Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
The role of religiosity in product and technology acceptance: Evidence from COVID-19 vaccines

Ludovico Bullini Orlandi, Valentina Febo, Salvatore Perdichizzi

PII: S0040-1625(22)00553-4
DOI: https://doi.org/10.1016/j.techfore.2022.122032
Reference: TFS 122032

To appear in: Technological Forecasting & Social Change

Received date: 1 March 2022
Revised date: 2 September 2022
Accepted date: 6 September 2022

Please cite this article as: L.B. Orlandi, V. Febo and S. Perdichizzi, The role of religiosity in product and technology acceptance: Evidence from COVID-19 vaccines, Technological Forecasting & Social Change (2022), https://doi.org/10.1016/j.techfore.2022.122032

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

© 2022 Published by Elsevier Inc.
The role of religiosity in product and technology acceptance: evidence from COVID-19 vaccines

Bullini Orlandi, Ludovico1*, Febo, Valentina2,1, Perdichizzi, Salvatore1

1Department of Management, University of Bologna, via Capo di Lucca 34, 40126, Bologna, Italy
2EM Normandie Business School, Metis Lab, France, 30-32 Rue Henri Barbusse, 92110 Clichy, France
ludovico.bullini2@unibo.it*, valentina.feb03@unibo.it, salvator.perdichizzi@unibo.it

Abstract

Previous research on religion and economic phenomena has suggested that religious attitudes are related to risk aversion. Moreover, risk attitudes play a significant role in the adoption and diffusion of technological innovations. However, the role of religiosity in technology-related phenomena is still relatively unexplored. The present study fills this gap and investigates the impact of religiosity on the acceptance of innovative technologies and products in the context of the COVID-19 pandemic. Specifically, we frame COVID-19 vaccines as new products based on innovative production technologies and show that their acceptance by the general public is negatively associated with country-level religiosity. Furthermore, we investigate the role of religious leaders in endorsing COVID-19 vaccines to their followers. Our hypotheses are empirically tested on 1,179 weekly observations of vaccination rates in 22 European countries characterised by different levels of religiosity. The results suggest that religiosity is negatively associated with vaccine rates after controlling for country-level social and economic factors. Conversely, the countries where Roman Catholics are the majority religious group display a positive association between religiosity and vaccine rates, highlighting the role of leaders in endorsing the COVID-19 vaccination campaign.

Keywords: religion; religiosity; religious leader; technology acceptance; risk aversion; COVID-19 vaccines.

Declarations of interest: none
1. Introduction

The COVID-19 pandemic has led to the introduction and spread of several technological innovations, such as contact tracing apps (Cloos & Mohr, 2022). Moreover, it has induced significant changes in collective behaviours, such as the adoption of social distancing to prevent the diffusion of the virus (Pedersen & Favero, 2020). However, one of the most critical issues faced for “flattening the curve” and redressing the heavy economic consequences of lockdown (Debecker & Modis, 2021) has been the success of the COVID-19 vaccination campaign.

There have been major issues related to individuals’ decision to adopt COVID-19 vaccines, which have been produced through innovative technologies, such as mRNA platforms (Ura et al., 2021) and adenovirus DNA vectors (Knoll & Wonodi, 2021). Both technologies are not completely new to academic researchers. Other mRNA treatments have already been tested in recent years (Kowalczyk et al., 2016), and adenovirus DNA vectors have been widely studied in the last three decades (Majhen et al., 2014). However, the first approval for use in humans of a vaccine based on adenovirus DNA vector dates back only to 2019 (Chang, 2021), while mRNA vaccines are considered a completely new pharmaceutical product (Mogaji, 2021). Consequently, both the technologies employed and the resulting products (namely, the Pfizer, Moderna, and AstraZeneca vaccines) were largely unknown to the general public in the earliest stages of the vaccination campaign.

Seminal works aiming to extend the technology acceptance model (Featherman, 2001) suggest that individuals’ behavioural intention to adopt a new technology is linked with the perceived associated risks, especially in the early stages of adoption (e.g., Ortega Egea & Román González, 2011). The same concerns about safety and/or risk have been found in adopting new products (Heiman & Muller, 1996; Ta & Prybutok, 2018). Moreover, research on COVID-19 vaccines suggests that the behavioural intention to get vaccinated is strongly related to the relative
perception of the risks connected to vaccines and the infection itself (Pelegrín-Borondo et al., 2021; Zhang et al., 2021).

If an innovation to be adopted is perceived by individuals as riskier than average, the role of risk preferences and all factors affecting them should not be underrated. We build on the relationship between religious attitudes and risk aversion and propose religiosity as a factor potentially influencing the adoption of COVID-19 vaccines. In doing so, we aim to fill a relevant gap in the literature on technology (product) acceptance, country-level characteristics, and individual behaviours.

Different disciplines have established an empirical link between religious attitudes and risk aversion. As summarised by Hilary and Hui (2009), the psychology and anthropology literature has consistently shown religiosity (usually measured through church attendance) to be positively correlated with risk aversion (Osoba, 2003) and negatively associated with risk-taking behaviours (e.g., gambling (Diaz, 2000)). Overall, we leverage previous evidence on the relationship between religiosity, risk aversion, and technology (product) intention to adopt and expect a negative association between country-level religiosity and COVID-19 vaccine diffusion.

Other factors could potentially moderate the relationship between country-level religiosity and vaccination rates. Namely, several studies have suggested that religious leaders play a relevant role in pushing their followers to adopt health-related practices (Anshel & Smith, 2014; Cohen-Dar & Obeid, 2017). Consequently, some correspondences from the Journal of Public Health suggest that religious leaders have a critical role in overcoming hesitancy and promoting COVID-19 vaccines (Corpuz, 2021; Gopez, 2021). Therefore, we expect religiosity to be positively associated with COVID-19 vaccine diffusion when the majority religious group in a country has leaders who are publicly and consistently favourable to COVID-19 vaccines.

We test our hypotheses by exploiting the empirical setting of the European Union, in which the European Medicine Agency (EMA), a supranational authority, is responsible for approving
vaccines. We observe weekly vaccination rates, computed as the number of first doses administered over the country population, between December 2020 and December 2021 in 22 European countries. Following previous research (Barro & McCleary, 2003), we capture country-level religiosity by leveraging answers to questions in the World Value Survey. We perform our analyses on a panel of 1,179 week-country observations.

Results suggest that religiosity is negatively associated with vaccination rates after controlling for other country-level social and economic factors. However, there is a positive association between religiosity and vaccination rates in countries where Roman Catholicism is the predominant religion. This last result supports the role of religious leaders in promoting technology (product) acceptance. For example, Pope Francis\(^1\) has frequently publicly endorsed vaccination against COVID-19 (Corpuz, 2021; Gopez, 2021).

2. Theoretical Framework

2.1. Religiosity, risk aversion, and innovative technology (product) acceptance

The first COVID-19 vaccines introduced in 2020 are based on innovative production technologies, namely, the mRNA platform (Ura et al., 2021) and adenovirus DNA vectors (Knoll & Wonodi, 2021). Both technologies were not new to academic researchers: treatments based on mRNA had already been studied before (Kowalczyk et al., 2016), and adenovirus DNA vectors were based on a long-standing research stream (Majhen et al., 2014). However, they were largely unknown to the general public in the earliest stages of the vaccination campaign. The same is true for the resulting products, the Pfizer, Moderna, and AstraZeneca vaccines. In fact, the first approval of a vaccine based on adenovirus DNA vector for human use dates back only to 2019 for Ebola (Chang, 2021), while mRNA vaccines are considered an entirely new pharmaceutical product (Mogaji, 2021).

\(^1\) https://www.nytimes.com/2021/08/17/business/media/pope-covid-vaccine-ad.html.
Even if academic research considers vaccines as innovative products (e.g., Li & Qiu, 2013; Mogaji, 2021) based on innovative technological platforms (e.g., Mascola & Fauci, 2020), only one study has analysed them in terms of behavioural acceptance as a function of their technological nature (Pelegrín-Borondo et al., 2021). Indeed, vaccines are very specific products based on complex technologies. For this reason, the decision on whether to get injected can be considered an “extreme case” of product and technology acceptance. Accordingly, the role of risk perception is also taken to the extreme, as vaccines involve health-related concerns.

Compared to average cases, extreme cases in social sciences are considered critical to reveal more about a phenomenon (K. K. Chen, 2015; Flyvbjerg, 2006). In some instances, they are the only means through which to understand certain phenomena (McKelvey & Andriani, 2005). Consequently, this study argues that the acceptance and diffusion of COVID-19 vaccines can be framed as an extreme case of technology and product acceptance, as vaccines: (a) incorporate innovative elements into their production technologies, (b) are new products themselves, and (c) are related to personal health, making individual risk perception exceptionally salient in their adoption.

The relative speed of production with respect to traditional vaccines, together with the adoption of a conditional authorisation model by health authorities (Cavaleri et al., 2021), is bound to affect the initial risks' perception of COVID-19 vaccines by the general public, who could consider them “too new” and “not tested properly” (Latkin et al., 2021). Previous research on technology and product acceptance models suggests that individual behavioural intention to adopt new technology (Featherman, 2001) or buy a new product (Heiman & Muller, 1996) is affected by the perception of the risks involved. A higher perception of “experiencing negative consequences or losses in uncertain situations” (Ortega Egea & Román González, 2011, p. 323) decreases individuals' intention to adopt an innovative technology (e.g., Slade et al., 2015) or to buy a new product (Barnes & Ayars, 1977; Cowart et al., 2008). Moreover, the role of risk preferences in technology (product) diffusion has also been considered central in the literature about the “diffusion
of innovation,” suggesting that both risk perception (Lilien, 1980) and risk aversion (Chatterjee & Eliashberg, 1990) negatively impact the diffusion of innovative technology (product). Consequently, factors affecting risk preferences, defined as preferences “for options perceived to be more or less risky” (Weber & Milliman, 1997, p. 123), should play a role in the decision of individuals to get vaccinated. We propose religiosity as one of those factors.

Different disciplines have established an empirical link between individual-level religious attitudes and risk aversion. As summarised by Hilary and Hui (2009), the psychology and anthropology literature has consistently shown religiosity (usually measured through church attendance) to be positively correlated with risk aversion (Osoba, 2003) and negatively associated with risk-taking behaviour (i.e., gambling (Diaz, 2000)). Hilary and Hui (2009) further explore this relationship by correlating questions related to religious beliefs and behaviours to questions associated with risk aversion in the European Social Survey and find a significant and positive relationship between their answers (Hilary and Hui, 2009). Moreover, experimental evidence further confirms these results (Hilary and Hui, 2009).

Both Miller and Hoffman (1995) and Hilary and Hui (2009) provide a theoretical explanation for the positive relationship between risk aversion and religiosity. Risk-averse individuals seek religion to alleviate anxiety caused by uncertainty encountered in their daily life (Hilary and Hui, 2009). The link between anxiety and religiosity is empirically confirmed by evidence from the World Values Survey, and experimental results show how anxiety is positively associated with risk aversion (Lerner & Keltner, 2001). Moreover, the economics literature has directly tested the link between religiosity and innovation. Bénabou et al. (2015a) show how religiosity and attitudes towards innovation and scientific progress at the individual level are negatively correlated. More importantly for our setting, Bénabou et al. (2015b) find that such a relationship also holds at the country level, as highly religious areas exhibit fewer patents per capita. Overall, these results support the idea of religion as a source of (endogenous) persistence
and resistance to change in the population of specific areas (Bénabou et al., 2015a, 2015b) and are consistent with individual-level evidence on religious people being less willing to take risks (Hilary and Hui, 2009).

This study, taking into consideration the arguments mentioned above, frames COVID-19 vaccines as new products made with innovative production technologies and perceived as involving some degree of risk by the target population. Therefore, it is reasonable to hypothesise that individuals’ risk aversion strongly influences their COVID-19 vaccine acceptance, and its consequent country-level diffusion. Risk-averse and highly religious people are more resistant to innovation (Hilary and Hui, 2009; Bénabou et al., 2015a), and this pattern also holds at the country level (Bénabou et al., 2015b). Thus, we would expect to observe lower vaccination rates in areas characterised by high levels of religiosity. Therefore, we formulate the following hypothesis:

**H1:** Highly religious countries exhibit a lower vaccination rate.

### 2.2. Religious leaders’ role in the health-related behaviour of religious followers

The role of religious leaders in influencing followers’ opinions and behaviours is a longstanding topic in social science (McKeown & Carlson, 1987; Pinto, 1964). Even if early experimental results have suggested a nonsignificant effect of the influence of religious leaders on followers’ political opinions (McKeown & Carlson, 1987), subsequent research has conceptualised and empirically supported the role of religious leaders in shaping their followers’ opinions about political and ethical matters such as arms race (Wald, 1992), immigration (Nteta & Wallsten, 2012), the death penalty, and abortion (Mulligan, 2006). More recently, several studies have analysed the role of religious leaders in endorsing and promoting health-related behaviour. Religious leaders can raise awareness about health-related issues (Cohen-Dar & Obeid, 2017) and promote virtuous behaviour in their religious communities (Anshel & Smith, 2014). Overall, there exists empirical evidence supporting the effectiveness of religious leaders’ involvement in promoting health-related practices (Toni-Uebari & Inusa, 2009).
Among all possible health-related concerns, vaccine acceptance and hesitance within religious communities have also been addressed (Wombwell et al., 2015). Likewise, the role of religious leaders in hampering or prompting vaccine diffusion has also been discussed (Williams et al., 2020). An in-depth analysis of religious scriptures and reports on vaccine attitudes in major religious communities found no strong canonical or doctrinal basis for refusing vaccines (Grabenstein, 2013). Moreover, calls for preserving life and caring for others in the community may encourage vaccination (Grabenstein, 2013). However, religious leaders’ attitudes towards vaccines vary from full acceptance to outright refusal (Ruijs et al., 2013), presumably leading to different vaccine-related attitudes in their respective communities (Williams & O’Leary, 2019).

During the COVID-19 pandemic, academic research has directly called for religious leaders to endorse COVID-19 vaccines to increase vaccine coverage inside religious communities (Corpuz, 2021; Galang, 2021; Nagar & Ashaye, 2022). However, to the best of our knowledge, no published scientific studies have empirically verified the conceptualised positive relationships between religious leaders’ support for vaccines and the effective vaccination rate. Therefore, building on the arguments above, we formulate the following hypothesis:

**H2:** Countries in which the religious leaders of majority religious groups have publicly endorsed COVID-19 vaccines exhibit a higher vaccination rate.

3. **Research Methodology**

3.1. *Data and sample*

Our dataset combines information from various sources. First, we obtain weekly data on vaccination rates and COVID-19 cases in the European Union from the European Centre for Disease Prevention and Control. Our timeframe starts in late December 2020, when the first doses were administered, and ends in December 2021.² We capture religiosity at the country level drawing from data from the seventh wave of the Joint European and World Values Survey. Finally,

² On the 21st of December 2021, the EMA approved the first vaccine against COVID-19 (the BioNTech/Pfizer one). Source: https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2466.
we obtain social and economic data on education, gender, health status, foreign population, national net income, and unemployment rates at the country level from Eurostat. The final sample consists of 22 European countries and 1,179 week-country observations.  

3.2. Variable definitions

Our outcome variable is the rate of vaccination against COVID-19 (\textit{Vaccinated (1st dose)}), measured by the weekly amount of first doses of all types of vaccine administered, standardised by the country population.

Our variable of interest is country-level religiosity. Following previous research (Barro and McCleary, 2003; Benabou et al., 2015b; Chen et al., 2016), we capture religiosity at the country level with five measures corresponding to the answers to five questions in the last wave of the joint World and European Values Survey.

One section of the World (European) Values Survey tracks the religious beliefs and practices of the respondents (Chen et al., 2016), and these data are consistently used in the literature to compare religious beliefs between societies. \textit{Member of Religion} is computed as the number of respondents for each country that answered “A religious person” to the question: “Independently of whether you attend religious services or not, would you say you are: Missing; Unknown; Not asked; Not applicable; No answer; Do not know; A religious person; Not a religious person; A convinced atheist; other answer” (Chen et al., 2016). \textit{Importance of Religion} is the number of respondents for each country that answered “Very important” or “Rather important” to the question: “Would you say religion is: Missing; Unknown; Not asked; Not applicable; No answer; Don’t know; Very important; Rather important; Not very important; Not at all important” (Chen et al., 2016). \textit{Religious Services} is the number of respondents for each country that declared to attend a religious service more than once a year when asked: “Apart from weddings and funerals, about how often do

\footnote{The countries included are Austria, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.}
you attend religious services these days? 1: More than once a week; 2: Once a week; 3: Once a month; 4: Only on special holy days; 5: Once a year; 6: Less often; 7: Never, practically never” (Chen et al., 2016). *Belief in God* is computed as the number of respondents for each country that answered “Yes” to the question: “Do you believe in God?” (Benabou et al., 2015a). *Importance of God* is computed as the number of respondents for each country who answered, “Very important” to the question “Importance of God in your life?” (Benabou et al., 2015a). All the previous variables are standardised by the number of total respondents in each country. Following Chen et al. (2016), we then built a country-level index of religiosity by extracting the first principal component of the five variables (*Religiosity Index*). Finally, *Catholic*, *Orthodox*, and *Protestant* are dummy variables equal to one if the predominant religion of the country is, respectively, Roman Catholic, a branch of the Orthodox Churches, or Protestantism, as reported on the CIA Factbook.4

We control for several country-level characteristics that could affect individual willingness to be vaccinated, the speed of national-level vaccination campaigns, and individual risk aversion. The first set of controls aims to account for local differences in the (potential) severity of the pandemic. We include the weekly COVID-19 contagion rate (*Contagion*) to account for differences in the stage of the pandemic each country is experiencing each week. Depending on the level of contagion, people could feel compelled to get vaccinated due to fear (Salali & Uysal, 2021). Then, we factor in country-level differences in the general health of the population through *Healthy population*, computed as the number of expected years without activity limitation. Especially in the first phases of the pandemic, attention was drawn to the correlation between health problems and severe or lethal cases of COVID-19 (Yang et al., 2020).

4 *Catholic* is equal to one for Croatia, France, Hungary, Italy, Lithuania, Poland, Portugal, Slovakia, Slovenia, and Spain. *Orthodox* is equal to one for Bulgaria, Cyprus, and Romania. *Protestant* is equal to one for Denmark, Finland, Germany, Norway, and Sweden.
The second set of controls accounts for differences in wealth and economic conditions across countries. For this purpose, we include *Unemployment rate* (or is the fraction of people unemployed over the labour force) and the national net income in EUR millions (*Income*).5

Finally, we follow Hilary and Hui (2009) and Iannaccone (1998) by including some demographic characteristics as possible individual-level determinants of religious participation. We include *Education*, measured as the fraction of the country’s population with a bachelor’s degree or higher. We control for gender-related risk aversion through the fraction of males over country population (*Male*). Finally, we include the fraction of the foreign population belonging to the EU27 countries over the country population (*Foreign (EU27)*) as a measure of minorities in each country. All socioeconomic controls apart from *Contagion* rates were measured in 2019.

### 3.3. Econometric model

Our econometric approach is based on a panel fixed effect technique to estimate the impact of religiosity on vaccination rates in the European Union. We include weekly fixed effects in all regressions to account for time confounding effects. To test our first hypothesis, we estimate the following equation:

\[
\text{Vaccinated (1st dose)}_{c,t} = \alpha + \beta_1 \text{Religiosity}_c + \beta_i \text{Controls}_{c,t} + \mu_t + \varepsilon_{c,t} \quad (1)
\]

\(\text{Vaccinated (1st dose)}\) is the weekly vaccination rate of country \(c\) at time \(t\). *Religiosity* is, alternatively, one of our religiosity-related variables in country \(c\) ((1) *Religiosity Index*, (2) *Member of Religion*, (3) *Importance of Religion*, (4) *Religious Services*, (5) *Belief in God*, (6) *Importance of God*). \(\text{Controls}_{c,t}\) is a vector of country-level socioeconomic control variables (*Contagion, Healthy population, Unemployment rate, Income, Education, Male, Foreign (EU27)*). The key coefficient is \(\beta_1\). If the coefficient is negative and statistically significant, then we can conclude that the level of religiosity observed in a country negatively impacts willingness to be

---

5 In our empirical analyses, we substitute *Income* with its natural logarithm.
vaccinated against COVID-19. $\mu_c$ represents weekly fixed effects, and $\varepsilon_{c,t}$ represents an error term. To account for the risk of serial correlations, we use clustered heteroscedasticity-adjusted standard errors at the country level.

We are also interested in understanding the possible moderating role of the leaders of majority religious groups that have endorsed COVID-19 vaccines on the relationship between country-level religiosity and vaccination rates (H2). To test H2, we compare predominantly Roman Catholic countries, where the clear and public endorsement of COVID-19 vaccines by Pope Francis (Corpuz, 2021; Gopez, 2021) should have a significant effect, with countries with a different majority religious group. First, we compare majority Roman Catholic countries with majority Orthodox countries as a benchmark of unclear endorsement because some published academic studies suggest that anti-vaccine movements could be stronger within Orthodox communities (Mărcău et al., 2022) and very few Orthodox Churches' religious leaders have endorsed COVID-19 vaccines (Dascalu et al., 2021). Second, we compare majority Roman Catholic countries with majority Protestant countries as a neutral benchmark because we did not find published studies indicating positive or negative attitudes towards COVID-19 vaccines or endorsements of Protestant religious leaders.

We estimated the following equation:

$$
\text{Vaccinated (1st dose)}_{c,t} = \alpha + \beta_1 \text{Religiosity Index}_c + \beta_2 \text{Major Religious Group}_c + \\
\beta_3 \text{Religiosity Index}_c \times \text{Type of Religion}_c + \beta_i \text{Control}_{c,t} + \mu_t + \varepsilon_{c,t} \tag{2}
$$

Where $\text{Religiosity Index}$ is our country-level index of religiosity. $\text{Major Religious Group}_c$ takes the value of one if the country’s predominant religion is either Roman Catholic ($\text{Catholic}$), a branch of the Orthodox Churches ($\text{Orthodox}$), or Protestant ($\text{Protestant}$). The coefficient of the interaction between these dummies and country-level religiosity ($\text{Religiosity Index}_c \times \text{Type of Religion}_c$) aims to explore the moderating effect of majority
religious groups with leaders endorsing COVID-19 on the relationship between religiosity and vaccination rates.

4. Empirical Analysis

4.1. Descriptive statistics

Table 1 presents the summary statistics. The mean (median) weekly vaccination rate is 1.19% (0.7%). In terms of religiosity indicators, Religiosity Index, Member of Religion, Importance of Religion, Religious Services, Belief in God, and Importance of God average 0.000, 0.581, 0.466, 0.254, 0.634, and 0.193, respectively. The predominant religion dummies show that, approximately 50% of countries included in the sample are predominantly Roman Catholic (Catholic), 13.3% of countries are predominantly Orthodox (Orthodox), and 23% of countries are mainly Protestant (Protestant).

Considering other country-level characteristics, the mean rate of Contagion is 8.6%, and on average, people reach 62 years of age before incurring into any activity-limiting health problem (Healthy population). The average Unemployment rate equals 5.6%, while the mean Income is 608,237,686 EUR million. Regarding sociodemographic controls, mean Education is 52.7%, average Male equals 48.8%, and the foreign population belonging to the EU27 countries averages to 2.9% (Foreign).

[Table 1 here]

Panel A (Panel B) of Figure 1 shows the geographical distribution of vaccination rates (religiosity) across the 22 European countries included in the sample, based on the average value of Vaccinated (1st dose) (Religiosity Index) by country from December 2020 to December 2021. The figure presents four categories obtained using a quantile methodology, with darker blue (red) representing higher (lower) average levels of vaccination rates (Panel A) and religiosity (Panel B). The highest vaccination rates are observed in Italy, Germany, Spain, and Portugal. The lowest
vaccination rates are observed in Romania, Bulgaria, Poland, and Croatia. Regarding the Religiosity index, the highest values are observed in Romania, Poland, Cyprus, and Italy, while the smallest values are for Sweden, Norway, Netherlands, and France.

[Figure 1 here]

Table 2 displays the correlation matrix. As expected, the vaccination rate is negatively correlated with our proxies of religiosity. Overall, the correlation among our variables of interest is low (<50%).

[Table 2 here]

4.2. Baseline results: Religiosity and COVID-19 vaccine

Table 3 tabulates the main results for Equation 1. In Column 1, we show the results for Religiosity Index, and in Columns 2-6 for each of the components of Religiosity Index (Member of Religion, Importance of Religion, Religious Services, Belief in God, Importance of God).

The coefficient of Religiosity Index is negative and statistically significant at the 5% level ($\beta=-0.0321$, t-statistic=-2.8290), which suggests that in countries where religiosity is higher, the vaccination rate is lower. In Column 2, we find that being a member of a religion is negatively associated with vaccination rates ($\beta=-0.0033$, t-statistic=-2.1194). Similarly, for the other religiosity measures (Importance of Religion, Religious Services, Belief in God, Importance of God), we find a consistently negative relationship between religiosity and vaccination rates. These results confirm that religiosity and its related risk aversion can be negatively associated with individuals’ acceptance of innovative technology (product); in fact, the results show that religiosity is generally associated with a lower willingness to take COVID-19 vaccines.\(^6\)

---

\(^6\) We rerun our analysis using an alternative version of our religiosity measures for robustness. We construct six different dummies (High Religiosity Index, High Member of Religion, High Importance of Religion, High Religious Services, High Belief in God, High Importance of God).
4.3. The moderation of majority religious groups with religious leaders that have publicly endorsed COVID-19 vaccines

Our next step is to assess whether different attitudes towards COVID-19 vaccines among religious leaders have affected vaccination rates. Empirically, we construct three dummies indicating each country’s predominant religion (Roman Catholicism, a branch of the Orthodox Churches, or Protestantism). Then, we interact these dummies with Religiosity Index. We expect that the observed impact of each religious leader’s endorsement of vaccines will be especially strong in countries where most of the population belongs to the religious group of reference. If the interaction coefficient ($\beta_3$ in Equation 2) is positive (negative), then we can conclude that the public stance of different religious leaders positively (negatively) mediates the relationship between religiosity and the level of vaccination against COVID-19. The results are reported in Table 4.

Notably, from Column 1, the interaction term Religiosity Index*Catholic is positive and statistically significant at the 5% level ($\beta=0.07856$, t-statistic=2.4407), suggesting that, for higher levels of religiosity, countries where the predominant religion is Roman Catholic have a higher vaccination rate than other countries. Indeed, when we consider the interaction term Religiosity Index*Orthodox in Column 2, we find a negative and statistically significant effect on vaccination rates ($\beta=-0.0729$, t-statistic=-2.5495). Finally, in Column 3, we find that the interaction term Religiosity Index*Protestant is negative and significant at the 5% level ($\beta=-0.1504$, t-statistic=-2.1539). Evidence from Columns 2 and 3 points towards a reinforcing role of Orthodox and Protestant on the already negative relationship between religiosity and vaccination rates.

---

*Services, High Belief in God, High Importance of God* that are equal to one of the values of the correspondent measure of religiosity is higher than the median of the countries considered in the analysis. Our inferences remain unaltered. These results are available upon request.
Overall, we find support for an active role of religious leaders in endorsing vaccines. Our findings are in line with that suggested by Corpuz (2021) and Gopez (2021) as we find a positive moderating effect of religiosity on vaccination in countries where the predominant religious group is Catholic. Unlike other religious leaders, Pope Francis has been a very vocal supporter of vaccination against COVID-19 (Corpuz, 2021; Gopez, 2021). Conversely, for higher levels of religiosity, countries where majority religious communities are guided by leaders who have not clearly endorsed COVID-19 vaccines exhibit even lower vaccination rates than what the baseline coefficient would suggest.

4.3. Robustness

In this section, we report two additional robustness tests. First, we re-estimated all our models using an alternative measure of religiosity. More specifically, we use data from the 2008 European Values Survey to construct our religiosity variables. Cultural attributes are generally characterised by temporal and spatial stickiness. However, using an older wave can ensure that our results are not affected by measurement error potentially correlated with a single wave. The results are reported in Panel A of Table 5 and are in line with those previously shown in Tables 2 (Models 1 to 6 of Table 5, Panel A) and Table 3 (Models 7 to 9 of Table 5, Panel A). Second, to account for possible autocorrelation within standard errors at the country and week level, we cluster standard errors at the country times week level. All results align with our baseline ones and are reported in Panel B of Table 5.

5. Discussion and contributions

Our study aims to contribute to the literature on technology (product) acceptance and religiosity’s socioeconomic impact. The ongoing debate about technology (product) acceptance has increasingly highlighted the critical role of risk perception and attitudes by potential adopters
However, scant research has addressed the potential role of religiosity, as related to risk aversion, in influencing individuals’ adoption of innovative technologies or new products. This issue is even more critical in a context in which a collective effort to adopt an innovation is instrumental for the common good, such as the serious concerns for public health during the COVID-19 pandemic.

As with other innovative technologies or products, those related to health can generate concerns about the risks involved in adoption (Ortega Egea & Román González, 2011). Especially in the early phases of the vaccination campaign, concerns about the safety of COVID-19 vaccines spread among the general population (Latkin et al., 2021). Consequently, the COVID-19 vaccination campaign provides an ideal context in which to test the relationship between religiosity and acceptance of innovative technology (product).

While religion can be seen as a source of doctrinal or scriptural motivations that could push towards vaccine hesitancy, a more in-depth study on this issue demonstrates that the majority of religions support the values of preserving life and caring for others (Grabenstein, 2013). Even in the presence of objectionable components or production processes, there should be more arguments favourable to acceptance (Grabenstein, 2013). However, if the innovation to be adopted is perceived by individuals as riskier than average, then the role of risk preferences and all factors affecting them should not be underestimated. Given the acknowledged empirical link between religious attitudes and risk aversion (Hilary and Hui, 2009), we argue that religiosity could be one of the factors potentially negatively affecting vaccination rates.

Our results seem to confirm this assertion. We find an overall negative and significant association between country-level religiosity and vaccination rates in the European Union after controlling for socioeconomic factors potentially related to vaccine acceptance.

We also aim to contribute to the literature on religiosity’s socioeconomic consequences by analysing the impact of religious leaders in endorsing innovative technologies or new products
among their communities. Previous research has shown that religious leaders can influence followers’ opinions and behaviours. However, most studies are qualitative and mainly investigate followers’ attitude changes on political or ethical topics. Conversely, our study conceptualises and empirically tests the effect of religious leaders’ endorsement on an effective behaviour that can be quantitatively measured and perceived as potentially risky, e.g., vaccination. Our results confirm that in countries where the majority religious group has a leader who has publicly and consistently supported vaccination against COVID-19, religiosity is positively related to vaccination rates. Conversely, in countries where the leaders of major religious communities have a neutral or an unclear position towards vaccination, religiosity remains negatively related to the vaccination rate at the country level.

Our study may have some policy implications. First, it highlights that religiosity affects the level of adoption of innovative technologies or products at the country level, plausibly through a risk aversion channel. Therefore, when a technological innovation or new product must be diffused at the country level, religiosity should be taken into consideration, and efforts should be focused on avoiding an incorrect perception of the risks associated with adoption. Such efforts should be especially targeted towards the spread of misinformation, which has a crucial role in individual perception of the risk involved in decision-making. Second, our study highlights the role of religious leaders’ endorsement in supporting this process. An early and public showing of strong support for the innovative technology or product by a religious leader, such as Pope Francis’s framing of vaccination as an “act of love,” seems to reverse the relationship between religiosity and the level of acceptance and diffusion of vaccines at the country level.

6. Limitations and future research direction

Even if we try to control for possible confounding effects in our econometric models, individual willingness to be vaccinated and the consequent diffusion of COVID-19 vaccines is a
complex phenomenon, and other unobserved factors could have influenced our results. Religiosity proxies are time-invariant, and this prevents us from including country fixed effects. Nevertheless, the inclusion of socioeconomic controls and weekly fixed effects should reduce the risk of confounding effects. Moreover, available data allow empirical testing of the relationship between religiosity and acceptance of vaccines at the national or subnational level. Future research could confirm this relationship at the individual level, even if such an approach could generate other methodological and privacy concerns, especially about how to measure actual vaccine-related behaviour.

In addition, we choose the peculiar empirical setting of COVID-19 vaccines. We argue that this is a suitable choice, as such vaccines can be framed as new products that involve innovative production technologies. Moreover, their perceived riskiness is a major factor impacting country-level vaccination campaigns. Nonetheless, future studies can investigate the relationships between religiosity and the acceptance of other technologies and/or products not necessarily related to health issues (e.g., digital innovations). However, in different contexts, it could be unlikely to observe public endorsement or disapproval by religious leaders. Therefore, despite the possible limitations of our study, we argue that it can provide a relevant contribution.
Table 1 – Summary statistics (countries included are Austria, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden). Vaccinated (1st dose) is the weekly amount of first doses of all types of vaccine injected, standardized by the country’s population. The measures of religiosity are proxied by the (1) Religiosity Index, (2) Member of Religion, (3) Importance of Religion, (4) Religious Services, (5) Belief in God, and (6) Importance of God. Catholic, Orthodox, and Protestant are dummy variables equal to one if the predominant religion of the country is Roman Catholicism, a branch of the Orthodox church, or Protestantism, respectively, as reported on the CIA Factbook. Contagion is the weekly contagion rate. Healthy population is the number of expected years without activity limitation. Unemployment rate is the fraction of people unemployed over the labour force. Income is the national net income in EUR millions. Education is the fraction of the population with a bachelor’s degree or higher in 2019. Male is the fraction of males over the population in 2019. Foreign (EU27) is the fraction of foreign population belonging to the EU27 countries over the country population.

|                                | Mean   | Median | SD    | p25   | p75   |
|--------------------------------|--------|--------|-------|-------|-------|
| Vaccinated (1st dose)          | 0.0119 | 0.0070 | 0.0121| 0.0028| 0.0178|
| Religiosity Index              | 0.0006 | -0.0047| 0.0212| -0.0176| 0.0176|
| Member of Religion             | 0.5812 | 0.5990 | 0.3525| 0.4322| 0.7360|
| Importance of Religion         | 0.4658 | 0.3995 | 0.173 | 0.3445| 0.5958|
| Religious Services             | 0.2536 | 0.1914 | 0.1493| 0.1187| 0.3506|
| Belief in God                  | 0.6340 | 0.6499 | 0.1759| 0.4914| 0.7606|
| Importance of God              | 0.1934 | 0.1852 | 0.1292| 0.1020| 0.2127|
| Catholic                       | 0.4996 | 0.0000 | 0.5002| 0.0000| 1.0000|
| Orthodox                       | 0.1329 | 0.0000 | 0.3397| 0.0000| 0.0000|
| Protestant                     | 0.2303 | 0.0000 | 0.4212| 0.0000| 0.0000|
| Contagion                      | 0.0855 | 0.0807 | 0.0440| 0.0543| 0.1081|
| Healthy population (age)       | 67.1506| 61.0000| 4.8767| 57.5000| 66.3000|
| Unemployment rate              | 0.0564 | 0.0500 | 0.0263| 0.0370| 0.0670|
| Income (EUR millions)          | 608237.6859| 241065.0000| 892261.4848| 60246.0000| 511239.0000|
| Education                      | 0.5274 | 0.5076 | 0.1665| 0.3918| 0.6250|
| Male                           | 0.4881 | 0.4884 | 0.0098| 0.4839| 0.4935|
| Foreign (EU27)                 | 0.0292 | 0.0218 | 0.0312| 0.0076| 0.0387|
Table 2 – Correlations between vaccinated population and various measures of religiosity. This table reports the pairwise correlations between the following variables at the country level: Vaccinated (1st dose), Religiosity Index, Member of Religion, Importance of Religion, Religious Services, Belief in God, Importance of God, Catholic, Orthodox, Protestant, Education, Male, Healthy population (age), Contagion, Foreign (EU27), Unemployment rate and Income.

|                               | Vaccinated (1st dose) | Religiosity Index | Member of Religion | Importance of Religion | Religious Services | Belief in God | Importance of God |
|-------------------------------|-----------------------|-------------------|-------------------|------------------------|-------------------|---------------|-------------------|
| Vaccinated (1st dose)         | 1.000                 |                   |                   |                        |                   |               |                   |
| Religiosity Index             | -0.059                | 1.000             |                   |                        |                   |               |                   |
| Member of Religion            | -0.056                | 0.900             | 1.000             |                        |                   |               |                   |
| Importance of Religion        | -0.061                | 0.967             | 0.792             | 1.000                  |                   |               |                   |
| Religious Services            | -0.042                | 0.943             | 0.830             | 0.207                  | 1.000             |               |                   |
| Belief in God                 | -0.043                | 0.969             | 0.903             | 0.283                  | 0.872             | 1.000         |                   |
| Importance of God             | -0.074                | 0.897             | 0.683             | 0.391                  | 0.801             | 0.821         | 1.000             |
| Catholic                      | 0.018                 | 0.402             | 0.513             | 0.329                  | 0.447             | 0.440         | 0.149             |
| Orthodox                      | -0.103                | 0.454             | 0.248             | 0.545                  | 0.294             | 0.455         | 0.575             |
| Protestant                    | 0.064                 | -0.459            | -0.408            | -0.452                 | -0.469            | -0.418        | -0.398            |
| Education                     | -0.005                | 0.248             | 0.062             | 0.298                  | 0.218             | 0.180         | 0.257             |
| Male                          | 0.021                 | -0.768            | -0.428            | -0.332                 | -0.278            | -0.410        | -0.272            |
| Healthy population            | 0.037                 | -0.211            | -0.400            | -0.058                 | -0.139            | -0.223        | -0.179            |
| Contagion                     | -0.102                | -0.035            | -0.004            | -0.065                 | 0.055             | -0.101        | -0.041            |
| Foreign (EU27)                | 0.089                 | -0.082            | -0.242            | -0.034                 | -0.024            | -0.008        | -0.084            |
| Unemployment rate             | 0.081                 | 0.099             | 0.075             | 0.126                  | 0.103             | 0.214         | 0.071             |
| Income                        | 0.081                 | -0.180            | -0.218            | -0.146                 | -0.110            | -0.159        | -0.210            |
Table 2 (Continued) – Correlations between vaccinated population and various measures of religiosity. This table reports the pairwise correlations between the following variables at the country level: Vaccinated (1st dose), Religiosity Index, Member of Religion, Importance of Religion, Religious Services, Belief in God, Importance of God, Catholic, Orthodox, Protestant, Education, Male %, Healthy population (age), Contagion, Foreign (EU27), Unemployment rate and Income.

|               | Catholic | Orthodox | Protestant | Education | Male % | Healthy population | Contagion | Foreign (EU27) | Unempl. rate | Income |
|---------------|----------|----------|------------|-----------|--------|---------------------|-----------|----------------|--------------|--------|
| Catholic      | 1.000    |          |            |           |        |                     |           |                |              |        |
| Orthodox      | -0.391   | 1.000    |            |           |        |                     |           |                |              |        |
| Protestant    | -0.547   | -0.214   | 1.000      |           |        |                     |           |                |              |        |
| Education     | 0.223    | 0.195    | -0.287     | 1.000     |        |                     |           |                |              |        |
| Male %        | -0.435   | -0.020   | 0.566      | -0.101    | 1.000  |                     |           |                |              |        |
| Healthy population | -0.166 | 0.074    | 0.308      | -0.045    | 0.447  | 1.000               |           |                |              |        |
| Contagion     | 0.213    | -0.087   | -0.438     | 0.219     | -0.152 | -0.155              | 1.000     |                |              |        |
| Foreign (EU27)| -0.286   | 0.224    | 0.219      | 0.289     | 0.363  | 0.218               | -0.096    | 1.000           |              |        |
| Unemployment rate | 0.401 | -0.077   | -0.120     | -0.106    | -0.108 | 0.294               | -0.013    | 0.125           | 1.000       |        |
| Income        | 0.030    | -0.224   | 0.239      | 0.172     | 0.144  | 0.433               | -0.199    | 0.143           | 0.215       | 1.000  |
Table 3 - Relation between religiosity and vaccination. Table 3 reports estimates from a panel regression model where the impact of religiosity on vaccination rate is analysed. All models include time fixed effect. The estimation period is Dec. 2020-Dec 2021. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

|                        | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model | (6) Model |
|------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Religiosity Index      | -0.0321** |           |           |           |           |           |
|                        | (-2.8290) |           |           |           |           |           |
| Member of Religion     | -0.0033** |           |           | -0.0041***| -0.0040** |           |
|                        | (-2.1194) |           |           | (-2.8575) | (-2.7222) |           |
| Importance of Religion |           |           |           |           |           | -0.0043** |
|                        |           |           |           |           |           | (-2.6459) |
| Religious Services     |           |           |           |           |           |           |
| Belief in God          |           |           |           |           |           |           |
| Importance of God      |           |           |           |           |           |           |
| Contagion              | 0.0065    | 0.0084    | 0.0047    | 0.0106    | 0.0042    | 0.0060    |
|                        | (0.7660)  | (0.9728)  | (0.5991)  | (1.2165)  | (0.5114)  | (0.6484)  |
| Healthy population     | -0.0083   | -0.0063   | -0.0063   | -0.0083   | -0.0088   | -0.0075   |
|                        | (-1.2810) | (-1.5621) | (-0.9924) | (-1.2221) | (-1.4492) | (-1.0417) |
| Unemployment rate      | 0.0254**  | 0.0249*   | 0.0244*   | 0.0291**  | 0.0210*   |           |
|                        | (2.1180)  | (1.9651)  | (1.9779)  | (2.4859)  |           |           |
| Income                 | 0.0010*** | 0.0010*** | 0.0009*** | 0.0010*** | 0.0009*** | 0.0009*** |
|                        | (3.0996)  | (3.3868)  | (3.0894)  | (3.3077)  | (3.2172)  | (2.7282)  |
| Education              | -0.0029   | -0.0023   | -0.0023   | -0.0033** | -0.0031*  | -0.0026   |
|                        | (-1.8895) | (-2.3251) | (-1.5502) | (-2.0974) | (-2.0747) | (-1.6228) |
| Male                   | -0.0620   | -0.0545   | -0.0660*  | -0.0575   | -0.0685   | -0.0556   |
|                        | (-1.5706) | (-1.2969) | (-1.7618) | (-1.4529) | (-1.6823) | (-1.4309) |
| Foreign (EU27)         | 0.0438*** | 0.0426*** | 0.0433*** | 0.0457*** | 0.0461*** | 0.0428*** |
|                        | (4.3484)  | (4.2298)  | (4.5105)  | (4.3166)  | (4.7429)  | (3.8620)  |
| Constant               | 0.0629**  | 0.0675**  | 0.0590**  | 0.0604**  | 0.0712**  | 0.0581**  |
|                        | (2.3612)  | (2.4704)  | (2.2165)  | (2.2147)  | (2.6876)  | (2.0962)  |
| Observations           | 1.179     | 1.179     | 1.179     | 1.179     | 1.179     | 1.179     |
| R-squared              | 0.648     | 0.647     | 0.648     | 0.647     | 0.648     | 0.648     |
| Time FE                | YES       | YES       | YES       | YES       | YES       | YES       |
Table 4 - Relation between types of religions and vaccination. Table 4 reports estimates from a panel regression model where the impact of types of religions on vaccination rate is analysed. We analyse three different religious groups: (1) Catholic (2) Orthodox and (3) Protestant. All models include time fixed effect. The estimation period is Dec. 2020-Dec 2021. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

|                      | Model (1)            | Model (2)            | Model (3)            |
|----------------------|----------------------|----------------------|----------------------|
| Religiosity Index    | -0.0725***           | -0.0113              | -0.0104              |
|                      | (-3.8685)            | (-0.8306)            | (-0.5801)            |
| Catholic             | 0.0010               |                      |                      |
|                      | (1.4319)             |                      |                      |
| Religiosity Index*Catholic | 0.0856**           |                      |                      |
|                      | (2.4407)             |                      |                      |
| Orthodox             |                      | 0.0006               |                      |
|                      |                      | (1.0999)             |                      |
| Religiosity Index*Orthodox | -0.0729**          |                      |                      |
|                      | (-2.5495)            |                      |                      |
| Protestant           |                      | -0.0004              |                      |
|                      |                      | (-0.7137)            |                      |
| Religiosity Index*Protestant | -0.1504**          |                      |                      |
|                      | (-2.1539)            |                      |                      |
| Contagion            | 0.0029               | 0.0016               | 0.0172               |
|                      | (-4.4680)            | (0.1878)             | (1.4603)             |
| Healthy population   | -0.0001              | -0.0001              | -0.0002              |
|                      | (-1.1455)            | (-0.8265)            | (-1.5275)            |
| Unemployment rate    | 0.0294**             | 0.0282**             | 0.0331***            |
|                      | (2.6210)             | (2.2648)             | (2.9463)             |
| Income               | 0.0000***            | 0.0000*              | 0.0000**             |
|                      | (3.3337)             | (2.7478)             | (3.9982)             |
| Education            | -0.0032*             | -0.0034*             | -0.0041**            |
|                      | (-1.9197)            | (-1.9975)            | (-2.5483)            |
| Male                 | -0.0173              | -0.0174              | -0.0611              |
|                      | (-0.4342)            | (-0.4269)            | (-1.2734)            |
| Foreign (EU27)       | 0.0475***            | 0.0439***            | 0.0380***            |
|                      | (4.4296)             | (4.6750)             | (4.3274)             |
| Constant             | 0.0240               | 0.0246               | 0.0482*              |
|                      | (1.3789)             | (1.4205)             | (2.0772)             |
| Observations         | 1,179                | 1,179                | 1,179                |
Table 5 – Robustness tests. Panel A reports the results using alternative measures of religiosity. Panel B reports the results with standard errors clustered at the country times week level. All models include time fixed effects. The estimation period is Dec. 2020-Dec2021. *, **, and *** indicate significance at the 10% level, 5%, and 1% level, respectively.

| Panel A                  | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model | (6) Model | (7) Model | (8) Model | (9) Model |
|--------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Religiosity Index (2008) | -0.0003*** |          |           |           |           |           |           |           |           |
|                          | (-3.2773) |           |           |           |           |           |           |           |           |
| Member of Religion (2008)| -0.0025**  |          |           |           |           |           |           |           |           |
|                          | (-2.6227)  |           |           |           |           |           |           |           |           |
| Importance of Religion (2008)| -0.0033*** |          |           |           |           |           |           |           |
|                          | (-3.2220)  |           |           |           |           |           |           |           |           |
| Religious Services (2008)|           | -0.0026***|           |           |           |           |           |           |
|                          |           | (-2.8723) |           |           |           |           |           |           |           |
| Belief in God (2008)     |           |           | -0.0042***|           |           |           |           |           |
|                          |           |           | (-3.4821) |           |           |           |           |           |           |
| Importance of God (2008) |           |           |           | -0.0059***|           |           |           |           |
|                          |           |           |           | (-3.1934) |           |           |           |           |           |
| Religiosity Index (2008)*Catholic |          |           |           |           |           |           | 0.0725**  |           |
|                          |           |           |           |           |           |           | (2.4931)  |           |
| Catholic                 |           |           |           |           |           |           |           | 0.0068    |
|                          |           |           |           |           |           |           | (0.4910)  |           |
| Religiosity Index (2008)*Orthodox |          |           |           |           |           |           | -0.0504*  |           |
|                          |           |           |           |           |           |           | (-1.7986) |           |
| Orthodox                 |           |           |           |           |           |           | -0.0743***|           |
|                          |           |           |           |           |           |           | (-2.6822) |           |
| Religiosity Index (2008)*Protestant |          |           |           |           |           |           |           | -0.1641***|
|                          |           |           |           |           |           |           | (-3.7850) |           |
| Protestant               |           |           |           |           |           |           |           | -0.1690***|
|                          |           |           |           |           |           |           | (-3.7489) |           |
| Controls                 | YES       | YES       | YES       | YES       | YES       | YES       | YES       | YES       | YES       |
| Observations             | 1,179     | 1,179     | 1,179     | 1,179     | 1,179     | 1,179     | 1,179     | 1,179     | 1,179     |
| R-squared                | 0.648     | 0.646     | 0.648     | 0.647     | 0.648     | 0.649     | 0.645     | 0.649     | 0.651     |
| Time FE                  | YES       | YES       | YES       | YES       | YES       | YES       | YES       | YES       | YES       |
| Panel B | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model | (6) Model | (7) Model | (8) Model | (9) Model |
|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Religiosity Index | -0.0321*** | -0.0617*** | -0.0167* | -0.0123 | (-2.9900) | (-3.1117) | (-1.9289) | (-1.4023) |
| Member of Religion | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Importance of Religion | -0.0041*** | -0.0040*** | -0.00050** | 0.0734** | (-2.5894) | (-3.0694) | (-2.2836) | (-2.2836) |
| Religious Services | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Belief in God | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Importance of God | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Religiosity Index*Catholic | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Catholic | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Religiosity Index*Orthodox | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Orthodox | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Religiosity Index*Protestant | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Protestant | -0.0033** | -0.0041*** | -0.0040*** | -0.0050** | (-2.5754) | (-3.0694) | (-3.0937) | (-2.2836) |
| Controls | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Observations | 1,179 | 1,179 | 1,179 | 1,179 | 1,179 | 1,179 | 1,179 | 1,179 | 1,179 |
| R-squared | 0.648 | 0.647 | 0.648 | 0.647 | 0.648 | 0.648 | 0.648 | 0.650 | 0.649 |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES | YES |
| Standard Errors | Country*Week | Country*Week | Country*Week | Country*Week | Country*Week | Country*Week | Country*Week | Country*Week | Country*Week |
Figure 1 - Figure 1 presents the geographical distribution of the vaccination rate (Panel A) and religiosity (Panel B) across the 22 EU countries analysed. The distribution is based on the mean value for the period Dec. 2020 - Dec. 2021. The figure presents four categories obtained based on quantile methodology, with darker blue colours representing higher vaccination rates (Panel A) and religiosity (Panel B).
References

Anshel, M. H., & Smith, M. (2014). The Role of Religious Leaders in Promoting Healthy Habits in Religious Institutions. *Journal of Religion and Health, 53*(4), 1046–1059. https://doi.org/10.1007/s10943-013-9702-5

Barnes, J., & Ayars, W. B. (1977). Reducing new product risk through understanding buyer behavior. *Industrial Marketing Management, 6*(3), 189–192. https://doi.org/10.1016/0019-8501(77)90017-7

Barro, R. J., & McCleary, R. M. (2003). Religion and Economic Growth across Countries. *American Sociological Review, 68*(5), 760. https://doi.org/10.2307/1519751

Bénabou, R., Ticchi, D., & Vindigni, A. (2015a). Religion and Innovation. *American Economic Review, 105*(5), 346–351. https://doi.org/10.1257/aer.p20151032

Bénabou, R., Ticchi, D., & Vindigni, A. (2015b). *Forbidden Fruits: The Political Economy of Science, Religion, and Growth* (N. w21105; pag. w21105). National Bureau of Economic Research. https://doi.org/10.3386/w21105

Cavaleri, M., Enzmann, H., Straus, S., & Cooke, E. (2021). The European Medicines Agency’s EU conditional marketing authorisations for COVID-19 vaccines. *The Lancet, 397*(10272), 355–357. https://doi.org/10.1016/S0140-6736(21)00085-4

Chang, J. (2021). Adenovirus Vectors: Excellent Tools for Vaccine Development. *Immune Network, 21*(1), e6. https://doi.org/10.4110/in.2021.21.e6

Chatterjee, R. A., & Eliashberg, J. (1990). The Innovation Diffusion Process in a Heterogeneous Population: A Micromodeling Approach. *Management Science, 36*(9), 1057–1079. https://doi.org/10.1287/mnsc.36.9.1057

Chen, H., Huang, H. H., Lobo, G. J., & Wang, C. (2016). Religiosity and the cost of debt. *Journal of Banking & Finance, 70*, 70–85. https://doi.org/10.1016/j.jbankfin.2016.06.005

Chen, K. K. (2015). Using Extreme Cases to Understand Organizations. In *Handbook of Qualitative Organizational Research* (0 ed., pagg. 65–76). Routledge. https://doi.org/10.4324/9781315849072-13
Cloos, J., & Mohr, S. (2022). Acceptance of data sharing in smartphone apps from key industries of the digital transformation: A representative population survey for Germany. *Technological Forecasting and Social Change, 176*, 121459. https://doi.org/10.1016/j.techfore.2021.121459

Cohen-Dar, M., & Obeid, S. (2017). Islamic Religious Leaders in Israel as Social Agents for Change on Health-Related Issues. *Journal of Religion and Health, 56*(6), 2285–2296. https://doi.org/10.1007/s10943-017-0409-x

Corpuz, J. C. G. (2021). Multisectoral Approach on COVID-19 vaccination: A proposed solution on vaccine hesitancy. *Journal of Public Health, 43*(2), 370–371. https://doi.org/10.1093/pubmed/fdb085

Cowart, K. O., Fox, G. L., & Wilson, A. E. (2008). A structural look at consumer innovativeness and self-congruence in new product purchases. *Psychology and Marketing, 25*(12), 1111–1130. https://doi.org/10.1002/mar.20256

Dascalu, S., Geambasu, O., Valentin Raiu, C., Azoicai, D., Damian Popovici, E., & Apetrei, C. (2021). COVID-19 in Romania: What Went Wrong? *Treaties in Public Health, 9*, 813941. https://doi.org/10.3389/fpubh.2021.813941

Debecker, A., & Modis, T. (2021). Poorly known aspects of flattening the curve of COVID-19. *Technological Forecasting and Social Change, 163*, 120432. https://doi.org/10.1016/j.techfore.2020.120432

Diaz, J. D. (2000). Religion and gambling in sin-city: A statistical analysis of the relationship between religion and gambling patterns in Las Vegas residents. *The Social Science Journal, 37*(3), 453–458. https://doi.org/10.1016/S0362-3319(00)00083-5

Featherman, M. (2001). Extending the Technology Acceptance Model by Inclusion of Perceived Risk. *AMCIS 2001 Proceedings*, 4.

Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry, 12*(2), 219–245. https://doi.org/10.1177/1077800405284363

Galang, J. R. F. (2021). Science and religion for COVID-19 vaccine promotion. *Journal of Public Health, 43*(3), e513–e514. https://doi.org/10.1093/pubmed/fdb128

Gopez, J. M. W. (2021). Building public trust in COVID-19 vaccines through the Catholic Church in the Philippines. *Journal of Public Health, 43*(2), 330–331. https://doi.org/10.1093/pubmed/fdb036
Grabenstein, J. D. (2013). What the World’s religions teach, applied to vaccines and immune globulins. *Vaccine, 31*(16), 2011–2023. https://doi.org/10.1016/j.vaccine.2013.02.026

Heiman, A., & Muller, E. (1996). Using Demonstration to Increase New Product Acceptance: Controlling Demonstration Time. *Journal of Marketing Research, 9.*

Hilary, G., & Hui, K. W. (2009). Does religion matter in corporate decision making in America? *Journal of Financial Economics, 93*(3), 455–473. https://doi.org/10.1016/j.jfineco.2008.10.001

Iannaccone, L. R. (1998). Introduction to the Economics of Religion. *Journal of Economic Literature, 36*(3), 1465–1495.

Knoll, M. D., & Wonodi, C. (2021). Oxford–AstraZeneca COVID-19 vaccine efficacy. *The Lancet, 397*(10269), 72–74. https://doi.org/10.1016/S0140-6736(20)32623-4

Kowalczyk, A., Doener, F., Zanzinger, K., Noth, J., Baumhof, T., Petin-Mleczek, M., & Heidenreich, R. (2016). Self-adjuvanted mRNA vaccines induce local innate immune responses that lead to a potent and boostable adaptive immunity. *Vaccine, 34*(33), 3882–3893. https://doi.org/10.1016/j.vaccine.2016.05.046

Latkin, C. A., Dayton, L., Yi, G., Konstantopoulos, A., & Boodram, B. (2021). Trust in a COVID-19 vaccine in the U.S.: A social-ecological perspective. *Social Science & Medicine, 270*, 113684. https://doi.org/10.1016/j.socscimed.2021.113684

Lerner, J. S., & Keltner, D. (2001). Fear, anger, and risk. *Journal of Personality and Social Psychology, 81*(1), 146–159. https://doi.org/10.1037/0022-3514.81.1.146

Li, M., & Qiu, Y. X. (2013). A review on current downstream bio-processing technology of vaccine products. *Vaccine, 31*(9), 1264–1267. https://doi.org/10.1016/j.vaccine.2012.12.056

Lilien, G. L. (1980). The Implications of Diffusion Models for Accelerating the Diffusion of Innovation. *Technological Forecasting and Social Change, 17*, 339–351.

Majhen, D., Calderon, H., Chandra, N., Fajardo, C. A., Rajan, A., Alemany, R., & Custers, J. (2014). Adenovirus-Based Vaccines for Fighting Infectious Diseases and Cancer: Progress in the Field. *Human Gene Therapy, 25*(4), 301–317. https://doi.org/10.1089/hum.2013.235

Mărcău, F.-C., Purec, S., & Niculescu, G. (2022). Study on the Refusal of Vaccination against COVID-19 in Romania. *Vaccines, 10*(2), 261. https://doi.org/10.3390/vaccines10020261
Mascola, J. R., & Fauci, A. S. (2020). Novel vaccine technologies for the 21st century. *Nature Reviews Immunology, 20*(2), 87–88. https://doi.org/10.1038/s41577-019-0243-3

McKelvey, B., & Andriani, P. (2005). Why Gaussian statistics are mostly wrong for strategic organization. *Strategic Organization, 3*(2), 219–228. https://doi.org/10.1177/1476127005052700

Mckeeown, B., & Carlson, J. M. (1987). An experimental study of the influence of religious elites on public opinion. *Political Communication, 4*(2), 93–102. https://doi.org/10.1080/10584609.1987.9962812

Miller, A. S., & Hoffmann, J. P. (1995). Risk and Religion: An Explanation of Gender Differences in Religiosity. *Journal for the Scientific Study of Religion, 34*(1), 63. https://doi.org/10.2307/1386523

Mogaji, E. (2021). Marketing the COVID-19 vaccine and the implications for public health. *Vaccine, 39*(34), 4766–4768. https://doi.org/10.1016/j.vaccine.2021.07.015

Mulligan, K. (2006). Pope John Paul II and Catholic Opinion Toward the Death Penalty and Abortion*. *Social Science Quarterly, 87*(3), 739–753. https://doi.org/10.1111/j.1540-6237.2006.00407.x

Nagar, S., & Ashaye, T. (2022). A Shot of Faith—Analyzing Vaccine Hesitancy in Certain Religious Communities in the United States. *American Journal of Health Promotion, 089011712110695*. https://doi.org/10.1177/08901171211069547

Nteta, T. M., & Wallsten, K. J. (2012). Preaching to the Choir? Religious Leaders and American Opinion on Immigration Reform: Preaching to the Choir? *Social Science Quarterly, 93*(4), 891–910. https://doi.org/10.1111/j.1540-6237.2012.00865.x

Ortega Egea, J. M., & Román González, M. V. (2011). Explaining physicians’ acceptance of EHCR systems: An extension of TAM with trust and risk factors. *Computers in Human Behavior, 27*(1), 319–332. https://doi.org/10.1016/j.chb.2010.08.010

Osoba, B. (2003). Risk preferences and the practice of religion: Evidence from panel data. *Unpublished Working Paper, West Virginia University.*

Pedersen, M. J., & Favero, N. (2020). Social Distancing during the COVID-19 Pandemic: Who Are the Present and Future Noncompliers? *Public Administration Review, 80*(5), 805–814. https://doi.org/10.1111/puar.13240
Pelegrín-Borondo, J., Arias-Oliva, M., Almahameed, A. A., & Prado Román, M. (2021). Covid-19 vaccines: A model of acceptance behavior in the healthcare sector. *European Research on Management and Business Economics, 27*(3), 100171. https://doi.org/10.1016/j.iedeen.2021.100171

Pinto, L. J. (1964). Pastors and Immigrants: The Role of a Religious Elite in the Absorption of Norwegian Immigrants. *American Journal of Sociology, 70*(2), 235–237.

Ruijs, W. L., Hautvast, J. L., Kerrar, S., van der Velden, K., & Hulscher, M. E. (2013). The role of religious leaders in promoting acceptance of vaccination within a minority group: A qualitative study. *BMC Public Health, 13*(1), 511. https://doi.org/10.1186/1471-2458-13-511

Salali, G. D., & Uysal, M. S. (2021). Effective incentives for increasing COVID-19 vaccine uptake. *Psychological Medicine, 1–3*. https://doi.org/10.1017/S0033291721004013

Slade, E. L., Dwivedi, Y. K., Piercy, N. C., & Williams, M. D. (2015). Modeling Consumers’ Adoption Intentions of Remote Mobile Payments in the United Kingdom: Extending UTAUT with Innovativeness, Risk, and Trust: CONSUMERS’ ADOPTION INTENTIONS OF REMOTE MOBILE PAYMENTS. *Psychology & Marketing, 32*(8), 860–873. https://doi.org/10.1002/mar.20823

Ta, A., & Prybutok, V. (2018). A mindful product acceptance model. *Journal of Decision Systems, 27*(1), 19–36. https://doi.org/10.1080/02684012.2018.1479149

Toni-Uebari, T. K., & Inusa, B. P. (2009). The role of religious leaders and faith organisations in haemoglobinopathies: A review. *BMC Hematology, 9*(1), 6. https://doi.org/10.1186/1471-2326-9-6

Ura, T., Yamashita, A., Mizuki, N., Okuda, K., & Shimada, M. (2021). New vaccine production platforms used in developing SARS-CoV-2 vaccine candidates. *Vaccine, 39*(2), 197–201. https://doi.org/10.1016/j.vaccine.2020.11.054

Wald, K. D. (1992). Religious Elites and Public Opinion: The Impact of the Bishops’ Peace Pastoral. *The Review of Politics, 54*(1), 112–143. https://doi.org/10.1017/S0034670500017204

Weber, E. U., & Milliman, R. A. (1997). Perceived Risk Attitudes: Relating Risk Perception to Risky Choice. *Management Science, 43*(2), 123–144. https://doi.org/10.1287/mnsc.43.2.123
Williams, J. T. B., Fisher, M. P., Bayliss, E. A., Morris, M. A., & O’Leary, S. T. (2020). Clergy attitudes toward vaccines and vaccine advocacy: A qualitative study. *Human Vaccines & Immunotherapeutics, 16*(11), 2800–2808. https://doi.org/10.1080/21645515.2020.1736451

Williams, J. T. B., & O’Leary, S. T. (2019). Denver Religious Leaders’ Vaccine Attitudes, Practices, and Congregational Experiences. *Journal of Religion and Health, 58*(4), 1356–1367. https://doi.org/10.1007/s10943-019-00800-2

Wombwell, E., Fangman, M. T., Yoder, A. K., & Spero, D. L. (2015). Religious Barriers to Measles Vaccination. *Journal of Community Health, 40*(3), 597–604. https://doi.org/10.1007/s10900-014-9956-1

Yang, J., Zheng, Y., Gou, X., Pu, K., Chen, Z., Guo, Q., Ji, R., Wang, F., Wang, Y., & Zhou, Y. (2020). Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: A systematic review and meta-analysis. *International Journal of Infectious Diseases, 94*, 91–95. https://doi.org/10.1016/j.ijid.2020.03.017

Zhang, K. C., Fang, Y., Cao, H., Chen, H., Hu, T., Chen, Y., Zhou, X., & Wang, Z. (2021). Behavioral Intention to Receive a COVID-19 Vaccination Among Chinese Factory Workers: Cross-sectional Online Survey. *Journal of Medical Internet Research, 23*(3), e24673. https://doi.org/10.2196/24673
Highlights

- Religiosity is correlated to product/technology acceptance via a risk-taking channel.
- We empirically analyze this relationship in the extreme case of COVID-19 vaccines.
- A negative relationship between religiosity and vaccination rates is confirmed.
- The religious leaders’ endorsement of vaccines is also conceptualized and tested.
Authors statements

- Ludovico Bullini Orlandi: Conceptualization, Supervision, Writing - original draft, Writing - review & editing
- Valentina Febo: Conceptualization, Data curation, Writing - original draft, Writing - review & editing
- Salvatore Perdichizzi: Methodology, Formal analysis, Writing - original draft, Writing - review & editing
Authors’ Biography

**Ludovico Bullini Orlandi** is an Assistant Professor in Organization and HRM at the University of Bologna and co-director of the Master in HR and Organization at the Bologna Business School. He holds a Ph.D. in Economics and Management from the University of Verona. His research interests revolve around digital transformation’s impact on HR and organizations. He teaches Organization Theory at the University of Bologna. He has held visiting and research collaborations at the University of Lund and the Karlsruhe Institute of Technology. He has also taught at the CUOA Business School, at the Catholic University of Lille, and the University of Verona.

**Salvatore Perdichizzi** is an Assistant Professor of Financial Markets and Institutions at University of Bologna, Italy. He received his PhD degree from the University of Milan - Bicocca. His research interests cover monetary policy and empirical banking, with a focus on the effectiveness of unconventional and conventional monetary policies on economic development, financial markets and banking stability, green and sustainable finance, bank lending conditions. He is Research Associate at the Yunus Social Business Centre of Bologna, and also served as a Research fellow at the University of Exeter Business School (England) and Catholic University of Sacred Heart - Milan.

**Valentina Febo** is a Ph.D. Candidate in Management (Banking and Finance track) at the University of Bologna. Her main areas of research are corporate finance, finance and culture, and corporate risk management. Her research interests revolve around how decision-makers’ cultural, social, and individual characteristics affect investment choices, risk-taking behavior, and corporate hedging.