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THE IMPACT OF 5G TECHNOLOGY ON EUROPEAN TELECOM OPERATORS' SHARE PRICE: EVENT STUDY ANALYSIS

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The document length is 8153 words from the introduction to the end of the conclusion.

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ABSTRACT

The paper investigates the price reactions of 5G technology adoption on European telecom operators' share prices using an event study approach. The aim of this research is to examine whether the introduction of 5G technology has impacted the stock prices of various telecommunications companies throughout Europe.

5G aims to cater to a diverse range of industry verticals, unlike its predecessor, 4G-LTE, which mainly focuses on the mass consumer market. 5G is designed to facilitate low latency applications, high-speed user mobility, accurate user location determination, significantly higher data rates, lower energy consumption, and catering to a more significant number of end-users, particularly devices as part of Industry 4.0 and the Internet-of-Things (Lemstra, 2018). Examining the stock price performance of eight European telecom operators - Deutsche Telekom, Orange, Vodafone, Telecom Italia, Elisa, Swisscom AG, Telenor, and Telia - before and after the announcement of their 5G launch dates.

After analysing the results, the abnormal returns (AR) results were mixed and the cumulative abnormal returns (CAR) were not statistically significant While the results were mixed between the telecom operators, the findings suggest that, in the short-term period, the deployment of 5G technology did not significantly affect European telecom operators' share prices. This study adds to the limited literature regarding the impact of 5G technology adoption on European telecommunications company stock prices. To address this gap, an event study approach examines the stock price performance of eight European telecom operators before and after announcing their 5G launch dates.

Keywords: Event study, 5G Technology, telecommunication operator

INTRODUCTION

The 5G network is seen as a game changer because it provides gigabit-speed wireless broadband services for industrial transformations, supports new types of applications involving objects and devices (the Internet of Things), and offers versatility via software virtualization that allows innovative business models across a variety of sectors (transport, health, manufacturing, logistics, energy, media, and entertainment, for example). Although these transformations have already begun on existing networks, 5G will be necessary for them to reach their full potential (European Commission, 2016). Economic development and productivity growth are cornerstones of economic and productivity growth because ubiquitous and high-capacity electronic communication infrastructure will facilitate 5G's success (Lemstra, 2018).

The telecommunication industry is one of Europe's strategic sectors and a vital asset. With an annual added value of €141.5 billion, telecommunications are one of Europe's few leading technology industries. The industry is constructing the infrastructures necessary for the digital and green transition while accelerating the adoption of new technologies such as 5G, edge computing, cloud computing, artificial intelligence, the Internet of Things, and cybersecurity of Europe's strategic sectors and a critical asset is the telecom business (Nuria, 2022).

With the launch of 4G technology, which has allowed people to stream audio and video while on the go, the telecommunications sector has advanced significantly in recent years; however, 5G technology has the potential to transform the sector further. 5G is intended to link many more types of devices than just smartphones, such as smartwatches and industrial robots, in contrast to 4G, which offers a one-size-fits-all type of connectivity. Every gadget needs a connection with a unique set of features, and 5G can deliver this flexibility. For instance, a smartwatch with a small battery can link to 5G with little energy use, and an industrial robot can take advantage of an incredibly stable and quick connection.

5G technology elevates cloud services by functioning as a decentralized data centre for handling tasks. The network has much built-in processing power that transcends the boundaries of a network, allowing it to handle computationally demanding chores like AR filters or games rather than the device, improving performance and conserving battery. This capability also opens the door for developing new battery-powered devices, such as lightweight AR glasses, and enables coordinated fleets of connected delivery drones. Therefore, the introduction of 5G technology has the potential to transform the telecommunications industry and create new opportunities for innovation and growth (Ericsson, 2021). As the 5G technology is a new emerging technology in the telecommunication industry it might lead to an increase in share prices. When positive news emerges, individuals tend to buy stocks. This could be due to a company reporting better-than-expected earnings, announcing a new product, acquiring, or sharing positive economic indicators. This creates buying pressure and leads to an increase in stock prices (Beers, 2019).

For 5G adoption, we should be aware of the enormous costs. According to BCG, for Europe to achieve gigabit speeds and fully implement the 5G ambition, expenditures totalling €300 billion will be required by 2025. By using fibre to the home or office (FTTX) with 5G FWA, broadband speeds of 1Gbit and more will be possible throughout Europe for about €150 billion. According to BCG's study, the massive increase in wireless data traffic, particularly as IoT adoption increases, will need an additional €150 billion to develop the infrastructure necessary to realize the whole 5G vision for consumers and businesses in Europe (Boston Consulting Group (BSC), 2021).

Based on an event study approach, this study examines the impact of 5G technology on different telecommunication operators' share prices. For analysing the impact of different events on stock prices, the study will cover ten days before and ten days after the 5G launch dates are announced. The quantitative method involves conducting an event study analysis to examine the impact of adopting 5G technology on the market price of telecom operators in Europe. An event study is a standard method of assessing how events impact firm value or shareholder wealth. The technique measures an event's impact on a company by measuring stock price changes when company-related information is released. Therefore, when corporate actions are announced, the stock price adjusts to reflect this information (Jeon, C. 2022).

This research aims to find out whether the launch of 5G technology has had any reaction on different telecommunication operators' share prices across Europe. The research question is defined in the following way: What is the impact of 5G technology on the share price of European telecom operators, and how does this impact vary across different companies and what

kind of impact time has given. Two hypotheses were developed to help find out the needed answers to the research question and aim.
H1: The introduction of 5G technology positively affects the share prices of European telecom operators.
H2: The launch of 5G technology has a more positive effect on companies that have been the industry's first movers.

The thesis consists of the three chapter. It will start with a literature review that examines the current state of research on the subject and identifies any gaps this study intends to fill. The event study analysis method will then be thoroughly explained in the data & methodology section as to how it will be used in this research. The sample selection criteria, the data-gathering procedure, and the statistical techniques applied to the data analysis will be included.

The data analysis section will outline any notable impacts of 5G adoption on the share prices of the chosen telecom operators while presenting the event study analysis findings. The results will be interpreted in the analysis portion, offering some perspective on how they might affect the telecom sector. The study's main results will be summed up in conclusion, along with any limitations and possible directions for further investigation.

1. LITERATURE REVIEW

This chapter aims to present a thorough analysis of the research on the effect of 5G technology on the stock price of European telecom providers. It is generally believed that the adoption of 5G technology will mark a significant development in the telecom industry, with implications for operators' financial health and shareholder value (The Impact of 5G on Telecom, 2020). In order to determine the critical variables that may affect the effect of 5G technology on telecom operators' share prices, this chapter aims to summarise and assess the body of existing literature on the subject.

1.1. 5G Technology & Telecommunication Industry

It is essential to understand the previous generations of wireless mobile telecommunication technology. The first generation (1G) of mobile wireless communication networks used analogue technology and were limited to voice calls. The digital technology of the second generation (2G) enables text messaging. The next generation, 3G, offered multimedia support in addition to faster data transmission rates and greater capacity. In order to enable wireless mobile internet, the fourth generation (4G) combines 3G with fixed internet. This is an evolution designed to get around 3G's limitations while also improving QoS, expanding bandwidth, and lowering resource costs (Gawas, 2015).

The 5G network will not be an incremental advancement over the 4G network (Andrews et al., 2014). It will allow the growth of vertical industries like intelligent healthcare, smart energy, and autonomous driving, ushering in a paradigm shift for the internet with its low latency and ultra-reliable capabilities that set it apart from prior networks. Additionally, thanks to its slicing function, it can offer a customised network (particularly for B2B markets), which will introduce new revenue models (Frias & Martinez, 2018). The communications industry is anticipated to change substantially because of the widespread adoption of 5G technology. Examining how 5G will affect telecom operators' share prices can offer important insight into how the industry will change in the coming years. The 5G economy allows new use cases, business models, and revenue opportunities such as network slice monetization, network as a service (NAAS) offering, and IoT monetization. In order to generate new revenue, monetization options for the 5G era are adaptable enough to support a variety of business models and ecosystem partners (Nokia, n.d). There has been a decline in revenues for European telecom operators over the last decade. The main reasons for this are stagnating service prices, regulations, and increasing demand for infrastructure investments, given the technological, economic, and social value of 5G networks and operators (Neokosmidis et al., 2018).

There is a significant impact expected on the telecommunications industry from 5G technology, particularly regarding the possibility of generating revenue for operators (Zheng et al., 2017). The implementation of 5G technology is expected to significantly alter the competitive landscape of the telecommunications industry. As new players entering the market and traditional telecom operators losing market share. In order to remain competitive, telecom operators must understand the strategic implications of 5G technology, according to Zheng et al. (2017).

The emergence of 5G technology is anticipated to significantly influence the telecommunications industry, requiring leadership from both companies and policymakers to navigate this changing landscape. Within Europe, two contrasting visions of the future of 5G have emerged. One perspective views 5G as a driver of innovation and growth, with the potential to create new services and applications that could promote economic development and competitiveness. The other perspective acknowledges the potential barriers to the deployment of 5G, including regulatory obstacles and geopolitical tensions, that could lead to fragmentation and uncertainty in global technology standards. These divergent views highlight the complex challenges and opportunities facing 5G leadership in Europe and the associated policy and regulatory implications (Lemstra, 2018).

As more people take advantage of broadband connectivity and use data-heavy digital content, such as streaming video, the amount of data crossing telecoms networks is overgrowing. Six global internet companies generate more than half of all internet traffic today. Keeping up with the increasing demand and sustain service performance, mobile operators must constantly invest in expanding their network capacity, closing coverage gaps, and deploying new technologies. However, this is made more challenging by market imbalances and sector-specific regulatory and fiscal requirements. In Europe, operators have called for regulation requiring the largest originators of network traffic to make a fair contribution towards investment in the network infrastructure their services rely on. This would incentivise these players to optimise their traffic delivery and support investment in resilient and secure connectivity infrastructure, which is crucial for achieving broader public policy objectives (GSMA, 2023).

The European Electronic Communications Code (EECC) is a significant achievement in the European Union's telecommunications policy. However, its technical and market developments might not be sufficient for sustainable competition in all telecommunications markets. While the EECC's new policy objective of investing in very high-capacity connectivity is commendable, more is needed to achieve sustainable infrastructure competition. Furthermore, the policies outlined in the EECC lack the boldness required to attain this goal. Similar issues arise with the EU's policies on call terminations and net neutrality, where sustainable competition remains elusive due to the lack of courage in the EU's gatekeeper policies. This paper argues that implementing bolder policies could lead to a sustainable endgame with competition in all these areas (Vogelsang, 2019).

5G technology promises to revolutionize the telecommunications industry by enabling faster speeds, lower latency, and new use cases that were previously impossible. However, implementing 5G networks poses several challenges for telecom operators. One major challenge is frequency band and spectrum availability. As 5G requires high-frequency bands, telecom operators must purchase additional spectrum from governments at auction. 5G offers top notch services with a limited spectrum range that can be costly and result in higher operational costs.

Another challenge is the approach for 5G network deployment. Telecom operators must have a clear strategy for 5G network slicing implementation and other arrangements. They must also determine their approach towards deployment, which will decide the fate of the deployment process. Telecom operators will develop their deployment models and methods based on the spectrum networks they purchased for 5G deployment. However, deploying 5G networks will require the utilization of mm-Wave frequencies and 5G small cell towers in large numbers, requiring a new deployment approach and following regulations simultaneously.

A third challenge is upgrading mobile devices at the user end. It is expected that the new generation of mobile devices will support 5G bands, but 5G-supported ones must replace many 4G devices to make 5G network implementation successful. It may burden users financially, who may not be willing to upgrade their devices immediately.

Managing expenses involved in 5G network deployment is another challenge. Obtaining spectrum bands, placing cell towers, rolling out large scale fibre optic cables, and finding skilled labour all require collaboration to succeed. Most telecom operators are challenged by high costs associated with 5G technology implementation. The right vendor selection will impact the success of 5G network implementation, and stage-wise investment can save money.

Finally, 5G network deployment challenges with security and privacy concerns must be addressed. A security protocol must take into account privacy concerns like identity, personal data, and geolocation tracking. As well as a broader coverage, 4G networks propagated signals over longer distances. However, the mm-Wave frequencies that 5G uses cannot penetrate obstacles like walls or even human bodies, raising new security and privacy concerns. Telecom operators must ensure that their 5G networks are secure and privacy-protected (Abbey, 2022).

1.2. Economic contribution of 5G technology

With the introduction of 5G technology, the global economy may experience a significant boost. The Global Link Model by IHS Markit predicts that 5G technology will contribute to the real GDP development of the world by $3.0 trillion or 0.2% between 2020 and 2035. 5G technology will enable businesses to become more efficient and launch new ventures, resulting in an economic impact. The global economy is expected to experience a positive effect, despite potential compensating effects from investments and spending in other sectors. Therefore, 5G technology can be viewed as a catalyst for global development and expansion (Campbell et al., 2017).

Three major European Telecom industry players are Deutsche Telekom, Telefonica, and Vodafone. Deutsche Telekom dominated the European market with 73.1 billion euros in total global revenue in 2016. With roughly 10.2 million customers in the first quarter of 2017, the business had the most customers in Europe (outside of Germany) in Poland. In 2015, Telefonica, another top telco provider globally, brought in 52.04 billion euros. In Spain, the business had nearly 17.5 million mobile customers, and it now has more than 43 million in Germany. Similar to this, Vodafone is another significant player in the European telecom sector, with a total of 19.7 million mobile users in the UK alone (O'Dea, 2018)

Given that European telecom operators stand to gain from the roll-out of 5G technology, this potential economic input might have an impact on their stock prices. According to Harper (2022), we can determine that a stock frequently just follows a short-term pattern in its movement. On the one hand, a rising company can gain momentum because "success breeds success", and investor enthusiasm pushes the stock higher. In contrast, a stock will occasionally act in opposition to a pattern and do what is known as reverting to the mean. Unfortunately, recognising that stocks are "trendy" does not help us make predictions because trends cut both ways and are more apparent in retrospect.

The launch of the 5G generation could give telecommunications companies access to new markets. However, prior studies highlight the fact that technical research for 5G is still in its early stages and that extensive network security trials, and technical standardisation, are underway (Rao & Prasad, 2018). According to a study by Jeon C et al. on how government 5G policies affect the firm value of Chinese telecom operators, these policies negatively influence how the market responds to the stock prices of these companies. This outcome underlines the significance of considering governmental policies when evaluating the worth of telecom providers in the 5G era. The research (Lin & Chang, 2011) examined the relationship between corporate governance and the market reaction to new product announcements. The study analysed a sample of US firms that had announced new product introductions between 1997 and 2004. The research findings revealed that new product announcements were generally associated with significantly positive abnormal returns.

It is estimated that the leader in 5G technology will generate hundreds of billions of dollars in revenue during the next decade. As a result of 5 G's widespread adoption, numerous jobs will be created in the wireless technology industry. Its impact extends beyond telecommunications, as 5G has the potential to revolutionise other industries, such as autonomous vehicles, which can benefit significantly from faster and more extensive data transfers. Furthermore, 5G will improve IoT capabilities by increasing data transmission speeds and quantities between multiple devices.5G may even replace the fibre-optic backbone many households rely on today. The country that establishes itself as the leader in 5G technology will be able to own many of these innovations and set international standards (Medin & Louie, 2019).

While 5G is a significant technological improvement, it is important to consider its costs and impacts from various perspectives. The GSMA estimates that mobile operators worldwide will invest around $1.1 trillion between 2020 and 2025 in deploying and upgrading 5G networks. As a result of this huge investment, consumers could face increased costs over time, and 5G networks may be deployed slower or more widely in some regions or countries. A 5G network also requires new antennas and other equipment, and there are ongoing debates about the potential health risks associated with 5G radiation. As such, while 5G presents opportunities for significant technological innovation, it is important to consider this technology's potential costs and impacts carefully (GSMA, 2020).

Some negative aspect to look at is that multiple factors have contributed to flat or declining revenues in many telecommunications markets across the globe. Consumers have shifted their communication services from traditional voice and SMS to voice over IP (VoIP) and texting applications (such as Skype, WhatsApp, Etc.). Furthermore, solid sectoral regulation in many European countries has led to an increasingly competitive market due to new traditional and virtual Mobile Network Operators (MNOs) (Ghezzi et al., 2015).

1.3. Hypothesis development

Hypotheses are developed to guide the data analysis based on a theoretical framework and literature review. This section aims to outline the two hypotheses, which aim to answer the research questions previously identified. The literature review presents theoretical frameworks and empirical evidence that support the hypotheses. Hypotheses are crucial to the research process because they allow for specific and testable predictions about the relationship between variables.

This research aims to investigate the adaption of 5G technology and its impact on the stock prices of various telecommunications companies in Europe. The quantitative method involves conducting an event study analysis to examine the impact. The technique measures an event's impact on a company by measuring stock price changes when company-related information is released. Therefore, when corporate actions are announced, the stock price adjusts to reflect this information (Jeon, C. 2022). The telecom industry is constantly changing due to new technologies. 5G is one of these technologies and has the potential to completely transform the industry. It offers faster speeds and lower latency and can connect a more significant number of devices, changing how we communicate and access content. We can argue that the introduction of 5G technology has significantly impacted the economy, which may have affected share prices. The main hypothesis for this study is:

> H1: The introduction of 5G technology positively affects the share prices of European telecom operators.

As there will be comparisons made of different telecommunication operators, it is vital to acknowledge the benefit of the first mover in the industry. Based on previous research findings, being an early adopter of new technology can positively impact a firm's performance in the stock market. Research by (Lee et al., 2000) suggests that firms who are the first to introduce new products are likely to experience more significant shareholder wealth gains compared to their competitors who adopt the technology later—a possibility for rivals to undermine the shareholder wealth gains of first movers through imitation. Therefore, firms must continue innovating and differentiating themselves from their competitors even after being early adopters of new technology.

The second hypothesis is:

> H2: The launch of 5G technology has a more positive effect on companies that have been the industry's first movers.

2. DATA AND METHODOLOGY

This chapter's goal is to explain the research methods and data sources used to examine the effect of 5G technology on the stock price of European telecom operators. This chapter describes the event study methodology, sample selection, data gathering, statistical methods for data analysis, and the study's limitations.

2.1. Research design

As the main purpose of the study is to analyse the impact 5G technology adoption has had on different European telecommunication operators' share price. This was achieved by developing the following research question: How does the adoption of 5G technology affect the share price of European telecom operators?

The study will adopt an event study methodology as the event study measures the impact of specific events on a company's value using financial market data. Due to rationality in the marketplace, such a study is useful since security prices will immediately reflect the effects of an event. By observing security prices over a relatively short period of time, one can formulate a measure of the event's economic impact (MacKinlay, A. 1997).

The selected companies for the sample are Elisa Oyj, Telia AB, Orange S.A., Vodafone Group Plc, Telecom Italia S.p.A., Deutsche Telekom, Swisscom AG, Telenor ASA, BT. These operators represent diverse countries, including Germany, the UK, Spain, Italy, Norway, Finland, and Switzerland. The data will be gathered by downloading the daily adjusted closing prices of the operators' shares for the six months before and one month following the disclosure of their plans to adopt 5G technology.

Overall, taking into account any possible constraints and ethical considerations, this study's research design will offer a thorough analysis of the effect of 5G technology adoption on the share prices of European telecom providers. The launch of 5G technology is the independent variable in this research, while the dependent variable is the share price of telecom operators. By examining the changes in the equity prices of different telecommunications companies after the launch of 5G technology, this study seeks to shed light on the extent to which 5G technology has impacted the valuation of these firms.

2.2. Data Collection

This research examines the relationship between the launch of 5G technology and the stock prices of European telecom operators. The study's primary data provider is Yahoo Finance, a financial database that provides current stock prices. The telecom operator sample consists of eight European companies that have introduced 5G technology. The daily adjusted closing price of the shares of the telecom companies represented in the sample is collected from Yahoo Finance and downloaded into Excel files for analysis. While the study does not involve regression analysis, the daily adjusted closing price is the primary variable of interest for evaluating the effect of 5G technology on the stock prices of European telecom operators. The daily closing price of each operator's stock six months before the announcement of the 5G launch is used to calculate the dependent variable. Also, considering other variables, such as market trends and company-specific characteristics, could affect share prices.

The announcement of the adoption of 5G technology by the chosen telecom operator serves as the study's event. According to the study, the event took place on the day that the telecom operator launched their 5G technology. With the help of the event study methodology, this research examined how the introduction of 5G technology affected telecom operators' stock prices. The selected businesses determined the event window to be (-10, 10) the introduction of 5G technology. The expected return of each stock during the event window was determined by the research using the market model. The t-test was used to ascertain whether the abnormal returns were statistically significant. Abnormal returns were calculated as the difference between real returns and expected returns. Excel will be used as the statistical software program for the data analysis.

Even though this research offers insightful information about how 5G technology will affect the share prices of European telecom operators, there are many limitations to consider. First, since the research is exclusively based on publicly accessible financial data from Yahoo Finance, it is possible that it is not entirely accurate or a good indicator of how 5G will affect stock prices in the long run. Furthermore, the focus is narrowed to European telecom operators, so it is possible that the results only apply to some regions or sectors. Finally, even though an effort was made to account for other potential influences on share prices, findings may still be affected by unmeasured variables. In this study, no human subjects were involved as no personal data or sensitive data was collected. Therefore, no ethical considerations were relevant to this research.

Table 1. The launch of 5G technology

Operator	Ticker	Date
Elisa Oyj	ELISA.HE	June 27, 2018
Telia Company AB	TELIA.ST	December 05, 2018
Swisscom AG	SCMN.SW	April 10, 2019
Vodafone Group PLC	VOD.L	May 14, 2019
Deutsche Telekom AG	DTE.DE	June 03, 2019
Telecom Italia SpA	TIT.MI	June 25, 2019
Telenor ASA	TEL.OL	March 13, 2020
Orange S.A	ORA.PA	December 03, 2020

Table 1 presents the sample of this study. This sample includes eight European telecommunications operators across Europe. They were implementing 5G technology between 2018 and 2020. Among these operators, Elisa Oyj was the first to introduce 5G in Europe on June 27th, 2018 (Elisa, 2018). Then, Telia Company AB launched 5G in Sweden on December 5th, 2018 (Telia Company, 2018). Swisscom AG followed suit by implementing 5G in 54 cities and communities throughout Switzerland on April 10th, 2019 (Hüsler, 2019). Vodafone Group PLC launched 5G in seven cities across the United Kingdom on May 14th, 2019 (Vodafone UK, 2019). Deutsche Telekom AG introduced 5G in Germany on June 3rd, 2019 (AG, 2019). Telecom Italia SpA launched 5G in five Italian cities on June 25th, 2019 (TeleGeography, 2019). Telenor ASA launched 5G in Norway on March 13th, 2020 (Telenor Group, 2020). Orange S.A. launched 5G in 15 cities throughout France on December 3rd, 2020 (Orange, 2020).

2.3. Methodology

The EURO STOXX 50 index served as a benchmark for comparing the share prices of European telecom operators. A stock market index that includes 50 major companies in 18 European countries, including major players in the telecom industry, is known as the EURO STOXX 50 (Qontigo, n.d.). The index is widely employed as a benchmark for the performance of the European stock market. It provides a useful reference for comparing the share price performance of telecom operators across different countries and time periods.

A company's stock prices can change due to market factors, such as interest rates or industry news, resulting in a normal return. However, an abnormal return may occur during a specific event or period, which normal market factors cannot explain. This excess return affects that event's effect on company's stock (Fama & French, 1992). The purpose of this is to evaluate abnormal returns (AR) of the telecommunications operators' actions and the announcement of the adoption of 5G. The market-adjusted method is an alternative option to a regression method that has been used in this research. The AR, which represents the difference between actual and expected returns based on market factors, should be zero in the absence of announcements regarding the adoption of 5G. The market index is used in this technique as a substitute for the market return. The anticipated return for the stock is determined by multiplying the market index return by the stock's beta. The value can be interpreted as a simple return due to the event. AR is the difference between the actual and the expected return based on Capital Asset Pricing Model (CAPM).To calculate AR using the market model method is as follows:

$$AR_{i,t} = R_{i,t} - (\alpha_i + \beta_i R_{m,t}) \quad (1)$$

The cumulative abnormal return (CAR) is the sum of the abnormal returns over a specific time period. It enables investors to assess the performance of a security or asset over a particular time frame, which is beneficial given that abnormal returns over brief windows frequently exhibit bias. Investors can use abnormal returns to monitor the performance of a single asset or a collection of assets compared to a predetermined benchmark, typically established using the CAPM equation. Abnormal returns enable investors to gauge the real magnitude of gains and losses by using the market return as a benchmark (CFI Team, 2023). The event window (-10,10) and the announcement of 5G technology as the event date were used in this research to compute the AR and CAR for each of the eight European telecom operators. The AR was calculated as the difference between the actual and expected returns for each day in the event window.

The CAR was then calculated by summing the AR for each day in the event frame. To test the reliability of the findings, the CAR was also calculated using various event windows, such as (0,1), (0,5), (-5,5) and (-5,10). To calculate the CAR using the market-adjusted method, the AR for each event window is summed, as shown in the following formulas:

$$\mathrm{CAR}(t_{1,}t_2) = \sum_{t=t_1}^{t_2} AR_{i,t} \quad (2)$$

Where t1 is the starting point of the event window, and t2 is the ending point of the event window. The summation is taken throughout the event window. AR i,t represents the abnormal return of the ith stock on day t, calculated comparative to its expected return based on the market model. For example, if the event window is (0,1) the equation is the following:

$$\mathrm{CAR}(0,1) = \sum_{t=t_0}^{t_1} AR_{i,t} \quad (3)$$

In the context of a given event, when the time frame falls within the range of (-5,10). Then the equation is the following:

$$\mathrm{CAR}(-5,10) = \sum_{t=t_{-5}}^{t_{10}} AR_{i,t} \quad (4)$$

In event studies, the t-statistic is a commonly used metric to evaluate the statistical significance of abnormal returns. Abnormal returns refer to the difference between expected and actual returns. These returns determine how an event has influenced a company's stock price. To calculate the t-statistic, one should divide the cumulative abnormal return (CAR) by the product of the standard deviation of the abnormal return (sdAR) and the square root of the length of the event window (L) in days. This formula is expressed as:

$$t_{CAR_i} = \frac{CAR_i}{\sqrt{L} \times sdAR_{i,}} \quad (5)$$

The t-statistic helps to determine whether the abnormal returns observed during the event window are statistically significant or can be attributed to random chance. A higher t-statistic indicates a greater deviation of the abnormal returns from what would be expected by chance and, thus, a higher level of statistical significance. By using the t-statistic to assess the significance of the observed abnormal returns, event studies provide a rigorous and quantitative framework to evaluate the impact of specific events on stock prices. The t-statistic is a widely accepted measure of statistical significance in finance and is used by researchers, analysts, and investors alike to make informed investment decisions.

3. EMPIRICAL RESULTS

This chapter presents the findings of the event study analysis conducted on the impact of 5G technology adoption on the share prices of eight European telecom operators. The analysis sample has data collected six months before and after the companies announced their 5G adoption plans. The cumulative abnormal returns (CAR) were calculated to measure the event's impact on the companies' share prices. The study also investigates the relationship between the magnitude of the event and the abnormal returns generated.

3.1. Statistical Analysis of abnormal returns

The primary measure of abnormal returns used in this study is the CAR, which is the cumulative sum of the differences between the actual and expected returns over the event window. The event window for this study is defined as 21 days, from ten days before to ten days after the companies' announcement of 5G adoption. The expected returns were estimated using the market model, which is a widely used method for estimating expected returns based on the stock's historical performance.

Table 2: CAR Descriptive Statistics

Variables	Mean	Median	Std. Dev	Min	Max
CAR(0,1)	-0.0054	-0.0004	0.0244	-0.0498	0.0254
CAR(0,5)	0.0013	-0.0018	0.0258	-0.0404	0.0493
CAR(-5,5)	0.0262	0.0322	0.0534	-0.0660	0.1212
CAR(-5,10)	0.0304	0.0322	0.0339	-0.0222	0.0726

Source: Author’s calculations

The following table presents the descriptive statistics for CAR’s (cumulative abnormal returns) for all eight telecom operators. CAR’s were calculated for different event windows: CAR (0,1) for the first day after the event, CAR (0,5) for the first five days after the event, CAR (-5,5) for the five days before the event, and CAR (-5,10) for the ten days before and after the event.

On the day after the 5G adoption announcement, the average CAR (0,1) for all eight operators is -0.0162, indicating a negative average abnormal return. There is a slight difference between the mean and median, which is -0.0115. The standard deviation is 0.0243, indicating a relatively high variation in the abnormal returns across the eight operators. Among the operators, the minimum CAR (0,1) is -0.0528, indicating a particularly large negative abnormal return, while the maximum is 0.0143, indicating a small positive abnormal return.

In both CAR (0,5) and CAR (-5,5), the mean CARs are negative, and the standard deviations are relatively high, which indicates variation in abnormal returns across operators. Some outliers have particularly negative returns, as the median CAR(0,5) is less negative than the mean. The CAR (-5,10) has a positive mean and median, indicating a small positive abnormal return for the ten days surrounding the event, though the standard deviation is relatively high, indicating some variation across operators.

Table 3: Cumulative Abnormal Returns for Eight Companies Across Four Event Windows with P-Values.

Ticker	CAR(0,1)		CAR(0,5)		CAR(-5,5)		CAR(-5,10)	
	CAR	p-value	CAR	p-value	CAR	p-value	CAR	p-value
ELISA.HE	-0.0005	0.977	0.0224	0.431	0.0608	0.116	0.0567	0.192
TELIA.ST	0.0228	0.153	0.0493	0.075*	0.0436	0.243	0.0705	0.118
SCMN.SW	0.0096	0.475	0.0013	0.957	-0.0285	0.364	-0.0160	0.672
VOD.L	-0.0498	0.008**	-0.0404	0.204	-0.0660	0.126	-0.0222	0.668
DTE.DE	-0.0003	0.976	-0.0048	0.789	0.0092	0.705	0.0174	0.550
TIT.MI	-0.0225	0.451	-0.0245	0.635	0.0332	0.634	0.0726	0.390
TEL.OL	-0.0276	0.091	-0.0048	0.789	0.1212	0.002**	0.0327	0.391
ORA.PA	0.0254	0.204	0.0116	0.737	0.0025	0.957	0.0316	0.576

Source: Author’s survey

Note: Significance levels are indicated by * for $p < 0.1$, ** for $p < 0.05$, and *** for $p < 0.01$

Table 3 illustrates the cumulative abnormal returns (CAR) for each of the eight telecom operators included in the study. The table provides insight into the impact of 5G adoption announcements on each operator's share price—notably, VOD.L experienced a significant negative abnormal return in the immediate aftermath of their announcement (**$p < 0.05$), with a CAR (0,1) value of -0.0498. This negative trend continued in the CAR (0,5) period, with a value of -0.0404 ($p > 0.05$). In contrast, TELIA.ST experienced a positive CAR (0,5) of 0.0493 ($p < 0.1$), indicating a potentially significant positive abnormal return in the five days following their 5G adoption announcement.

The table also shows the CAR values for longer periods, including CAR (-5,5) and CAR (-5,10), which provide insight into the longer-term impact of 5G adoption on share prices. ORA.PA experienced negative CAR values across all periods, indicating a sustained negative trend following their announcement. The negative trend was most significant in the CAR (-5,10) period, with a value of -0.0660 ($p < 0.05$). Conversely, TIT.MI experienced a positive CAR (-5,10) of 0.0726 ($p < 0.1$), indicating a potentially significant positive impact on share prices in the ten days following their announcement. ELISA.HE and SCMN.SW experienced positive CAR (0,5) values of 0.0224 and 0.0013, respectively, but these results were not statistically significant at the *$p < 0.1$ level.

In table 4 from appendix, the abnormal returns of eight telecom operators are displayed in the announcement of their adoption of 5G technology. Table 4 presents the analysis results, which show the abnormal returns of eight telecom operators in the days surrounding the announcement of their 5G plans. It is important to note that Day 0 represents the day of announcing the operator's 5G launch.

The analysis results indicate that the 5G announcement had a mixed impact on the share prices of European telecom operators. Specifically, on the day of the announcement, Vodafone (VOD.L), Deutsche Telekom (DTE.DE), Telecom Italia (TIT.MI), and Telenor (TEL.OL) experienced negative abnormal returns, while Orange (ORA.PA) had a small positive abnormal return. In contrast, ELISA.HE, Telia Company (TELIA.ST), and Swisscom (SCMN.SW) experienced positive abnormal returns on the announcement day. Over the following days, the impact of the 5G announcement continued to vary across the telecom operators. Notably, Telia Company (TELIA.ST) and Swisscom (SCMN.SW) continued to experience positive abnormal returns in the days following the announcement. Conversely, Deutsche Telekom (DTE.DE) and Telenor (TEL.OL) continued to experience negative abnormal returns in the days following the announcement. The other operators experienced mixed results over this period. It is worth noting that the announcement's impact on abnormal returns varied across operators, implying that other factors, such as the operator's 5G implementation plan or historical performance, may have influenced the market's response.

Based on the last model, table 5-T-statistics for cumulative abnormal returns, the t-statistics presented in the table, we can observe that VOD.L experienced a negative abnormal return during the first day of the event period. This is evident by the statistically significant t-statistic of -2.739 at the 5% level—similarly, TEL.OL saw a positive abnormal return during the (-5,10) event window, as indicated by the statistically significant t-statistic of 3.193 at the 5% level. However, most other CAR estimates in the table do not have statistically significant t-statistics. This suggests insufficient evidence to reject the null hypothesis of no effect—for instance, ELISA.HE, DTE.DE, and SCMN.SW have relatively small t-statistics that are not statistically significant at conventional levels. In contrast, the CAR results for TEL.OL showed a statistically significant positive abnormal return at the event window (0,1) with a t-statistic of -1.706 (p-value = 0.091), indicating that the market reacted positively to the news about TEL.OL during the first day of the event period. The t-statistic of -1.706 suggests that the observed abnormal return is -1.706 standard errors away from what would be expected underneath the null hypothesis. While this p-value is not significant at the conventional level of 0.05, it is close to the significance and suggests some evidence of a positive market reaction to the news.

The positive CAR values persisted until the event window (0,5) (t-statistic = -0.268, p-value = 0.789), but there was no statistically significant abnormal return beyond that. The t-statistic of -0.268 suggests that the observed abnormal return is only -0.268 standard errors away from what would be expected underneath the null hypothesis. This t-statistic is not statistically significant, indicating no clear evidence of a persistent positive market reaction to the news about TEL.OL beyond the first few days of the event.

CAR results for DTE.DE showed a statistically significant negative abnormal return at the event window (0,1) with a t-statistic of -0.030 (p-value = 0.976), indicating that the market reacted negatively to the news about DTE.DE during the first day of the event period. A t-statistic measures how many standard errors a sample statistic is away from the null hypothesis. The null hypothesis assumes that in this situation, there is no effect of the 5G announcement on the share price of DTE.DE. The t-statistic of -0.030 suggests that the observed abnormal return is only 0.030 standard errors away from what would be expected underneath the null hypothesis. While this t-statistic is not statistically significant, it indicates some evidence of a negative market reaction to the news. The negative CAR values persisted up to the event window (-5,5) (t-statistic = 0.380, p-value = 0.705), which suggests that the adverse market reaction persisted over a more extended period. The t-statistic of 0.380 suggests that the observed abnormal return is 0.380 standard errors away from what would be expected underneath the null hypothesis. This t-statistic is not statistically significant either, but it provides additional evidence that the 5G announcement may have a negative effect on the share price of DTE.DE.

Overall, the results suggest that the market reacted differently to the news about these companies, with DTE.DE showing an adverse market reaction that persisted over a more extended period, while TEL.OL showed a positive market reaction limited to the first few days of the event. The other companies showed mixed results, with some indicating positive abnormal returns and others showing no statistically significant abnormal returns. The t-statistics provide important information about the strength and significance of these observed abnormal returns, allowing us better to understand the market reactions to the 5G announcement.

3.2. Discussion

This section will explain the hypotheses and how they relate to the findings. Additionally, it is vital to acknowledge the study's limitations and suggest potential routes for future research.

In general, CAR values in Table 2 indicate that the impact of 5G adoption announcements on share prices varies across operators and periods. Some operators experience notable negative impacts in the short term, while others experience positive impacts. The adoption of 5G technology is a significant event that investors closely follow and can significantly impact share prices. The irregular returns show that the market's reaction to telecom operators' announcements of 5G adoption was mixed and not uniform. The analysis revealed interesting patterns regarding the impact of 5G adoption announcements on the share prices of telecom operators. For the CAR values for each of the eight operators in the study, TEL.OL experienced a significant negative abnormal return immediately following their announcement, while ELISA.HE experienced a significant positive abnormal return. The table also provided insights that the announcement of 5G adoption had a mixed impact on the abnormal returns of the operators, with some experiencing positive and statistically significant abnormal returns. The significance of abnormal returns varied across operators, with some having positive abnormal returns and others having negative ones. As Joseph Schumpeter described, the theory of creative destruction could explain this phenomenon. Innovation involves the replacement of old ideas and technologies with new ones. Although 5G technology has the potential to create new opportunities for telecom operators and shake up existing industries, this process may take time to happen. It could take some time for everything to unfold fully. Research (Mazzucato, 2006) supports the idea that innovation and uncertainty are essential in shaping market behaviour and investor decision-making. Her work suggests that periods of radical innovation can lead to herd behaviour and the mispricing of stocks, which highlights the need for a deeper understanding of the dynamic feedback between innovation and uncertainty in the market valuation process. In summary, this research adds to the growing body of literature recognising the importance of innovation and uncertainty in shaping market behaviour and investor decision-making.

The main hypothesis was defined in the following way: The introduction of 5G technology positively affects the share prices of European telecom operators. After analysing the results, indicators are that the introduction of 5G technology did not significantly affect the share prices of the telecom operators considered in this study. The CAR and AR values were not statistically significant at conventional levels, and the direction of the effect was mixed. For Deutsche Telekom, the CAR and AR values did not provide enough evidence to reject the null hypothesis, which states that introducing 5G technology does not affect the share prices of European telecom operators. Similarly, the CAR and AR values did not suggest a significant impact of 5G technology on share prices for Swisscom. For Telenor, the CAR and AR values analysis revealed a mix of positive and negative abnormal returns on different days, without a consistent pattern of abnormal returns that would suggest a significant positive or negative effect of 5G technology on Telenor's stock prices. Finally, for Telecom Italia, CAR and AR values were not statistically significant, and there was no significant abnormal return for any event windows.

Factors other than the implementation of 5G technology, such as economic conditions or industry-specific events, may play a more significant role in impacting the stock prices of telecommunications companies. After analyzing eight European telecom operators, it is still being determined whether the introduction of 5G technology positively impacts their share prices. Some operators showed positive CARs and statistically significant t-statistics, while others showed negative CARs and insignificant t-statistics. Therefore, there is a necessity for more research to provide sufficient evidence to accept or reject the hypothesis and to arrive at conclusive results.

The second hypothesis was defined in the following way: The launch of 5G technology has a more positive effect on companies that have been the industry's first movers. Hypothesis H2 was rejected based on the study results. Specifically, Elisa and Telia did not produce statistically significant results in their cumulative abnormal returns (CAR) compared to the other six operators. While Elisa and Telia exhibited positive CAR results in almost all event windows, the study observed a negative CAR result in Elisa's (0,1) event window. Two of the remaining six operators had positive CAR results, leading to the rejection of the second hypothesis. Moreover, Elisa and Telia's abnormal returns (AR) were positive on the day following the event, whereas five of the other six operators did not show positive AR. However, the positive AR for the first movers did not provide significant evidence to support the second hypothesis, as the magnitude of Elisa's abnormal return on the day after the event was only 0.0045.

In conclusion to, the research question, the adoption of 5G technology has had mixed effects on the share prices of European telecom operators. The effects vary depending on the specific stock and the time period analysed. Some share prices experienced positive cumulative abnormal returns, while others experienced negative returns. However, none of the CARs are statistically significant at the 5% level. Therefore, we cannot conclude that the adoption of 5G technology has significantly impacted the share prices of European telecom operators. This result could be due to an economic and political uncertainty, or other unfortunate events. One reason can be that many of the companies 5G launch was at the time of Covid-19. Selling pressure and prices for many stocks decline, when negative news arises, and it is common for people to sell their stocks.

CONCLUSION

This thesis examined the impact of 5G technology on the share prices of eight different European telecom operators using an event study analysis.

The aim of this study was to find out whether the launch of 5G technology has any reaction on different telecommunication operators' share price across Europe since the 5G has been a major change in the industry. After finding the aim the research question was formulated. What is the impact of 5G technology on the share price of European telecom operators, and how does this impact vary across different companies? Based on the research question and the aim the main and second hypothesis were developed.

> H1: The introduction of 5G technology positively affects the share prices of European telecom operators.
> H2: The launch of 5G technology has a more positive effect on companies that have been the industry's first movers.

The economic contributions of 5G technology did not align with the results obtained from various tables, as the statistical significance needed to be more significant.

After analysing the results, both the first and second hypotheses were rejected. I found that the adoption of 5G technology has not had a significant short-term positive effect on share prices, even though there is a slight short-term positive effect of 5G technology on share prices with some operators. As the second hypothesis was also rejected, where Elisa and Telia had no significant cumulative abnormal returns, results compared to the other six operators. Although Elisa and Telia demonstrated positive cumulative abnormal return results in almost all event windows. Furthermore, Elisa and Telia's abnormal returns (AR) were positive the day following the event, while five of the other six operators did not exhibit positive abnormal returns. However, the positive AR shown by the first movers did not provide enough evidence to support the second hypothesis.

The research focused on examining the impacts of 5G technology on the share price of European telecom operators and how it has impacted among different operators. By analyzing the data, we have obtained insightful results on the matter, and it can be concluded that the results were inconclusive and lacked statistical significance.

Telecom operators, investors, and policymakers can benefit from the findings of this thesis. Investors should consider the long-term potential of 5G technology rather than expecting immediate gains. Policymakers should continue to support the development and adoption of 5G technology as a crucial component of economic growth. Telecom operators should communicate realistic expectations to their investors and focus on long-term strategies rather than short-term gains.

To provide direction for future research, it would be interesting to investigate the long-term effects of 5G adoption on the telecom industry, including its influence on competition, innovation, and investment. Furthermore, exploring the potential opportunities and challenges that arise from 5G technology for other industries and sectors, such as healthcare, transportation, and energy, would be beneficial.

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APPENDICES

Appendix 1. Estimates of abnormal returns

Table 4: Abnormal returns

Day(t)	ELISA.HE	TELIA.ST	SCMN.SW	VOD.L	DTE.DE	TIT.MI	TEL.OL	ORA.PA
-10	-0.0018	-0.0019	-0.0015	0.0123	0.0136	0.0392	0.0022	0.0336
-9	-0.0032	-0.0020	-0.0002	-0.0091	-0.0136	-0.0053	0.0037	0.0070
-8	-0.0073	0.0051	-0.0007	0.0002	-0.0019	0.0040	0.0345	0.0056
-7	0.0011	0.0121	-0.0010	-0.0004	0.0064	-0.0056	0.0151	0.0001
-6	0.0015	0.0102	0.0063	0.0014	-0.0021	0.0035	-0.0005	0.0019
-5	0.0150	0.0049	-0.0138	0.0114	0.0076	0.0109	-0.0027	-0.0028
-4	0.0033	-0.0019	-0.0102	0.0005	0.0053	0.0093	0.0130	0.0000
-3	0.0074	-0.0014	-0.0105	0.0013	0.0018	0.0172	0.0075	-0.0104
-2	0.0100	-0.0130	-0.0025	0.0043	0.0026	0.0370	-0.0090	-0.0049
-1	0.0027	0.0056	0.0071	-0.0432	-0.0034	-0.0166	-0.0096	0.0090
0	-0.0049	0.0043	0.0119	-0.0422	0.0044	-0.0030	0.0094	0.0133
1	0.0045	0.0184	-0.0023	-0.0077	-0.0047	-0.0195	-0.0370	0.0121
2	-0.0054	0.0122	-0.0120	-0.0150	0.0031	0.0116	0.0618	-0.0006
3	0.0096	0.0097	0.0110	-0.0003	0.0040	-0.0051	0.0672	-0.0028
4	0.0026	0.0065	-0.0011	0.0281	-0.0041	0.0013	0.0206	0.0123
5	0.0161	-0.0019	-0.0062	-0.0033	-0.0075	-0.0098	-0.0156	-0.0227
6	-0.0005	-0.0081	0.0016	-0.0006	0.0115	0.0228	-0.0399	0.0034
7	0.0040	0.0238	0.0074	-0.0069	-0.0012	0.0135	-0.0308	0.0085
8	-0.0117	0.0089	-0.0093	0.0211	-0.0028	0.0025	-0.0279	0.0064
9	-0.0074	-0.0022	0.0033	0.0083	-0.0030	-0.0040	0.0239	-0.0016
10	0.0117	0.0046	0.0095	0.0219	0.0037	0.0046	0.0019	0.0123

Source: Mentula (2023), Author's calculations.

Appendix 2. T-statistics for cumulative abnormal returns

Table 5: T-statistics for cumulative abnormal returns.

Ticker	CAR(0,1)		CAR(0,5)		CAR(-5,5)		CAR(-5,10)	
	CAR	t-statistic	CAR	t-statistic	CAR	t-statistic	CAR	t-statistic
ELISA.HE	-0.0005	-0.0283	0.0224	0.0610	0.0608	0.0570	0.0567	0.0240
TELIA.ST	0.0228	1.4390	0.0493	1.7990	0.0436	1.1740	0.0705	1.5760
SCMN.SW	0.0096	0.7170	0.0013	0.0540	-0.0285	-0.9110	-0.0160	-0.4240
VOD.L	-0.0498	-2.7390	-0.0404	-1.2820	-0.0660	-1.5470	-0.0222	-0.4310
DTE.DE	-0.0003	-0.0300	-0.0048	-0.2683	0.0092	0.3800	0.0174	0.5600
TIT.MI	-0.0225	-0.7580	-0.0245	0.4510	0.0332	0.4770	0.0726	0.6340
TEL.OL	-0.0276	-1.7060	-0.0048	-0.2683	0.1212	3.1927	0.0327	0.8620
ORA.PA	0.0254	1.2760	0.0116	0.3370	0.0025	0.0530	0.0316	0.5610

Source: Mentula (2023), Author's calculations.

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