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How Social Media usage by managers affects corporate value: The case of Elon Musk

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Abstract

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The emergence of social media has revolutionized the world where this innovation has erased boundaries, created a new reality and brought color to people's lives. Online platforms have an effect similar to an epidemic, since almost everyone who uses the Internet is present on social networks. Initially, this worldwide phenomenon started by providing freedom of expression to its users, allowing them to be architects and creators of content, promoting themselves on a large scale, having greater visibility and more exposure. Everybody is interconnected through this virtual world. So, social networks have become a privilege not only for the CEOs, who can use them to make announcements about companies and new events, to promote actions of solidarity and Corporate Social Responsibility, but it also gave organizations the opportunity to be closer to their customers and receiving their feedback more easily, publicizing their products and services more efficiently. The constant use of social media has led to an increase of free information, which has driven investors to analyze the sentiment and opinions expressed in these platforms, and determine whether there is any relationship between the emotion intrinsic to the message broadcasted and the stock price changes. This dissertation aims to demonstrate that CEOs' online messages on social media can influence not only their reputation, integrity and credibility, but also affect stock prices. Elon Musk's tweets are used as a reference to verify whether online posts on Twitter have an impact on investors' opinions and trigger movements on the stock market or not.

Abstract (Portuguese Version)

Título: How Social Media usage by managers affects corporate value: The case of Elon Musk

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Palavras-Chave: Redes Sociais; Twitter; Preço das ações; Sentimento; CEO celebridade.

O aparecimento das redes sociais transformou o mundo onde vivemos, trouxe novos mundos ao mundo, criando uma realidade paralela àquela em que vivemos. As redes sociais tiveram um efeito semelhante ao de uma epidemia, porque grande parte das pessoas que usam a internet têm redes sociais. Inicialmente, este fenómeno mundial começou por promover liberdade de expressão aos seus utilizadores e permitiu-lhes serem os arquitetos, criadores de conteúdo, divulgando-o a uma larga escala, tendo maior visibilidade e exposição. Como se pode constatar, neste mundo virtual, estamos todos interligados, pelo que estas plataformas sociais tornaram-se um privilégio, não só para os CEOs, onde estes podem comunicar novidades relativamente às empresas e a novos eventos, demonstrar responsabilidade social e promover ações de solidariedade, como também para as empresas, já que lhes permite estar mais perto dos seus clientes, receber *feedback* quase imediato e promover os seus produtos e serviços. O uso constante das redes sociais conduziu ao aumento de informação disponível, levando os investidores a analisarem os sentimentos e opiniões expressos e a constatar se há alguma relação entre a emoção intrínseca à mensagem nas plataformas sociais e as alterações nos preços das ações. Esta tese pretende mostrar que as publicações nas redes sociais, feitas pelos CEOs, podem influenciar não só a sua reputação e credibilidade, como também os preços das ações. Nesta tese, usam-se como referência os *tweets* de Elon Musk para verificar se as mensagens online partilhadas na rede social Twitter podem ter um impacto no mercado de ações ou não.

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1. Introduction

The days where the book is a speechless object that talks, are completely gone. Nowadays, the world is ruled by much faster and more effective tools. Thus, the knowledge is no longer in the book anymore, instead it is at distance of a computer key, a phone touch, a costless click from home.

Social media has become a worldwide phenomenon, considered essential and important by many. Yet, this term still is a vague and undefined topic. What comes to people's mind, in the first place, are famous networks as Facebook, Twitter, Instagram, Snapchat, LinkedIn, YouTube and Tik Tok, where any person can be the architect and designer of their own content and present their creations to a larger crowd. Over the years, organizations have increased their presence and engagement on social media, once they view it as a prominent marketing tool where they can promote themselves freely and faster; reinforce the vision and mission directly to those people who are already consumers, and possibly attract new clients and investors; make announcements about new events; demonstrate corporate social responsibility; show potential collaborations and present desired products; and have the benefit to receive instant feedback. Nowadays, a brand is not how the company defines it, it is instead how customers perceive it and label it, and then communicate their opinion to others. The consumers have been using social networks as a shortcut, to share their sentiment and thoughts about the brands and companies that they follow. So, this new way of electronic word-of-mouth is a major factor in attracting organizations to be involved in social media, because it is more powerful and persuasive than the traditional media and the general marketing events.

Everyone, without exception, must realize that, although social media personifies perfectly the freedom of speech, it is not a diary. For this reason controversial opinions and problematic commentaries should not be shared, but only well-defined messages and structured information, as online posts can be seen by everybody and they can also be shared by any user and be reviewed at any point in time.

Companies have already made their way into these platforms, so what about the chief executive officers? Are the CEOs present on social networks? The answer is yes, however, in a reduced number. CEOs are becoming more involved with social media, but they still do not entirely comprehend how their actions and activities on social media can impact on many aspects, such as their credibility, public image, reputation and also the company that they work for. They are the face of their organizations, so it only makes sense for them to be friendly,

social, polite, sincere and behave correctly. CEOs' attitudes must incorporate ethic and morals, CEOs must perform at higher standards, it is not sufficient to just act as a regular person.

Ultimately, social media cannot be viewed merely as a marketing tool. Over the last years, a financial role has been attributed to it. Social platforms can be perceived as strategic tools which have been used to anticipate movements in the financial market, to help predict the stock price based on the analysis of sentiments from investors' online messages. As Abraham Lincoln and Angle (1991) stated:

> *"(...) public sentiment is everything. With public sentiment, nothing can fail; without it nothing can succeed. Consequently, who moulds public sentiment, goes deeper than who enacts statues or pronounces decisions. He makes statutes and decisions possible or impossible to be executed." (p. 128)*

From all the social media mentioned above, Twitter is the one that is most business-directed, because it is a microblogging platform that allows users to write messages, tweets, with only 280 characters length, which "force" people to be precise, meticulous and direct in what they intend to say. This platform promotes real-time data and information, which allows people to connect with each other, about news that are important to them. The majority of people who use twitter do not go there to tweet, but simply to get informed about what is happening around the world, to check the topics on the trend list, to search for disclosure of topics that would interest them, which might influence the sentiment, behavior and decision-making process of consumers.

Jansen, Zhang, Sobel, and Chowdury (2009) stated that approximately 19% of the tweets mention or are related to brands or organizations. In 80% of these Twitter posts, which are associated with product brands, people aim to seek information and ask questions about it. The remaining 20% of these tweets that mention brands have a sentiment, feelings and opinions attached to them, regarding the products or services of the company that the brand belongs to.

So, CEOs, as the face of organizations, must be active and present on social media, but mainly on Twitter, ensuring that everyone understands the plans and behavior adopted by the company, and make sure that all the questions about their brand are answered, in order that people formulate an actual, factual and detailed opinion, and consequently improve their sentiment about their products.

This dissertation aims to demonstrate that Elon Musk tweets can not only affect his public image and Tesla Inc reputation, but his Twitter posts can also influence the stock price. This dissertation intends to answer three questions:

i. What is the importance of social media and why CEOs and companies must be present in them?
ii. Why, from all social media, is Twitter considered the most effective, superior and substantially better when compared to others?
iii. Do tweets from CEOs affect the behavior of consumers, the investors' sentiment, and can they influence the changes on stock price?

This thesis is divided into two main parts: the first one focuses on the definition and the importance of social media, the impact of social networks, the characteristics that a CEO must have in order to be successful and outperform others, and the reasons why Twitter is the best social platform for CEOs to be present on social media; the second part demonstrate how social media can influence movements on the financial market and how, specially Twitter, may have an impact on the stock price. The following section, Section 3, presents the data and methodology which briefly shows the process how the tweets are collected through programming language python and how the abnormal returns were calculated. Further, Section 4 displays discussion and results of the analysis that were performed and the respective interpretations, illustrating the effect that Elon Musk's tweets have on Tesla Inc stock price, on the organization itself, and the impact on his person. Section 5 will present the conclusion, and lastly, Section 6 shows the limitations and future research.

2. Literature Review

2.1 Social Media

2.1.1 Definition of Social Media

Technology is reshaping the world. Since its appearance and continuous progress, humanity took a magnificent 180º turn. This globe, where we have been living, experienced itself, a real metamorphosis. While in the past we used to move slowly on the ground, to meet friends, travel, go shopping, pay bills, and to search for any type of information, in today's reality we can "fly" like a butterfly. Nowadays, all these things can be done without going out of our houses, with a costless click.

From a scientific perspective, technology has given the world new worlds, helping to improve medicine and discover new processes to delay the effects of diseases as: cancer, Alzheimer, Parkinson, HIV, and the list goes on. Society is completely influenced by new technology, it is dictating the trajectory of our present and future because it is constantly changing. What used to be considered impossible yesterday, today can be perceived as a regular, trivial thing, and what now is mainstream, tomorrow can be entirely obsolete.

Alongside technology, the Internet was invented in 1992 and, years after, in 2004, the "beloved child", Social Media, was born, which is an expression thrown around a lot during the last decade. However, this is still a vague subject, mainly used to describe nearly every website. This term may be personified as Tree Diagram, and then be interpreted as a system of relationships, where the nodes represent the actors, and the edges are the relationships between those actors or *"group of Internet-based applications that are built on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content."* (Kaplan & Haenlein, 2010, p. 61). The objective behind the birth of social media was due to the fact that humans are not an "island", we are gregarious beings, with an intrinsic desire to discuss gossips, share knowledge, talk about news and rumors.

These Social Networks exist in every single format (blogs, social gaming, photo-sharing platforms, business network, microblogs, discussion forums and chat apps, podcasts) such as: Facebook, founded in 2004, allows users to post and share content quickly, join groups, with common interests, send messages and talk with friends and family, through videocalls and

messenger. It is also possible to buy or sell items, on the marketplace section. Facebook has approximately 2.50 billion users, being the largest social media platform, according to Statista.

Instagram, established in 2010, is an online platform, where the purpose is to share photos, videos, daily stories, and then customize them with filter effects, making them more appealing and elegant to the human eye. This company is attracting more and more followers, making it the second most engaged social network. Instagram has over 1 billion users, according to Statista (just for curiosity, Cristiano Ronaldo is the person with more followers, approximately 206 million).

Twitter is a micro-blogging service, created in 2006, recognized as *"the SMS of the Internet"* (D'Monte, 2013, para. 8), that focus mainly on self-expression and "discussion", in real time, enables consumers to write abbreviated and meticulous messages, with a limited length of 280 characters, well-known as Tweets. Also, Twitter gives consumers the opportunity to retweet, that is, to repost another user's posts attaching one's own comments to it, and still give credit to the creator. This stage provides a list of topics that are trending at the moment, around the world, keeping you informed. This application has become notorious for being, most of the times, the first one to contribute with news and fresh information. In addition, this service offers the opportunity to use Twitter developer, which allows users to create and access Rest and premium APIs that enable Twitter users to collect data and post automatic messages through programing language. This micro-blogging service has 386 million users, according to Statista.

WhatsApp is an online platform, set up in 2013, that allows users to communicate with each other for free, through text and voice messages, or it is always possible to make videocalls. This app is mostly used by students because it gives them the possibility to create groups, where they can share documents, images, any type of file, and location. In 2018, this platform lunched a standalone business app, called WhatsApp Business. Its main target is small business companies, allowing owners to communicate with customers who use the standard WhatsApp client. WhatsApp has 2 billion users, according to the web page Statista.

LinkedIn is a professional network, established in 2003, that makes most of its goods available to its customers for free. It provides around 3 product lines: Talent Solution, which incorporates Recruiting, Learning and Development; Marketing Solutions and Premium Subscriptions. Its products are offered through two approaches: Online channel, a self-service platform that involves business and individual members purchasing subscriptions; and an offline field sales organization, that aims to help both big and small business consumers. In

2019, LinkedIn had 610 million members, available in approximately 200 countries, according to the website Statista.

YouTube, launched in 2006, is one of the largest, if not the world's biggest online video platform with an ample range of user-generated and company media content such as: music videos, original videos, television clips, video blogs, videos from gaming to educational content. Although most of its services are free (it is always necessary to keep in mind the term copyright, because its content underlies regional restrictions), in October 2015, this company launched YouTube Red, currently known as YouTube Premium, with the intention to offer original series; access to all the content, without advertising; and the ability to keep listening audio of the video even with the cellphone blocked, which is a dream option for the consumers. This firm had 2 billion users, in April 2020, according to Statista.

These websites previously described have common features as: profile pages, newsfeed, notifications, like buttons, friends or followers (the information presented about the number of users of the social media mentioned above was collected from the website Statista).

2.1.2 Social Media impact

There is a large amount of people constantly active, in the internet. Nearly every user on the internet has accounts in social media. They are more alive and involved in this virtual environment than in real life, expressing their opinions over innumerous networks. *"Social media is landscape-shifting"* (SEC, 2012, p. 1), it has completely revolutionized the way people interact with each other. It has changed the conventional two-way professional-client communication into an active and engaging multi-party dialogue between brands, investors, consumers, within a transparent interface available to a third-party witness. It has also helped to shift from a static framework as webpages, into a platform where consumers can create their own content and post it whenever they want.

There is a variety of elements that contribute to the corporation's success, being social media a key aspect that gives CEOs and firms an unmatched opportunity to participate in social interactions at a large scale, enabling us to put "ourselves" out there, which was not possible until social media was universally popularized. *"If your business is not on the Internet, then your business will be out of business"* (Bill Gates, 2017, para. 4).

Companies should not be only present on Social Media, once there is no point on just having an account in these platforms, without having any activity. Organizations and high-level executives must be active and proactive in order to create new dimensions of interactions to

further engage with their clients, proving their worth to new consumers, so they can increase their market share. *"A brand is no longer what we tell the consumer it is – it is what consumers tell each other it is."* (Scott Cook, 2012, para. 1). Organizations and CEOs must use their communication tools on social media, to bring and show brand awareness, that is, to disclose performance details, statistics, and inside information to possibly attract new investors, and to demonstrate Corporate Social Responsibility, which is very appreciated by the consumers, in order to boost their reputation and, as result, to eventually, expand. SEC (2013) stated that:

> *"The Securities and Exchange Commission today issued a report that makes clear that companies can use social media outlets like Facebook and Twitter to announce key information in compliance with Regulation Fair Disclosure (Regulation FD) so long as investors have been alerted about which social media will be used to disseminate such information." (para. 1)*

Although social media may be beneficial, it can be very problematic too, considering aspects like: i) fake news - at this point in time, it is necessary to be very careful, due to the fact that everything that we read on the internet, is not one hundred percent true; ii) self-image theft and manipulation - every person wants to be loved, to a degree where people steal and use photos from others to get more likes and followers; there are even individuals that try to manipulate their own lives by posting amazing daily pictures, expecting others to believe that they are living a perfect life, even if it does not correspond to reality; iii) cyberbullying, which is becoming more common, these days; iv) spam (clickbait and phishing) and fraud (websites like Airbnb are constantly duplicated into false websites). The Securities and Exchange Commission (2014) stated that "Social media lets fraudsters contact many different people at a relatively low cost. It is also easy to create a site, account, email, direct message, or webpage that looks and feels legitimate (…)" (para. 2).

As the great actor, Denzel Washington (2018), wrote on the Instagram page "Just because you don't share it on social media, it doesn't mean you are not up to big things. Live it and stay low key. Privacy is everything". In conclusion, it is extremely important to take into account security as well as privacy.

2.1.3 CEOs' Characteristics

Previous articles in the corporate finance and behavioral economics field studied that characteristics of firm executives can impact on corporate performance and consequently benefit shareholders or not. There are four major attributes that CEOs must pay attention to:

I) Reputation represents how the CEOs are socially viewed among others, their attitudes will be judged by other people, who will label them as good, unpleasant or charismatic people.

The reputation and image portrayed by the chief executives will influence the expectations of external stakeholders on how others view the CEOs, and then determine their involvement and identification with the companies. This is a method to measure the influence and recognize his or her performance. Rindova and Fombrun (1999) explained reputation of an organization as the stakeholder's expectations and opinions regarding the probability that the firm can demonstrate financial worth on key dimensions of performance and present sustainable competitive advantage. As it can be seen, the CEO's reputation, the organization accomplishments and its corporate performance go hand to hand. On September 9th, 2018 Elon Musk was a guest on *The Joe Rogan Experience* podcast. This interview lasted approximately two hours and a half, but only fifteen seconds were necessary to generate controversy, when Musk decided briefly to take two hits of a marijuana-tobacco joint. Even though marijuana is legal in California state, this situation deteriorated his public image, Tesla stock price plunged to $263.24, decreasing 6% from its previous price. This episode also made both Dave Morton and Gaby Toledano, the chief accounting officer and the chief people officer respectively, to resign only after one-month in the company. This situation escalated to the point where some of the investors asked the Board of Directors to replace Elon as the CEO, according to Sharma and Panchadar (2018), from the agency Reuters.

II) Status refers to a person's position in the society, ranks an individual in a hierarchy scale based upon honor, dignity, respect and prestige. This small term can be truly precious not only to the company, but mainly to the chief executive officer, in a way that it may bring privileges, valuable partnerships, more visibility, play certain roles in certain series or movies, get the best of deals, and endorsement opportunities. Podolny and Phillips (1996) declared:

> *"the expectation of higher quality from those who are higher in status generally results in cumulative advantages to the possession of status. To the extent that others have an expectation that the performance of a high-status actor will be superior, these others are more willing to commit resources to the actor. With these greater resources, the actor will be able to improve his or her performance, which will increase his or her status to a greater extent, which in turn will increase the resources on which the actor can draw, and so on." (p. 456)*

Podolny and Phillips (1996) also defend that:

> *"Higher status scientists are more likely to receive greater rewards for a given quality effort. For example, an article of a given quality is more likely to be widely read and cited if its author is high-status than if its author is low-status. This different return to the same quality effort, in turn, is likely to increase the status differential between the high-status and low-status actor." (p. 457)*

The status of a CEO is an extremely powerful intangible asset for the organization.

III) Legitimacy symbolizes the quality or state of being legit, it is a principle that acknowledges anything or anyone as authentic, within the norms of ethic and morals. It is

understood as widespread acceptance and public approval of a governing regime's authority. Suchman (1995) affirms "Legitimacy is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions." (p. 574). It is imperative for CEOs and the respective organizations to act according to the law, otherwise their reputation and legitimacy will be tarnished, or even reach the point of bankruptcy.

IV) Celebrity - there are several forms of defining this word: 1) According to Rein, Kottler, and Stoller (1987) it can be interpreted as an individual *"whose name has attention-getting, interest-riveting and profit generating value"* (p. 15); 2) McCracken (1989) announces that *"The number and variety of the meanings contained in celebrities are very large. Distinctions of status, class, gender, and age, as well personality and lifestyle types (...)"* (p. 312). McCracken (1989) also claims that *"Celebrities deliver meanings of extra subtlety, depth and power (...). Even when they deliver meanings that can be found elsewhere, they deliver more powerfully. Celebrities evoke the meanings in their persona with greater vividness and clarity."* (p. 315);

3) Gamson (1994) acknowledges two distinct approaches to interpret this expression: a) *"fame is deserved and earned, related to achievement and quality."* (p. 15); b) *"the publicity machine focuses attention on the worthy and the unworthy alike, churning out many admired commodities, called celebrities, famous because they have been made to be"* (p. 16); 4) Frank and Cook (1995) consider celebrities *"people of enormous talent, energy and drive"* (p. 8), who have possibly become one of the greatest in his or her job, and big enough to be capable of influencing the market; 5) Rindova, Pollock, and Hayward (2006) stated that there are two peculiar characteristics about this term: a) *"a social actor attracts large-scale public attention: the greater the number of people who know of and pay attention to the actor, the greater the extent and value of that actor's celebrity."* (pp. 50-51); b) *"(...) the actor elicits positive emotional responses from the public"* (p. 51). Additionally, Rindova et al (2006) suggest that the term celebrity stems from the relationship established between the actor and the audience, instead of being a particular characteristic of the actor.

When individual celebrities are at the top of their game, are the best in what they do and take into account these four aspects, they are able to achieve even mogul status, converting their names into valuable brands. For example, Jay-Z considered the best rapper alive, started his career as a hip-hop artist and now has a diversified portfolio of outstanding partnerships, with Samsung, Microsoft, and more recently with NFL, and has become CEO of Def Jam. As Jay-Z

stated *"My brands are an extension of me."* (2010, para. 7). He is the first billionaire in the music business.

Another worldwide icon, Cristiano Ronaldo is recognized as one of the greatest football players of all time, whose success inside the pitch contributed to his accomplishments outside of it. He and Lebron James are the only two athletes who have lifetime contract with Nike. His name is associated with prosperity, fulfillment, and triumph. He has multiple endorsements with other brands such as Herbalife Nutrition, TAG Heuer, MTG, MEO. He has also decided to turn his initials into a successful brand, CR7, which produces a variety of goods (footwear, underwear, denim and fragrances). According to Settimi from Forbes (2020), Cristiano Ronaldo is set to become the first billionaire soccer player, by the end of this season.

Furthermore, a CEO is not just a mere employee, instead he or she symbolizes the highest position in an organization, someone who is involved in key decisions and high-level processes, that ultimately will be responsible for the good or poor results. This highly visible position will represent the personality and the face of the company. In this contemporary world, journalists, paparazzi, electronic mass media are consistently looking for the "next big thing", always analyzing celebrity CEOs' attitudes, who are known and famous enough to arouse positive or bad emotions in others. So, CEOs from popular, notorious firms have to carry themselves carefully, always keeping in mind, their reputation, legitimacy and status. Hayward, Rindova and Pollock (2004) stated:

> *"CEOs at larger firms are more likely to become celebrities than those at smaller firms. Naturally, larger organizations are of greater interest to the public, and thus are more likely to receive greater volumes of media coverage. Larger firms and firms that have strong market positions, such as being the top firms in their industries, are more likely to have such performance and to become the focus of journalists' attention." (p. 639)*

Celebrity CEOs, besides having the same rights and responsibilities of regular chief executives, are public figures with a high profile who have a significant influence on society and people's lives and who get immense attention from the general public. These CEOs tend to obtain the confidence of shareholders more easily, and eventually trust their resources, due to their distinctive, consistent actions and bold speeches. Lovelace, Bundy, Hambrick and Pollock (2018) defended:

> *"We draw on theories of heroic drama and organizational life cycles to specify four prominent celebrity CEO archetypes: creators, who found new businesses and/or are credited with generating bold new innovations; transformers, who reshape currently successful firms to avoid potential future problems; rebels, who steer established firms in new directions that are widely at odds with industry norms; and saviors, who rescue established companies from imminent failure." (p. 420).*

One great example of a celebrity CEO is Elon Musk, who combines all the factors required to be one. Obviously, first because he is the chief executive officer of Tesla Inc, The Boring Company and Space X. Secondly, he has an assiduous presence on social media, mainly on Twitter, where he is followed by 35.9 million users, according to his Twitter page on June 15th 2020, and was considered one of the most influential people of it, in 2019 by Statista – his online activity is always a center of debate for his followers and media outlets. Additionally, Musk frequently attends public events, whether to present new models of Tesla cars or to be among other superstars at ceremonies as the 2018 Met Gala, a fundraising event, where he and his girlfriend, Grimes, made their first appearance as a couple, and where they were surrounded by famous guests as Rhianna, Bradley Cooper and Irina Shayk, Kim Kardashian, George Clooney, in this celebrity-oriented gala. In 2018, he was acknowledged as one of the world's most powerful people, ranking 25th position on Forbes list. Lastly, he belongs to the first category of celebrity CEOs mentioned earlier. Elon is a creator, an innovator, a truly visionary leader. SpaceX and NASA teamed up for a huge project and, on May 30th 2020, Musk company lunched two National Aeronautics and Space Administration astronauts to the ISS (International Space Station) for the first time. In 2024 he plans to send people to Mars, something never done before. In 2019, he was granted the title of the most innovative leader, by Forbes.

2.1.4 Why is Twitter more affective to the CEOs than other social media?

From all the social media, Twitter is the most prominent network used as an unfiltered communication channel that provides a faster, direct, short effective messages to a wide-scale public. But what is it that makes this social media so peculiar and more efficient than other media? This outlet offers the perfect environment to spread the right emotion because tweets are restrained to 280 characters, so this constraint inspires users to be precise and succinct. In opposition to Facebook, this platform leans to active business rather than personal communication. The consumers have been increasing substantially, from 30 million active users, in the first quarter of 2010, to 330 million in the first quarter of 2019, according to the website Statista, https://www.statista.com/statistics/282087/number-of-monthly-active-twitter-users/.

Twitter can be exploited as a marketing weapon, where CEOs broadcast positive real-time messages about their companies to their followers, boosting their popularity and sales, share future events and products, and get the proper feedback from their clients. *"(...) despite*

the abundance of available information and considerable noise, Twitter users follow the accounts to which they subscribe closely and are highly attentive to their content" (Sprenger & Welpe, 2010, pp. 21-22).

Thus, persons should be extremely conscious about what they post online. For instance, in 2019 Kevin Hart had to step down from hosting the prestigious Oscars ceremony due to a past homophobic tweet from 2011, which was brought to light and he refused to apologize to the academy.

This is the appropriate place where organizations must share legit and honest information about short additions of earnings releases, reveal and comment on future acquisitions and mergers to the actual shareholders and to potential investors, who do not have yet a financial stake on the company. For that reason, it can be possibly viewed as a powerful influencing tool. *"(...) Twitter-enabled social interaction can help to bring about tangible commitments from stakeholders that can in turn lead to stakeholder commitments, and intra-subjective outcomes."* (Fischer & Reuber, 2011, p. 11). Besides giving the opportunity to follow and like others' posts, this environment helps to observe, monetarize the tweets from its clients mentioning the company, and quickly answering to them, becoming closer, because "relationships (particularly with shared rewards) shape the trajectory of opportunity" (Read, Dew, Sarasvathy, Song, & Wiltbank, 2009, p. 4). Also, one main asset of this platform is retweeting the tweets, which means we are able to spread and preserve the original message, adding our own opinion to it. *"Users can post original tweets under their Twitter accounts and can "retweet," which means posting another user's tweet, while giving credit to the originator."* (Fischer & Reuber, 2011, p. 3). Tweeting may be perceived as a strategic tool as well, in a sense that it can: i) build and/or promote organizational culture; Tony Hsieh, quoted in Steinberg (2008):

> *"For customers, I think it's a way to get an inside glimpse of what our people are like and what our culture is like. Our belief is that your culture and your brand are, ultimately, the same thing. (...) For us, I just think it's important to be real and authentic." (para. 17)*

ii) establish CEO's and firm reputation, validating the authenticity of their persona and character; for example Dara Khosrowshahi (2018), Uber CEO once tweeted *"Congratulations #Australia on moving forward with marriage equality – we're proud to show our support!"*, supporting LGBT community; iii) create brand image, because the Facebook and Twitter pages are possibly the first results that people see while looking for the brands, therefore these must cultivate, shape and stamp their blueprint on online environments, showing their mission and vision, values and how original and friendly they are. Nonetheless, there is a chance that Twitter

will reveal and unmask "inauthentic" or narcissistic leaders if their use is undisciplined and uncontrolled.

People must be aware that, despite the fact this application connects us with the rest of the world, it can also be used to help predict future movements on the stock market, Sprenger, Tumasjan, Sandner, & Welpe (2013) stated:

> *"(...) there are investors who attribute their trading success to the information they find on social media websites and Twitterbased trading systems (...) Therefore, the investor community has come to call Twitter and related third-party applications such as StockTwits.com, which filter stock-related microblogs, "a Bloomberg for the average guy"." (pp. 1-2)*

A great example was when Kylie Jenner (2018), the youngest sister of Kim Kardashian, with approximately 32 million followers, tweeted *"sooo does anyone else not open Snapchat anymore? Or is it just me... ugh this is so sad."*. This post expressing her unhappiness and loss of interest on the app, contributed to a decrease of 6.1% of Snapchat's stock along with a huge loss of $1.3 billion loss in market value, according to Bloomberg.

2.2 The Stock Market

2.2.1 How can Social Media influence the stock market?

Malkiel & Fama (1970) stated:

> *"In general terms, the ideal is a market in which prices provide accurate signals for resource allocation, that is, a market in which firms can make production-investment decisions, and investors can choose among the securities that represent ownership of firms' activities under the assumption that security prices at any time "fully reflect" all available information. A market in which prices always "fully reflect" available information is called "efficient"". (p. 383)*

However, there are analysts who oppose to the efficient market theory. Despite the availability of any type of information, researchers defend the existence of diverse irregularities that cause movements in the stock market such as: 1) Calendar anomalies that include i) January effect, meaning that, in this month, the returns are higher than in the other months of the year, due to the tax-loss selling (Thaler, 1987); ii) Monday effect indicates that the returns are relatively lower compared to those from previous Friday (Jaffe, Westerfield, & Ma, 1989); 2) Technical anomalies as the Momentum effect that states assets that performed well (poorly) in the past, will continue to outperform (drop) in the forthcoming future; 3) "Size anomaly": neglected firm effect points that lesser known firms tend to achieve higher returns than famous corporations, because these are more likely to be scrutinized by analysts.

Additionally, there are also different factors that trigger changes on share prices, as fundamental factors that incorporate earnings per share and price-to-earnings-ratio, and technical factors that consist of inflation, deflation, economic growth, and interest rates. Lastly, the final "component" is market sentiment. Market sentiment is portrayed by two distinct situations: when stock prices increase, there is a bullish market sentiment, if the share prices fall off, the market sentiment is bearish. Behavioral finance researchers do believe that investors' psychology and emotions are drivers that may help to predict fluctuations on share prices. Previous studies have successfully measured mood contagion, evidencing that it is a psychological technique by which "star" leaders transfer thoughts to the followers, influencing their opinions (Bono & Ilies, 2006).

Emotional contagion can be decoded as *"the tendency to automatically mimic and synchronize expressions, vocalizations, postures, and movements with those of another person's and, consequently, to converge emotionally"* (Hatfield, Cacioppo, & Rapson, 1992, pp. 153-154). There are no limits to express our feelings, these can be manifested from body language and facial expressions to the speech tone. Even when people share information on social media, via written text, audio communication, videos or through photos, the emotion is always inherent in the message.

Over the last decade, social media is being used to evaluate the investor's sentiment, since it gives him realistic freedom of speech in a remarkable way, better than any other common means of communication; that is, prior to the emergence and rise of social platforms, the opportunity to share personal beliefs and perception was particularly confined to the politicians, journalists or columnists.

Nowadays, social networks empower users with access to a numerous source of information and different points of view from experts or non-experts. *"(...) social media platforms are unique in allowing users to directly interact with each other and to provide immediate and publicly visible feedback."* (Chen, De, Hu, & Hwang, 2014, p. 4). It is always necessary to keep in mind that the possible impact of social platforms on stock prices will always depend on how the situations are disclosed and announced. "Despite the capability of social media to compensate a lack of traditional information, there is a need for a critical mass of individuals interested in a company to make the predictions reliable." (Teti, Dallocchio, & Aniasi, 2019, p. 2). Luo, Zhang and Duan (2013) said:

> *"In this sense, social media metrics may allow investors to not only monitor the firm's customer sentiment and brand performance but also predict its future business value. Because social media can equip investors with the most updated information about the prospects of firm future performance, it may serve as a leading indicator of firm equity value." (p. 146)*

In conclusion, while making decisions, investors do pay attention to social media and to the sentiment analysis that collect information that is not yet reflected in the stock price (Teti et al, 2019).

Over the years, a wide variety of incidents have highlighted the relevance of social media. However, on the other hand, they have also demonstrated the danger and the noticeable repercussions that it may cause. Well-reported events can be very dangerous too, as the United Airlines incident, in April 9th 2017, when the passenger Dr. David Dao broke his nose, lost his teeth and suffered a concussion while being aggressively removed from the airplane, because the United Flight 3411 was overbooked. This situation was filmed very explicitly, and it became known worldwide. The company suffered backlash from every person and websites where the video was available. After bad news started flourishing the market, on Tuesday, April 11th 2017, a negative sentiment flooded investors' judgement, which consequently resulted into the crash of United Continental share price by 1.1%. The stock closed the day at $70.71 and losing around $250 million in market value, according to Wise, from the agency Reuters (2017).

2.2.2 Why can a Twitter post affect the stock price?

From all the websites and platforms that are contemplated as social media, Twitter has been quickly becoming the most dominant and mainstream micro-blogging service. It has been used not merely for financial forecasting, but also to project politician elections. Sprenger and Welp (2010) found that the quantity of running candidates mentions proved to be accurate predictors of the outcome. Twitter has been adopted to extract the sentiment expressed through the behavior from accounts of companies, CEOs and others with powerful positions within the organization, for better understanding of stock market movements.

A great example is the CEO of Tesla and Space X, Elon Musk who, on August 7th 2018, tweeted *"Am considering taking Tesla private at $420. Funding Secured."*, making the Tesla stock price increase 11%, closing that day at $379.57, according to Sage and Rai, from the agency Reuters (2018). Despite the rise of the share price, his willing to take the company private went wrong. It left many investors wondering if it was going to happen or was just another antic from Musk, because the number 420 represents the slang tag for marijuana. Plus, the Securities and Exchange Commission (SEC) made him pay $20 million for inaccurate and misleading declarations, according to SEC (2018).

For instance, in April, 2013, the Associated Press (AP) twitter account was hacked, so a fake tweet emerged, stating *"Breaking: Two Explosions in the White House and Barak Obama is injured."*. Within two minutes the Dow Jones Average index had fallen 143.5 points and the S&P 500 Index lost around $136 billion of its value, according to Selyukh from the agency Reuters (2013). Even though AP reacted instantly, denying the occurrence of this event, the damages were already done because this tweet was viewed by, approximately, two million followers and retweeted by many others.

So, how is it possible to examine and interpret the abundant data exchanged on Twitter and the almost instant trade of millions of shares? For this purpose, a trading system that operates over computer programs and different algorithms, named High Frequency Trading (HFT), is adopted. It allows traders to execute huge transactions (purchases and sales of shares), in mere few seconds. Adinah Brown (2017) said:

> *"These automation tools use social media updates (most significantly Twitter), incorporating phrases that reference corporate mergers, links to SEC releases and other 'red alert' business news terminology into their algorithms. Not only that, but more recently these tools can now give a determination to the severity of the news item, identifying really awful or game changing news from select sources such as AP's twitter account." (para. 14).*

Furthermore, Bollen and Mao (2011) proved empirically that Twitter data can forecast Dow Jones Industrial Average with an accuracy of 87,6%. Bloomberg collects tweets from Wall Street analysts and U.S policy departments, breaks down the data from it and then sends meaningful information to its clients, who then use this as an advantage to know which stocks they should consider, and when they must be purchased or sold.

3. Data and Methodology

It is important to remember that the general goal of this dissertation is to prove that the use of social media, specially Twitter, can affect not only the CEO who uses it but also the company that he or she works for. Firstly, it is necessary to understand the anatomy of Twitter data. Tweets are short messages with only 280 characters length. Besides the text and sentiment attached to the online post, it provides several types of information related to the users: i) the date and respective time (hours and minutes) when the tweet was created; ii) the tweet source labels, which tell you how the message was posted (on the right of date and time, it usually appears: Twitter for iPhone, Twitter for Android, Tweetbot for Mac, etc); iii) the Retweet count, which will show you how many times your original written text was shared, iv) the Likes count, which represents the number of likes that the tweet has; v) the geolocation, which is the location where this online message was written, if available; vi) the user and screen name; vii) the entities, which are highlighted in blue, appear on different forms, hashtags, @mentions or even links/URLs.

The ambition of this dissertation is to extract the tweets from Elon Musk and prove that online posts besides influencing the public image and reputation of the CEO, can also have an impact on the Tesla stock price market.

The first step was focused on collecting Musk's tweets, from the beginning of 2015 until the end of March 2020. So, in order to obtain all the data properly, the software chosen was the programming language Python, which allows to further treat and save the data on excel. In the Python code, it was used the clean function, which is a utility function that helps to extract and clean the information from the tweet text, by removing links, special characters and keep only simple regular expressions.

For sentiment analysis it was used the sentiment function of textblob, which would help to interpret the feelings and opinions inherent to the tweet. Further, the polarity score will measure the sentiment with positive (score > 0), neutral (score = 0) or negative value (score < 0), which would give a preliminary indication of the possible impact that the Tweet might have on the share price.

After, it is declared the multiple variable called *campos,* in order to be able to store a range of elements, such as: *i*, which will help to count the number of tweets extracted; *id*, which is a tweet reference, each tweet has its own id; *created_at* – this item tells when the online post was posted on Twitter, date, hour and minutes; *YesNo* will show which Elon Musk's Tweets,

from 2015 until 2020, have the word Tesla and those that have not, so the tweets that mention the word Tesla will have a score of 1, and those that mention other words besides Tesla will have attached a score of 0; *cleanText* will display the Tweet text, without links and special characters, merely the simple expressions and words that form the written message; *retweets* counts the number of retweets that each online post has, that is, how many times the tweet created was shared by other users; *favorites* – this element tells how many likes each tweet has; *mentions* displays the twitter accounts that are mentioned; *username* exhibits the users to whom Elon Musk replies. This list of items represents the columns name of the file that will be created.

Between the beginning of 2015 and the end of March 2020, the Tesla CEO tweeted 8112 times, which includes tweets from his Twitter page, replies to others who previously mentioned him on their online posts or just tweets that he felt that his intervention was necessary. However, the goal is to analyze only the tweets from his main page and his replies to his own tweets (which is called Twitter thread), so after deleting replies to other Twitter users, the final number of tweets selected was 2438.

The second step was to get the daily stock prices of Tesla, for the same period of time (2015 to 2020), so the tool used was Thomson Reuters DataStream. Then, to better understand the possible fluctuations of stock prices, a daily comparison of Tesla stock price at day t and Tesla stock price at day t-1 was made.

The third step was based on choosing the tweets that were associated with the days, when the difference of stock price (between day t and day t-1) was greater than or equal to an increase of 4 dollars, and also those tweets on the days when the difference of stock price was less than or equal to a decrease of 4 dollars or more.

Taking into account all the steps described above, from 2438 tweets only 798 represent the final sample.

The fourth step consisted on interpreting each tweet and confirm if this online post could in fact help or be the reason for the movement on stock prices. As Elon Musk uses a lot irony, and misspelled words, the sentiment analysis used on the Python code was not enough. So, in order to get better results, the tweets were analyzed one by one, and always considering Thomson Reuters news related to Tesla and Elon Musk, changes in recommendations from analyst, and Securities and Exchange Commission announcements, because due to his constantly imprudent use of Twitter, he was sued by SEC and asked to step out as CEO. Plus, Musk's tweets are the reason why there are so many short sellers betting against Tesla, making this company the most-shorted US equity.

During the tweets analysis, an assumption was made: if there is not news about Tesla on platforms, such as Thomson Reuters and many others, changes in analysts' opinions, or explicit reasons that are associated with the decrease or increase of stock price, then the Twitter post and its sentiment are appropriate to cause a change in the price, and the tweet will justify the increase or decrease of stock price.

Regarding the number of followers, it was used the website https://www.trackalytics.com/twitter/profile/elon%20musk/, which provided the numbers of Elon Musk's followers on Twitter, since June 3rd 2017 until May 8th 2020, and showed that on the last date, he had almost 34 million followers.

Finally, to see if the tweets really cause changes in the stock market, it was decided to compute the abnormal returns of Tesla, on the days that Elon Musk used Twitter, between 2015 and 2019. Abnormal returns represent the unexpected profit of a stock, during a given period of time, that is, *"Stock returns or abnormal returns are the returns beyond what is expected on average in the stock market based on the extended Fama-French model."* (Luo, & Zhang, 2013, p. 8). The first step is to determine the expected returns of Tesla Inc stock, so it was used the extended version of Fama-French three-factor model, Carhart four-factor model:

$$R_t - R_{ft} = \alpha + \beta_1(R_{mkt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 MOM_t + e_t \quad (1)$$

Regarding the variables of the first equation, R_t represents the observed return of Tesla Inc, on day t. It was used The Center for Research in Security Prices, more known as CRSP database) to collect the returns of Tesla Inc. Concerning the remaining factors, R_{ft} symbolizes the risk-free rate, on date t; R_{mkt} is the date t return on the market index; SMB_t (Small Minus Big), is the "size effect"; HML_t (High Minus Low) exemplifies the value premium; MOM_t is the momentum factor. These variables were collected through Kenneth R. French – Data Library. Lastly, e_t is the residuals of the model.

The Abnormal returns can be mathematically described as the difference between the actual returns and the expected returns:

$$AR_t = (R_t - R_{ft}) - (\alpha + \hat{\beta}_1(R_{mkt} - R_{ft}) + \hat{\beta}_2 SMB_t + \hat{\beta}_3 HML_t + \hat{\beta}_4 MOM_t + \hat{\beta}_5 Tweets_t) \quad (2)$$

In the second equation a dummy variable was added, $Tweets_t$, which will assume the value of 1 if Elon Musk's tweets are related with Tesla, and 0 if Musk's tweets mention other topics than Tesla and its products.

4. Discussion and Results

Social Media has not only become the perfect place for people to present their creations, photos and videos about their lives and ideas, but it has also turned into an attractive venue for them to reveal information, opinions and thoughts. Nowadays, people even use social media to evaluate possible fluctuations on stock price, interpret the sentiment about security, suggested by other investors and share their own analysis. Empirical studies have proved that mood contagion exists and also that investors may be influenced by the "word of mouth", in this case, it translates to the "word written", because a brand is no longer what is defined and delineated by the company. Instead, it is labeled as how the consumers and investors view and perceive it.

Previous articles proved that the sentiment and emotions shared by the investors about security would help to anticipate and predict unexpectable earnings and future stock returns. In this thesis, the goal is to show that the use of social media by chief executive officers provides faster and free real-time messages that may affect efficiently the opinion and sentiment of consumers, shareholders and stockholders. Particularly, this academic work focus on proving that the use of Twitter by Elon Musk may not only affect his reputation but also that his tweets can influence Tesla stock price.

From the methodology clarified before, the final data analyzed was formed by 798 tweets, from 308 different days. From the beginning of 2015 until the end of March of 2020 Musk wrote, on average, 2.59 tweets per day. From the 798 Twitter posts, 168 were related with the company Tesla and its electric car models, representing about 21%, while the remaining 630 tweets were mainly about topics such as SpaceX, Nasa, Mars, The Boring Company, memes, jokes, enigmatic and cryptic messages, climate change and artificial intelligence. These other posts corresponds to, approximately, 79% of all tweets. In terms of likes and retweets, those tweets that are associated with Tesla have approximately 6.3 million likes and around 747.331 retweets, and those that mention other topics have around 36.4 million and 4.8 million, respectively. This demonstrates that Elon Musk is constantly present on Twitter, unlike the traditional CEOs who merely tweet when they have big announcements or key information to share with the investors. On 17 of the 308 days, Musk's tweets were Enigmatic messages (5.52%); on 136 days, Musk's tweets did not affect Tesla Stock Price (44.16%); on 124 days, his tweets led to the increase of Tesla stock price (40.26%); and on 31 days, Elon Musk's tweets led to the decrease of Tesla stock price (10.06%). Therefore, from all the days interpreted and

examined, only around half of days (155 days) experienced a change in stock price that was stimulated by Elon Musk's tweets, corresponding to 50.32%.

Two graphics were generated, in order to analyze the movements of Tesla stock price over the years. Regarding graph 2, which merely considers the tweets that mention Tesla an its electric car models, it shows that the lowest point was on February 10th 2016, when Tesla stock price dropped to $143.67, and the highest point was on February 10th 2020, when the stock price reached $771.28, which shows the growth of the stock price and the trust the investors put in the company. There is no trend, the share price changes over the years. Although it presents slight changes, most of the time the share price is between $200 and 400$, there are no drastic price changes. The overall path is positive, the average price per share is $300.24.

On the other hand, considering graph 3, based on the tweets that are related to other topics, the lowest mark is on February 16th 2016, when the price per share hit $155.17, and the highest point is on February 19th 2020, when the stock price skyrocketed to an all-time high of $917.42. Although the stock reached higher prices, the share price also experienced a lot of fluctuations between 2015 and 2020. For example, on May 1st 2017 the stock price was $322.83; a few days ahead, on May 4th 2017, the price per stock was $295.46; on the next day, on May 5th 2020, the share price was $308.35; on May 9th 2017, the price per share was $321.26; on May 17th 2017, the stock price was $306.11; on May 23rd 2017, the share price was $303.86; two days after, on May 25th 2017, the price per share was $316.83; the next day, on May 26th 2017, the stock price was $325.14; and, on the last day of the month, on May 31st 2017 the price was $341.01. Another example happened during October 2018, when the stock price was always changing: $310.70; $281.83; $250.56; $256.88; $258.78; $271.78; $263.91; $294.14; $314.86 and $330.90. In this situation, the share price changes constantly, there are lot of fluctuations, almost as an irregular heartbeat. The average stock price related to Elon Musk's tweets that mention other topics is $217.83, and the stock price is more irregular and unreliable than Twitter posts that mention Tesla, Inc.

The main differences between these two graphs is that when tweets are related to Tesla, the price changes are "softer", smooth and there are not abrupt and sudden movements, which contributes to enhance its reliability and increase the faith and confidence among investors. As for tweets about different topics as Elon Musk himself, memes, jokes, cryptic messages, the stock price tends to vary a lot, and be very harmful not only for the CEO, who is the face behind the brand and this type of situations will hurt his or her credibility. This kind of circumstances also makes a stock highly volatile, causing the short sellers continuously betting against the company.

As for to the abnormal returns measured between the beginning of 2015 until the end of 2019, the final sample is formed by 2250 tweets (from January 1st 2020 to March 31st 2020, Elon Musk shared 188 Twitter posts. As previously mentioned from the January 1st 2015 until March 31st 2020, Musk had tweeted 2438 times. 2250 is equal to 2438 minus 188).

When Elon Musk decides to tweet about Tesla Inc, the r^2 is 18.41%, which means that this model predicts 18.41% of the variation of abnormal returns. It is not great, however this value does not necessarily suggest that this is a bad model, because human behavior is very hard to predict and understand, therefore, studies in the consumer behavior, emotions and psychology fields tend to have a low r-square. The abnormal returns are approximately 0.016%, the *p-value* is around 0.93, which is greater than 0.05, and also its *t-statistic* is 0.085, which confirms that abnormal returns are not statistically significant from 0. The coefficient of the factor *Mkt-rf* is almost 1.00, which means that Tesla stock price is as volatile as the market index. It is roughly 1% less volatile than the rest of the market. As it can be seen, the *t-stat* is approximately 15.48 and it has a p-value lower than 0.05, which means that it is statistically significant from 0. The positive *SMB* coefficient of 0.619 shows that Tesla Inc belongs to the small cap stocks, which is a group of public companies with small market capitalization. The *p-value* is about 0.135, which means that *p-value* > 0.05, so the variable is not statistically significant. In what concerns the *HML* factor, its coefficient is around -0.33, which shows that Tesla Inc stock is more sensitive to low Book-to-Market ratio, meaning that the stock is potentially undervalued. The beta of this factor is not statistically significant, because the *p-value* is higher than 0.05. The coefficient of momentum factor shows that the returns over the past 12 months, have been positive. This is not statistically significant, because *t-stat* is lower, around 0.25, and its *p-value* is superior than 0.05.

On the other hand, first, when Elon Musk's tweets are not related with Tesla Inc, the r^2 is about 13.66%, which means that this model does not explain the variation of abnormal returns so well as the model previously explained. This model only explains around 13,66% of the model. The abnormal returns are close to 0.095% and the *p-value* is around 0.11, which is greater than 0.05. Also its *t-statistic* is 1.58, which confirms that abnormal returns are not statistically significant from 0. Secondly, the coefficient of *Mkt-rf* factor is about 1.29, which means that Tesla stock price has higher volatility when compared to the market index, it is 29% more volatile than the rest of the market. As it can be seen, the *t-stat* is approximately 6.086, which is statistically significant from 0. The *SMB* coefficient is positive and around 0.41, which shows that Tesla Inc belongs to the small cap stocks. The *p-value* is about 0.02, which means

that *p-value* < 0.05, so the variable is statistically significant. Regarding the *HML* factor, the coefficient is around -0.45, which shows that Tesla Inc stock is more sensitive to low Book-to-Market ratio. The beta of this factor is statistically significant, because the *p-value* is lower than 0.05, its *p-value* is 0.0003, and as it can be seen through the *t-stat* it is over -3.61. The momentum factor shows that the returns over the past 12 months have been negative. When Elon Musk decides to tweet about topics other than Tesla, the *t-stat* is lower, around -0.67, and its *p-value* is greater than 0.05, which means that it is not statistically significant.

5. Conclusion

Social media has become the mainstream place where everybody meets. This is the perfect marketing avenue that gives freedom to the companies and CEOs to express faster and free messages to a broader audience. But ultimately, given its importance, social media has been adopted to help predict the company stock prices. Over the last years, specially Twitter has become crucial for the analysis of financial markets. In this dissertation, it is shown that 50.32% of Elon Musk's daily tweets contain significant information and a valuable sentiment that help and are key to the daily movements of Tesla Inc stock prices. Another finding is that when the tweets are related to Tesla and its electric model cars, the stock price tends to increase, plus the changes in the share price are more stable. However, when Musk posts on Twitter are associated with other topics, there is no trend of stock price movements; additionally, the stock price experiences drastic changes, the prices reach higher and lower prices quickly, and the share price seems to be more volatile. The abnormal returns just confirm it. From 2015 until 2019, Musk used Twitter to broadcast subjects about the organization 282 times and Tesla, Inc. stock generated an unexpected return around 0.016%, with a standard deviation of 37.10%, which showed that stock price increased and the prices are not so much disperse. When the tweets are about other topics, which occurred 1968 times, the abnormal returns were around 0.095% with a standard deviation of approximately 86.48%, meaning that unexpected returns were higher than the previous situation. However, the stock daily returns are widely spread, meaning that the values were very different from each other.

In conclusion, CEOs' tweets included relevant information and data that is not yet completely integrated in the financial market indicators. Therefore, investors should analyze the sentiment and feelings shared on the CEOs' tweets, in order to make a decision about buying, keeping or selling the stock.

As previously said, the success or failure of Tesla is attached to Elon Musk's success or failure. The corporate and his personal reputation have become one, they walk hand in hand, because the company's reputation is primarily dependent on his actions. After analyzing Elon Musk's tweets one by one, and making a lot of investigation, and tracking his number of followers since June 2017, it was concluded he is an innovation guru. He has helped to launch Pay Pal, which introduced online payments. Later on, in 2002, Musk lunched SpaceX, which paved the way to the commercial space exploration. One year after, in 2003, Musk established Tesla Inc, formerly known as Tesla Motors, Inc. The disruptive ideas of Musk and unique

progress of Tesla, towards electric vehicles, helped to introduce Model S to the automotive industry, in 2012. Since then, this company has produced four more brand new models. And by March 2020, Tesla had sold over a million cars.

However, Elon Musk's Twitter posts continuously hurt his and Tesla's reputation, since Musk tends to pick online fights with government regulators, such as the Securities and Exchange Commission, which is not beneficial for Tesla and its investors. Several controversial comments have been made by him throughout the years, which made Tesla, Inc stock price rock-bottom. In addition, the production and delivery timelines, communicated through Twitter, are rarely achieved, as excuses are made and targeted dates postponed. It is safe to say that many of Tesla's problems arise the lack of communications strategy, as Elon Musk's voice is not being used as leverage for the company. His public image and reputation is not an asset – instead, it has been a liability for Tesla, questioning the vision and values of the company. The combination of Musk's statute of celebrity CEO, and his systematic tweeting, have raised a lot of questions towards his inappropriate behavior and attitudes which are detrimental to Tesla.

In conclusion, the fact that Musk is outspoken, "loud" and a visible leader, it can be harmful for the corporate reputation of Tesla, Inc and its credibility, but also, it can be very helpful, because this company does not invest in publicity and advertising. Instead, Elon Musk is the one, who promotes its products, and he is "card up its sleeve" of Tesla marketing strategy.

6. Limitations and Future Research

For 1917 days (from the beginning of 2015 until the end of March 2020), the Tesla Inc CEO tweeted approximately 8112 times, meaning that he wrote around 4.23 tweets per day. Elon Musk, being one of the most influential people on Twitter in 2019, and the CEO of Tesla Inc, SpaceX and The Boring Company, should only broadcast necessary and important messages related to his three companies, news announcements, share positive thoughts, be cordial, polite and respectful in his comments.

Instead, most of the times, Musk posts memes, cryptic and enigmatic messages, criticizes others, tells jokes, insults and sometimes tweets about things that are not completely true, as the time he tweeted about having a funding secured and was planning to take Tesla private. However, the Securities and Exchange Commission sued Elon Musk for violating the securities laws and for fraud charges, because Musk's online comments were not accurate, they were quite the opposite, his statements were false and misleading (SEC, 2018). Occasionally, his behavior on Twitter is so awful and unacceptable, that it got to a point in which the Securities and Exchange Commission required that someone from Tesla's Board must supervise and preapprove his Twitter activity and other public communications.

One of the biggest limitations was not only the type of tweets posted by Elon Musk, because sometimes he would just put a fire emoji, or a triple fire emoji, or would write enigmatic messages such as "It's what you don't say" (2017) or "Fate *loves* irony. Frankly, too much." (2019), but also the way he would write them. That is, he often writes misspelled words as "u", instead of "you", "srsly" instead of "seriously" and many other words. These aspects have affected and may misrepresent the sentiment analysis obtained through Natural Language Toolkit (NLTK), from the Python code. For this reason, all the 798 tweets were analyzed one by one, which was very time consuming, as well as, taking other aspects into account, as recommendations from analysts, announcements from the Securities and Exchange Commission that were related to Tesla and Elon Musk, Forbes news, Thomson Reuters news, and Quarter earnings reports. Therefore, due to Elon Musk's "twitter-fingers", only 50.32% of his tweets represented the reason why the stock price increases or decreases.

Another limitation was found while collecting the number of followers between 2015 and March 2020, because even using the Twitter developer, it is only possible to collect 5000 users per request. This would only return the Twitter user's ID (a unique number that each user has) and the corresponding screen name, and not the respective timeline since the users started

following Elon Musk. For this reason, it was used the website https://www.trackalytics.com/twitter/profile/elon%20musk/, in order to get the number of followers over the years, but this webpage only presents the followers since June 3rd 2017.

Future researches can be applied to Donald Trump in order to analyze the stock market, because he is constantly posting tweets. Most of the times, Trump is honest, controversial and offensive, and he is not afraid to viciously criticize others, in order to make a point. Plus, previous tweets of his, have already proved to cause movements on the Standard & Poor's 500 index.

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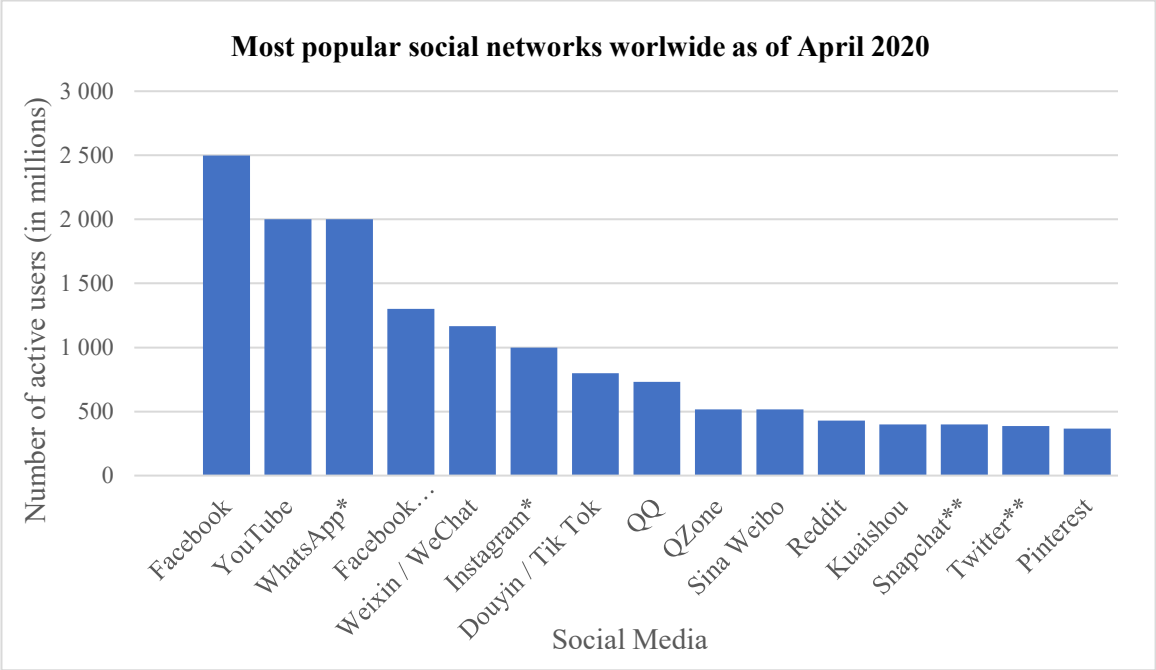
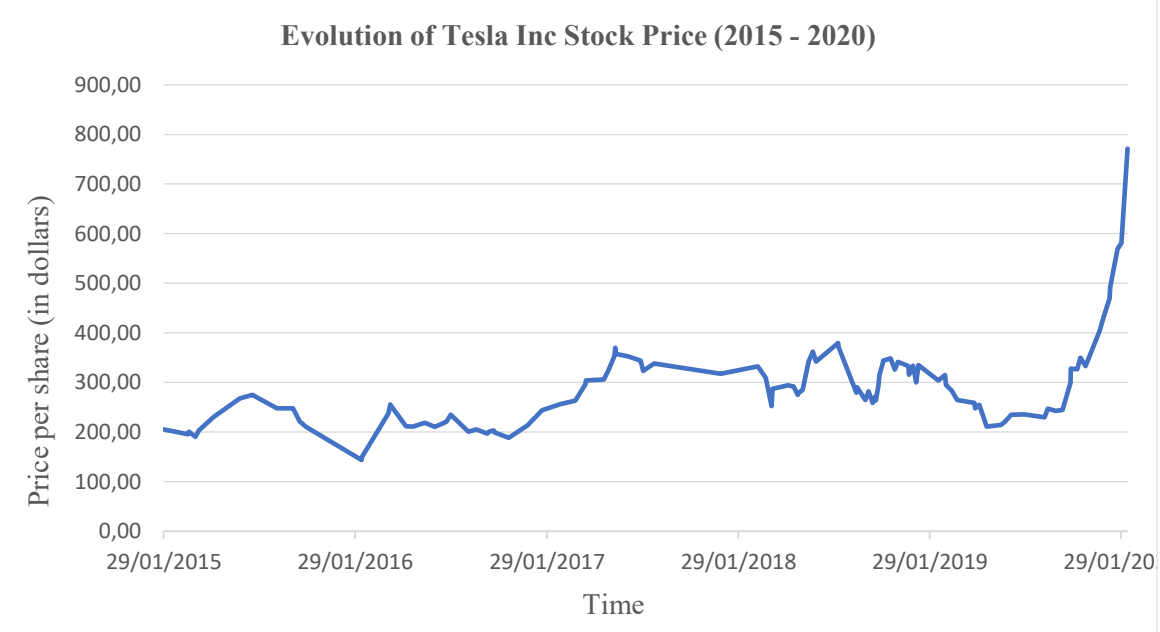
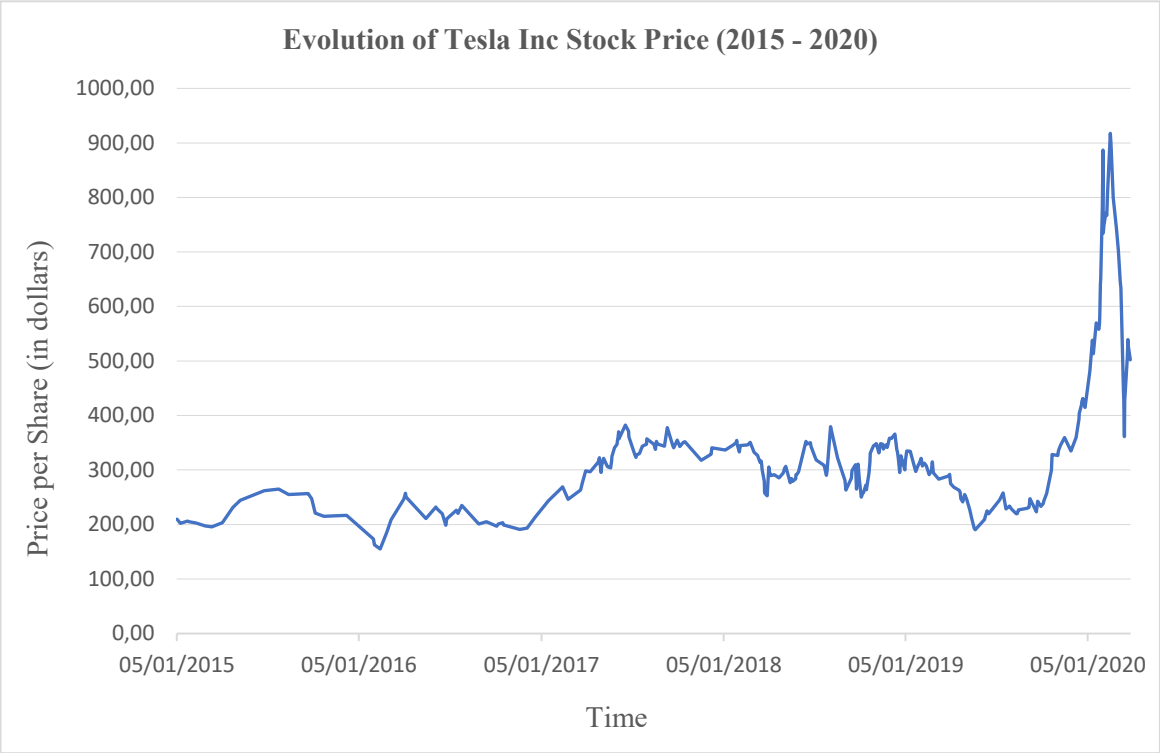
8. Appendix



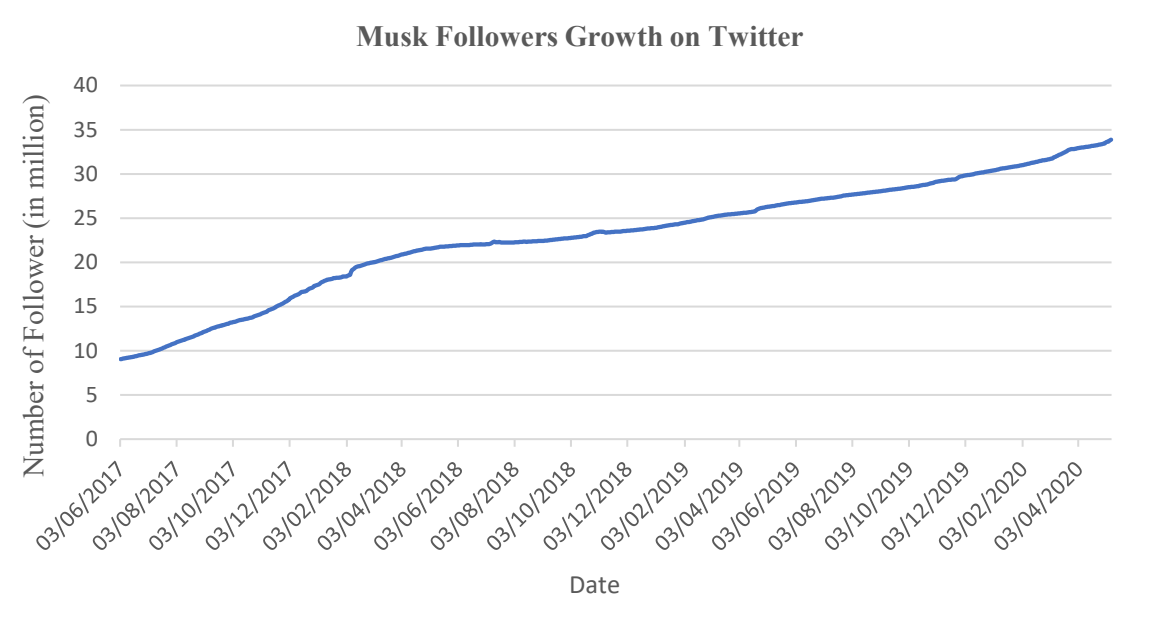
Graph 1 (Retrieved from the website Statista,
https://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/**)**



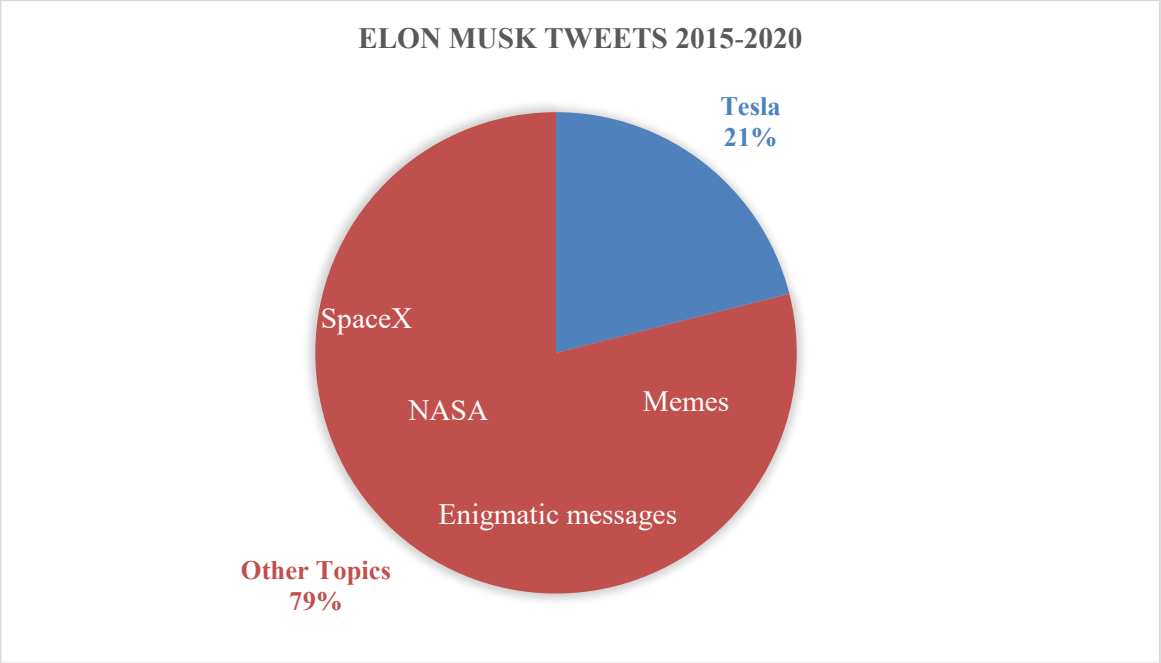
Graph 2



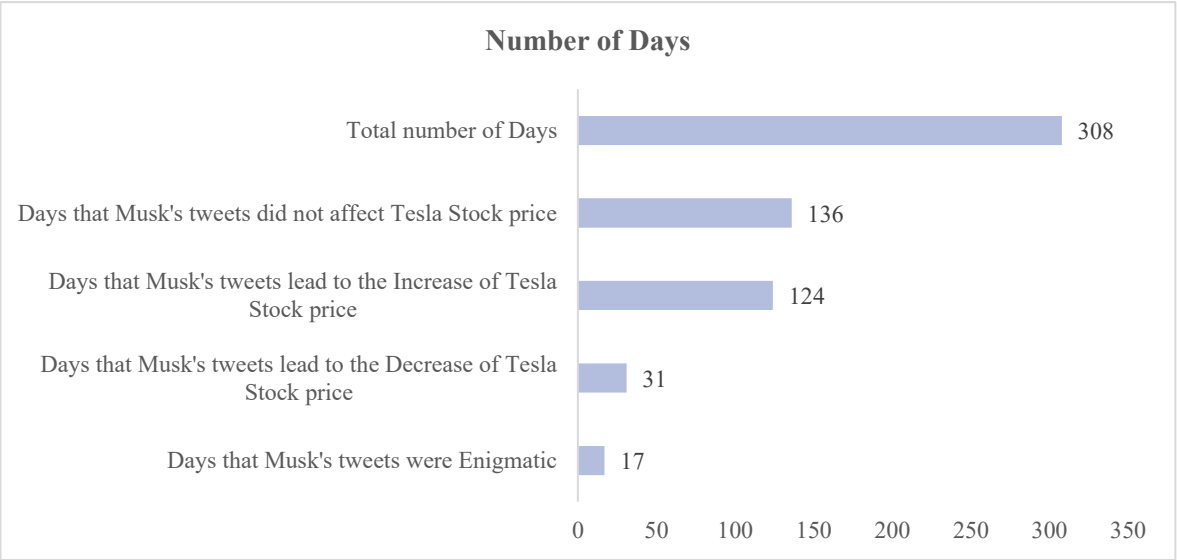
Graph 3



Graph 4



Graph 5



Graph 6

	Number of Days	Percentage
Days that Musk's tweets were Enigmatic	17	5,52%
Days that Musk's tweets led to the Decrease of Tesla Stock price	31	10,06%
Days that Musk's tweets led to the Increase of Tesla Stock price	124	40,26%
Days that Musk's tweets did not affect Tesla Stock price	136	44,16%
Total number of Days	308	100,00%

Graph 7

Tweets about:	Number	Percentage
Tesla	168	21,05%
Other Topics	630	78,95%
Total	798	100%

Graph 8

Tweets related to:	Number of Retweets	%	Number of Likes	%
Tesla	747331	13,36%	6318844	14,77%
Other Subjects	4844574	86,64%	36455520	85,23%
Total	5591905	100%	42774364	100,00%

Graph 9

Results, when the variably Dummy *Tweets* assume value of 1, meaning the tweets of Elon Musk are associated with Tesla Inc.

SUMMARY

OUTPUT

Regression Statistics	
Multiple R	0,429113958
R Square	0,184138789
Adjusted R Square	0,1723574
Standard Error	0,03101751
Observations	282

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	0,060148198	0,01503705	15,6296328	1,52109E-11
Residual	277	0,266497797	0,000962086		
Total	281	0,326645995			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Alpha	0,000159436	0,001867934	0,08535406	0,932041573	-0,00351771	0,003836586	-0,00351771	0,003836586
Variable Mkt - rf	0,996628258	0,064401590	15,47521185	4,65802E-51	0,870325584	1,122930932	0,870325584	1,122930932
Variable SMB	0,618654212	0,412314626	1,500442071	0,134638861	-0,19301395	1,430322373	-0,19301395	1,430322373
Variable HML	-0,32863472	0,419866526	-0,78271236	0,434464666	-1,15516929	0,497899848	-1,15516929	0,497899848
Variable Mom	0,087261679	0,349820668	0,249446894	0,803199989	-0,60138306	0,775906418	-0,60138306	0,775906418

Results, when the variably Dummy *Tweets* assume value of 0, meaning the tweets of Elon Musk are not associated with Tesla Inc.

SUMMARY
OUTPUT

Regression Statistics	
Multiple R	0,369635238
R Square	0,136630209
Adjusted R Square	0,134870923
Standard Error	0,026492617
Observations	1968

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	0,218031834	0,054507959	77,6622903	3,22011E-61
Residual	1963	1,37774874	0,000701859		
Total	1967	1,595780574			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Alpha	0,000949127	0,000600466	1,580649806	0,114119235	-0,00022849	0,002126746	-0,00022849	0,002126746
Variable Mkt - rf	1,293931026	0,212553471	6,087555386	3,81014E-09	0,875505693	1,712356359	0,875505693	1,712356359
Variable SMB	0,414661891	0,136441281	3,039123411	0,002403992	0,147076906	0,682246876	0,147076906	0,682246876
Variable HML	-0,45155724	0,125065005	-3,61058026	0,000313178	-0,69683138	-0,20628310	-0,69683138	-0,20628310
Variable Mom	-0,06534772	0,097580992	-0,66967671	0,503142661	-0,25672095	0,126025509	-0,25672095	0,126025509


Elon Musk
11,2 mil Tweets
Seguindo
Elon Musk
@elonmusk
Born 69 days after 4/20
Traduzir bio
Ingressou em junho de 2009
seguindo 89 35,9 mi seguidores

Python Code:

```
import datetime
import tweepy
import re
import textblob
import os
import xlsxwriter
import GetOldTweets3 as got


def clean_tweet(tweet):
    return ' '.join(re.sub("(@[A-Za-z0-9]+)|([^0-9A-Za-z \t])|(\w+:\/\/\S+)", " ", tweet).split())


def get_tweet_sentiment(text):
    analysis = textblob.TextBlob(clean_tweet(text))
    if analysis.sentiment.polarity > 0:
```

```
        return analysis.sentiment.polarity, 'positive'
    elif analysis.sentiment.polarity == 0:
        return analysis.sentiment.polarity, 'neutral'
    else:
        return analysis.sentiment.polarity, 'negative'


def GeraFicheiro(palavras_interesseZero, odir = 'Resultados'):
    tweetCriteria = got.manager.TweetCriteria().setUsername("elonmusk") \
                .setSince("2015-01-01") \
                .setUntil("2020-03-31") \
                .setMaxTweets(0) \
                .setEmoji("unicode")
    tweets = got.manager.TweetManager.getTweets(tweetCriteria)

    campos = ["i","id","created_at","YesNo", "polarity", "sentiment",
      "text", "cleanText",
```

```
"retweets","favorites","mentions","hashtags","permalink","username","to","geo"]


    if not os.path.exists(odir):
        os.mkdir(odir)


    palavras_interesse = []
    for palavra in palavras_interesseZero:
         palavras_interesse.append(palavra.upper())
    print("palavras_interesse: ", palavras_interesse)


    nomeFicheiro2 = "{}/tweets_{}.xlsx".format(odir, datetime.datetime.now().strftime('%Y-%m-%d_%H_%M_%S'))
    workbook = xlsxwriter.Workbook(nomeFicheiro2)
    worksheet = workbook.add_worksheet()
    row = 0
    c = 0
    for c in range(len(campos)):
```

```
        worksheet.write_string(row, c, campos[c])
    row += 1
    num_tweests = 0
    for item in tweets:
        num_tweests = num_tweests + 1
        YesNo = "0"
        palavras = str(item.text).split()
        for palavra in palavras:
            if palavra.upper() in palavras_interesse:
                YesNo = "1"
                break
        polarity, sentiment = get_tweet_sentiment(item.text)


        c = 0
"retweets", "favorites", "mentions", "hashtags", "permalink", "username", "to", "geo"
          worksheet.write_string(row, c, str(num_tweests));c = c + 1
```

```
worksheet.write_string(row, c, str(item.id));c = c + 1

worksheet.write_string(row, c, str(item.date));c = c + 1

worksheet.write_string(row, c, str(YesNo));c = c + 1

worksheet.write_string(row, c, str(polarity));c = c + 1

worksheet.write_string(row, c, str(sentiment));c = c + 1

worksheet.write_string(row, c, str(item.text));c = c + 1

worksheet.write(row, c, clean_tweet(item.text));c = c + 1

worksheet.write_string(row, c, str(item.retweets));c = c + 1

worksheet.write_string(row, c, str(item.favorites));c = c + 1

worksheet.write_string(row, c, str(item.mentions));c = c + 1

worksheet.write_string(row, c, str(item.hashtags));c = c + 1

worksheet.write(row, c, str(item.permalink));c = c + 1

worksheet.write_string(row, c, str(item.username));c = c + 1

worksheet.write_string(row, c, str(item.to));c = c + 1

worksheet.write_string(row, c, str(item.geo));c = c + 1

row += 1
```

```
    workbook.close()
    print("Excel file ready")
    os.system('"{}"'.format(str(nomeFicheiro2).replace("/", "\\")))
  return nomeFicheiro2


odir = 'Resultados'
query = "from:elonmusk Tesla -filter=retweets"
query = "Paulo Nunes -filter=retweets"
palavras_interesseZero = ['@Tesla', 'Tesla']
nomeFicheiro = GeraFicheiro(palavras_interesseZero, query, odir, 'en')
```