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Does Urban Fixed-Line Telecommunication Density Influence Profitability and Operational Efficiency in Greece's Telecommunications Industry?

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Abstract

Purpose: This study investigates the influence of Urban Fixed-Line Telecommunication Density on financial performance in Greece's telecommunications industry, focusing on the nation's three leading telecom companies.
Design/Methodology/Approach: Using a balanced panel dataset covering a ten-year period, the study employs fixed and random effects regression models to assess the impact of Urban Fixed-Line Telecommunication Density on key financial indicators. The Hausman test is applied to identify the most suitable model for each metric, while the Breusch-Pagan test evaluates the presence of heteroscedasticity.
Findings: The results reveal a substantial relationship between Urban Fixed-Line Telecommunication Density and financial performance, with fixed effects proving more suitable for certain indicators and random effects for others. Potential heteroscedasticity detected in several models suggests the need for robust estimations.
Practical Implications: This study underscores the importance of telecommunications infrastructure in supporting financial growth and operational efficiency, providing insight for policymakers and industry leaders on prioritizing infrastructure improvements.
Originality/Value: The research offers a unique perspective on the role of fixed-line telecommunication density in enhancing financial performance in a liberalized, competitive market, filling a gap in telecommunications and infrastructure research in Greece
Paper Type: Research Paper

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INTRODUCTION

Telecommunications infrastructure is becoming more and more important in the digital age, influencing social connections and economic growth. Even though mobile technologies are gaining popularity faster than fixed-line telecommunications, fixed-line services are still an essential part of urban infrastructure, especially in developed nations like Greece. The extent to which fixed-line telecommunication services are prevalent in urban areas is a measure of how widely available and accessible communication technology is—a necessity for households, businesses, and government operations alike. To better understand this aspect of urban infrastructure, the Urban Fixed-Line Telecommunication Density (UFLTD) has been calculated, a key metric that captures the relationship between fixed telephone subscriptions and the urban population. By estimating this ratio (UFLTD = fixed telephone subscriptions / urban population), research aims 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.

Greece's economic and social progress has long been based on the telecommunications sector, whose evolution reflects broader global trends. As a historical and infrastructure statistic, Urban Fixed-Line Telecommunication Density (UFLTD) has been essential to comprehending the connection between economic outcomes and telecommunications infrastructure. UFLTD offers a strong lens through which to examine the financial performance of major industry participants, especially in Greece, a nation distinguished by its distinct urbanization patterns, regulatory changes, and economic difficulties. But as the telecommunications industry changes, it's unclear if UFLTD is enough to fully capture the range of its effects, particularly in light of innovative advancements like satellite-based technologies. Greece's historical reliance on fixed-line infrastructure reflected its attempts to upgrade and incorporate the telecoms framework of the European Union. UFLTD is an essential component of this journey, especially in cities where economic activity and productivity are driven by connectivity. UFLTD is a significant indicator in urban-centric studies like this one because the growth of fixed-line networks represented advancement and modernization for Greek telecom behemoths like OTE, Vodafone, and Wind. According to our investigation, UFLTD showed strong relationships with financial performance indicators, confirming its ongoing importance in cities where dependable, fast connections are still necessary for both homes and enterprises.

However, the conventional dominance of fixed-line networks is being challenged by the emergence of cutting-edge satellite systems, such as those offered by Starlink. The future of telecommunications is represented by these technologies, which are intended to address connectivity gaps in isolated and underserved areas. Greece's geographic characteristics, such as its islands and rugged terrain, make it a prime target for using satellite technology to supplement current networks, even though the country has historically placed a high priority on urban connectivity. This change forces a reassessment of UFLTD's suitability as the exclusive measure of telecoms advancement. In spite of this, UFLTD is still significant in the Greek setting. It offers a historical standard by which new technologies may be evaluated, reflecting the history and effects of urban connection. Future studies must, however, incorporate contemporary metrics like satellite connections, mobile data usage, and broadband adoption in order to stay forward-looking. The interaction between established and new technologies in influencing financial performance and economic outcomes would be more accurately captured by this more comprehensive framework.

Developing an understanding of the connection between urban fixed-line communications density and telecom businesses' financial success might help one better understand the dynamics of the industry as a whole. Companies that offer fixed-line telecommunication services must modify their business strategies to satisfy the growing need for dependable and quick communication services from urban populations while preserving profitability. The three biggest telecom providers in Greece—COSMOTE, VODAFONE, and WIND (since merged with Nova)—are the subject of this paper. These companies control almost 80% of the telecom sector and hold a significant market share in both mobile and fixed-line services, making them the leading enterprises in the Greek market.

The Greek telecom industry experienced several challenges in the past decade, such as the global COVID-19 pandemic and the financial crisis that overtook the nation from 2009 to 2018. Fixed-line telecommunication services have remained crucial in despite these challenges, especially in cities where households and businesses continue to depend on reliable communication lines. Since fixed-line infrastructure is frequently used to supply broadband internet services, the density of these lines is critical to the financial sustainability of telecommunications companies. The primary objective of this paper is to examine the correlation between COSMOTE, VODAFONE, and WIND's financial performance and changes in Urban Fixed-Line Telecommunication Density (UFLTD) between 2013 and 2022. This study intends to evaluate how changes in Urban Fixed-Line Telecommunication Density over time have affected these companies' profitability by concentrating on important profitability ratios like Return on Equity

(ROE), Return on Capital Employed (ROCE), Gross Profit Margin (GPM), Operating Profit Margin (OPPR), and Net Profit Margin (NPM). These ratios offer a thorough understanding of a company's capacity to make money from operations, equity, and capital, and are generally recognized as crucial markers of its financial well-being and effectiveness.

COSMOTE, VODAFONE, and WIND have a combined market share of more than 80% in fixed-line services, making the Greek telecom industry a fiercely competitive market controlled by only a few of major firms. The market leaders in mobile and fixed-line telecommunication services include COSMOTE, a division of OTE (Hellenic Telecommunications Organization), VODAFONE, and WIND. To handle the growing urban population and the rising need for quicker, more dependable internet and communication services, these businesses have made significant investments in enlarging their infrastructure. In Greece, the years 2013–2022 are especially intriguing for telecommunications research. Greece had several macroeconomic changes during this time, including the financial crisis' recovery, the introduction of high-speed broadband, and growing urbanization. These elements most certainly have an impact on the operational effectiveness and financial success of telecom firms. Moreover, as distant work, e-commerce, and online education proliferated, the global COVID-19 epidemic sped up the adoption of digital communication technology, making fixed-line services essential for families and companies alike.

Demand for dependable fixed-line telecommunication services, especially for high-speed internet, which is frequently provided via fixed infrastructure, increased along with Greece's urban areas. An indicator of the accessibility of these services in metropolitan areas is the metropolitan Fixed-Line Telecommunication Density (UFLTD) measure, which shows how well-positioned COSMOTE, VODAFONE, and WIND are to serve the populace. We may gain a better understanding of the relationship between changes in infrastructure deployment and these organizations' profitability and financial resilience by examining the changes in UFLTD.

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, the following hypotheses has been developed, 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.

LITERATURE REVIEW

Within the service industry, the telecommunications sector has become one of the most competitive and rapidly expanding during the last 20 years. In the current digital era, this sector is essential to many facets of human existence. Additionally, in the face of increased rivalry, telecommunications companies are placing a greater emphasis on customer happiness (Drosos et al. 2015). Greece's economy depends heavily on mobile communications and telecommunications, which boost government revenue, job creation, and income growth (Drosos et al. 2011; Goyal and Kar 2020; Abor et al. 2018). Three huge companies control the majority of the Greek telephone market: Wind, Vodafone, and Cosmote, which continuously has the most market share (Rizomyliotis et al. 2018). Customer happiness and quality have a big impact on corporate performance, which is essential to the effective administration and running of businesses. Both financial and non-financial indicators, such as organizational structure, process efficiency, and reputation, can be used to assess a company's performance (Bontis 1998; Bontis et al. 2000). Financial measurements include market share, earnings, and return on investment. This study uses financial ratio analysis to evaluate the performance of businesses.

Since the late 1800s, financial ratio analysis has been a fundamental component of evaluating the performance of businesses (O'Connor 1973). For meaningful interpretation, raw accounting data must be converted into ratios, as Horrigan (1965) pointed out. In order to facilitate comparisons between businesses and industries, the Harvard Business Review (1925) emphasized the value of financial ratios for a wide range of stakeholders, including executives, investors, credit managers, and financial institutions. This method is essential for determining if a business is performing better or worse than industry standards. However, knowledge of the benefits and drawbacks of financial ratios is necessary for their efficient application.

Enhancing shareholder value through increased firm profitability is the main goal for telecommunications companies (Dong et al. 2020; Liu et al. 2021). Although using debt as a funding source can increase financial risks, using borrowed money wisely can increase profitability. On the other hand, poor debt management might result in losses (Notta and Vlachvei 2014). Because it allows shareholders to maintain control while exposing creditors to the majority of the company's risk, leverage is essential to profitability. Shareholder returns are increased if debt-financed investments produce returns higher than interest expenses (Brigham and Houston 2021). Leverage can boost returns during economic expansion, but it also raises the danger of losses during downturns, warn Nugroho et al. (2019).

When Gazilas and Vozikis (2024) looked at the General Private Clinics Sector in Greece from 2012 to 2020, they discovered a significant positive relationship between market concentration as indicated by the Herfindahl-Hirschman Index (HHI) and financial indicators like operational profit margin and return on equity. Greater profitability and operational efficiency were linked to higher market concentration. Barnes (1987) highlighted the strategic importance of financial ratio analysis, which helps with regulatory compliance, performance comparisons, and management effectiveness evaluation. Additionally, ratios equalize firm size, which makes cross-company comparisons more relevant. Furthermore, industry norms act as benchmarks that impact strategic planning, according to Lev (1969).

In order to assess performance, Theuri (2002) emphasized the significance of regularly monitoring financial ratios in the context of small and medium-sized businesses (SMEs). He suggested that SMEs begin with a small number of crucial statistics before expanding their investigation, classifying them into categories like management effectiveness, profitability, and financial stability. For internal decision-making, relying only on financial statements that adhere to GAAP, FASB, or SEC standards might not offer the level of detail required. However, more efficient performance evaluation is made possible by combining ratio analysis with these claims (Berry and Lusch 1996). According to Sudaryo et al. (2021), interest rates and financial distress are positively correlated in a number of industries, including telecommunications. They emphasized how important it is for managers to keep an eye on interest rates in order to reduce financial risks. Similarly, Khafid et al. (2019) showed that high debt-to-equity or debt-to-asset ratios, which indicate excessive leverage in telecom companies, dramatically raise the risk of financial distress. Andersen et al. (2011) emphasized the significance of managing operational risks in telecoms and other businesses by connecting the financial crisis to poor risk management.

According to Belesis et al.'s (2023) analysis of the effects of COVID-19 on Greece's leading publicly traded enterprises, industries such as gasoline manufacturing and car rentals saw sharp drops in income. On the other hand, Gazilas (2023) investigated how resilient Greece's energy companies were to the epidemic, demonstrating that some managed to sustain high net profit margins while others had difficulties. These results are consistent with those of Patrone and DuBois (1981), who promoted the use of financial measures in comparison while taking external factors and industry standards into account. Even if there aren't many studies on how capital structure affects telecommunications profitability (e.g., Wiyasa and Basyith 2020; Fauzi et al. 2022), what is known emphasizes how crucial it is to contextualize financial ratio analysis in order to fully capture sector-specific dynamics.

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:

$$\mathbf{UFLTD}_{it} = \frac{\text{Fixed Line Subscriptions}_{it}}{\text{Urban Population}_{it}} \tag{1}$$

where:
i denotes the company,
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.

$$\mathbf{ROE}_{it} = \frac{\text{Net Income}_{it}}{\text{Shareholders' Equity}_{it}} \tag{2}$$

$$\mathbf{ROCE}_{it} = \frac{\text{Earnings Before Interest and Taxes}_{it}}{\text{Total Assets}_{it} - \text{Current Liabilities}_{it}} \tag{3}$$

$$\mathbf{NPM}_{it} = \frac{\text{Net Income}_{it}}{\text{Total Revenue}_{it}} \tag{4}$$

$$\mathbf{GPM}_{it} = \frac{\text{Total Revenue}_{it} - \text{Cost of Goods Sold}_{it}}{\text{Total Revenue}_{it}} \tag{5}$$

$$\mathbf{OPPR}_{it} = \frac{\text{Operating Income}_{it}}{\text{Total Revenue}_{it}} \tag{6}$$

where:
i denotes the company,
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:

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i \tag{7}$$

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.

$$\sigma_x = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2} \tag{8}$$

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:

$$\sigma_x^2 = \frac{1}{N-1}\sum_{i=\perp}^{N}(x_i - \bar{x})^2 \tag{9}$$

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:

$$\gamma = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^3}{\left(\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2\right)^{3/2}} \tag{10}$$

Kurtosis, 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:

$$\kappa = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^4}{\left(\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2\right)^{2}} \tag{11}$$

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

$$\mathrm{Corr}(X,Y) = \frac{\sum_{t=1}^{T}(X_{it} - \bar{X})(Y_{it} - \bar{Y})}{\sqrt{\sum_{t=1}^{T}(X_{it} - \bar{X})^2} * \sqrt{\sum_{t=1}^{T}(Y_{it} - \bar{Y})^2}} \tag{12}$$

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

$$\textbf{Financial Ratio}_{\textbf{it}} = \alpha_i + \beta\,\textbf{UFLTD}_{it} + \epsilon_{it} \tag{13}$$

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:

$$\textbf{Financial Ratio}_{\textbf{it}} = \alpha_i + \beta\,\textbf{UFLTD}_{it} + \mathbf{u_i} + \epsilon_{it} \tag{14}$$

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.

$$H = \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right)' * \left(\mathrm{Var}(\hat{\beta}_{FE}) - \mathrm{Var}(\hat{\beta}_{RE})\right)^{-1} * \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right) \tag{14}$$

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

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

$$x^2 = \sum_{i=\perp}^{N}\left(\frac{(yi - \hat{yi})^2}{\sigma^2}\right)^2 \tag{15}$$

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

RESULTS AND DISCUSSION

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

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

*Note: 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.

CONCLUSIONS

With a focus on fixed-line telecommunications specifically, this study aimed to determine how urban fixed-line telecommunication density affected the financial performance of Greek telecom operators. This research offers major insights into the dynamics of financial performance within this crucial industry by examining a number of financial ratios, such as Return on Equity (ROE), Return on Capital Employed (ROCE), Gross Profit Margin (GPM), Operating Profit Ratio (OPPR), and Net Profit Margin (NPM). The regression analysis produced significant findings about the impact of urban fixed-line telecommunication density on financial performance metrics.

Higher levels of urban fixed-line telecommunication density may result in lower returns for shareholders and decreased operational efficiency, according to the fixed effects models, which specifically showed that urban fixed-line telecommunication density had a significant negative impact on ROE and OPPR. On the other hand, the analysis revealed a significant correlation between ROCE, GPM, and NPM and Urban Fixed-Line Telecommunication Density, suggesting that efficient telecommunications infrastructure management can improve operational efficacy and profitability. These results are consistent with Jensen's (1986) observations regarding the significance of careful capital allocation in optimizing firm value, especially in capital-intensive sectors like telecoms. While the random effects model was considered more appropriate for ROE and OPPR, the Hausman test findings confirmed that fixed effects were appropriate for ROCE, GPM, and NPM. The necessity for rigorous statistical examination in financial assessments was further underscored by the Breusch-Pagan test, which revealed possible heteroscedasticity, especially in the cases of ROE and OPPR. According to Wooldridge (2010), this kind of methodological rigor is essential to guaranteeing the accuracy of econometric findings.

Researchers in the future can broaden the study by incorporating data from other telecom industries or nations, which could provide comparative analysis and enhance the body of existing knowledge. Additionally, examining how urban fixed-line telecommunication density interacts with non-financial performance metrics like brand loyalty and customer happiness may offer a comprehensive knowledge of how telecommunication density affects total business success. To further the depth of analysis in this area, future studies might also look at how macroeconomic factors like interest rates and market volatility affect the association between urban fixed-line telecommunication density and financial performance.

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