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INFODEMIC AND INTENTION TO VACCINATE: CAUSES AND EFFECTS OF COVID-19 Pandemic

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INTRODUCTION

Despite the phenomenon of misinformation having ancient roots, there being evidence of it since the time of the Roman Empire (Darnton, 2017), it gains considerable relevance with the advent of social media.

Indeed, the latter work like an echo chamber (Sadiq and Saji, 2022), so mere suppositions initially shared amongst few peers may quickly become global news, not finding barriers to online dissemination.

The growing use of smartphones and other mobile devices lead to a change in the ways of gathering information all over the world. Social Networks, blogs and search engines become sources of information, thus social media seem to supersede traditional media, such as newspapers, radio and TV.

In particular, for Italians, social media have a significant role in the information palimpsest: during the COVID-19 Pandemic, 15 million of Italians have used social networks as a source of information, in addition to traditional sources, but a considerable part of Italians solely consulted internet and social media to get information (almost 5 million). Furthermore, over 5 million have also relied on unofficial websites (Ital communications - Censis report, 2021).

In uncertain contexts, when people are faced with a lack of information they need, such as a health emergency, disinformation arises quickly. This is due to the fact that, to overcome the anxiety generated by the pandemic, when people fail to receive information from official sources, collect related information from informal sources, which would help them to control social tension (Sadiq and Saji, 2022).

This has generated a no less important epidemic, parallel to that of health: an epidemic of information that has no equal in history either on the side of the speed of diffusion or the magnitude (Baines and Elliot, 2020). Indeed, at the Munich Security Conference in February 2020, the general director of the WHO (World Health Organization), asserts that his organization is not just fighting an epidemic, it is also fighting an infodemic.

The WHO defines an infodemic such as an overabundance of online and offline information, that includes false, wrong or manipulated content (WHO, 2020b). The

circulation of information through social media has many similarities to the evolution and transmission of infectious diseases, hence the neologism infodemic.

Before the COVID-19 pandemic, it had never happened that 50 million Italians, almost all of the adult population (99.4%), sought information on a topic. Moreover, 29 million of them said they encountered online news that then turned out to be false or wrong (Ital communications - Censis report, 2021).

The Covid-19 pandemic is an example of how a sudden and unknown event, which has impacted transversely on our life, triggers an unprecedented demand for information, that lead to a bad communication which, in the best hypothesis, has confused Italians on things to do and in many cases created misinformation.

In this context, disinformation becomes a global threat and its study becomes a public interest, both in terms of the determinants of the phenomenon and its consequences. Indeed, the confusion generated by misinformation could lead to further repercussions for public opinion. Population has, in good faith, taken the information, including false news, most relevant to their personal situation and used it to formulate their own interpretation of the pandemic (Tagliabue et al., 2020). For instance, initial and overly optimistic medical statements that viewed the epidemic as a simple flu lead people to have a poor perception of the risks associated with COVID-19 infection. Indeed in Italy, in March 2020, while the maximum increase in new cases was recorded more than 10,000 people were sanctioned for not respecting the lockdown (Tagliabue et al., 2020).

In general, personal interpretations of the pandemic based on fake news could lead people to ignore social distancing and self-isolating, to not use diagnostic tests and personal protective equipment, to refuse the vaccine. Thus, campaigns of vaccination could not meet their targets, hence stopping the virus circulation can be very difficult. Put in a nutshell, the first step to combat the pandemic is to combat disinformation.

In this regard, my thesis intends to evaluate, first, a possible determinant of disinformation and then a possible consequence of it.

To this aim, a survey was administered to a sample of students of the University of Calabria, in southern Italy and the collected data were used to estimate an empirical model of the relationship between the use of social media and disinformation on COVID-19, and of the link between the latter disinformation and the propensity to get vaccinated.

There is no clear definition of disinformation in the literature. Generally, considering the definitions used by the WHO, misinformation refers to false or misleading but unintentional content, while fake news refers to knowingly created and shared false information. In general, the term disinformation is used as a synonym of fake news (Allcott and Gentzcow, 2017).
In my study disinformation is used as a synonymous of bad information, regardless of the awareness underlying the creation of fake news.

The remainder of my thesis is organized as follows. The first chapter presents my empirical work on the relationship between the use of social media as a source of information about COVID-19 and disinformation. In the second chapter, the role of disinformation as a determinant of the propensity to get vaccinated is assessed. Finally, the conclusive section discusses limitations and implications that the results suggest.

CHAPTER 1
PANDEMIC AND INFODEMIC: THE ROLE OF SOCIAL MEDIA IN DISINFORMATION RELATING TO COVID-19 IN ITALY

Abstract:

With the growing use of smartphones and, generally, mobile devices, we witness a change in the ways of gathering information: internet and search engines, but also blogs and social networks seem to supersede traditional media, such as newspapers, radio and TV. The circulation of fake news encounters lower barriers online and it contributes to make the end of the Covid-19 pandemic more difficult: the confusion engendered by false contents compromises people's cooperation on necessary measures and restrictions in the fight of the current pandemic.

This study investigates the role of social media in the spread of false information in the context of Covid-19 pandemic, by using a sample of students of a university of southern Italy and by estimating a probit model in which the probability of being misinformed is linked to a set of media use indicators and other control variables identified as predictors of disinformation by previous literature.

The results show that the use of social media as a source of information for covid-19 is positively and significantly associated with disinformation: social networks use seem increasing the probability of being misinformed about the pandemic. All the estimates conducted as robustness checks confirm this result.

These findings suggest a considerable policy implication: countering fake news is a relevant tool to combat the pandemic.

1.1 **Introduction**

In May 2023, the World Health Organization (WHO) declared the end of Public Health Emergency of International Concern (PHEIC), due to the first pandemic caused by a coronavirus (defined as Covid-19 and declared by the WHO since March 2020).[1]

The end of the emergency, however, does not correspond to the end of the pandemic: the virus has not disappeared, nor have the effects of the infection disappeared. Even today, every 3 minutes in the world someone dies because of covid-19 and one in ten of those infected will develop long-term consequences.

At the time of writing, over 700 million confirmed cases and almost 7 million deaths have been reported worldwide. In Italy, there have been 26 million confirmed cases, among which more than 190.000 deaths.

There is no certainty that Italy has been the first outbreak in Europe, but it has definitely been the first western country to face the health emergency: during the first months of the pandemic, it was the European country most affected by Covid-19 in terms of both infections and deaths. The Italian authorities immediately responded to this emergency with strict containment measures: on 9 March was declared the first national lockdown that started phase 1 of pandemic management. During this phase, from 9 March to 3 May, any movement was forbidden: both from and to the territories as well as within the territories themselves, except for proven health or work needs. This has allowed Italy to overcome the first pandemic wave. Indeed, the New York Time, an American daily newspaper, described Italy as a "model of viral containment that holds lessons for its neighbors and for the United States". [2] The phase 2, from 4 May to 14 June, was instead characterized by a gradual relaxation of containment measures: visits of relatives, physical activities, take-away service for catering, recovery of various productive activities, and openings of public parks were allowed.

[1] The Italian National Institute of Health defines coronaviruses such as a large family of RNA viruses that can cause infectious respiratory diseases of varying severity: from the common cold to fatal respiratory

syndromes (Rezza et al, 2020). Among numerous coronaviruses that are common in several animal species, only seven ones are known for infecting humans (Rezza et al, 2020). Four of these human coronaviruses (in particular the following viruses: 229E, NL63, OC43 and HKU1) generally occur with the symptoms of the common cold and only rarely cause more severe infections, such as pneumonitis or bronchiolitis, especially in infants, the elderly and persons with weakened immune systems. The other 3 human coronaviruses cause much more serious and sometimes fatal respiratory infections. Indeed, these coronaviruses are responsible for serious outbreaks of deadly pneumonia in the 21st century: SARS-CoV in 2002, MERS-CoV in 2012 and SARS-CoV-2 in 2020.

[2]https://www.nytimes.com/2020/07/31/world/europe/italy-coronavirus-reopening.html

The Covid-19 pandemic is also the first one in history in which technology and social media play a major role in the control and prevention of the contagion. Indeed, this pandemic has been accompanied by a no less relevant epidemic of information. In February the WHO Director-General spoke for the first time of "infodemic": "We're not just fighting a pandemic; we're fighting an infodemic" (Tedros Adhanom, February 2020).

The circulation of information through social media has many similarities to the evolution and transmission of infectious diseases, hence the name infodemic (neologism of information and epidemic): "infections and opinions are both shaped by social contacts' ' (Kucharski, 2016). The WHO defines an infodemic such as an overabundance of online and offline information, that includes false, wrong or manipulated content (WHO, 2020b).

A massive infodemic causes a real difficulty for people to recognize credible sources and select reliable information they need (Kim and Kim, 2020). Indeed, during a disease outbreak, the circulation of inaccurate information is likely causing confusion, thus people, uncertain about what they need to do to protect themselves and others, could take behaviours that can harm public health: during an epidemic of an infectious disease, such as Covid-19, individual behaviour can impact the health of others (Kristensen, 2021). Consequently, human behaviour plays a noticeable role in the control of health emergency (Matrajt and Leung, 2020).

Indeed, an infodemic reduces the effectiveness of public health measures because of a lower observance of the necessary rules to control the health emergency and, thus, it intensifies or lengthens the pandemic. For this reason, being well informed about the virus, the disease and the routes of infection is the best way to prevent and slow down transmission. On the contrary, the intentional creation and the rapid circulation of false and manipulated information relating to the Covid-19 pandemic could undermine the global efforts to stop the virus circulation. Effective communication is an essential determinant to reduce significantly not only panic levels during pandemics but also the spread of Covid-19 infections (Ataguba et al., 2020).

In this regard, the expansion of social media and internet use can be a double-edged sword: it can help people to be more rapidly and easily informed but can also amplify the spread of fake news and harmful messages. Information shared via "informal" platforms

on internet and social media is usually unverified (most sites do not have a scientific review process), consequently it could be inaccurate (Ataguba et al, 2020). Thus, even if social media are being used on a massive scale to keep people informed and safe, at the same time it plumps the infodemic, creating the opposite effect: social distancing and self-isolating could be ignored, diagnostic tests and personal protective equipment go unused, campaigns of vaccination could not meet their targets, hence the virus circulation will continue. Kim and Kim (2020) believe that, for all these reasons, the infodemic about Covid-19 is making the pandemic worse.

Moreover, during a health emergency or a disaster, the usage of social media as a source of information increases noticeably: people, in fact, want to get as much news as possible (Kawasaki et al., 2012). Di Fonzo and Bordia (2007) assert that fake news finds fertile breeding grounds in ambiguous or threatening contexts, which make people in need of understanding and security. For example, after the attacks of September 11 internet use doubled: from the 6 million before the event to an average of 11,7 million in each day during the following week (Glass, 2002). Also during the SARS epidemic, most people obtained information through the media and the Internet (Glik, 2007).

Previous studies have tried to define fake news, but few researches have empirically analysed the determinants of disinformation: the belief in fake news seems correlated to various factors (Bryanov and Vziatysheva, 2021), such as personal and psychological features (Comandini, 2018; Pennycook and Rand, 2019), political views (Allcott and Gentzkow, 2017; Stefanone et al., 2019; Sulaiman et al., 2020) and also frequency of social media use (Zanin et al., 2020). The present analysis focuses on this last aspect: the role of social media in the current infodemic related to Covid-19 pandemic. The analysis conducted by Zanin et. al (2020), indeed, reveals the key role of the media on the level of knowledge of the emergency situation and consequently on the acceptance of restrictive measures imposed to combat the pandemic.

Drawing on a survey submitted to about 2700 students enrolled at the University of Calabria from 28 May to 18 July 2020, the relationship between the use of social media and disinformation related to Covid-19 is estimated. A variable selection technique (Lasso) is used to help create a parsimonious model. Finally, the special regressor method is implemented for testing the robustness of the estimates.

The remainder of the chapter is structured as follows: section 2 is a literature review, section 3 presents data and descriptive primarily analysis, section 4 describes the econometric analysis, section 5 underlines limitation and implication of the analysis and, finally, section 6 concludes this research.

1.2 **Literature Review**

1.2.1 *Fake News and Social Media*

Allcott and Gentzkow (2017) define fake news as "news articles that are intentionally and verifiably false" (p. 213). This definition does not include reports that are incorrect but unintentional and misleading but not false. According to Lazer et al. (2018), the spread of false information intentionally created to deceive people is classifiable like an information disorder associated to fake news, known as disinformation, but the definition of fake news includes all fabricated information that mimics the form of real news but not the organizational process or the intent. Even the Treccani encyclopaedia classifies fake news such as information both in part or totally non-truthful, disclosed intentionally or unintentionally through the web, the media or the communication technologies and characterized by apparent plausibility.

All the different definitions presented in this section share the characteristic that the fake news content is fabricated and differs from the real facts.

Although the phenomenon of fake news is not recent, it gains relevance with the rise of social media (Pennycook and Rand, 2019): the online circulation of false information makes social media an "echo chamber" (Kucharski, 2016). Indeed, social media are replacing newspapers as the main source of information, despite a lower information quality of websites due to the lack of reviews of articles (Williamson, 2016) and the possibility for users to freely share content (Tacchini et al., 2017). Indeed, in the communication market, production, distribution and consumption nowadays coincide in the web: the users who read the news are the same ones who produce and share them (Ital communications - Censis report, 2021).

Moreover, social media users can not choose the source of the articles they encounter online (newspapers, news websites, posts from friends), while with traditional news media, people choose the source first and then read the news (Moravec et al., 2019).

The sixteenth Italian Censis report on Communication revealed that the newscasts still hold the record in Italy (59.1% of Italians use them as a source of information), but Facebook is the second medium for disseminating news (31.4%) and also the search engines, like Google, are taking the ground (20.7%). For the elderly, television is the main source of information (96.5%), but newspapers and magazines still rank above the internet (42.0%) and smartphones (38.2%), by contrast for young people between 14 and 29 years old, TV, internet and smartphones are matched with about points equal (respectively 89.9%, 90.3% and 89.8%) and, moreover, 86.9% of young people use social media as a way to get informed. This turnaround fosters the spread of false information: fake news finds fertile ground in social media for both economic and political or cultural reasons. First of all, the internet has drastically reduced barriers to the establishment of websites for sharing news: the costs of entering the market are incredibly small; secondly, a reason is the political polarization: the tendency of those belonging to a certain political or ideological spectrum to develop strong negative feelings towards their political rivals. On social networks, the polarization is a typical attribute of discussions between users on civil or cultural issues (Comandini, 2018).

Because of the growing process of mass digitalization, news easily reaches a public with different levels of media literacy. A person with a low level of this literacy may not understand the damage generated by sharing a dubious news article (Stefanone et al., 2019). Moreover, according to the Programme for the International Assessment of Adult Competencies, skills of Italian adults in text comprehension are among the lowest in OECD countries. In particular, only 3.3% of Italian adults reach high levels of linguistic competence and only 26.4% reach the intermediate level.[2] This makes Italians particularly vulnerable to being deceived by fake news (Comandini, 2018).

Individual behaviour is affected by fake news: these compromise political elections and safety of people, by causing significant effect on real events. For example, Allcott, Gentzkow and Yu (2019) have evaluated the amount of fake news circulated on social media from January 2015 to July 2018: the shares of contents on Facebook and Twitter

[2] The data refers to the international survey, conducted in over 40 countries in 2013, within the Programme for the International Assessment of Adult Competencies (PIAAC). The Survey provides data on literacy, numeracy and problem solving of adults aged between 16 and 64 years old. Full version available from: https://www.oecd.org/skills/piaac/Country%20note%20-%20Italy%20(ITA).pdf

from major news sites, small news sites and business and culture sites remained stable throughout the analysed period with a similar trend on both platform, but the spread of fake news rose steadily on both social networks before the 2016 election. Simultaneously, also Resnick et al. (2018) got the same results.

Intuitively, it seems plausible that the phenomenon of fake news had a potential influence on the 2016 American presidential election. The impact of fake news on 2016 political elections in America has been investigated by Allcott and Gentzkow (2017). They found that American interviewees, before the 2016 election, spend 66 minutes per day gathering information on election news and 38% of these time (25 minutes) on social media. Moreover, the sharing of fake news pro Trump on Facebook was considerably higher than that pro Clinton (30 million of shares against 8 million) and the authors estimated that, in the months just before the elections, at least one fake news may have been read and remembered by the average American adult.

Recent empirical researches try to individuate the predictors of belief in fake news (Bryanov and Vziatysheva, 2021). First of all, social media users are exposed to an overload of information that leads them to resort to heuristics[3] for processing information, including therefore inconsistencies in the content, subjectivity, and credibility of the source (Schaewitz et al., 2020). Even the collective approval of a content (such as the likes associated with a post on Facebook) is considered a sign of the credibility of the information (Luo et al., 2020). But the individual characteristics of users influence the predisposition to believe in fake content they encounter online, as well as how the news is presented.

Analytic thinking predicts the ability to discern between fake and real news (Pennycook and Rand, 2019), but most people have serious difficulty evaluating the quality of information on the net, because of the lack of digital media literacy (Guess et al., 2020).

[3] In the decision-making process, a person typically uses two cognitive systems: the rational one, based on rules and procedures but slow in application, and the intuitive one, based on instinct and sensations, unconscious but quick. To solve most of the daily problems, which require quick solutions, people use the intuitive system, therefore cognitive shortcuts, also called heuristics. The distortions of this cognitive system also compromise the information market: fake news finds fertile ground on social networks also because news consumers use their emotional side and not the rational one to choose the articles they can rely on (Comandini , 2018).

Nevertheless, leading people to think about the veracity of the content necessarily improves the individual's ability to recognize fake news (Pennycook et al., 2020).

However, susceptibility to fake news is also driven by ideological prejudices as well as reasoning skills. Sulaiman et al. (2020) believe, for example, that social media users, but in general news consumers, tend not to verify the truthfulness of news when it is aligned with their opinions. Humans continually seek confirmation of their opinions, being victims of a cognitive bias known as *confirmation bias*. During the process of acquiring information, individuals attribute greater credibility to those that confirm our hypotheses and, conversely, ignore or belittle those that contradict them. Indeed, people may be susceptible to fake news that supports their political ideology (Kahan, 2017; Van Bavel and Pereira, 2018; Sindermann et al, 2020).

Religious ideology also plays a role in the information processing: Stefanone et al. (2019) found that religiosity is a predictor of credibility. In confirmation of this bias, it should be noted that, for instance, evangelical Christians avoid media sources that share contents against their religious beliefs.

The re-sharing of content on social networks is the driving force behind the dissemination of news (Koohikamali and Sidorova, 2017). According to a study conducted by Kwak et al. in 2010, for example, a post reshared on Twitter can reach 1000 users on average, regardless of the number of followers of the original tweet. A significant predictor of news sharing, according to Salehan et al. (2013), is trust in social networks. Social media have, indeed, become an integral part of our lives, so it is reasonable to think that users tend to strongly trust the content they encounter online. Trust in social networks would seem to be, theoretically, a predictor of disinformation.

1.2.2 *Disinformation and Covid-19 Pandemic*

Fake news about Covid-19 is being produced and, thanks to social media, spread rapidly and borderless on a large scale: the resulting infodemic is unrivalled for size and speed (Baines and Elliot, 2020). The results of the study conducted by Rovetta et al. (2021) suggest that the Italian mass media played a decisive role in the spread of the COVID-19 infodemic. For instance, Italians declaring that they encountered online news that turned out to be false or wrong are as many as 29 million (Ital communications - Censis report,

2021). Indeed, because of mobile phones, internet and social media, mere suppositions initially shared amongst few peers may quickly become global news.

This phenomenon is fuelled by the structure of social networks, which lowers the level of attention of users, compromising the ability to discern real news, although, in itself, recognizing a true news from a false one in the health context can require higher levels of competence. On the one hand, social media platforms provide immediate feedback on the level of approval of the shared news (for example, the number of "likes" on Facebook), on the other hand the news contents are mixed with the ones of which the accuracy is not relevant (such as photos of children, videos of animals, etc.). Due to these considerations, it is reasonable to think that users, when browsing social media platforms, may get used to a lower level of accuracy, which lowers the ability to discern true news from false ones (Pennycook et al., 2020). Indeed, participants in the survey conducted by Zanin et al. (2020) who use social networks as their main source of information are less aware of the covid-19 pandemic and experience a greater state of fear, while newspapers encourage a higher level of knowledge.

According to a global study conducted by WHO, Wunderman Thompson, the University of Melbourne and Pollfish (2021), a young person daily uses an average number of 5 social networks and relies on them for Covid-19 information. Also Sulaiman, Adeyemi and Ayegun (2020) note that social networks are used as a source of information about the current pandemic. Indeed, most of the young Nigerians interviewed by the aforementioned authors used the main social platforms, including Facebook, Twitter, WhatsApp and Instagram, to share news on Covid-19.

Even for Italians, social media have a significant role in the information palimpsest: 15 million of Italians have also used social networks to get information, over 5 million have also relied on unofficial websites and 4.7 million have solely consulted the internet and social media (Ital communications - Censis report, 2021).

Sharma et al. (2020) focused their research on Twitter and identified false or misleading information related to COVID-19, spreading on this platform. They collected Twitter conversations during the month of March 2020, using the following keywords related to COVID-19 to filter relevant tweets about the pandemic: Covid19, coronavirus, corona virus, 2019nCoV, CoronavirusOutbreak, coronapocalypse. The dataset contained 30.8 million tweets from 182 countries. The country with the highest rate of twitter use is the

United States, nevertheless not all fake news originates from there: in some cases it is observed that tweets come from other countries and also spread to the United States. For instance, the fake news about the banning of the use of Hydroxychloroquine treatments done by Nevada Governor's Chief Medical Officer spread in a few minutes to other countries, while the one about toilet paper as a means of spreading the virus originated in Australia and quickly spread also in the USA. The conspiracy about covid like bioweapon, on the other hand, does not have an identified country of origin but has spread in a short time in many countries. According to the Ital Communications - Censis report of 2021, indeed, the first fake news and perhaps the most widespread in Italy concerns precisely the origin of the virus: 38.6% of Italians are convinced that the virus is a laboratory product intentionally created to enrich pharmaceutical companies that produce vaccines or to reduce the world population.

In the dataset collected by Sharma et al. (2020), however, the most widespread fake news with over 10,000 retweets spreading in multiple countries is not health but political: it concerns affordability and price control on vaccines.

Also Aria et al. (2022) highlighted how the Covid-19 related-speech developed on Twitter, analysing the posts published between February and December 2020. In particular, after the declaration of the pandemic, due to the lack of reliable information and the stress caused by the isolation, there was a peak in tweets: the main topic was the government's action, followed by issues relating to the Italian healthcare system.

There is evidence on the disadvantages of social media in crises but also on the advantages (Lunn et al., 2020): during the spread of Ebola virus, for example, the use of social media was associated with a reduction of credibility and an increase of panic and uncertainty, which may determine an harmful behaviour (Kilgo et al., 2018) but by contrast, during the MERS epidemic the exposure to information on social media was related to negative emotions, such as fear, that caused more preventive behaviours (Lee and Han, 2020).

Indeed, in an emergency condition, that in itself is confused, such as the epidemic of Covid-19, two types of information bias can occur: the one from negative information that causes the so-called “catastrophic thinking” and the other one from positive information that generates “unrealistic optimism” (van den Broucke, 2020). The excessive purchase of personal protective equipment, that contributed to the lack of this product in the clinical sector and to a growth in its price, was a consequence of the first information bias

(Tagliabue et al., 2020). The second bias may cause an underestimated perception of risk and, consequently, a lower attention to the compliance with the safety measures, leading in turn to an increase in infections and deaths.

The harm relating to disinformation during the COVID-19 pandemic is high especially where the mistrust in authorities and governments is widespread and the credibility in institutions is eroded (Ataguba et al., 2020). According to the aforementioned study conducted by WHO, Wunderman Thompson, the University of Melbourne and Pollfish, from late October 2020 to early January 2021, almost 60% of worldwide interviewed between Gen Z and Millennials believed that the media and their governments are not completely transparent about the pandemic (WHO et al., 2021). Already in the years preceding the pandemic, the citizens of developed countries exhibited a marked decline in confidence in the traditional media, in America more markedly among the Republicans than the Democrats and in Italy between the right and the M5S compared to the left (Comandini, 2018). A fortiori, indeed, "communication processes must contain elements of trust, credibility, honesty, transparency and accountability for the sources of information" (Glik, 2020; p. 35). But during this pandemic, information on COVID-19 changes rapidly (the variants of the virus, the vaccines, the variation of the consequent restrictions): also institutional sources, such as health professionals and researchers, seem to provide controversial arguments. We need only think that some doctors and virologists asked for a lockdown but others at the same time claimed there was no need or that while some asked not to let your guard down, others declared the virus clinically dead. It becomes more difficult in this context to distinguish credible sources. Indeed, for 49.7% of Italians, media communication on the epidemic was confused (Ital communications - Censis report, 2021). As a result, individuals rely on unofficial, false and potentially dangerous news: for instance, the effectiveness of chloroquine as a cure for covid-19 has been a popular fake news in Nigeria, the spread of which has resulted in several hospitalizations for overdose of chloroquine in a Lagos hospital (Sulaiman et al., 2020); the false news on the correlation between the 5G network and coronavirus has led in the United Kingdom to arson attacks on antennas and control units of the ultra-fast network (Ital communications - Censis report, 2021); the news that high-concentration alcohol could disinfect the body and kill the virus has produced 800 deaths and 5876 worldwide hospitalizations (Islam et al.,

2020); with the spread of a video on social media in which it is falsely reported that the seeds of Datura confer immunity against Covid-19, in India at least 12 people became seriously ill after consuming a liquor based on these toxic seeds (Islam et al., 2020).
Although the phenomenon of fake news is digital, it has serious real consequences. In this regard, knowing the determinants of disinformation related to covid-19 is a matter of great interest. In addition to the demographic variables included in the literature among the determinants of disinformation, such as age, sex, income, level of education (Allcott and Gentzkow, 2017; Bryanov and Vziatysheva, 2021; Pennycook and Rand, 2019; Stefanone et al., 2019; Sulaiman et al., 2020) we must add an indicator of "knowing someone who has contracted Covid-19", identified among the predictors of disinformation by Kim and Kim (2020).

Despite citizens being exposed to an excessive amount of information on Covid-19, 58.3% of 23500 citizens of 24 countries assert they do not have the complete picture on the pandemic (WHO et al., 2021). Also Okan et al. (2020), according to a survey conducted in Germany during the first weeks of the first wave of the epidemic, concluded that even among those who claim to feel very informed, there are people who feel confused by all the information received on COVID-19. Furthermore, young people interviewed were more confused than the elderly: an explanation may lie in a more widespread use of social media, therefore in greater exposure to fake news or controversial information. However, the authors do not consider this aspect in their analysis. Our study, on the contrary, specifically focuses on this aspect.

1.3 **Research Question, Hypotheses and Data**

The information quality to which people are exposed is fundamental for the control of the Covid-19 pandemic, nevertheless social media has been fertile ground for the proliferation of fake news, from conspiracy theories on the creation of the virus in the laboratory to miracle vitamin-based treatments.
In theory, the disinformation related to Covid-19 can lead people to potentially harmful behaviors: resorting to ineffective remedies, not respecting the provisions, spreading the virus. This explains the growing interest for the topic by researchers, national institutions

and world organizations and their commitment in the fight against the current infodemic.

To fight the Covid-19 infodemic, however, it is important to understand why people believe false information about the virus and how it is spread.

The empirical question investigated in the following study is the role of social media in disinformation related to the Covid-19 pandemic. As a preliminary analysis, I evaluate the difference in the average disinformation between groups, that are identified by main socio- demographic variables. Furthermore, I carry out an econometric analysis to assess whether the use of social media is associated to disinformation.

1.3.1 *Data collection method and participants*

An online survey was conducted for 51 days (28 May 2020 - 18 July 2020), by using Surveymonkey. For the entire data collection period Italy was in the second phase of pandemic management, when restrictive virus containment measures have been gradually relaxed. A part of the participants was invited to complete the survey during some university lessons, another part was contacted by email (2702 emails were sent to economics, economics and business, and engineering students, and the response rate was 12.73%).[4] The collected information was verified by checking the presence of inconsistent values (for instance, in the dates of birth provided, the monthly net income of the family or the number of inhabitants of the municipality of residence, etc.). The final sample consists of 833 individuals

All participants were informed of the anonymity of the data acquired and their processing limited to the purposes related to this research activity.

The choice of young individuals as focus for the analysis is due to their digital literacy and competences: they are the main users of the most popular social networks. Moreover, as young individual, they are potentially asymptomatic, which can promote the spread of the virus. [5]

[4] Permission to use student emails was sent to all University Departments. A positive answer was obtained by the coordinators of the following degree programmes: Economics, Statistics and Finance; Computer Engineering, Modelling, Electronics and Systems. Moreover, some Professors of the Department of Economics and Business agreed on administering the survey during their online lectures.

[5] In fact, the difficulty in detecting infected people for lack of symptoms or similarity of symptoms to a simple cold reduces the ability to trace the infection and allows the rapid spread of the virus (Zanin et al., 2020).

1.3.2 *Survey and variables*

The survey consists of four sections. First, it investigates the media habits of interviewees. They are asked to what extent they use the following sources to gather information about Covid-19: friends and family; TV and radio; Social Media, posts or blogs; local or national institutions (Region, Italian National Institute of Health); World Health Organization; scientific papers. They had to assign a score from 1 to 7 depending on the level of use. Furthermore, in order to measure the level of disinformation, a list of both fake and real news[6] is presented, and surveyed people are asked to indicate how much they believe in each statement on a 7-point Likert scale.[7] Thus the index of disinformation used in the analysis - average of the credibility scores of each item – gauges the degree of belief in fake news. In the second section, personal attitudes are investigated (religious and political faith). Personal identifying data, education and family background are collected in the third section and, finally, in the fourth section participants give information about their academic experience (attended university, year of the course, degree program). Table 1.1 provides a further description of each variable used in this analysis.

[Table 1.1]

1.3.3 *Descriptive analysis*

Although only 3.44% of respondents reported they fully trust the net (which includes blogs, search engines, social networks) as a source of news, according to 77.81% of the sample, free news is enough to be well informed, and only a negligible percentage of the participants have paid a subscription to a newspaper (about 3%).

[6] Fake news are: "There is a correlation between the Covid-19 epidemic and the 5G network", "the new coronavirus is a laboratory product", "hyperimmune plasma is a valid alternative to the vaccine, already tested and costless", "Covid-19 has a similar death rate to the flu", "massive doses of vitamin C are an effective treatment for Covid-19", and finally "the virus is weakening". Real news are: "The use of gloves does not protect against the virus" and "sales of Corona beer dropped dramatically as the virus spread"

[7] One point means that the statement is absolutely not true and 7 points mean that it is absolutely true. The responses to real contents are then specularly converted (1 corresponds to a 7; 2 corresponds to 6; 3 corresponds to 5).

Moreover, the sample is balanced across gender: 50,45% of the sample are male and 49,55% female. By birth, the sample ranges from a minimum of 18 to a maximum of 57 years old but 95.25% of the participants in the analysis are in the age group 19-29.

The preponderant religious faith is Catholicism: 62% of the sample are Catholic and 34.34 atheist, while the rest of the respondents profess a differing faith, such as Islamic and Protestant. Regarding political convictions, instead, 30% of the sample has a leftist ideology, whereas 9.83% have rightist beliefs and 51.83% has no political ideology. These data are in line with national ones: according to a survey conducted in Italy in 2017 about 40% of young people are far from political parties or movements, half of these do not recognize in the distinction between right and left, but the rest are completely uninterested in politics.[8] Even according to an ISTAT survey on political participation in Italy, conducted in 2019, about 30% of young people between 14 and 34 are not interested in politics at all.[9]

Table 1.2 shows which are the fake news that users have believed most (mean of credibility). It also specifies the percentage of users who read the news (exposition) and the percentage which shared it (sharing).

Table 1.2. Credibility, exposition and sharing of considered fake news.

FAKE NEWS	MEAN OF CREDIBILITY	EXPOSITION	SHARING
There is a correlation between the Covid-19 epidemic and the 5G network.	1,44	79,24%	2,95%
The new coronavirus is a laboratory product.	3,59	91,40%	18,82%
Hyperimmune plasma is a valid alternative to the vaccine, already tested and costless.	3,8	78,84%	21,92%

[8] Survey conducted in 2017 e published in "La condizione giovanile in Italia – Rapporto Giovani 2018" (ed. Il Mulino).

[9] Report Istat "La partecipazione politica in Italia", 2019.

The use of gloves does not protect against the virus.	3,77	77,89%	19,19%
Covid-19 has a similar death rate to the flu.	3,16	80,84%	16,48%
Massive doses of vitamin C are an effective treatment for Covid-19.	2,07	53,45%	6,53%
The virus is weakening.	3,67	84,64%	24,35%
Sales of Corona beer dropped dramatically as the virus spread.	2,7	49,08%	9,49%

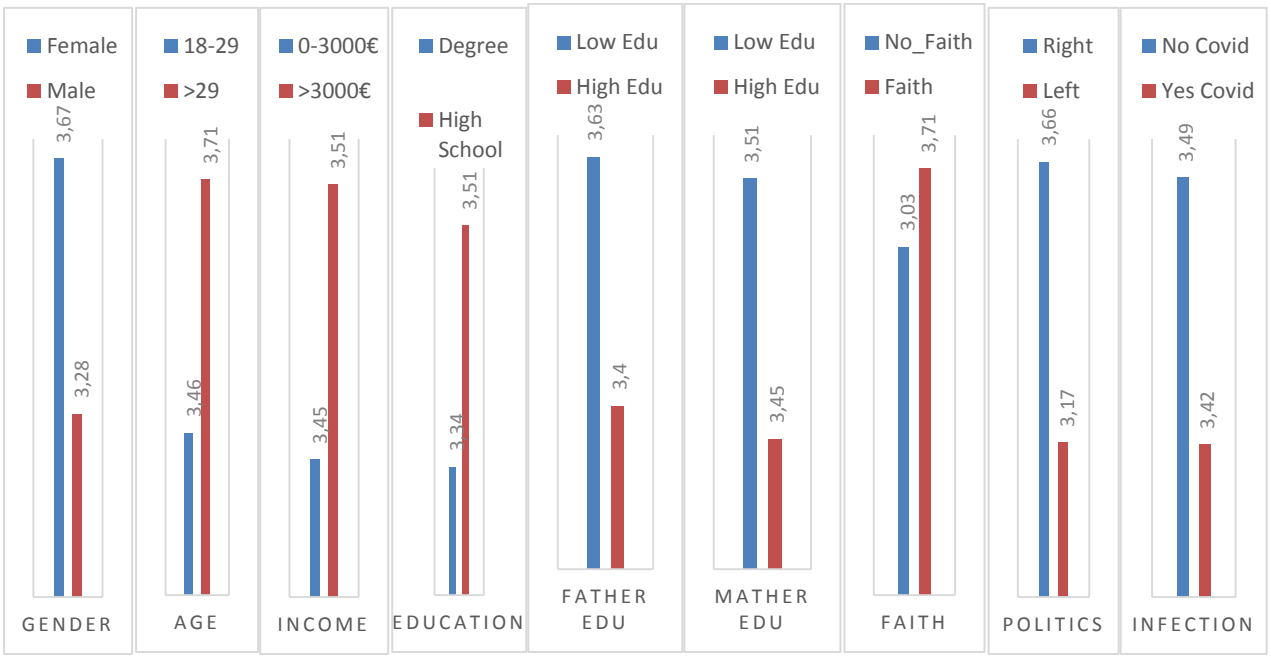
The fake news about the origin of the virus is the most popular: over 90% of respondents were exposed to this news. This finding do not differ from national data: according to the Ital Communications – Censis report of 2021, this fake news is perhaps the most widespread and 38.6% of Italians are convinced that the virus is an intentionally created laboratory product. In addition, it is among the fake content to which the respondents believed the most. Indeed, just two false information have more credibility: the weakening of the virus and the belief that hyperimmune plasma is a valid alternative to the vaccine, already tested and without costs. On the contrary, the correlation between Covid-19 epidemic and the 5G network is the least believable fake news in the interviewed sample. Despite the high percentage of participants who read this news (almost 80%), only 2.95% of the sample shared it. Therefore, it would seem reasonable to say that the sharing of news is associated with the credibility of the same: in the sample analysed, the phenomenon of sharing news with the intention of denying the false content appears negligible.

Indeed, the sharing of unverified news on social media is a risky behaviour, which affects one's own reputation: it is likely to be affected by risk propensity. Koohikamali and Sidorova (2017) note, in this regard, that the risk propensity is a significant predictor of re-sharing.

In general, there seems to be a tendency not to believe in the news to which one has been less exposed: the news of the drastic drop in sales of Corona beer, although it is true, has a fairly low mean of credibility compared to the fake news presented.

An analysis of the difference in disinformation between groups is presented in Figure 1.1.

Figure 1.1. Comparison of mean of disinformation between groups



T-tests are used to compare the mean of each variable between two groups, evaluating whether the difference in the means is zero. First of all, the mean of disinformation between females and males is tested: females are significantly more misinformed about Covid-19 than males (3,67 versus 3,28, p-value=0,000). It should be noted that the results of the previous literature regarding gender as a predictor of disinformation are not unambiguous. Kim and Kim (2020), for example, notes that women tend to believe less in fake news than men and this is the opposite of what happens in the sample of the analysis.

Respondents over 29 years old are more misinformed than those aged between 18 and 29 and the difference is statistically significant (p-value=0.0093). Supposedly, the demographic group with higher health risks should rely on authoritative sources and be properly informed, but paradoxically the oldest group of the sample is the most uninformed. This result is probably explained by lower digital and media literacy (Guess et al., 2020; Ital communications - Censis report, 2021).

Regarding the educational factor, only the education level of the mother is not significant (p-value=0,3284), instead graduates and who has the father highly educated are less misinformed, in the first case at a level of significance of 5% (p-value=0,0317) and in the

second at a level of 1% (p-value=0,0005). Numerous extant studies identify education as a predictor of susceptibility to fake news (Kim and Kim, 2020; Comandini, 2018; Allcott and Gentzkow, 2017): a low level of education promotes belief in fake news.

It is also interesting to note that, in line with previous literature, political and religious faith are associated with disinformation (Kahan, 2017; Van Bavel and Pereira, 2018; Sindermann et al., 2020): the group of faithful is more misinformed than the atheists (p-value=0,000) and even those who declare right-wing political inclination compared to those who manifest left-wing ideals (p-value=0,0002).

Paradoxically, the difference in disinformation between those who have closely experienced the disease (had a death for covid-19 in family or had a family member with severe symptoms) and those who did not is not statistically significant (p-value=0.7143). However, it should be noted that only 3.19% of respondents had relatives affected by the disease or had themselves the virus.

1.4 **Econometric Analysis**

The aim of the econometric analysis is to ascertain whether, other things being equal, the use of social media as a source of information influences disinformation and thus assess the role of social media in the proliferation of fake news.

1.4.1 *Methodology*

A Probit model is adopted to examine the relationship between the probability of misinformation and the use of social media. First, a general specification is estimated, including as controls all variables identified as disinformation predictors from the extant literature.[10] Then - due to the large number of predictors - the Lasso technique is used to select a parsimonious model.[11]

In general, dichotomous choice models can be illustrated in terms of an underlying latent variable process. In this analysis, we assume the existence of a latent propensity to believe

[10] These results are reported in the table A1 in the Appendix.

[11] The word Lasso originally was the acronym of "least absolute shrinkage and selection operator". Lasso is a method for selecting and fitting covariates.

in fake news, indicated by f^*, generated by the following process: $f_i^* = X'_i\beta + u_i$, where u_i is an error term and the vector X includes the potential determinants of misinformation. We assume that the phenomenon of misinformation is observed when $f^* > 0$. By defining a dummy variable $\delta = 1$ if the disinformation score is higher than 4, the probability of observing misinformation is expressed as $P(\delta_i = 1|X_i) = P(f_i^* > 0) = P(u_i > -X'_i\beta) = F(X'_i\beta)$ where F is the standard normal distribution function.

Moreover, an ordered probit model is estimated, considering as dependent variable the level of disinformation of each respondent (obtained as the average of the degree of credibility reported for each fake news).[12] Also the ordered response models can be illustrated in terms of an underlying latent variable process. Thus, we again assume the existence of a latent continuous propensity to believe in fake news underlying the ordinal responses observed, indicated by y^*, that is a combination of the vector X of predictors and an error term ε_i: $y_i^* = X'_i\beta + \varepsilon_i$. The observed ordinal variable, y_i, takes on values 1 through 7 according to the following scheme: $y_i = j \leftrightarrow \gamma_{j-1} < y_i^* \leq \gamma_j$, where γ_j are unknown parameters with $\gamma_0 = -\infty$, $\gamma_1 = 0$ and $\gamma_M = +\infty$. The probability of observing the particular ordinal outcome j coincides with the probability that the latent variable will fall into the range of extremes γ_{j-1} and γ_j. We consider the probabilities of each ordinal outcome:

$$\begin{aligned} P(y_i = 1|X_i) &= P(\gamma_0 < y_i^* \leq \gamma_1) = P(-\infty < y_i^* \leq \gamma_1) \\ &= P(y_i^* \leq \gamma_1) = P(X'_i\beta + \varepsilon_i \leq \gamma_1) = P(\varepsilon_i \leq \gamma_1 - X'_i\beta) \\ &= \phi(\gamma_1 - X'_i\beta) \\ P(y_i = 2|X_i) &= P(\gamma_1 < y_i^* \leq \gamma_2) = P(\gamma_1 - X'_i\beta < \varepsilon_i^* \leq \gamma_2 - X'_i\beta) \\ &= \phi(\gamma_2 - X'_i\beta) - \phi(\gamma_1 - X'_i\beta). \end{aligned}$$

Finally, we generically have:

$$P(y_i = j|X_i) = \phi(\gamma_j - X'_i\beta) - \phi(\gamma_j - 1 - X'_i\beta)$$

[12] As the dependent variable in a ordered probit model must be discrete, the average credibility (identified in our analysis as an index of disinformation) is approximated to the nearest integer. It takes on the values 1 through 7, corresponding to the categories identified by a 7-point Likert scale (one point means that the statement is absolutely not true and 7 points mean that it is absolutely true).

Where γ is an unknown parametron to be estimated jointly to β. MLE is used to estimate this model.

A critical assumption of ordered probit models is known as "parallel slopes": the coefficient β_k of a certain explanatory variable X_k does not vary depending on the considered alternative.

1.4.2 *Results and discussions*

First of all, a preliminary model in which the dependent variable assumes value 0 if the average of disinformation is less than 4 and 1 otherwise and including all the disinformation predictors identified in the previous literature has been estimated (complete estimates are available in the appendix, Table A1). In this model, social media use as a source of information significantly and positively influences disinformation about covid-19 (column 1, table A1).

Table 1.3, column 1, reports the marginal effects of the parsimonious model estimation, based on the Lasso method ("benchmark model"); other columns (from 2 to 9) presents the marginal effects of parsimonious models, where the dependent variables gauges the degree of credibility of each fake news (again assuming value 0 if the degree of credibility is less than 4 and 1 otherwise).

In the benchmark model, the use of social media, the exchange of information between friends and family and the consultation of information provided by WHO as a source of information about covid-19 seem to be significantly and positively associated to the probability of being misinformed, by contrast reading of scientific papers seems to have a negative association with disinformation related to Covid-19.

[Table 1.3]

Focusing on the heart of my research, in the benchmark model, all other things being equal, social media use as a source of information is correlated to an increase in the probability of being misinformed, at a significance level of 1%. In particular, for a unitary increase in the use of social media as a source of information, on average, the probability of being misinformed increases by almost 2%, at a significance level of 1%. Moreover, looking at the level of credibility of single fake news (columns 2-9, table 1.3), the use of

social media is associated to an increase in the propensity to believe that the virus was weakening (column 8, table 1.3) and that hyperimmune plasma is a valid alternative to the vaccine, already tested and costless (column 7, table 1.3). The results obtained are, therefore, in line with previous literature and theoretical expectations: social media as a source of information can play a role in disinformation. It seems reasonable to think that social media is an important proliferation channel of fake news due to the lack of review of the shared news. Moreover, thanks to the previous literature, we also know that social networks reduce the level of attention and consequently the ability to discern true news from false ones (Pennycook et al., 2020). In addition, information is then exchanged between peers without checking the authoritativeness of the source. This can easily contribute to the spread of fake news. Indeed, on the basis our analysis (column 2-9, table 1.3) the exchange of information between friends and family positively and significantly influences disinformation not only in the benchmark model, but also in the other models: exchanges of information between peers seem to be a predictor of the credibility of fake news related to the origin of the virus (column 3, table 1.3), the mortality rate (column 6, table 1.3) and the weakening of the virus (column 8, table 1.3), as well as the news that vitamic C is an effective treatment for covid-19 (column 7).

As concerns the consultation of information provided by WHO, the result of the benchmark model is in contrast with our theoretical expectations. Indeed, paradoxically, it seems that WHO, despite the authoritativeness of the source, increases disinformation: a theoretical explanation of this result can be attributed to abrupt new findings, determined by the change of contest caused by the pandemic and new data available. From this perspective, also authoritative sources seem to provide controversial arguments (Ital communications - Censis report, 2021). Another argument in support of this result may be the level of illiteracy of Italians, who may not have the skills to understand the contents of a news. For this purpose, it is important to note that according to the Programme for the International Assessment of Adult Competencies, only 3.3% of Italian adults reach high levels of competence in text comprehension.

Instead, in line with theoretical expectations, consultation of scientific papers influences negatively the propensity to believe in fake news. Indeed, in the benchmark model, the more scientific papers are used as source of information, the less fake news are believed, with an average marginal effect of 0.0609, at a level of significance of 1%.

In addition, in the benchmark model, females have a greater propensity to believe in fake news than males and with increasing age the probability to be misinformed rises (column 1, table 1.3). Also both the family educational background (identified in the level of education of the father) [13] and own level of education (the final vote of own educational qualification)[14] seem to influence disinformation (column 1, table 1.3): the higher the level of education, the less likely respondent is to believe in fake news. These findings seem to confirm the results of previous literature, indeed Alcott and Gentzkow (2017) also identify education as one of the determinants of disinformation and Kim and Kim (2020) reveal that respondents who attend college or had higher diploma believe less in fake news.
Other significant predictors of disinformation are identified in political and religious ideology: the susceptibility to false news is, in fact, guided by ideological prejudices (Pennycook and Rand). In confirmation of these considerations, in this sample, the political affiliation to the right-wing faction positively and significantly influences the probability of being misinformed, while atheism has a negative and significant impact on disinformation (column 1, table 1.3). Furthermore, in terms of magnitude, these latter factors appear to have a significantly large coefficient: policy makers should act to strengthen the values of tolerance and civic sense.

Table 1.4 reports the ordered probit model estimates of the parsimonious model, based on the Lasso method, both for the average of disinformation (column 1) and the degree of credibility for each fake news (column 2-9).

[Table 1.4]

The use of social media as a source of information seems to have a role in the general disinformation (column 1, table 1.4) but also in disinformation for the news related to the origin of the virus (column 3, table 1.4), to the hyperimmune plasma such as a valid alternative to the vaccine (column 4, table 1.4) and to the weakening of the virus (column

[13] The level of education of the father is a discrete variable that assumes values from 1 to 4, respectively for elementary licence, middle licence, diploma and degree.
[14] The final vote is a discrete variable that assumes values from 1 to 4, respectively if the vote gained in the own highest educational qualification is low, lower-middle, higher-middle, high.

8, table 1.4). Moreover, it also seems to increase the propensity to believe that there has been a collapse in the sales of Corona beer, which is however a real news.
Also the exchange of information between peers is associated to an increase in the general propensity to believe in fake news (column 1, table 1.4) and the specific probability to believe in almost all considered fake news: this source of information is not significant only for the news of correlation between covid-19 and 5g and the collapse of the sale of Corona beer (columns 2-9, table 1.4).
Moreover, political and religious ideology seems to influence significantly the propensity to believe in fake news: in line with the theoretical expectations and previous empirical results of this research. In particular, the right-wing ideology is positively correlated with the propensity to believe in fake news, vice versa the atheism and the left-wing ideology are negatively correlated with this propensity.
In addition, the more scientific papers are used, the higher the education qualification, the more educated the father is, the less fake news are believed (column 1, table 1.4).

As a robustness check, I first replace the discrete variable use of social media with a dummy variable, coded equal to 1 if the self-reported use is greater than 4 and then with the variable trust in social media. The results obtained (presented in the appendix in table A2) are in line with the precedent ones: the belief that the network (blogs, search engines, social networks) informs users in an accurate and balanced way has a positive and significant correlation with disinformation while trust in science has a significant but negative association (column 2, table A2). It is interesting to note that in terms of magnitude, the coefficient relating to the dummy variable "social" is among the largest (column 1, table A2).

Finally, we address concerns of endogeneity. Indeed, there may be unobserved effects, related to unacknowledged psycho-attitudinal factors affecting both disinformation and use of social. Furthermore, a simultaneous causality bias may occur.
First, the endogeneity tests of Wu-Hausman and Durbin-Wu-Hausman have been implemented. Using as instrument the variable "Follower_Facebook" (a continuous variable indicating the self-reported amount of followers that respondents have on Facebook), the regressor "source_social" (a discrete variable that takes values from 1 to 7 depending on the extent in which respondents use social media as a source of information

about covid-19) would seem to be exogenous.[15] The instrument used for the analysis seems to be both theoretically and practically a valid instrument. Intuitively, the number of followers could be related to the use of social media but not directly to disinformation. These results are confirmed by regressing the "source_social" on the "follower_Facebook" and the other explanatory variables.[16]

Furthermore, we adopt the special regressor method, which allows to estimate a binary choice model with discrete endogenous regressors. Since our variable of interest (source_social) is discrete, with a range between 1 and 7[17], the special regressor should provide efficient estimates. In addition to the instrument, a special regressor is necessary for the estimation of the model: the inhabitants number of the place of residence has been chosen. This explanatory variable presents indeed the typical characteristics of the special regressor: it is continuously distributed and does not significantly affect "source_social".[18]

The results obtained with the special regressor method are shown in Table A3 in the Appendix.

Even implementing this model, the use of social media seems to positively and significantly influence the probability of being misinformed. This robustness check therefore seems to confirm the results previously presented.

1.5 **Implications and limitations**

This research has important theoretical and practical implications: our results show how social media plays an important role in online disinformation from Covid-19. Demonstrating the role of social networks in disinformation, it is necessary on a practical level to undertake policy measures that counteract the spread of fake news online. However, the presented analysis has several limitations. First of all, the sample used in the study is composed of university students. It is possible to increase the validity of these results by replicating the study with a demographically more heterogeneous sample,

[15] The p-value of the Wu-Hausman F test is 0.54152 and those of the Durbin-Wu-Hausman chi-sq test is 0.53550. Since the test is not significant, one cannot reject the null hypothesis that considers the variable "source_social" as exogenous. The results of this test therefore seem to corroborate the use of the probit model.

[16] Results are reported in table A4 in the Appendix.

[17] See table 1.

[18] This can be seen from the OLS regression in which the dependent variable is source_social, reported in the table A4 in the Appendix.

despite young people, even if less at risk of developing serious symptoms of COVID-19, are a key group in the context of this pandemic: both because they act as a vehicle of contagion for those most at risk and therefore share the collective responsibility of stopping the transmission and because they are the most active online, interacting daily with an average number of 5 digital platforms. It would be particularly interesting to note, for example, the differences in disinformation between millennials and generation Z compared to baby boomers. Furthermore, the low response rate obtained from the survey may lead to bias in the estimates: on the one hand, only the individuals most interested in the topic or who use mobile devices the most could have responded since it was an online survey, leading to a sample selection bias; on the other hand, the reduced sample size leads to larger standard errors and less precise estimates.

Furthermore, the level of health literacy and the level of hypochondria are not assessed: these conditions could compromise the ability to discern true news from false ones in the context of this pandemic. More generally, although this study tried to control for potential endogeneity problems, there may be unobserved effects, related to unacknowledged psycho-attitudinal factors affecting disinformation.

Finally, the role of social media in disinformation could be underestimated: according to Bryanov and Vziatysheva (2021), based on the results obtained by Pennycook et al. (2020), data collected from investigations that include the task of discerning fake news can be skewed towards greater accuracy, due to the fact that individuals are induced to think about the truthfulness of the news, compared to their usual state of mind while browsing online.

1.6 **Conclusions**

Disinformation on social media is a problem as old as their existence, but the Covid-19 pandemic has worsened this condition: the originated "infodemic" has polarized public debate on this issue, amplified the hate speech, fomented violence, heightened the risk of human rights violations, threatened the advance of democracy, caused xenophobia and psychological disorders (Ali, 2020; WHO, 2020c).

It is therefore of great interest to understand which are the predictors of disinformation to implement the right government policies that can mitigate the negative effects.

In the present study, we analysed the role of social media in disinformation relating to covid-19. To collect data, a survey was administered to economics and engineering students of University of Calabria, in the South of Italy, between 28 May 2020 to 18 July 2020, i.e. during the so called phase 2 of covid-19 pandemic in Italy. Collected data are used to implement, first, a probit model in which an index of disinformation is used as dependent variable and all the predictors of disinformation identified by previous literature are included (the use of social media, family and friends, institutions, traditional media, scientific papers and WHO as sources of information, demographic characteristics such as gender, age, number of family members, income and inhabitants of the country of residence, personal attitudes such as the religious and political beliefs, the degree, the final grade, the level of education of the father and mother and finally the close acquaintance with a confirmed case of Covid-19). Second, we use the lasso technique to select a parsimonious model. The excluded variables are: traditional media and institutional sources use, level of education of mother, income and inhabitants of country residence. The selected variables are used to implement both a probit model and an ordered probit model. Finally, two further robustness checks are conducted: one replacing social media use with the trust in social media and another for concerns of endogeneity using the special regressor method.

The results of present research are in line with theoretical expectations and with previous literature: social media have a significant role in the diffusion of misleading contents, which influence the behavior of individuals.

In a media environment in which social media lends itself to become the main and primary source of information, it is essential to ensure that fake news is rejected.

WHO recognizes that a key part of controlling the Covid-19 pandemic is the management of the infodemic: member States, regional and international organizations, also through a coordinated approach, must combat misinformation providing reliable and accurate content and advocating the maximum transparency. For this purpose, it is important to provide scientific data to the public and universal access to credible health information.

Italy is one of the 132 states that have signed the cross-regional statement on COVID-19 infodemic, with which it is committed to fight infodemic and promote correct information

and trust in science. Furthermore, the Italian Ministry of Health has published an archive in which the experts of the Ministry of Health and of the Italian National Institute of Health deny the most widespread fake news, in light of the scientific and regulatory evidence, available at the date of publication of each news.[19]

Despite the efforts made by governments and the World Health Organization, much more is needed to eliminate the impact of disinformation on Covid-19. Even the managers of social media platforms through which fake news are spread, researchers and digital engineers can fight the phenomenon of disinformation by devising and implementing effective tools and strategies (WHO, 2020c). The amount of shared information and the speed of propagation, indeed, make it impossible to promptly assess the reliability of the news, highlighting the need for automatic systems of detecting fake news (Tacchini, 2017). However, Guess et al. (2020) found that even a series of simple guidelines ("be sceptical about headlines", "beware of unusual formatting") improve the discernment rate of fake news (26% more in the US sample and 19% in the Indian one). According to Pennycook et al. (2020), indeed, the ability to discern true news from false ones is compromised by the decrease in attention that characterizes social media users when they browse social network platforms. Keeping a high level of attention can, therefore, help to counteract the spread of fake news.

Influencers and leaders of society, whose opinions and habits have a major impact on the behavior of individuals, can also contribute by spreading accurate information and preventing the spread of disinformation (WHO, 2020c).

Despite the penalties of the Italian regulatory system (from simple sanctions to imprisonment) for those who spread false news that could arouse public alarm or depress the public spirit in times of war or for those who disseminate false and defamatory content, an organic discipline for hoaxes on the web does not exist. Consequently, there is no penalty if the dissemination of false content does not fall within other already regulated crimes, precisely as defamation and procured alarm.

[19] Archive available from: https://www.salute.gov.it/portale/nuovocoronavirus/archivioFakeNewsNuovoCoronavirus.jsp

To this end, in the absence of sanctions as a deterrent to the behaviour of sharing false news, to contribute to the fight against the infodemic it is appropriate that governments leverage awareness-raising campaigns for a conscious use of social media, which allow both to recognize fake news and to avoid its spread.

Table 1.1. Description and summary of variables

		Mean	Std. Dev.	Min	Max	Obs
disinformation	Average (rounded to the nearest integer) of the credibility scores of each item for which respondents assigned one point if the statement is absolutely not true and 7 points if it is absolutely true.	3.483	0.853	2	6	813
disinformation_d	Dummy=1 if disinformation >= 4.	0.492	0.5	0	1	813
corr_Covid_5G	Credibility score (1=absolutely not true: 7=absolutely true) reported by respondents to the following item: "There is a correlation between the Covid-19 epidemic and the 5G network."	1.44	1.057	1	7	810
corr_Covid_5G_d	Dummy=1 if disinformation >= 4	0.097	0.296	0	1	810
lab_product	Credibility score (1=absolutely not true: 7=absolutely true) reported by respondents to the following item: "the new coronavirus is a laboratory product".	3.592	1.958	1	7	813
lab_product_d	Dummy=1 if disinformation >= 4	0.547	0.498	0	1	813
hyperimm_plasma	Credibility score (1=absolutely not true: 7=absolutely true) reported by respondents to the following item: "Hyperimmune plasma is a valid alternative to the vaccine, already tested and costless".	3.795	1.794	1	7	811
hyperimm_plasma_d	Dummy=1 if disinformation >= 4	0.604	0.486	0	1	811
Gloves	Credibility score (1=absolutely not true: 7=absolutely true) reported by respondents to the following item: "The use of gloves does not protect against the virus".	3.766	2.001	1	7	813
gloves_d	Dummy=1 if disinformation >= 4	0.608	0.489	0	1	813
Mortality	Credibility score (1=absolutely not true: 7=absolutely true) reported by respondents to the following item: "Covid-19 has a similar death rate to the flu".	3.164	1.834	1	7	813
mortality_d	Dummy=1 if disinformation >= 4	0.44	0.497	0	1	813
vitaminC	Credibility score (1=absolutely not true: 7=absolutely true) reported by respondents to the following item: "Massive doses of vitamin C are an effective treatment for Covid-19".	2.067	1.438	1	7	811
vitaminC_d	Dummy=1 if disinformation >= 4	0.194	0.396	0	1	811
Weakening	Credibility score (1=absolutely not true: 7=absolutely true) reported by respondents to the following item: "The virus is weakening".	3.665	1.724	1	7	813
weakening_d	Dummy=1 if disinformation >= 4	0.565	0.496	0	1	813
coronabeer	Credibility score (1=absolutely not true: 7=absolutely true) reported by respondents to the following item: "Sales of Corona beer dropped	2.702	2.043	1	7	810

	dramatically as the virus spread".					
coronabeer_d	Dummy=1 if disinformation >= 4	0.775	0.417	0	1	810
source_social	The extent to which the respondents use social media (posts or blogs) as a source of information about Covid-19 (1=deeply disagree; 7=completely agree).	4.017	2.102	1	7	811
social	Dummy=1 if source_social >= 4	0.586	0.493	0	1	811
source_friends	The extent to which the respondents use their friends and family as a source of information about Covid-19 (1=deeply disagree; 7=completely agree).	3.31	1.846	1	7	813
source_tv	The extent to which the respondents use traditional media (TV, radio, newspapers) as a source of information about Covid-19 (1=deeply disagree; 7=completely agree).	4.859	1.952	1	7	813
source_istitution	The extent to which the respondents use local and national institutions (Region, Italian National Institute of Health) as a source of information about Covid-19	5.135	1.902	1	7	813
source_WHO	The extent to which the respondents use Who as a source of information about Covid-19.	4.478	2.239	1	7	811
source_paper	The extent to which the respondents use scientific papers as a source of information about covid-19.	4.515	2.138	1	7	811
final_vote	Final grade of higher educational qualification (1=low; 2= lower-middle; 3=higher-middle; 4=high).	3.106	0.925	1	4	772
trust_in_SocialMedia	Score from 1 to 7 (1=deeply disagree; 7=completely agree) assigned to following statement: "The network (blogs, search engines, social networks) informs users in an accurate and balanced way".	3.122	1.65	1	7	814
trust_in_Science	Score from 1 to 7 (1=deeply disagree; 7=completely agree) assigned to following statement: "I believe credible scientific information provided by scientific sources".	5.931	1.289	1	7	813
family_members	Continuous variable that identify the number of household members of respondents.	3.216	1.001	0	9	777
Female	Dummy=1 if the respondent is a female, 0 otherwise.	0.496	0.5	0	1	783
Age	Continuous variable that identify the age of respondents.	23.243	3.865	18	57	781
dead_Covid	Dummy=1 if the respondent had bereavement or serious health problems in the family caused by Covid-19.	0.032	0.176	0	1	814
no_faith	Dummy=1 if the respondent is atheist..	0.343	0.475	0	1	795
right_wing	Dummy=1 if the respondent has a right-wing political conviction.	0.098	0.298	0	1	600
left_wing	Dummy=1 if the respondent has a left-wing political conviction.	0.3	0.459	0	1	600
Degree	Dummy=1 if the respondent is graduated.	0.202	0.402	0	1	783

mother_educ	Educational qualification of mother (1=primary school diploma; middle school diploma; high school diploma; degree or post degree qualification).	2.764	0.806	1	4	776
father_educ	Educational qualification of father (1=primary school diploma; middle school diploma; high school diploma; degree or post degree qualification).	2.831	0.776	1	4	777
Income	Net monthly household income (1 if income is under 1000€; 2 between 1000 and 3000€; 3 between 3000 and 5000€; 4 more than 5000€).	2.203	0.947	1	4	769
Inhabitants_city	Number of inhabitants of city of residence (1 if inhabitants is under 3000; 2 between 3000 and 6000; 3 between 6000 and 15000; 4 between 15000 and 60000; 5 more than 60000).	2.847	1.414	1	5	771

Table 1.3. Probit Estimates

	(1) disinformation_d	(2) corr_Covid_5G_d	(3) lab_product_d	(4) hyperimm_plasma_d	(5) gloves_d	(6) mortality_d	(7) vitaminC_d	(8) weakening_d	(9) coronabeer_d
source_social	0.0165***	0.0038	0.0074	0.0137	-0.0093*	-0.0002	0.0155*	0.0447***	-0.0182***
	(0.0061)	(0.0025)	(0.0095)	(0.0098)	(0.005)	(0.0123)	(0.0079)	(0.0111)	(0.0056)
source_friends	0.0294**	0.0049	0.0388***	0.0102	-0.01698**	0.0174***	0.0133***	0.0263**	-0.0077
	(0.0117)	(0.004)	(0.0046)	(0.0072)	(0.0071)	(0.00598)	(0.0044)	(0.0129)	(0.0064)
source_paper	-0.0609***	-0.0023	-0.0162**	0.0174	-0.0431***	0.0112	-0.0003	0.0065	-0.0274***
	(0.0170)	(0.0055)	(0.0071)	(0.0121)	(0.0127)	(0.0143)	(0.0048)	(0.0094)	(0.0098)
source_WHO	0.0195*	-0.0009	-0.005	0.0013	0.0203	-0.0003	0.0123**	0.0168*	0.0066
	(0.0114)	(0.0027)	(0.00397)	(0.0146)	(0.0128)	(0.0084)	(0.0048)	(0.01002)	(0.0108)
final_vote	-0.0503***	-0.0138***	-0.0671***	-0.0271	0.0149	-0.0147	-0.0349***	-0.0212	-0.03098**
	(0.0099)	(0.0046)	(0.014)	(0.0204)	(0.0192)	(0.0247)	(0.0112)	(0.0235)	(0.0124)
female	0.1343***	0.0206*	0.2067***	0.1011***	-0.0164	0.0856***	0.0223	0.0876***	0.1710***
	(0.0406)	(0.0121)	(0.0513)	(0.0299)	(0.01604)	(0.0252)	(0.0346)	(0.0296)	(0.0256)
age	0.0105*	0.0003	-0.0075	0.0084**	0.0019	-0.0005	-0.0139	0.00297	0.0016
	(0.0057)	(0.001)	(0.0052)	(0. 0034)	(0.0047)	(0.0035)	(0.0265)	(0.0053)	(0.0027)
dead_Covid	-0.3066***	0.361	0.1651	-0.1563	-0.8502	-0.1244	-0.0986	0.0865	-0.0889
	(0.0697)	(0.036)	(0.114)	(0.1269)	(0.0615)	(0.13)	(0.0765)	(0.1128)	(0.1456)
family_members	-0.0128	-0.0065	-0.0404***	-0.0061	-0.0178	0.0435***	0.0193	0.0041	-0.0195*
	(0.0188)	(0.008)	(0.0122)	(0.01)	(0 01397)	(0.0169)	(0.0574)	(0.0127)	(0.0117)
no_faith	-0.2655***	-0.0625***	-0.1896***	-0.1654***	0.0429	-0.0395*	-0.1321***	-0.1007*	-0.1226***
	(0.023)	(0.012)	(0.0175)	(0.0241)	(0.0571)	(0.0219)	(0.0081)	(0.0543)	(0.0261)
right_wing	0.357***	0.0161*	0.1862***	0.1304*	-0.428**	0.087	-0.008	0.12199**	-0.0326
	(0.0963)	(0.0094)	(0.0679)	(0.0782)	(0.0188)	(0.0533)	(0.0265)	(0.0576)	(0.02999)
left_wing	-0.1335***	-0.0035	-0.1858***	-0.1398***	0.035	-0.0721*	-0.0445***	-0.0006	-0.0245
	(0.0375)	(0.0122)	(0.0252)	(0.03698)	(0.0074)	(0.0411)	(0.0153)	(0.0438)	(0.0259)
degree	-0.0949	0.0116	-0.0929	-0.0513	0.0074	0.0802***	0.0336	0.0505	-0.1212***
	(0.0622)	(0.0233)	(0.0731)	(0.0444)	(0.006)	(0.0158)	(0.0243)	(0.0447)	(0.0249)
father_educ	-0.0535*	-0.0237**	-0.0366	-0.0395	-0.0317	-0.0253**	-0.0015	0.0171	-0.0271

	(0.0277)	(0.0113)	(0.0281)	(0.0297)	(0.0299)	(0.0111)	(0.0123)	(0.0234)	(0.0214)
_cons	-0.0708	-0.294	1.463**	-0.0919	0.826**	-0.630	-0.832	-1.569**	2.153***
	(0.605)	(0.539)	(0.487)	(0.427)	(0.313)	(0.407)	(1.031)	(0.561)	(0.318)
N	555	555	555	555	555	555	555	555	555

Note: Average marginal effects are reported in the table. Standard errors are reported in parentheses. Asterisks *** (**) ((*)) indicate significance respectively at the level of 1% (5%) ((10%))

Table 1.4. Ordered Probit Estimates

	(1) disinformation	(2) corr_Covid_5G	(3) lab_product	(4) hyperimm_plasma	(5) gloves	(6) mortality	(7) vitaminC	(8) Weakening	(9) coronabeer
source_social	0.0391**	0.00463	0.0410*	0.0525***	-0.0256	-0.000241	0.0204	0.0943***	-0.0396***
	(0.0170)	(0.0241)	(0.0242)	(0.0188)	(0.0158)	(0.0365)	(0.0142)	(0.0187)	(0.00525)
source_friends	0.0771***	0.0752	0.0859***	0.0344*	0.0211**	0.0437***	0.0607**	0.0461**	-0.000925
	(0.0159)	(0.0602)	(0.0178)	(0.0196)	(0.00967)	(0.0124)	(0.0247)	(0.0226)	(0.0234)
source_paper	-0.0248**	-0.00789	0.000819	0.0321	-0.0623*	0.0224	-0.00372	0.0397*	-0.0733***
	(0.0119)	(0.0372)	(0.0168)	(0.0268)	(0.0369)	(0.0252)	(0.0116)	(0.0241)	(0.0114)
source_OMS	0.00664	-0.0211	-0.0189	-0.00511	0.0275	-0.0268**	0.0107	-0.00103	-0.00390
	(0.0179)	(0.0235)	(0.0223)	(0.0191)	(0.0260)	(0.0132)	(0.0263)	(0.0224)	(0.0133)
final_vote	-0.114***	-0.117**	-0.113**	-0.0875***	0.0421	-0.0461	-0.142***	-0.0262	-0.0373
	(0.0214)	(0.0557)	(0.0455)	(0.0298)	(0.0264)	(0.0704)	(0.0323)	(0.0384)	(0.0306)
Female	0.348***	0.436***	0.288**	0.203***	-0.126***	0.109	0.197	0.0631	0.414***
	(0.0902)	(0.0440)	(0.118)	(0.0747)	(0.0276)	(0.0619)	(0.151)	(0.0535)	(0.0690)
Age	0.0235**	-0.00349	-0.0180	0.0308***	0.00449	-0.000534	-0.0295	0.0308	0.0251
	(0.0104)	(0.0122)	(0.0180)	(0.00967)	(0.00454)	(0.00599)	(0.0201)	(0.0190)	(0.0154)
dead_Covid	-0.302	0.0822	0.131	-0.160	-0.0943	-0.261	-0.380*	-0.00201	-0.0367
	(0.260)	(0.414)	(0.116)	(0.341)	(0.102)	(0.314)	(0.224)	(0.221)	(0.373)
family_members	-0.0344	-0.0726	-0.0377	-0.0565***	0.0000111	0.0872**	0.0151	0.0354	0.000981
	(0.0489)	(0.0801)	(0.0332)	(0.0214)	(0.0211)	(0.0357)	(0.0198)	(0.0416)	(0.0268)
no_faith	-0.726***	-0.596***	-0.467***	-0.363***	0.0947	-0.151***	-0.555***	-0.335***	-0.383***
	(0.0391)	(0.138)	(0.0374)	(0.0505)	(0.111)	(0.0542)	(0.0596)	(0.0737)	(0.0461)

right_wing	0.198***	0.387***	0.398**	0.219	-0.151	0.140	-0.0586	0.267**	0.00429
	(0.0719)	(0.0835)	(0.184)	(0.155)	(0.109)	(0.138)	(0.0858)	(0.117)	(0.0701)
left_wing	-0.339***	-0.125*	-0.470***	-0.248***	0.126**	-0.179***	-0.116*	-0.0360	-0.0673
	(0.0691)	(0.0654)	(0.0697)	(0.0481)	(0.0540)	(0.0487)	(0.0671)	(0.0731)	(0.0590)
Degree	-0.197**	-0.0495	-0.160**	-0.131	-0.0327	0.0979	0.0447	0.147	-0.323***
	(0.0855)	(0.129)	(0.0661)	(0.109)	(0.0938)	(0.0680)	(0.0863)	(0.0994)	(0.0857)
father_educ	-0.120*	-0.225**	-0.130**	-0.0972*	-0.0480	-0.0655**	-0.0270	0.0454	-0.100
	(0.0646)	(0.0880)	(0.0598)	(0.0512)	(0.0641)	(0.0287)	(0.0385)	(0.0496)	(0.100)
/									
cut1	-1.509**	-0.0603	-1.880**	-0.726*	-1.318***	-0.581	-0.865	0.474	-1.903***
	(0.474)	(0.408)	(0.681)	(0.301)	(0.223)	(0.392)	(0.623)	(0.405)	(0.490)
cut2	0.0401	0.256	-1.455*	-0.262	-0.820***	-0.147	-0.373	0.870*	-1.537**
	(0.470)	(0.454)	(0.701)	(0.282)	(0.242)	(0.411)	(0.627)	(0.368)	(0.505)
cut3	1.271*	0.543	-1.071	0.161	-0.304	0.281	0.0530	1.441***	-1.137*
	(0.538)	(0.459)	(0.682)	(0.300)	(0.271)	(0.380)	(0.582)	(0.423)	(0.480)
cut4	2.430***	0.812	-0.521	0.710*	0.0406	0.733	0.509	2.042***	-0.810
	(0.515)	(0.445)	(0.639)	(0.325)	(0.250)	(0.442)	(0.588)	(0.401)	(0.452)
cut5		1.493**	0.121	1.305***	0.391	1.225**	0.945	2.674***	-0.573
		(0.461)	(0.641)	(0.330)	(0.256)	(0.462)	(0.540)	(0.349)	(0.472)
cut6		1.717***	0.573	1.936***	0.694**	1.604***	1.279*	3.232***	-0.350
		(0.519)	(0.593)	(0.312)	(0.253)	(0.449)	(0.642)	(0.374)	(0.467)
N	555	553	555	554	555	555	555	555	553

Note: Standard errors are reported in parentheses. Asterisks *** (**) ((*)) indicate significance respectively at the level of 1% (5%) ((10%))

Appendix

Table A1. Preliminary probit estimates

	(1) disinformation_d	(2) corr_Covid_5G_d	(3) lab_product_d	(4) hyperimm_plasma_d	(5) gloves_d	(6) mortality_d	(7) vitamin_d	(8) weakening_d	(9) coronabeer_d
source_social	0.0436**	0.0613*	0.0141	0.0269	-0.00387	0.0134	0.0835**	0.101***	-0.0592**
	(0.0180)	(0.0340)	(0.0265)	(0.0286)	(0.0140)	(0.0335)	(0.0371)	(0.0290)	(0.0233)
source_friends	0.0917**	0.0693	0.107***	0.0257	-0.0253	0.0643**	0.0682***	0.0679*	-0.0237
	(0.0381)	(0.0446)	(0.0166)	(0.0229)	(0.0242)	(0.0271)	(0.0221)	(0.0373)	(0.0219)
source_tv	-0.0285	-0.00186	-0.00651	0.0288	-0.0848***	-0.0557***	-0.0340	0.0393***	-0.00272
	(0.0203)	(0.0835)	(0.0179)	(0.0316)	(0.0297)	(0.0166)	(0.0238)	(0.0139)	(0.0197)
source_istitution	-0.00659	-0.204***	0.00227	0.0230	0.0123	-0.0658**	-0.0602	0.0207	0.00551
	(0.0372)	(0.0676)	(0.0232)	(0.0381)	(0.0311)	(0.0332)	(0.0468)	(0.0347)	(0.0263)
source_WHO	0.0577	0.0790	-0.0124	-0.0115	0.0634*	0.0331	0.0877***	0.0335	0.0251
	(0.0408)	(0.0633)	(0.0147)	(0.0414)	(0.0339)	(0.0327)	(0.0340)	(0.0226)	(0.0488)
source_paper	-0.0700***	-0.0151	-0.0444**	0.0422	-0.125***	0.0227	-0.00495	0.0136	-0.0983***
	(0.0171)	(0.0656)	(0.0197)	(0.0295)	(0.0263)	(0.0344)	(0.0288)	(0.0267)	(0.0354)
final_vote	-0.134***	-0.235***	-0.175***	-0.0718	0.0380	-0.0421	-0.171***	-0.0701	-0.110***
	(0.0286)	(0.0513)	(0.0377)	(0.0520)	(0.0587)	(0.0591)	(0.0600)	(0.0591)	(0.0423)
family_members	-0.0452	-0.0925	-0.117***	-0.0137	-0.0524	0.101**	-0.0118	0.0720	-0.0429
	(0.0564)	(0.0792)	(0.0365)	(0.0313)	(0.0433)	(0.0495)	(0.0614)	(0.0553)	(0.0338)
female	0.395***	0.320**	0.564***	0.257***	-0.0442	0.304***	0.160	0.222***	0.571***
	(0.0907)	(0.141)	(0.109)	(0.0674)	(0.0618)	(0.0510)	(0.184)	(0.0747)	(0.0949)
age	0.0270*	0.00230	-0.0194	0.0229**	0.00484	-0.00136	-0.0126	0.0262	0.00636
	(0.0154)	(0.0112)	(0.0127)	(0.00994)	(0.0145)	(0.00794)	(0.0233)	(0.0217)	(0.0109)
dead_Covid	-0.789***	0.473	0.424	-0.398	-0.189	-0.277	-0.421	0.190	-0.320
	(0.187)	(0.437)	(0.331)	(0.357)	(0.173)	(0.338)	(0.397)	(0.319)	(0.481)
no_faith	-0.714***	-0.850***	-0.491***	-0.406***	0.0801	-0.129*	-0.643***	-0.252*	-0.420***
	(0.0530)	(0.185)	(0.0378)	(0.0526)	(0.129)	(0.0712)	(0.0732)	(0.149)	(0.0738)

right_wing	0.407***	0.164	0.535***	0.305*	-0.102***	0.279**	0.0229	0.347**	-0.132
	(0.0826)	(0.115)	(0.160)	(0.185)	(0.0359)	(0.137)	(0.115)	(0.149)	(0.137)
left_wing	-0.327***	-0.133	-0.468***	-0.363***	0.0912	-0.158	-0.207***	-0.0267	-0.0655
	(0.109)	(0.169)	(0.0797)	(0.0866)	(0.107)	(0.113)	(0.0647)	(0.119)	(0.0846)
degree	-0.255	0.219	-0.231	-0.121	0.0194	0.204***	0.175	0.132	-0.437***
	(0.163)	(0.323)	(0.183)	(0.110)	(0.165)	(0.0303)	(0.127)	(0.105)	(0.0865)
mother_educ	0.0291	0.00242	0.0850	0.0773	0.0425	-0.00211	0.156	0.0778	-0.134
	(0.0525)	(0.145)	(0.0556)	(0.0814)	(0.0451)	(0.0831)	(0.132)	(0.0787)	(0.0819)
father_educ	-0.162**	-0.340***	-0.122	-0.144*	-0.0659	-0.0850	-0.0911	0.0144	-0.0534
	(0.0762)	(0.120)	(0.0757)	(0.0768)	(0.0882)	(0.0616)	(0.107)	(0.0743)	(0.120)
income	-0.00965	0.0417	-0.0835*	-0.0000497	-0.0309	-0.0285	-0.0139	-0.126***	0.0663**
	(0.0941)	(0.0854)	(0.0458)	(0.0476)	(0.0402)	(0.0697)	(0.0635)	(0.0409)	(0.0300)
inhabitants_city	0.0174	-0.0832**	0.00844	0.00229	-0.0461	0.0552***	0.0153	-0.000641	0.0384
	(0.0512)	(0.0404)	(0.0637)	(0.0381)	(0.0311)	(0.0176)	(0.0451)	(0.0443)	(0.0365)
_cons	0.0467	0.608	1.556**	-0.377	1.117***	-0.294	-0.695	-1.709***	2.076***
	(0.642)	(0.749)	(0.653)	(0.688)	(0.167)	(0.337)	(0.691)	(0.636)	(0.418)
N	549	549	549	549	549	549	549	549	549

Note: Standard errors are reported in parentheses. Asterisks *** (**) ((*)) indicate significance respectively at the level of 1% (5%) ((10%))

Table A2. Probit estimates using trust in social media

	(1) disinformation_d "source_social" replaced with "social"	(2) disinformation_d variables "source" replaced with "trust"	(3) corr_Covid_5G_d variables "source" replaced with "trust"	(4) lab_product_d variables "source" replaced with "trust"	(5) hyperimm_plasma_d variables "source" replaced with "trust"	(6) gloves_d variables "source" replaced with "trust"	(7) mortality_d variables "source" replaced with "trust"	(8) weakening_d variables "source" replaced with "trust"	(9) vitaminC_d variables "source" replaced with "trust"	(10) coronabeer_d variables "source" replaced with "trust"
social	0.3454**	-	-	-	-	-	-	-	-	-
	(0.0086)									
source_friends	0.0703***	-	-	-	-	-	-	-	-	-
	(0.1508)									
source_paper	0.0625	-	-	-	-	-	-	-	-	-
	(0.0394)									
source_WHO	-0.0293***	-	-	-	-	-	-	-	-	-
	(0.0108)									
trust_in_SocialMedia	-	0.0978***	0.183***	0.105**	0.0956***	0.0692***	0.0378**	0.100***	0.0776***	0.0797***
		(0.0346)	(0.0523)	(0.0427)	(0.0342)	(0.0246)	(0.0165)	(0.0242)	(0.0207)	(0.0254)
trust_in_Science	-	-0.175***	-0.201***	-0.163***	-0.0493**	-0.0187	-0.0540	-0.110***	-0.0252	-0.0295*
		(0.0602)	(0.0302)	(0.0260)	(0.0231)	(0.0483)	(0.0428)	(0.0408)	(0.0598)	(0.0164)
final_vote	-0.1978***	-0.118***	-0.157**	-0.158***	-0.0611	-0.0358	-0.0322	-0.146**	-0.0838*	-0.000413
	(0.048)	(0.0392)	(0.0779)	(0.0495)	(0.0611)	(0.0665)	(0.0568)	(0.0609)	(0.0507)	(0.0811)
family_members	-0.443	-0.0436	-0.0989	-0.128***	-0.0173	0.0140	0.107**	-0.0275	0.0427	-0.00821
	(0.0581)	(0.0636)	(0.116)	(0.0340)	(0.0303)	(0.0274)	(0.0514)	(0.0606)	(0.0520)	(0.0302)
female	0.3727**	0.447***	0.377***	0.610***	0.311***	0.136**	0.279***	0.209	0.367***	-0.479***
	(0.1521)	(0.0520)	(0.109)	(0.0842)	(0.0688)	(0.0619)	(0.0664)	(0.227)	(0.102)	(0.0623)
age	0.0257***	0.0228**	-0.00582	-0.0207**	0.0213**	0.0117	-0.0000377	-0.0192	0.0155	-0.0157
	(0.0043)	(0.0114)	(0.0130)	(0.0105)	(0.0108)	(0.00716)	(0.0116)	(0.0243)	(0.0220)	(0.0143)
dead_Covid	-0.0861	-0.768***	0.526	0.431	-0.290	0.171	-0.256	-0.303	0.277	-0.0404
	(0.3472)	(0.199)	(0.469)	(0.298)	(0.326)	(0.210)	(0.331)	(0.420)	(0.253)	(0.416)
no_faith	-0.5349***	-0.681***	-0.730***	-0.441***	-0.377***	0.00959	-0.0901*	-0.639***	-0.302**	0.410***
	(0.0565)	(0.0773)	(0.162)	(0.0404)	(0.0635)	(0.121)	(0.0485)	(0.0711)	(0.153)	(0.0503)

right_wing	0.2887**	0.431***	0.236***	0.576***	0.345*	0.111	0.264	0.0406	0.396***	-0.00532
	(0.1265)	(0.0839)	(0.0891)	(0.170)	(0.183)	(0.110)	(0.138)	(0.115)	(0.139)	(0.0487)
left_wing	-0.2874**	-0.288**	-0.124	-0.470***	-0.316***	-0.102	-0.158	-0.136**	0.0268	0.114
	(0.1185)	(0.126)	(0.201)	(0.0867)	(0.0684)	(0.0977)	(0.130)	(0.0604)	(0.125)	(0.118)
degree	-0.0367	-0.215*	0.269	-0.217	-0.108	0.0961	0.199***	0.202*	0.144	0.160
	(0.1464)	(0.128)	(0.289)	(0.154)	(0.0852)	(0.0998)	(0.0324)	(0.112)	(0.117)	(0.123)
father_educ	-0.2147*	-0.135*	-0.297*	-0.0719	-0.127**	0.0381	-0.0678	-0.0724	0.0239	0.116
	(0.3879)	(0.0817)	(0.158)	(0.0698)	(0.0577)	(0.0310)	(0.0604)	(0.119)	(0.0681)	(0.0738)
_cons	-1.1923***	0.931	0.628	2.164***	0.126	-0.619**	-0.299	0.174	-0.353	-0.161
	(0.3879)	(0.687)	(0.807)	(0.650)	(0.861)	(0.291)	(0.517)	(0.674)	(0.502)	(0.494)
N	554	554	554	554	554	554	554	554	554	554

Note: Standard errors are reported in parentheses. Asterisks *** (**) ((*)) indicate significance respectively at the level of 1% (5%) ((10%))

Table A3. Special regressor estimates

	(1) disinformation	(2) corr_Covid_5G	(3) lab_product	(4) hyperimm_plasma	(5) gloves	(6) mortality	(7) vitaminC	(8) weakening	(9) coronabeer
inhabitants	0.00000140	0.000000530	0.00000268**	0.00000152	0.000000929	0.00000144	0.000000765	0.00000256	0.000000950
	(0.00000115)	(0.000000398)	(0.00000136)	(0.00000136)	(0.00000103)	(0.00000187)	(0.000000597)	(0.00000186)	(0.00000164)
source_social	0.0532**	0.0214	0.0614**	0.0561***	0.0380*	0.0384	0.0214	0.0675***	0.0351***
	(0.0228)	(0.0141)	(0.0301)	(0.0130)	(0.0195)	(0.0270)	(0.0191)	(0.0156)	(0.0136)
source_friends	-0.0123*	-0.00531	-0.0125	-0.0145***	-0.0135	-0.00956	-0.00537	-0.00981	-0.0118**
	(0.00705)	(0.00323)	(0.00907)	(0.00449)	(0.00835)	(0.00789)	(0.00570)	(0.0110)	(0.00591)
source_paper	-0.00381	0.000744	-0.00759	-0.000623	-0.00295	-0.00245	0.00108	0.00474	0.000473
	(0.00353)	(0.00159)	(0.00525)	(0.00434)	(0.00536)	(0.00705)	(0.00267)	(0.00656)	(0.00644)
source_OMS	0.0105*	0.00328	0.0122**	0.00908*	0.00710**	0.00668	0.00374	0.00966	0.00478
	(0.00586)	(0.00276)	(0.00532)	(0.00524)	(0.00318)	(0.0108)	(0.00312)	(0.00744)	(0.00512)

final_vote	-0.000167	-0.000163	-0.0126	-0.000572	-0.00626	0.000726	-0.00504	-0.0113	-0.00411
	(0.0165)	(0.00307)	(0.0149)	(0.00451)	(0.0118)	(0.0136)	(0.0122)	(0.0269)	(0.0132)
female	-0.0222	-0.00956	-0.0172	-0.0310**	-0.0524	-0.0174	-0.00849	-0.0122	-0.0255
	(0.0226)	(0.00817)	(0.0398)	(0.0142)	(0.0436)	(0.0250)	(0.0221)	(0.0276)	(0.0266)
age	0.00234	0.00102*	0.00323	0.00151	-0.00242	0.00262	0.00152	-0.00272	-0.00123
	(0.00187)	(0.000518)	(0.00474)	(0.00237)	(0.00435)	(0.00326)	(0.00242)	(0.00596)	(0.00575)
dead_Covid	-0.0212	0.00399	0.109	0.00558	0.00153	0.00373	-0.00576	0.0329	0.00299
	(0.0294)	(0.0151)	(0.0707)	(0.0429)	(0.0281)	(0.0364)	(0.0256)	(0.0519)	(0.0516)
family_members	0.00475	0.00234	0.00233	0.00421	0.00798	0.00662	0.00537	0.00765	0.0136
	(0.00610)	(0.00218)	(0.00755)	(0.00635)	(0.0119)	(0.00904)	(0.00471)	(0.0121)	(0.0181)
no_faith	-0.00139	0.00572	-0.00137	0.0158	-0.000218	0.0198	-0.00174	-0.00922	-0.00582
	(0.0356)	(0.00658)	(0.0308)	(0.0143)	(0.0133)	(0.0250)	(0.0212)	(0.0232)	(0.0348)
right_wing	0.00217	-0.00840	0.0187	0.00720	-0.0207	0.0259	-0.00901	-0.0195	-0.0213
	(0.0170)	(0.00932)	(0.0368)	(0.0361)	(0.0309)	(0.0792)	(0.0211)	(0.0208)	(0.0360)
left_wing	-0.0133	-0.00705*	-0.0111	-0.0192	-0.0198	-0.00495	-0.0108	-0.0144	-0.0225
	(0.0188)	(0.00366)	(0.0178)	(0.0172)	(0.0191)	(0.0419)	(0.0188)	(0.0374)	(0.0247)
degree	-0.00410	0.000956	-0.0269	-0.00428	-0.0217	-0.00688	0.00416	0.0305	-0.0105
	(0.0207)	(0.00955)	(0.0390)	(0.0170)	(0.0205)	(0.0264)	(0.00968)	(0.0311)	(0.0324)
father_educ	-0.0133	-0.00588	-0.0282	-0.00713	-0.0204	-0.0125	-0.00432	-0.0178	-0.0132
	(0.0143)	(0.00702)	(0.0238)	(0.0127)	(0.0217)	(0.0314)	(0.0160)	(0.0279)	(0.0247)
_cons	-0.205	-0.112*	-0.135	-0.196**	0.0422	-0.180	-0.122	-0.121	-0.0271
	(0.175)	(0.0634)	(0.259)	(0.0907)	(0.179)	(0.239)	(0.167)	(0.250)	(0.264)
N	414	414	414	414	414	414	414	414	414

Note: Average marginal effects are reported in the table. Standard errors are reported in parentheses. Asterisks *** (**) ((*)) indicate significance respectively at the level of 1% (5%) ((10%))

Table A4. OLS regression, dependent variable source_social

	(1) source_social
follower_Facebook	0.000231**
	(0.0000936)
Inhabitants	-0.000000655
	(0.000000980)
source_friends	0.313***
	(0.0496)
source_paper	0.0145
	(0.0508)
source_OMS	-0.193***
	(0.0485)
final_vote	-0.158
	(0.0963)
Female	0.648***
	(0.184)
Age	-0.0881***
	(0.0243)
dead_Covid	-0.0524
	(0.489)
no_faith	-0.257
	(0.186)
right_wing	0.128
	(0.289)
left_wing	0.500***
	(0.193)
Degree	0.216
	(0.209)
father_educ	-0.221**
	(0.110)
family_members	-0.0790
	(0.0859)
_cons	6.564***
	(0.903)
N	498

Note: Standard errors are reported in parentheses. Asterisks *** (**) ((*)) indicate significance respectively at the level of 1% (5%) ((10%))

CHAPTER 2
DETERMINANTS OF INTENTION TO VACCINATE DURING COVID19 PANDEMIC: THE ROLE OF DISINFORMATION AND SOCIAL MEDIA

Abstract:

The role of disinformation in the general vaccine hesitancy is nowadays well known: according to the World Health Organization, the spread of fake news is one of the major threats to global health. Moreover, during a health emergency, such as the covid-19 pandemic, fake news finds fertile breeding grounds, because people need to feel informed and safe. In this context, the circulation of false information could have a negative impact on the population's opinion about a vaccine against SARS-CoV-2. The aim of this research is to study the relation between the intention to vaccinate against Covid-19 and disinformation. To this end, a survey was submitted to a sample of Italian university students and an econometric analysis was performed using a probit model. The results show that a reduced ability to discern fake news, both assessed in the study and self-reported, is associated with a lower probability of wanting to get vaccinated. In line with previous literature, this suggests that governments and international health organizations need to make great efforts in the campaign against fake news: the vaccine skepticism is not only a great obstacle to the end of the pandemic but also a possible cause of future lockdowns and economic crises.

2.1 Introduction

The Covid-19[20] Pandemic can be considered the first one in history in which social media play a key role in the information process: social media use is nowadays widespread and this fosters a fast and global exchange of information (Harrison et al., 2020). During a health emergency or a disaster, people want to get as much news as possible, because of their need of understanding and security, thus fake news finds fertile breeding grounds in these contexts (Kawasaki et al., 2012; Di Fonzo and Bordia, 2007).

Indeed, the expansion of social media as a source of information about Covid-19 pandemic could contribute to vaccine hesitancy with the spread of fake news and harmful messages. Even if social media are being used on a massive scale to keep people informed and safe, at the same time they could plump the infodemic, creating the opposite effect: social distancing and self-isolating will be ignored, diagnostic tests and personal protective equipment go unused, campaigns of vaccination will not meet their targets.

At the time of writing, the health emergency has ended but not the pandemic: the risk of dangerous mutations cannot yet be ruled out and the virus continues to circulate, causing infections and deaths. In this regard, despite the partial immunity due to infections and vaccines, efforts of governments and international health organizations are still aimed at finding increasingly effective therapies and vaccines, always keeping virological surveillance active, in order to achieve an effective and definitive management strategy for this infection that will probably accompany humanity for a long time.

Initially, indeed, governments around the world reacted to the pandemic with more or less severe lockdowns of regions and countries, which reduced contacts between people and therefore the spread and transmission of the virus. Italy, in particular, has been the first western country to face a health emergency: during the first months of the pandemic, it was

[20] In December 2019, a new coronavirus called SARS-Cov-2 (Severe Acute Respiratory Syndrome Coronavirus 2) was identified by the Coronavirus Study Group of the International Committee on Taxonomy of Viruses, in a group of chinese individuals affected by a form of pneumonia caused by an unknown pathogens. From Medical Dictionary (2010) of the Treccani Encyclopaedia, coronaviruses (CoV) are viruses spherical in shape, with a viral genome composed by a single-stranded RNA and a surface in which there are crown-like structures ("corona" is the Latin for crown, hence the name coronavirus). The disease was named COVID-19 (Coronavirus Disease 19) by the WHO. The virus can cause infectious respiratory diseases of varying severity, from the common cold to fatal respiratory syndromes (Rezza et al, 2020) and it spread quickly around the world, causing the death of thousands of people. For this reason the WHO declared on 11 March 2020 a pandemic.

the European country most affected by Covid-19 in terms of both infections and deaths. The Italian authorities immediately responded to this emergency with strict containment measures: on 9 March the first national lockdown was declared[21]. This has allowed Italy to successfully overcome the first health emergency. Indeed, the New York Time, an American daily newspaper, described Italy as a "model of viral containment that holds lessons for its neighbours and for the United States". But after this period, the management of the pandemic has been characterised by intermittent lockdowns and for long periods this cannot be a sustainable solution because the school closures and the stop of productive activities lead to devastating economic consequences. Thus, mass immunisation is needed for stopping the virus circulation and avoiding economic crises.

Indeed, nowadays, two years after the news of the first case of SARS-Cov-2, the vaccine remains the main weapon against the covid-19 pandemic because it allows the coexistence with the virus: the vaccine scepticism is not only a great obstacle to the end of the pandemic but also possible cause of future lockdowns and economic crises.

Because of the variability and inconsistency of vaccine compliance, a complex phenomenon that varies according to place, time and vaccines themselves (Krishnamoorthy et al., 2019; Dror et al., 2020; Larson et al., 2016) and because of the concerns of the global public health community about the vaccine refusal of the last decades (Harrison et al., 2020), the study of predictors for the acceptance of a vaccine against covid-19 is a global interest.

Indeed, several studies have tried to identify the determinants of vaccine propensity against covid-19, succeeding with success in the intent. The intention to vaccinate is deeply influenced by several factors (Troiano and Nardi, 2020): gender (Dror et al., 2020; Kreps et al., 2020), level of education (Kreps et al., 2020; Salali and Uysal, 2020) having a child (Dror et al., 2020), political ideology (Ward et al, 2020; Kreps et al., 2020), unemployment and job insecurity (Dror et al., 2020), religious convictions (Olagoke et al., 2020).

[21] During this phase, from 9 March to 3 May, any movement was forbidden: both from and to the territories as well as within the territories themselves, except for proven health or work needs. Even the non-essential productive activity has been stopped.

However, few previous researches of my knowledge have evaluated the role of disinformation related to Covid-19 pandemic and the use of social media as a determinant of the willingness to get vaccinated (Montagni et al., 2021; Lee et al., 2022). Thus, this analysis focuses on this last aspect. Not surprisingly, Krishnamoorthy et al. (2019), interviewing parents and health workers about vaccine hesitancy against measles and rubella in a rural Indian region, found that the main reasons for the vaccine hesitancy were the rumours about the safety of the vaccine spread through social media.

To investigate the disinformation about Covid-19 of young Italian people, an anonymous survey has been distributed to students of University of Calabria, the most numerous campus of Southern Italy. The data collected was used to estimate the impact of the use of social media and disinformation about Covid-19 on the vaccine hesitancy.

2.2 Literature review

2.2.1 Determinants of vaccine hesitancy against covid-19

Even before the current pandemic, in 2019, the WHO declared vaccine hesitancy among the ten health threats worldwide. In recent decades, hesitancy and refusal to vaccinate have indeed become a widespread problem from the United States to Europe. In particular, according to a 67-country survey conducted by Larson et al. (2016), the European region accounted for seven of the ten countries with the lowest levels of safety-based vaccine confidence, including Italy.

Not surprisingly, today we are witnessing a significant increase in previously managed infectious diseases. For instance, in the first half of 2019 the reported cases of measles had already exceeded the annual totals since 2006 (Harrison et al., 2020).

Nevertheless vaccines have played a key role in eradicating many infectious diseases or in reducing mortality rates from vaccine-preventable diseases, such as for smallpox, polio, rabies, typhoid, plague and many more (Harrison et al., 2020; European Commission and WHO, 2019). In general, it is estimated that vaccines today are able to avoid 2.5 million deaths a year (European Commission and WHO, 2019). Disease prevention is not only healthier and easier than treatment but also cheaper (Özceylan et al., 2020).

If we look at the evidences, therefore, the distrust in vaccines seems to be incomprehensible, but it is also the functioning of vaccines that makes it a complex phenomenon: by eradicating diseases, vaccines detach people from the real perception of

the danger of the diseases themselves and fuel the belief of their uselessness. If this were the only problem, however, in an optimistic view, the risk of the health system collapse and the amount of deaths due to the current pandemic would have to raise confidence levels in vaccines (Harrison et al., 2020). Dror et al. (2020) also assumed that the economic consequences of restrictions related to Covid-19 would have a deterrent effect against vaccine hesitancy, to prevent layoffs, school closures and unemployment. Job uncertainty actually seems to have this effect: those who lost their job during the Covid-19 crisis are more likely to get vaccinated than those who continued to work or stayed home confident of returning to work soon (Dror et al ., 2020) and even those who have risked losing their job than retirees or previously unemployed are more likely to accept the vaccine (Olagoke et al., 2020). But the deterrent power of job uncertainty and the fear of an economic crisis are not sufficient to stem the problem of vaccination. Indeed, a growing anti-vaccine movement threatens the efforts of governments around the world (Kreps et al, 2020).

Indeed, many other factors contribute to the vaccine hesitancy against covid-19, from the attributes of vaccines to the socio-demographic characteristics of individuals and to trust in institutions (Troiano et al., 2020).

Four attributes referred to vaccines as determinants of vaccine hesitancy are commonly analysed in the literature (Kreps et al, 2020): efficacy, higher incidence of side effects, lower incidence, duration of protection.

In this regard, it should be emphasised that the Covid-19 vaccine, like the flu vaccine, has a shorter duration of protection than other ones (measles, rubella, polio). It is no coincidence that people currently vaccinated against seasonal flu have a strong tendency to also accept the COVID-19 vaccine (Dror et al., 2020). The impossibility of obtaining permanent immunity with the Covid-19 vaccine could, however, fuel scepticism towards the vaccine.

Furthermore, although possible side effects are relatively rare, the risk of their occurrence can significantly influence vaccine hesitancy (Lee et al., 2022).

To the doubts about its effectiveness and the belief that the vaccine is useless because of the conviction that the Covid-19 is only a flu, we must add the fear that the vaccine is dangerous because it has been produced too quickly (Troiano et al., 2020). Indeed, it generally takes an average of ten years to develop a new vaccine (Lee et al., 2022). In the current pandemic context, nevertheless, all the actors involved have joined forces reducing the time of marketing of vaccines: researchers, also focusing on the experience and

progress made with previous SARS-Cov and MERS-Cov, have accelerated the process of designing vaccines candidates for the testing phase (Dhama, 2020); governments have allocated large sums for vaccine research, allowing testing of multiple vaccine candidates simultaneously; regulatory agencies of the results have revised the results as they were produced (rolling review) and not at the completion of all studies. The clinical part of the experiment on volunteers has not been accelerated but, despite this, the reduction of the time with which the vaccine was placed on the market has created scepticism among individuals, surprisingly even among health professionals (Dror et al., 2020). Thus, the evaluation of the vaccine benefit-risk balance, even among medically informed people, is based on a personal perception that can be influenced by safety misinformation (Dror et al., 2020).

While health expertise does not seem to be sufficient to correctly assess vaccine efficacy, healthcare personnel involved in the care of COVID-19 positive patients seem more likely to get vaccinated (Dror et al., 2020), while no significant difference has been found between people who have been diagnosed with COVID-19 and those who have never had it (Ward et al., 2020).

Instead, COVID-19 related anxiety and concerns regarding the SARS-CoV-2 vaccine have a strong influence on vaccine acceptance (Salali et al., 2020; Ward et al., 2020; Dror et al. 2020).

Kreps et al., (2020) then evaluated three additional attributes: the approval of the EMA and FDA, the nation of origin of the vaccine and the political leader who approved the vaccine. Interestingly, respondents were less likely to choose vaccines developed outside the United States, particularly in China. Moreover the willingness to receive a vaccine was slightly higher when it was recommended by Biden rather than by Trump.

To these factors must be added the following demographic characteristics of the participants: age, sex, education, income level, political ideology, religious beliefs (Troiano et al., 2020).

A tendency for women to be less likely than men to vaccinate seems to be in the studies analysed (Dror et al., 2020; Lee et al., 2022; Salali et al., 2020; Ward et al., 2020). Several studies show higher risks of complications, infectivity and death of COVID-19 among males (Galbadage et al., 2020). The increased risk of COVID-19 mortality for males may influence men to accept a vaccine (Dror et al., 2020). Furthermore, if the women in question are also mothers, they are likely to make health decisions for their children as

well. This may lead them to search for information online and to be exposed to Novax content (Özceylan et al., 2020).

Having a child is also reported in the literature among the determinants of vaccine hesitancy (Dror et al., 2020; Salali et al., 2020).

Indeed, although in the past it has been shown that vaccines protect society from epidemics and deadly diseases, modern parents are largely unfamiliar with the history and importance of vaccines (Özceylan et al., 2020).

Results related to age are ambiguous: according to the study conducted by Dror et al. (2020) it is interesting to note that age was not considered a predictor of vaccine acceptance. Seventy years old, apparently healthy, ignore age as a risk factor, which therefore does not help to reduce the vaccine hesitancy. Even according to Kreps et al. (2020) the increase in age reduces the willingness to receive vaccination. Lee et al. (2022) instead identify high levels of hesitancy between 20 and 30 years old.

In addition, a low or intermediate household income level is positively associated with rejection of the vaccine (Ward et al., 2020).

Looking at the educational aspect, instead, having a degree reduced the chances of accepting the vaccine in Turkey, but not in the United Kingdom (Salali et al., 2020). Opposite results are instead obtained in a study conducted by Ward et al. (2020) in France: people with a lower level of education than the high school diploma are more likely to refuse the vaccine.

Religiosity is negatively associated with the intention to vaccinate against covid-19 (Olagoke et al., 2020). The result is consistent with the belief that the pandemic can be seen as an act of God that cannot be modified or prevented (Sinding Bentzen 2019). In addition, highly religious people trust sources of informal information, whose content may be dominated by Novax messages (Olagoke et al., 2020).

Finally, according to Ward et al. (2020) those who are close to right political thoughts are inclined to reject the vaccine. The rift, in fact, seems to be not classic between Centre, Left and Right but between those who feel close to the governing parties and those who feel close to the extreme parties. These findings are interesting because, at that time, no politician had questioned the safety or effectiveness of the future COVID-19 vaccine. Even in the United States, political partisanship seems to be a determining factor of vaccine hesitancy: Democrats were more likely to receive vaccination than Republicans (Kreps et al., 2020).

2.2.2 Social Media Use and Fake News about Covid-19 Pandemic: disinformation as a possible predictor of intention to vaccinate

The phenomenon of fake news now globally widespread has not even spared the Covid-19 pandemic. Because of mobile phones, internet and social media, mere suppositions initially shared amongst few peers may quickly become global news: the resulting infodemic is unrivalled for size and speed (Baines and Elliot, 2020).

In Italy, according to the sixteenth Italian Censis report on Communication (2020), Facebook is a rising medium for disseminating news (31.4% of Italian use it as a source of information), second only to the newscasts (59.1%), but and also the search engines, like Google, are taking the ground (20.7%). Moreover, looking at the younger population (14-29 years old), 86.9% of people use social media as a way to get informed.

On a global level, a study conducted by WHO, Wunderman Thompson, the University of Melbourne and Pollfish, revealed that a young person daily uses an average number of 5 social networks and relies on them for Covid-19 information.[22]

Moreover, almost 60% of these worldwide respondents declared that the media and their governments are not completely transparent about the pandemic (WHO et al., 2021). Information on COVID-19 changes rapidly: also institutional sources, such as health professionals and researchers, seem to provide controversial arguments. As a result, individuals rely on unofficial, false and potentially dangerous news: for instance, the effectiveness of chloroquine as a cure for covid-19 has been a popular fake news in Nigeria, the spread of which has resulted in several hospitalizations for overdose of chloroquine in a Lagos hospital (Sulaiman et al., 2020); the false news on the correlation between the 5G network and coronavirus has led in the United Kingdom to arson attacks on antennas and control units of the ultra-fast network (Ital communications - Censis report, 2021); the news that high-concentration alcohol could disinfect the body and kill the virus has produced 800 deaths and 5876 worldwide hospitalizations (Islam et al., 2020); with the spread of a video on social media in which it is falsely reported that the seeds of Datura confer immunity against Covid-19, in India at least 12 people became seriously ill after consuming a liquor based on these toxic seeds (Islam et al., 2020).

Therefore, it is possible to note how fake news, no matter how digital they are, has real serious consequences.

[22] "Social media & COVID-19: A global study of digital crisis interaction among Gen Z and Millennials". Available from https://covid19-infodemic.com/

Fake news about the vaccine can have even more devastating consequences: citizens do not trust science and institutions, they use alternative untried care, they refuse the vaccine and mass immunisation does not reach its target.

According to the report about Fake News and Covid-19 Vaccination conducted by the Mesit Foundation - Social Medicine and Technological Innovation and published in December 2021, Facebook and Telegram users who follow pages or groups Novax for covid-19 increased by 130%, reaching 358 thousand people. In addition, over 7 out of 10 false information about anti-covid-19 vaccines are related to the danger of side effects: "1000% of adverse reactions", "Ema and Aifa conceal serious reactions and post-vaccination deaths", "more deaths for vaccine than for Covid-19", "mRNA vaccines modify DNA", "it is more dangerous to vaccinate than to contract covid-19". To this false information, it is possible to add those according to conspiracy theory and economic interest of pharmaceutical companies such as "the vaccine is a weapon for depopulation", "the green pass is needed for mass murder", "the Big Pharma pay virologists to sponsor their vaccines".

Even before this pandemic, fake news has been identified as one of the causes of vaccine hesitancy. For instance, although measles is one of the leading causes of death and disability among children worldwide and rubella is responsible for irreversible birth defects such as blindness and deafness in approximately 40,000 children each year, a study by Krishnamoorthy et al. (2017) in a rural region of India found that nearly one-fifth of parents were reluctant to give their children measles and rubella vaccination. They reported that rumours on social media are the main causes of their vaccine hesitancy.

With specific regard to vaccination against Covid-19, Montagni et al. (2021), using a sample of French adults, found that the lack of ability to discern the true news from those false negatively affects the intention to vaccinate. Lee et al. (2022) evaluated how the use of offline media (television, radio, newspapers), online media (internet sites) and social media (Youtube, Twitter, Facebook, blog) influenced the intention to vaccinate in South Korea. Both the use of online media and offline media positively influences the intention to vaccinate: in particular, TV, radio and newspapers are associated with a perception of greater benefits of the vaccine against covid-19. The use of social media, instead, is related to vaccine hesitancy.

This result confirms the findings of Wilson et al. (2020) for vaccines in general: the use of social media is highly predictive of the belief that vaccines are not safe.

2.3 Research question, Hypotheses and Data

According to these premises, it is rational to assume that misinformation regarding covid-19 pandemic and social media use as a source of information can be predictors of the refusal of the vaccine.

2.3.1 Data collection method and survey

The survey was conducted in Italy during the second phase of pandemic management, when restrictive virus containment measures have been gradually relaxed, in particular by 28 May 2020 to 18 July 2020. By using Surveymonkey, a platform for creating online questionnaires, the survey was created and shared online with the participants. A part of the participants was invited to complete the survey during the university lessons, another part was contacted by email: 2702 emails were sent to economics and engineering students[23], obtaining a response rate of 12.73%.

When the survey is completed, after a check of inconsistence of the values (for instance, in the date of birth or the number of inhabitants of the municipally of residence, etc.), the sample is composed by 833 students.

The survey consists of four sections. First, it investigates the media habits of interviewees: their willingness to pay to obtain information related to pandemic, the extent of use of traditional and social media as sources to gather information about Covid-19, and their level of disinformation. In the second section, personal attitudes and habits are investigated (religious convictions and political faith). Personal identifying data, education and family background are collected in the third section and, finally, in the fourth section participants give information about their academic experience (year of the course, degree program, average grade).

2.3.2 The outcome variable and the explanatory variables

The independent variable was the intention to get vaccinated against the Covid-19. The participants of the survey had to answer the item "If a Coronavirus vaccine were available, would you get vaccinated?" with the following response modalities: "yes", "no, I don't think I'm taking a high risk", "no, to avoid the side effects of the vaccine", "no, I don't want to favour the multinationals of the drug". All the negative respondents have been merged to

[23] Engineering and Economics are the most numerous departments of the University of Calabria. Permission to use student emails was requested and obtained by the coordinators of the respective degree programmes

create the dummy variable "NOVAX", which is 1 if the interviewed belongs to the anti-vaccination group and 0 if the respondent would get vaccinated. An alternative outcome variable was created to verify the sensitivity of the findings: "NOVAX_1". With this variable a subgroup of people who refuse the vaccine is represented: it is a dummy who coded 1 if the respondent does not intend to get vaccinated but believes that the part of the population most at risk has to be vaccinated. Instead, it is scientifically proven that a very high percentage of people, and not just those at risk, must be vaccinated to achieve mass immunisation, necessary for stopping the virus circulation. "NOVAX_2" was created for subgroup of people who are not planning to vaccinate because they are not considering themselves taking risks from the contagion and "NOVAX_3" for those who do not wish to be vaccinated because they are scared of the vaccine's side effects.

The primary explanatory variable of interest for this analysis is the capability of fake news detection and thus the consequent level of disinformation. An index of disinformation is created by using the data provided by participants in the first part of the survey. Indeed a list of eight items, containing either fake or real news, was presented to respondents, who were asked to rate the extent to which they believe in each statement using a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree).[24] The index of disinformation is created by using the average value of the eight credibility score, after specularly converting the responses to real contents (1 corresponds to a 7; 2 corresponds to 6; 3 corresponds to 5). The higher the level of credibility reported, the lower the ability to discern true news from false news. Based on this data, three different disinformation indicators have been created: “DISINF” is a dummy variable coded 1 if the average credibility value is greater than 4, “DISINF_1” is coded 1 if the average credibility value is greater than or equal to 4 and, finally, “DISINF_2” is the discrete variable of the average value of the credibility score reported by each respondents.

Moreover, as a robustness check, also the self-reported capability to detect fake news is used for the estimates. The variable "INABILITY_FN" represents a dummy variable which is 1 if the respondents believe to have a limited capability to discern fake news, 0 otherwise.

[24] Fake news are: “There is a correlation between the Covid-19 epidemic and the 5G network”, “the new coronavirus is a laboratory product”, “hyperimmune plasma is a valid alternative to the vaccine, already tested and costless”, “Covid-19 has a similar death rate to the flu”, “massive doses of vitamin C are an effective treatment for Covid-19”, and finally “the virus is weakening”. Real news are: “The use of gloves does not protect against the virus” and “sales of Corona beer dropped dramatically as the virus spread

The secondary focus of the study is based on social media as source of information. For this aim, a discrete variables ("SOCIAL") has been created. Indeed, respondents assign a score from 1 to 7 in relation to the level of use of Social Media to gather information about Covid-19. Furthermore, the survey also investigates the level of trust that respondents have in Social Media as source of information related to COVID-19. This degree of confidence will also be used as a focus in the estimates.

Other control variables, individuated by previous literature as predictor of vaccine hesitancy, are included in the analysis.
Their description is presented in table 2.1, with their respective descriptive statistics.

[Table 2.1]

Among the participants, 82.66% declare their intention to get vaccinated, while 17.35% do not intend to do so. In particular, 8.12% believe they run no risk: it is important to recall that the sample is made up mainly of young people, who are more likely to be asymptomatic. Moreover, 8.12% think that the vaccine has important side effects, while only 1.1% do not want to enrich the drug multinationals.
The most popular fake news concerns the origin of the virus: over 90% of respondents were exposed to this news. This finding does not differ from national data: according to the Ital Communications – Censis report of 2021, this fake news is perhaps the most widespread and 38.6% of Italians are convinced that the virus is an intentionally created laboratory product. In addition, it is interesting to note that the fake content to which the respondents believed the most is really about vaccine: the items refers that hyperimmune plasma is a valid alternative to the vaccine, already tested and without costs (78,84% of the sample read the news and 21,92% shared it).[25]

[25] Table 1.2 of the first chapter of this thesis (p. 21) presents the main credibility for each content, the percentage of sample who read the news (exposition) and the percentage who shared it.

2.4 Econometric analysis

2.4.1 Methodology

The hypothesis of the study is that disinformation and social media use play a role in the decision to get vaccination. Both these assumptions are tested empirically. A probit model is estimated to analyse associations between the probability of refusing the vaccine against SARS-CoV-2 and disinformation (research question 1) and also between the probability of not wanting to be vaccinated and the media use as sources of information for Covid-19 pandemic (research question 2).

The model for the research question 1 is set up as follows:

$$Pr(NOVAX_i = 1|X_i) = F(\beta_0 + \beta_1 DISINF_i + \phi Z_i) \quad (1)$$

where NOVAX is the dummy variable equal to 1 if the respondents intend to not vaccinate; DISINF is the indicator of disinformation, the focus of the analysis, described in section1.9.2; whereas is a vector of other controls variables (summarized in Table 1) identified from the previous literature as determinants of vaccine hesitancy.

While the model used for the research question 2 is:

$$Pr(NOVAX_i = 1|X_i) = F(\alpha_0 + \alpha_1 SOCIAL_i + \gamma Z_i) \quad (2)$$

where SOCIAL is a discrete variable capturing the use of social media as source of information about COVID-19, while the other variables are the same presented above for equation (1).

In general, dichotomous choice models can be illustrated in terms of an underlying latent variable process. In this analysis, we assume the existence of a latent propensity to not get vaccinated, indicated by f^*, generated by the following process: $f_i^* = X'_i\beta + u_i$, where u_i is an error term and the vector X includes the potential determinants of intention to vaccinate. We assume that the phenomenon of refusal of vaccination is observed when $f^* > 0$. By defining a dummy variable δ=1 if there is intention to not vaccinate, the probability of observing refusal of vaccination is expressed as $P(X_i) = P(f_i^* > 0) = P(u_i > -X'_i\beta) = F(X'_i\beta)$ where *F* is the standard normal distribution function.

First, to verify research question 1 the general specification described in equation (1) is estimated, including as controls all variables identified as vaccine hesitancy predictors from the extant literature. Then, to further verify the sensitivity of the findings, the model is run using alternative constructions of outcome variables and also by replacing the variable "DISINF" with different constructions of the disinformation index and with the self-reported capacity to detect fake news.

Instead, for the research question 2, first, the benchmark model is estimated with explanatory variable of interest "SOCIAL", then this is replaced by the respective trust that the respondent claims to have in the use of social as a source of information about the covid-19 and finally the model is run using alternative dependent variables to "NOVAX".

Tables 2.2 and 2.3 report the correlation matrices of all the variables employed in the estimation of research questions 1 and 2, respectively.

[Table 2.2 – Table 2.3]

2.4.2 Results and discussion

Table 2.4 shows the estimation results of the benchmark analysis for the research question 1 and the respective estimates with the alternative outcome and explanatory variables, as robustness checks. In particular, eight regressions are performed: column (1) present the benchmark analysis in which the outcome variable is "NOVAX" and the independent variable of interest is "DISINF"; in columns from (2) to (4), "DISINF" is replaced with alternative variable: "DISINF_1", "DISINF_2" and "INABILITY_FN"; in column (5), (6) and (7) alternative outcome variables are used ("NOVAX_1", "NOVAX_2", "NOVAX_3"). [27]

Finally, attempts to tackle problem of endogeneity were implemented.[28]

[27] Although the previous literature does not find a significant effect of having experienced COVID in the family with serious consequences, theoretically it is plausible to think that there is a correlation. In this regard, as a further check, "COVID_FAM" (a dummy coded 1 if the respondent had a death for Covid-19 in family or had a family member with severe symptoms) was added among the regressors. As output (unreported and available upon request) shows, results are confirmed.

[28] The variable "CONNECTION_QUALITY" (a discrete variable indicating the self-reported quality of internet connection, which assumes values from 1 to 7) is used as instrument variable of disinformation. Indeed, it seems to be both theoretically and practically a valid instrument: theoretically, the quality of the connection is related to disinformation but not directly to the propensity to refuse the vaccine. The results,

[Table 2.4]

Focusing on the variable of interest, there is a significant and positive relationship between the inability to discern fake news, thus disinformation, and the probability of refusing the vaccine, in all the estimates presented.

Thus, these results seem to corroborate the thesis according to which disinformation is a predictor of the vaccine refusal issue, as assessed by prior literature. Montagni et al. (2021), for instance, found that, in France, the poor ability to recognize real contents from fake news affects the propensity to vaccinate against covid-19.

Examining the benchmark model, it is interesting to note that there is also significant relations between the probability of vaccine refusal and gender, income, trust in institutions, having experienced anxiety and having leftist ideals.

First of all, being female is positively associated with the probability of refusing the vaccine. Notably, a tendency for women to be less likely than men to vaccinate seems to be in numerous other studies (Dror et al., 2020; Lee et al., 2022; Salali et al., 2020; Ward et al., 2020). On one hand, several studies show higher risks of complications, infectivity and death of COVID-19 among males (Galbadage et al., 2020). The increased risk of COVID-19 mortality for males may influence men to accept a vaccine (Dror et al., 2020). On the other hand, other studies that found high rates of women expressing concerns about the safety of vaccines and expressing a lack of trust in the quality and impartiality of information provided by healthcare professionals (Troiano et al., 2021).

As income increases, the propensity to refuse the vaccine increases, contrary to what Ward et al. (2020) obtained: a low or intermediate household income level is positively associated with rejection of the vaccine.

According to Troiano et al.,(2021), the willingness for vaccination is deeply influenced especially by the trust in health institutions, as demonstrated in studies focused on other

obtained by regressing "DISINF" on the "CONNECTION_QUALITY" and the other explanatory variables, confirm the hypotheses. Despite the limitations of the model due to the characteristics of the variables, an instrumental variable model was applied. These results are not significant but the regressor "DISINF" would seem to be exogenous, according to Wu-Hausman and Durbin-Wu-Hausman test. The p-value of the Wu-Hausman F test is 0.88583 and those of the Durbin-Wu-Hausman chi-sq test is 0.88454. Since the test is not significant, the null hypothesis that considers the variable as exogenous cannot be rejected. Thus, the results of this test seem to corroborate the use of the probit model.

vaccines. In particular, also in this analysis, trust in institutions is associated with a lower probability of refusing the SARS-CoV-2 vaccine.

Furthermore, as anxiety increases, the probability of refusing the vaccine decreases. The same negative relationship there is between leftist ideals and the probability of rejecting vaccines.

These results are in line with previous literature: COVID-19 diagnosis, concern and political preferences are factors associated with SARS-CoV-2 vaccine refusal (Ward et al., 2020). COVID-19-related anxiety seemed to have a strong influence on intentions to vaccinate: those who had higher COVID-19-related anxiety scores had higher odds of vaccine acceptance (Salali et al.,2020).

Also in Ward et al. (2020), such as in this analysis, a negative association links the probability of rejecting the vaccine and possessing leftist ideals.

Table 2.5 presents estimation results obtained to verify the research question 2. Six regressions are shown: column (1) presents the benchmark analysis, where the outcome variable is "NOVAX" and the independent variable of interest is "SOCIAL"; in column (2) "SOCIAL" is replaced by trust in Social Media as source of information ("T_SOCIAL"); in column (3), (4) and (5) the alternative outcome variable "NOVAX_1", "NOVAX_2" and "NOVAX_3" are used.

[Table 2.5]

The use of social media does not appear to be significant in most of the regressions presented, except considering the subsample of those who believe they do not run any risk from the infection (NOVAX_2) and those who fear the side effects of the vaccine (NOVAX_3).

In the first case, there is a negative relationship: as the use of social media as a source of information about covid-19 increases, the probability of refusing the vaccine on the basis of the belief that there is no risk is reduced. Conversely, in the second case, the use of social media as a source of information about covid-19 is positively and significantly associated with the propensity to refuse the vaccine due to fear of side effects.

Among the significant variable, such as female, income, anxiety, left_wing, also trust in institutions remains significant in almost all estimates. Indeed, in line with the previous

literature (Troiano et al., 2021), as trust in institutions increases, the propensity to refuse the vaccine decreases.

This study suggests the need for policy makers, such as government and public health authorities, to make further efforts to campaign against disinformation and make choices that build trust in institutions. Sociodemographic factors such as gender and personal attitude like political ideology should be considered in public health interventions to probably promote a more effective vaccine campaign.

2.5 Conclusions and Limitations

Social media have always played a decisive role in the management of health-related information (Tagliabue, Galassi, Mariani, 2020), but the coexistence of pandemic and an increasingly digital life has increased the demand for information of the Italians, in a process that seems to be unstoppable (Censis, 2023). In this context, the study of predictors for the acceptance of a vaccine against covid-19 is a global interest, both because the vaccine compliance is a complex phenomenon that varies according to place, time and vaccines themselves (Krishnamoorthy et al., 2019; Dror et al., 2020; Larson et al., 2016), but above all because in the last decades the trust in vaccines and vaccination policies is decreasing, by causing serious concerns of the global public health community (Harrison et al., 2020).

Therefore, faced with the phenomenon of vaccine hesitancy, we must ask ourselves what could be the answer of institutions. Making vaccinations against Covid-19 mandatory could be counterproductive, because, according to public opinion, it damages a fundamental right contemplated by the Constitution. The population prefers to have freedom of choice regarding vaccination. (De Santis, 2022)

From this perspective, public authorities must rely on other levers, adopting measures aimed at combating the disinformation, misinformation and vaccine hesitancy.

Indeed, during the Covid-19 pandemic, according to Montagni et al. (2021), it became fundamental to mitigate the impact of disinformation on the intention to not vaccinate.

This study investigates the relations between intention to vaccinate against coronavirus and disinformation and between vaccine refusal and the sources used to get informed, among a sample of southern Italian university students.

The initial theoretical hypothesis that a high level of disinformation leads to vaccine rejection is confirmed by the results of the study: both the calculated ability to discern fake news and that self-reported by respondents are significantly and positively associated with the willingness to get vaccinated.

Instead, the estimates relating to the use of social media is not significant. In line with expectations, however, is the fact that trust in institutions increases the willingness to get vaccinated.

A consistent communication by institutions is crucial to building public confidence in vaccine programs (Montagni et al., 2021).

Consequently, it is important to adopt policies and strategies that aim to reduce the circulation of fake news. But the functioning of online information highlights the difficulty of combating misinformation on social media. On the one hand, the application of a regulatory system of sanctions is impossible, since the absence of intermediation makes it difficult to identify responsibilities: the user of social media spreads false or incorrect information involuntarily. Typically the spread of incorrect information occurs without malice and, indeed, in the belief that it is disseminating useful information for everyone (Candido, 2020). On the other hand, the functioning of social media algorithms (Twitter, Facebook, YouTube) which connect users with the same interests, ideas and propensities, to maximize online permanence of users, means that false or bad information not only they circulate very quickly but are amplified, creating polarization and fragmentation of the public debate online (Pariser, 2012, Susser et al., 2019).

Furthermore, while developing programs to erase fake news from the internet, in order to avoid the danger of censorship and limitation of freedom of manifestation of thought, the process of identifying and removing fake news is too slow compared to the speed of propagation of online news.

For this reason, the only activities of identifying and eliminating fake news shared online, implemented by the platforms themselves, do not seem to be sufficient to stem the phenomenon (Censis, 2023).

If the ex post corrective intervention is not sufficient, it is necessary to act in advance, intervening to develop a conscious and responsible use of social media.

In this regard, the development of educational programs that increase the ability to discern real from fake news, thus generating reliable and high quality communication, acquires considerable importance.

The fight against misinformation online can hardly be addressed without developing digital civic education programs, instrumental to the conscious and informed education of individual consensus and, in general, public opinion (De Santis, 2022).

However, the present analysis has several limitations. First of all, the sample is not demographically heterogeneous. According to the third Censis Report on disinformation and fake news, the largest percentage of Italians who believe they are unable to recognize fake news concerns the over 65s, but the sample used in the study is composed of university students.

Moreover, although a large number of predictors of the willingness to get vaccinated identified from the previous literature were included in the model, the estimations could suffer from endogeneity problems for the unobserved effects, related to unacknowledged psycho-attitudinal factors affecting the intention to be vaccinated.

In addition, the level of disinformation could be underestimated: according to Bryanov and Vziatysheva (2021), based on the results obtained by Pennycook et al. (2020), data collected from investigations that include the task of discerning fake news can be skewed towards greater accuracy, due to the fact that individuals are induced to think about the truthfulness of the news, compared to their usual state of mind while browsing online.

TABLE 2.1 - Summary statistics of the variables

Variables	Description	Mean	Std. Dev.	Min	Max	Obs
Dependent Variable						
NOVAX	Dummy=1 if the respondent intends not to get vaccinated	0.17	0.38	0	1	813
Alternative Dependent Variable for Robustness Checks						
NOVAX_1	Dummy=1 if the respondent intends not to get vaccinated but has the belief that the part of population most at risk should do it	0.22	0.42	0	1	813
NOVAX_2	Dummy=1 if the respondent intends not to get vaccinated because he believes he does not run any risk	0.08	0.27	0	1	813
NOVAX_3	Dummy=1 if the respondent intends not to get vaccinated but because he fears the side effects of vaccine	0.08	0.27	0	1	813
Independent Variable						
DISINF	Dummy=1 if the disinformation index illustrated in the paragraph 1.9.2 is greater than 4.	0.13	0.34	0	1	834
DISINF_1	Dummy=1 if the disinformation index illustrated in the paragraph 1.9.2 is greater than or equal to 4.	0.49	0.5	0	1	834
DISINF_2	A discrete variable for the disinformation index illustrated in the paragraph 1.9.2	3.48	0.85	2	6	834
Alternative Independent Variable for Robustness Checks						
INABILITY_FN	The self-reported inability to discern fake news	0.03	0.18	0	1	813
Source of information about Covid-9						
SOCIAL	Social media	4.02	2.10	1	7	811
Trust in source of information for Covid-19						
T_SOCIAL	A discrete variable for the trust in Social Media	3.12	1.65	1	7	814
T_ISTIT	A discrete variable for the trust in Local or national institutions (Region, Italian National Institute of Health)	5.18	1.44	1	7	813
Personal attitude						
NO_FAITH	Dummy=1 if the respondent has no religious faith	0.34	0.48	0	1	795
LEFT_W	Dummy=1 if the respondent has left-wing ideals	0.30	0.47	0	1	600
Personal data, education and family background						
AGE	The age of the respondent (in years)	23.2	3.87	18	57	781
FEMALE	Dummy=1 if the respondent is female	0.49	0.50	0	1	783
GRADE	A discrete variable for the vote gained in the own highest educational qualification (low, lower-middle, higher-middle, or high)	3.11	0.93	1	4	772
INCOME	A discrete variable for the net monthly income of the respondent's family (0 to 1000, 1000 to 3000, 3000 to 5000, or more than 5000, in euros)	2.20	0.95	1	4	769
ANXIETY	Dummy=1 if the prevailing feeling experienced since the beginning of the pandemic has been anxiety	0.29	0.45	0	1	833
PARENTS_ED	A dummy variable =1 if at least one of the respondent's parents has a degree.	0.26	0.44	0	1	777

TABLE 2.2 - Correlation matrix of explanatory variables using in the analysis of research question 1

		1	2	3	4	5	6	7	8	9	10
1	DISINF	1									
2	FEMALE	0.126	1								
3	AGE	0.085	-0.044	1							
4	INCOME	0.039	-0.013	-0.035	1						
5	T_INSTIT	-0.080	0.042	-0.004	0.034	1					
6	GRADE	-0.098	0.188	-0.140	-0.090	0.014	1				
7	PARENTS_ED	-0.061	-0.017	-0.096	0.154	-0.045	-0.043	1			
8	ANXIETY	0.059	0.254	0.048	-0.007	0.008	-0.003	0.006	1		
9	NO_FAITH	-0.181	-0.222	-0.063	-0.058	0.053	0.007	-0.019	-0.106	1	
10	LEFT_WING	-0.075	0.012	0.046	0.060	0.179	0.035	0.047	-0.046	0.141	1

For the description of the variables, see Table 1.

TABLE 2.3 - Correlation matrix of explanatory variables using in the analysis of research question 2

		1	2	3	4	5	6	7	8	9	10
1	SOCIAL	1									
2	FEMALE	0.204	1								
3	AGE	-0.124	-0.041	1							
4	INCOME	-0.012	-0.008	-0.038	1						
5	T_INSTIT	0.097	0.044	-0.005	0.026	1					
6	GRADE	-0.052	0.186	-0.137	-0.088	0.016	1				
7	PARENTS_ED	-0.066	-0.018	-0.097	0.156	-0.048	-0.042	1			
8	ANXIETY	0.042	0.259	0.050	-0.008	0.013	-0.005	0.011	1		
9	NO_FAITH	-0.145	-0.224	-0.064	-0.058	0.050	0.008	-0.022	-0.100	1	
10	LEFT_WING	0.051	0.015	0.045	0.068	0.173	0.036	0.048	-0.047	0.142	1

For the description of the variables, see Table 1.

TABLE 2.4 – Estimation results of research question 1: benchmark model and robustness checks

	(1) PROBIT Benchmark	(2) PROBIT "DISINF" replaced with "DISINF_1"	(3) PROBIT "DISINF" replaced with "DISINF_2"	(4) PROBIT "DISINF" replaced with "INABILITY_FN"	(5) PROBIT "NOVAX" replaced with "NOVAX_1"	(6) PROBIT "NOVAX" replaced with "NOVAX_2"	(7) PROBIT "NOVAX" replaced with "NOVAX_3"
DISINF	0.1678***	-	-	-	0.1878***	0.1016***	0.0455***
	(0.000)				(0.001)	(0.000)	(0.000)
DISINF_1	-	0.0883***	-	-	-	-	-
		(0.000)					
DISINF_2	-	-	0.0801***	-	-	-	-
			(0.000)				
INABILITY_FN	-	-	-	0.0841***	-	-	-
				(0.009)			
FEMALE	0.0342*	0.0371*	0.0237	0.0522**	-0.0314	-0.0117	0.0367
	(0.086)	(0.088)	(0.246)	(0.028)	(0.134)	(0.668)	(0.147)
AGE	0.0012	0.002	0.0014	0.0027	0.0083*	0.0019	-0.0003
	(0.604)	(0.288)	(0.482)	(0.157)	(0.090)	(0.300)	(0.846)
INCOME	0.0084*	0.0121**	0.0105**	0.011	-0.019	0.0048	0.0042
	(0.100)	(0.034)	(0.023)	(0.116)	(0.214)	(0.226)	(0.479)
T_INSTIT	-0.0378***	-0.0385***	-0.0348***	-0.0394***	0.0137	-0.0167**	-0.0168***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.362)	(0.016)	(0.000)
GRADE	-0.0038	-0.0064	-0.00001	-0.0133	0.0079	0.0148**	-0.0148
	(0.851)	(0.741)	(1.000)	(0.522)	(0.484)	(0.031)	(0.404)
PARENTS_ED	-0.0411	-0.0428	-0.0427	0.0489	0.0415	-0.0315	-0.0053
	(0.306)	(0.364)	(0.313)	(0.288)	(0.288)	(0.153)	(0.824)
ANXIETY	-0.0473***	-0.0497***	-0.0526***	0.0409**	0.0401	-0.008	-0.0212
	(0.007)	(0.001)	(0.000)	(0.017)	(0.166)	(0.594)	(0.131)

NO_FAITH	-0.0588	-0.0495	-0.0314	-0.0764	-0.0547	-0.0055	-0.0434***
	(0.219)	(0.301)	(0.499)	(0.121)	(0.234)	(0.872)	(0.005)
LEFT_WING	-0.0551**	-0.0506*	-0.0438*	-0.0597**	-0.0745***	0.0423	-0.0286***
	(0.013)	(0.064)	(0.084)	(0.026)	(0.006)	(0.104)	(0.009)
_cons	-0.2035	-0.3758	-1.5065***	-0.1532	-1.61*	-1.3983***	-0.3497
	(0.664)	(0.345)	(0.001)	(0.711)	(0.000)	(0.003)	(0.712)
N	555	555	555	554	555	555	555

In columns 1-4, the dependent variable is NOVAX. In column 5 the dependent variable is the alternative outcome variable NOVAX_1, in column 6 NOVAX_2 and in column 7 NOVAX_3. For the description of the variables, see Table 1. Standard errors are adjusted for robust clustering applied within geographic units of provinces. Average marginal effects are reported in the table and in parenthesis the p.value of the tests. Respectively, asterisks ***, ** and * represents statistical significance at the 1, 5 and 10 percent level.

TABLE 2.5 – Estimation results of research question 2: benchmark model and robustness checks

	(1) PROBIT Benchmark	(2) PROBIT "SOCIAL" replaced with "T_SOCIAL"	(3) PROBIT "NOVAX" replaced with "NOVAX_1"	(4) PROBIT "NOVAX" replaced with "NOVAX_2"	(5) PROBIT "NOVAX" replaced with "NOVAX_3"
SOCIAL	0.0003	-	0.012	-0.0077***	0.0059***
	(0.954)		(0.184)	(0.005)	(0.004)
T_SOCIAL	-	0.005	-	-	-
		(0.594)			
FEMALE	0.0528**	0.0503**	-0.0205	0.0042	0.0417**
	(0.028)	(0.020)	(0.538)	(0.866)	(0.042)
AGE	0.0026	0.0024	0.0108**	0.0025	0.0002
	(0.239)	(0.265)	(0.026)	(0.185)	(0.906)
INCOME	0.0143**	0.0121*	-0.016	0.0096***	0.0053
	(0.026)	(0.063)	(0.307)	(0.002)	(0.386)
T_INSTIT	-0.0384***	-0.0416***	0.0091	-0.0171**	-0.0174***
	(0.000)	(0.000)	(0.570)	(0.033)	(0.000)
GRADE	-0.013	-0.0108	0.0028	0.0071	-0.0162
	(0.516)	(0.600)	(0.831)	(0.429)	(0.350)
PARENTS_ED	-0.0457	-0.0475	0.0424	-0.0409*	-0.0019
	(0.300)	(0.314)	(0.310)	(0.076)	(0.938)
ANXIETY	-0.0516***	-0.0429***	0.0319	-0.0094	-0.0242**
	(0.003)	(0.006)	(0.386)	(0.589)	(0.045)
NO_FAITH	-0.069	-0.0702	-0.0578	-0.0189	-0.0419***
	(0.130)	(0.162)	(0.190)	(0.569)	(0.002)

LEFT_WING	-0.0598**	-0.0627**	-0.0927***	-0.0455	-0.029***
	(0.025)	(0.017)	(0.002)	(0.108)	(0.008)
COVID_FAM	-	-	-	-	-
_cons	-0.204	-0.1793	-1.7843***	-1.0754**	-0.5923
	(0.622)	(0.744)	(0.000)	(0.043)	(0.541)
N	552	552	552	552	552

In columns 1 and 2 the dependent variable is NOVAX. In column 3 the dependent variable is the alternative outcome variable NOVAX_1, in column 4 NOVAX_2 and in column 5 NOVAX_3. For the description of the variables, see Table 1. Standard errors are adjusted for robust clustering applied within geographic units of provinces. Average marginal effects are reported in the table and in parenthesis the p.value of the tests. Respectively, asterisks ***, ** and * represents statistical significance at the 1, 5 and 10 percent level.

CONCLUSIONS

The COVID-19 pandemic has been associated with serious epidemic of information: fake news and misinformation related to COVID-19 have spread like wildfire on social media.

The phenomenon of spreading fake news during epidemic has been known to occur since the Middle Ages (Zaracostas, 2020). However, social media amplifies it considerably.

For the population to be able to react effectively to a pandemic, it is necessary to provide high-quality information, with the relevant science-based evidence. On the contrary, disinformation clearly hinders mitigation, spreads misleading messages about the disease and promotes ineffective precautionary measures (Mheidly and Fares, 2020).

This necessarily could lead to the slowing down, or worse, failure of policies implemented to stop the circulation of the virus.

Considering the relevance of the topic, two empirical works have been performed to evaluate, first, the use of social media as a determinant of disinformation and, then, the propensity to reject the vaccine against SARS-CoV-2 as a consequence of disinformation.

To collect data, a survey was submitted to students of a university in southern Italy, between 28 May 2020 to 18 July 2020, during the so-called phase 2 of Covid-19 Pandemic in Italy.

The results of research are in line with theoretical expectations and with previous literature: on the one hand, from the first empirical work, social media would seem to have a significant role in the diffusion of fake news, on the other hand the second analysis shows that disinformation is positively associated with the propensity to refuse the vaccine.

These results confirm the importance of fighting the circulation of fake news and disinformation: this challenging task is already recognized by WHO as a key part of controlling the Covid-19 pandemic. For this purpose, all the actors involved, such as governments, international organizations, regional institutions, social media platforms should work in coordination. Indeed, several social platforms, such as Facebook, Google, YouTube, Twitter are collaborating with one another and government health agencies in order to promote accurate information around the virus from authoritative sources (Singh and Bagchi, 2020).

Nevertheless, according to the third Censis Report on disinformation and fake news (2023), the only activities of identifying and eliminating fake news shared online, implemented by the platforms themselves, do not seem to be sufficient to stem the phenomenon. The efforts of governments and the WHO for combating disinformation in social media, which seem to be not even enough, should be geared towards improving the ability of social media users to discern real news from fake news, for a more conscious use of social media. Indeed, Guess et al. (2020) found that even a series of simple guidelines, that contain recommendations as "be skeptical about headlines", "beware of unusual formatting", improve the discernment rate of fake news.

But further research is called for on this crucial point: how societies can control the flow of information and how they can determine what is true and false, without limiting human rights, such as the freedom of speech, democracy, and associations.

However, some limitations of my research need to be acknowledged. First of all, the disinformation grade of respondents could be underestimated.

In the survey, they were asked to indicate to what extent they believed in each reported news. From this collected data, the disinformation index was later created. But the level of attention of respondents and their mental state when they are induced to evaluate the truthfulness of a content is not the same as when browsing social media. Indeed, according to Bryanov and Vziatysheva (2021), based on the results obtained by Pennycook et al. (2020), data collected from investigations that include the task of discerning fake news can be skewed towards greater accuracy.

Another limit is related to the sample used: despite young people could be a key group in the context both for their role in the transmission of the virus, both for their

massive use of social media, a demographically more heterogeneous sample, representative of the whole population could enforce the validity of results.

Furthermore, despite the large number of predictors used in the models and the attempts to address endogeneity concerns adopting instrumental variables estimators, unobserved effects, related to unacknowledged psycho-attitudinal factors, call for caution in interpreting the detected associations as causal relationships.

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SURVEY

INFORMATION ON THE PROTECTION OF PERSONAL DATA

The personal data acquired through the following survey will remain anonymous and will be processed in full compliance with Regulation (EU) 2016/679, the Code regarding the protection of personal data (in particular, Article 106 Deontological rules for processing for statistical purposes or scientific research), as well as in compliance with the Deontological Rules for processing for statistical purposes or scientific research published pursuant to art. 20, comma 4, of d.lgs. 10 August 2018, n. 101, 19 December 2018.

Pandemic, Infodemic and behaviors in the various phases of the spread of the Coronavirus

FIRST PART: Media and Covid-19 pandemic

➔ Complete the following matrix:

	Have you read the news?	Did you share the news?	How credible is it on a scale of 1 to 7?
There is a correlation between the Covid-19 epidemic and the 5G network			
The new coronavirus is a laboratory product			
Hyperimmune plasma is a valid alternative to the vaccine, already tested and costless			
The use of gloves does not protect against the virus			
Covid-19 has a similar death rate to the flu			
Massive doses of vitamin C are an effective treatment for Covid-19			
The virus is weakening			
Sales of Corona beer dropped dramatically as			

the virus spread			

➔ What sources do you use to get information about Covid-19? (assigns a score from 1 to 7 depending on the level of use)

☐ Family and Friends
☐ Tv/Radio
☐ Social media, posts or blogs
☐ Local or state institutions (Region, Italian National Institute of Health)
☐ WHO (World Health Organization)
☐ Scientific papers

➔ Assign a score from 1 to 7 (1=deeply disagree; 7=completely agree) to the following statements:

☐ Traditional media (newspapers, TV, Radio) inform users in an accurate and balanced way
☐ The network (blogs, search engines, social networks) informs users in an accurate and balanced way.
☐ I believe credible scientific information provided by government sources.
☐ I believe credible scientific information provided by scientific sources.
☐ WHO (World Health Organization)
☐ Scientific papers

➔ What has been the prevailing feeling since the beginning of the pandemic?

☐Anxiety
☐Stress
☐Fear
☐Sadness
☐Anger
☐Hate
☐Concern
☐Loneliness
☐Indifference
☐Happiness
☐Sense of belonging to the community
☐Hope
☐Nervousness
☐ Other

➔ Have there been losses or serious health problems in your family caused by Covid-19?

☐ Yes
☐ No

➔ How much confidence do you have in your ability to recognize fake news?

☐ A lot
☐ Enough
☐ Little
☐ None

➔ If a Coronavirus vaccine were available, would you get vaccinated?

☐ Yes
☐ No, I don't think I'm taking a high risk
☐ No, to avoid the side effects of the vaccine
☐ No, I don't want to favour the multinationals of the drug

➔ Should the population be vaccinated?

☐ Yes, the entire population
☐ Yes, but only the population groups most at risk
☐ No, to avoid the side effects of the vaccine
☐ No, I don't want to favour the multinationals of the drug

SECOND PART: Personal attitudes

➔ Do you profess a religious faith?

☐ Yes, Catholic
☐ Yes, Muslim
☐ Yes, Protestant
☐ Yes, other
☐ No

➔ Do you have a political ideology?

☐Yes, right-wing
☐Yes, left-wing
☐Yes, center
☐No

➔ How do you rate the average quality of your connection from 1 to 7 (1= bad; 7 = excellent)?

➔ What is the (approximate) number of your followers? (if you do not use the social mentioned below indicates 0)

Instagram =
Facebook =
Twitter =

THIRD PART: Personal Identifying Data and Education

➔ Gender

☐ F
☐ M

➔ Year of birth: _____

➔ What qualification did you obtain?

☐ Scientific high school diploma
☐ Classical High School Diploma
☐ Technical maturity
☐ Professional maturity
☐ Other type of maturity
☐ Bachelor Degree

➔ With what grade did you obtain the aforementioned title? _____

➔ What is your mother's educational qualification?

☐ Elementary school
☐ Middle school diploma
☐ High school diploma
☐ Bachelor's degree/postgraduate specialization

➔ What is your father's educational qualification?

☐ Elementary school
☐ Middle school diploma
☐ High school diploma
☐ Bachelor's degree/postgraduate specialization

➔ Which category best represents your family's monthly net income??

☐ 0€-1000€
☐ 1000€-3000€
☐ 3000€-5000€
☐ More than 5000€

➔ How many members are there in your family (excluding you)? _____

➔ Please indicate municipality and province where you reside _____

➔ The number of inhabitants of your municipality of residence is between:

☐ 0-3000
☐ 3000-6000
☐ 6000-15000
☐ 15000-60000
☐ More than 60000

FOURTH PART: Academic experience

- ➔ What is the University you attend? _____
- ➔ Course of study: _____

- ➔ Degree type:

  - ☐ Bachelor
  - ☐ Master
  - ☐ Single-cycle
  - ☐ Other

- ➔ Year of course:

  - ☐ First
  - ☐ Second
  - ☐ Third
  - ☐ First out of course
  - ☐ Second out of course
  - ☐ Other _____

- ➔ What Is The Average Grade You Got In The Exams? _____

- ➔ Have you been invited to fill in this survey during a university lesson (or via a message on your institutional email inbox)?

  - ☐ Yes
  - ☐ No