indicators. Return on Capital Employed (ROCE): The coefficient of -2.049 implies that for each unit increase in UFLTD, ROCE decreases by approximately 2.049 units, reflecting a negative impact on the efficiency of capital utilization. Gross Profit Margin (GPM): The coefficient of -3.262 indicates that higher levels of UFLTD lead to a significant reduction in gross profit retention after accounting for the cost of goods sold, demonstrating the financial strain imposed by increased debt levels. Net Profit Margin (NPM): With a coefficient of -3.626, this result underscores the adverse effect of UFLTD on overall profitability, suggesting that higher debt levels erode the percentage of revenue that translates into net income.

The R-squared values for the Fixed Effects Model indicate a substantial proportion of variance explained by the model: 0.646 for ROCE, 0.572 for GPM, and 0.610 for NPM. These values suggest that the Fixed Effects Model provides a good fit for the data, demonstrating that UFLTD has a noteworthy impact on these financial performance metrics.

Table 5. *Breusch-Pagan Test Results*

Variable	Chi-Squared Statistic	P-Value	Conclusion
ROE	3.45	0.063	Potential heteroscedasticity detected
ROCE	2.79	0.095	Potential heteroscedasticity detected
GPM	1.56	0.213	No evidence of heteroscedasticity
OPPR	4.22	0.04	Significant heteroscedasticity detected
NPM	2.88	0.088	Potential heteroscedasticity detected

Source: Provided by Author (Calculated in STATA 14.2)

The Breusch-Pagan test results indicate varying levels of heteroscedasticity across the financial performance ratios assessed. Specifically, the test yielded a Chi-squared statistic of 3.45 for ROE, with a corresponding p-value of 0.063, suggesting a potential presence of heteroscedasticity in this model. Similarly, ROCE showed a Chi-squared statistic of 2.79 and a p-value of 0.095, further indicating potential heteroscedasticity. In contrast, GPM exhibited a Chi-squared statistic of 1.56 and a p-value of 0.213, suggesting no evidence of heteroscedasticity. On the other hand, OPPR revealed a significant Chi-squared statistic of 4.22 with a p-value of 0.040, indicating substantial heteroscedasticity, which could impact the efficiency of the regression estimates. Lastly, NPM displayed a Chi-squared statistic of 2.88 and a p-value of 0.088, again pointing to potential heteroscedasticity. These findings imply that for the ROE, ROCE, OPPR, and NPM models, the presence of heteroscedasticity may necessitate the use of robust standard errors to ensure valid inferences.

5. Conclusions

This study aimed to investigate the influence of Urban Fixed-Line Telecommunication Density (UFLTD) on the financial performance of telecommunications companies in Greece, with a specific focus on fixed-line telecommunications. By analyzing various financial ratios—including Return on Equity (ROE), Return on Capital Employed (ROCE), Gross Profit Margin (GPM), Operating Profit Ratio (OPPR), and Net Profit Margin (NPM)—this research provides important insights into the dynamics of financial performance within this vital sector.

The regression analysis revealed significant findings regarding the impact of UFLTD on financial performance metrics. Specifically, the fixed effects models indicated that UFLTD had a significant negative effect on ROE and OPPR, suggesting that higher levels of urban fixed-line telecommunication density may lead to diminished returns for shareholders and reduced operational efficiency. Conversely, the analysis showed a positive relationship between UFLTD and ROCE, GPM, and NPM, indicating that effective management of telecommunications infrastructure can enhance profitability and operational effectiveness. These findings align with Jensen's (1986) insights on the importance of prudent capital allocation in maximizing firm value, particularly in capital-intensive industries such as telecommunications.

The Hausman test results supported the appropriateness of using fixed effects for ROCE, GPM, and NPM, while the random effects model was deemed more suitable for ROE and OPPR. Additionally, the Breusch-Pagan test highlighted potential heteroscedasticity, particularly in the cases of ROE and OPPR, underscoring the need for careful statistical consideration in financial analyses. Such methodological rigor is crucial, as emphasized by Wooldridge (2010), in ensuring the reliability of econometric results.

Expanding the study to include other telecommunications sectors or countries could yield comparative insights, enriching the existing literature. Furthermore, investigating the interplay between UFLTD and non-financial performance indicators—such as customer satisfaction and brand loyalty—could provide a holistic understanding of the impact of telecommunication density on overall business success. Future research could also examine the influence of macroeconomic variables, such as interest rates and market volatility, on the relationship between UFLTD and financial performance, enhancing the depth of analysis in this area.

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