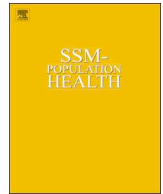




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Article

“Thou Shalt not Smoke”: Religion and smoking in a natural experiment of history

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ABSTRACT

We provide a new identification strategy to analyse the implications of religious affiliation on unhealthy behaviour by focusing on the link between religiousness and smoking. Our quasi-experimental research design exploits the exogenous dramatic fall in religious affiliation that took place in East Germany after the post-war separation. Our conditional difference-in-differences estimates on data from the German Socio-Economic Panel (SOEP) for the period 1998–2006 indicate that individuals who are not affiliated to any religious denomination are consistently 13–19 percentage points more likely to smoke than are religious individuals. We interpret our results on the basis of a restraining effect of religious ethics on unhealthy behaviour, confirming the view that religion is a far-reaching vehicle for the enforcement of social norms.

“You may say, ‘I am allowed to do anything.’ But I reply, ‘Not everything is good for you.’ And even though ‘I am allowed to do anything,’ I must not become a slave to anything”

(Corinthians, 6: 12).

“Or do you not know that your body is a temple of the Holy Spirit within you, which you have from God, and that you are not your own? For you were bought with a price; therefore glorify God in your body”

(Corinthians, 6: 19–20).

1. Introduction

A growing body of the economic literature aims at analyzing the implication of culture on individual behaviour, recognizing that cultural norms may be able to explain differences in redistribution preferences (Luttmer & Singhal, 2011), social capital (Guiso, Sapienza, & Zingales, 2009), household living arrangements (Giuliano, 2007), women's attitudes toward work and fertility (Alesina & Giuliano, 2010; Fernandez & Fogli, 2009), and economic growth (Algan & Cahuc, 2010).

Being a conveyor of social norms and precepts, religion is one of the most pervasive and influential of cultural dimensions. These social norms relate to many aspects of human behaviour, including health (Koenig, King, & Carson, 2012). In some cases, religions have clear and

direct precepts regarding the pursuit of a healthy life, as in the case of Christianity, exemplified by Saint Paul's exhortation to glorify God in one's body (Corinthians: 6: 19–20). In other cases, religious tenets may have an indirect effect on the believers' health, as in the case of the specific Islamic dietary precepts on alcohol consumption. Some practices typical of religious rituals also have beneficial health effects, such as male circumcision, which is associated with a significant reduction in the risk of acquiring HIV (Siegfried, Muller, Deeks, & Volmink, 2009), urinary tract infections, penile cancer (Blank et al., 2012), and human papillomavirus (Larke, Thomas, dos Santos Silva, & Weiss, 2011).

Other findings in the literature show how higher levels of religiousness, either measured by church attendance or self-rating, are negatively associated with myocardial infarction (Medalie et al., 1973), blood pressure (Graham et al., 1978), sexually transmitted diseases (Naguib, Comstock, & Davis, 1966), and tuberculosis (Kuemmerer & Comstock, 1967). Religious attendance is also associated with a lower mortality rate from emphysema and chronic liver cirrhosis (Comstock & Partridge, 1972). Despite the broad consensus on the positive association between religion and health, the identification of a causal relationship is hard to obtain.

Recent contributions have also shown that smoking, a well-known source of health risks including lung cancer and cardiovascular diseases (Doll & Hill, 1956), is negatively associated with religious affiliation (Bowie, Parker, Beadle-Holder, Ezema, & Bruce, 2017; Fletcher &

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Kumar, 2014; Garrusi & Nakhaee, 2012; Gillum, 2005; Hyman, Fenta, & Noh, 2008; Lillard & Price, 2007; Mellor & Freeborn, 2011; Osoba, 2004; Petersen, Thompson, Dadi, Tolcha, & Cataldo, 2018; Sullivan, 2010; Whooley, Boyd, Gardin, & Williams, 2002). However, most of these findings are likely to be biased because of endogeneity. For example, religiousness and smoking may be correlated through unobserved third factors, or affected by reverse causality. The endogeneity may be even more serious when attendance at religious services is considered, given its behavioural nature. Since smoking is an important concern for public health and given the still large diffusion of religiousness in contemporary societies, this research area remains open to investigation.

According to economic theory, smokers prefer to trade an immediate pleasure derived from the act of smoking in exchange for increasing the probability of contracting a disease in the future (Becker & Murphy, 1988; Chaloupka & Warner, 2000). The link between smoking and health is no longer controversial, as according to the National Cancer Institute, smoking causes an “estimated 443,000 deaths [in the US] each year, including approximately 49,000 deaths due to exposure to second-hand smoke” (Agaku, King, & Dube, 2012). The consequences of smoking may also be severe in spheres other than health. The economic literature shows that smokers tend to receive lower monetary compensation than non-smokers do, probably because smoking is time-consuming, leading to lower productivity (Hersch, 1996) and less time spent on making sound on-the-job decisions (Hersch & Viscusi, 1990).

The literature suggests a number of mechanism through which religion may affect smoking behaviour.

First, focusing on Christianity, which is the religious denomination this paper focuses on, its ethical precept of leading a “good” and ethical life and exercising a restraint on unhealthy behaviour provides a set of incentives that may significantly affect the individual trade-off between the costs and benefits of smoking. In addition, God’s judgment and the possibility of an afterlife contingent on lifetime behaviour may affect the individual’s attitude toward death and habits that may affect the length of life (Bartke & Schwarze, 2008). As an example, the Roman Catholic Church took an official position against smoking and its harmful health effects in the Pope’s Bull of Indication of the Great Jubilee of the Year 2000, calling for all Christians to abstain from consuming tobacco.

Second, being a Christian, an individual may join networks that lead a healthier life, therefore suggesting a network/contagion effect (Brown et al., 2014).

Third, spirituality may confer extra strength to abstain from short-term pleasures, since spiritual individuals may find it easier to forego current consumption in exchange for some future spiritual reward (Gonzales et al., 2007).

Fourth, more risk adverse individuals self-select versus individuals may self-select into religiousness and therefore they may be less inclined to smoke. Indeed, religiousness is generally attached to a reduced willingness to take risks (Miller, 2000; Miller & Hoffmann, 1995), and religious individuals appear to be more anxious than atheists (Ahmad, 1973; Rokeach, 1968), an attitude that is usually correlated with less risky behaviour (Gasper & Clore, 1998; Lerner & Keltner, 2000). However, in general, it is not clear whether it is religiousness that affects risk-aversion (and consequently unhealthful behaviour) or vice versa. In addition, both phenomena may be explained by third factors not included in the model. As Iannaccone (1998) suggested, “Good kids [...] avoid drugs, stay in school and go to church”, leading to a spurious correlation between religiousness and risky behaviour, rather than a causal relationship. It follows that religious individuals may be selected according to their characteristics related to risk-aversion, so simple OLS estimates of the effect of religiousness on smoking may be biased.

Typically, individuals choose whether to be atheist or religious according to individual latent characteristics. Most people’s religion is acquired within the family through inter-generational transmission (Myers, 1996), so those who choose to be religious tend to inherit the

religion of their parents. This explains the historical persistence of the geographical distribution of religious minorities in Europe (Nunziata & Rocco, 2018, 2016) and how the individual choice to be an atheist is likely to be endogenous when modelling economic outcomes. Therefore, if we are interested in estimating the behavioural implications of religious beliefs, we must adopt a research design that aims at eliminating the bias induced by omitting latent individual characteristics.

We use data from the German Socio-Economic Panel (SOEP) to provide new empirical evidence on the behavioural effect of religiousness on smoking in a quasi-experimental setting.¹

Our research design exploits the separation of Germany after World War II as a unique natural experiment of history through which Christianity was almost entirely removed from the eastern part of the country only.

Simple descriptive statistics from the SOEP after re-unification reveal an impressive difference in the patterns of religiousness between the people of the former German Democratic Republic (GDR) in the East and those of the Federal German Republic (FGR) in the West.² Despite no systematic differences between GDR and FGR before the separation (Alesina & Fuchs-Schuendeln, 2007) and a similar pre-war attachment to Christianity, even almost thirty years after German re-unification, individuals who declare no religious affiliation make up almost 70 percent of the population that lives in the eastern part of the country and only 10 percent of those who live in the western part, a striking difference considering that today we observe Germans’ religious beliefs after the fall of the former GDR, i.e. in the absence of political intimidation. This divergence can be attributed to the dramatic differences in the public attitudes to religion between the two regimes that resulted from the separation. While FGR was characterized by freedom of religion,³ the political system in the GDR strongly opposed religion in many ways because of the influence of the Marxist ideology that was at the core of the leading Socialist Unity Party (Sozialistische Einheitspartei Deutschlands, SED). This large divergence in religiousness was not present before the separation. Froese and Pfaff (2005) report that more than 92 percent of Eastern Germans were affiliated with a religious denomination in 1950, and the persistent shift toward atheism and agnosticism in GDR can be attributed to the exogenous shift in the political regime, providing a unique quasi-experimental setting for investigating whether religiousness (or lack of religiousness) plays a role in shaping individual behaviour.

Our aim is to determine whether religious affiliation may prevent smoking among believers, that is, whether religious norms have an impact on health, versus the alternative view that sees a simple selection effect of more healthy individuals into religious affiliation. Our research design is based on a matching procedure that compares individuals who declare no religious affiliation in the East, as a result of the exposition to the exogenous switch to state-atheism, with comparable individuals with similar pre-separation parental background who are instead affiliated with a religious denomination as a result of the religious freedom they experienced in the West.

The choice of atheism versus religiousness by the group of individuals that emerge from the matching procedure is the result of the exogenous shock triggered by the atheist Communist regime after the separation. In other words, we compare the behaviour of atheists to that of religious individuals, where the difference in religiousness is activated by the quasi-experimental treatment.

Since in our data we can only distinguish between individuals who declare themselves as affiliated to a religious denomination and those

¹ Note that in our data, being religious means being Christian, either under the Protestant or Catholic denomination. We will use therefore the term religious as a synonym of being a Christian throughout the text.

² In what follows, we use FGR (GDR) and West (East) as synonyms.

³ Freedom of religion was explicitly mentioned by Article 4 of the Constitution, the Basic Law of the Federal Republic of Germany.

who are not, for simplicity and sake of brevity, in what follows we refer to the latter as “atheists”, i.e. “without god” according to the Greek etymology. What we mean is indeed “atheist or agnostic”.

Our approach needs to consider that individuals in the East and the West differ not only in their exposure to religious precepts but also in the complexities of the political systems in which they were raised. Our outcome of interest, smoking, does not seem to be directly affected by the pedagogy of the past Communist regime. Simple regressions show that, once atheism and individual level controls are accounted for, the probability to smoke is not statistically different when comparing former FGR and GDR. Nevertheless, a rigorous analysis should separate the direct effect of the East German state on smoking from its indirect effect through atheism. We use two alternative strategies to remove the direct “regime effect” on smoking. The first consists in matching those individuals who were resiliently religious in the East, despite any external influence, with similar individuals in the West who freely chose to be religious. The difference in outcomes between the two similarly religious groups should be related to the differences caused by the two German political systems and not to religiousness. The second strategy consists in estimating our effect of interest exploiting the within state variability in the data, i.e. keeping the political regime constant, controlling for state (Länder) fixed effects. Finally, we perform a number of robustness checks, including checking the robustness of our findings to the inclusion of regime-specific real cigarettes price at the time the individual was likely to start smoking, and regime-specific cohort dummies.

This paper contributes to the literature on the effects of religion on health in several ways. First, we suggest a new identification strategy that relies on a unique natural experiment of history where religious affiliation was indeed almost eliminated in one part of Germany. Second, our analysis provides new insights on whether religion maintains its preceptive and pedagogic role in modern societies, i.e. on whether religion remains to this day an instrument through which social norms are followed.

Our empirical findings consistently show that atheists are 13–19 percentage points more likely to smoke. These results suggest that simple OLS estimates of the effect of religion on smoking may suffer from a non-negligible bias.

The rest of the paper is structured as follows. Section 2 explains the differing attitudes to religion of the West German FGR state versus the East German GDR, inspired by the SED party. The data used in our empirical analysis are described in section 3. The identification strategy is presented in section 4. Section 5 presents the estimation results and robustness checks. Finally, section 6 concludes.

2. Religion and Atheism in post war Germany: GDR vs FGR

After the end of World War II, the East German churches' religious autonomy was severely affected by the policies of the ruling SED party of Germany. Beginning in the late 1940s, the SED began to openly criticize religion for its negative influence on the population, especially on “the hearts and minds of the next generations” (Ross, 2002). Both Catholicism and Protestantism were a concern for the SED. The conflict between the government and the churches led to the repression of various religious events by the police and to limiting Christian students' access to (or even excluding them from) education and professions.

Among the religious organizations, the Protestant Youth Congregation (the *Junge Gemeinde*) in particular was considered by the SED to be a key obstacle to the supremacy of the Communist Free German Youth (Freie Deutsche Jugend, FDJ) that was intended to introduce the citizens aged 14–25 to the Marxist-Leninist doctrine (Ostermann, 2001). The FDJ came under attack from the government in the late 1940s and the 1950s.⁴ After 1953 the relationship between the

Junge Gemeinde and the SED worsened. The government implemented a series of new measures against religious organizations, such as expelling the leaders and most active members from schools and institutions of higher education and banning of all public activities. All of the leaders of the Protestant Youth Congregation were precluded from holding any important public job in the GDR. In 1954 the SED introduced a secular rival ritual to the Christian confirmation, the *Jugendweihe*, which became compulsory for all students in East Germany after 1958.

The confrontation between the churches and the SED party increased in 1971 when the government tightened the admissions requirements to the high schools and the principle of admitting pupils to universities on the basis of their political curricula was emphasized to the point that selection criteria were openly based on “political attitude”.⁵

After the meeting between the leader of the SED party, Erich Hocknecker, and the representatives of the Church League (*Kirchenbund*) on 6 March 1978, the confrontation between the two parties improved, leading to a recognition of churches as independent entities (Peperkamp & Rajtar, 2010). However, even though the relationship between the churches and the SED party was more peaceful, the complete end of the confrontation and the discrimination against Christians ended only with the peaceful revolution in November 1989 and subsequent reunification of the country. Despite the end of anti-religious policies and the re-unification of Germany, the extent of religiousness in East Germany was deeply affected, and the percentage of atheists in eastern Germany remains much larger than that in western Germany even today. Our research design exploits this exogenous polarisation in order to investigate the implication of religiousness on smoking.

3. Data and descriptive statistics

We use data from the ongoing annual SOEP for the period 1990–2006. The SOEP survey started as a nationally representative survey of private household living in the former FGR in 1984 and broadened to the whole of Germany in 1990. The current sample consists of 12,000 households and more than 20,000 individuals.⁶

In addition to including information about smoking habits and religiousness, the SOEP provides a wide range of socio-demographic information on individuals, including age, gender, education, health, income (both at the individual and the household levels), employment status, religious affiliation, and the German State of residence (i.e., FDR or GDR) at the time reunification took place. We also observe the German State of birth and residence in 1989 of the respondents' parents. Since all of the parents in our sample did not move across the East/West border in the post-war years, we can exclude any endogenous sorting effect due to migration, especially from the East to the West in the years following the separation.

Our outcome of interest is the dummy *Smoker*, which is equal to 1 when the individual is a smoker, and zero otherwise. This information is provided for all individuals age 16 or older in the wave years 1998, 1999, 2001, 2002, 2004, and 2006. We drop from the sample individuals age 65 or older since, after age 65, the prevalence of non-smokers is higher than that of smokers because of the higher mortality attached to smokers (Christopoulos, Han, Jaber, & Lillard, 2011).⁷

(footnote continued)

resolution of the II SED party congress in September 1947 as the “transition from anti-fascist democratic school to the socialist school”.

⁵ Before 1971, admission to universities was determined on the basis of the pupil's academic curricula and “social” activities. The commission in charge of the enrolment procedure was composed by representatives of the unions (FDGR), the FDJ, and teachers.

⁶ For a more detailed description, see Wagner, Frick, and Schupp (2007).

⁷ Similarly, Luy (2004) explained that life expectancy between the former GDR and the former FGR differed significantly, so including only people age 65

⁴ (Peperkamp & Rajtar, 2010, chapter 3) defined the period after the

We focus on the smoking behaviour of males only because smoking behaviour among females is usually affected by female emancipation (Cavelaars et al., 2000; Schaap et al., 2009). The latter is likely to have been influenced by the former regimes in Germany.⁸ Therefore, we dropped the females from our sample in order to avoid possible confounding factors that derive from gender differences between West and East.⁹ We also consider only German nationals who were born and raised either in the West or in the East, excluding those who were raised partly in one and partly in the other, and eliminating those individuals who migrated from one state to the other, since they could have done so possibly as a result of peculiar unobservable characteristics.¹⁰ The information on religiousness is derived from the SOEP question: “Are you a member of a church or denomination?” where the possible answers are: Catholic, Protestant, Member of another Christian Denomination, Member of some other Denomination (Please Specific), Do not belong to a Denomination or Religion. We define an individual as atheist (i.e. more precisely, atheist or agnostic) in absence of any religious affiliation. Since the data was collected after the fall of the GDR regime, we observe the respondents’ self-declared belief in the absence of any political intimidation. Table A1 in the Appendix display the distribution of respondents across all possible answers, including the very low percentage of missing.

Our analysis can exploit only the cross-sectional variability in the SEOP, not the panel dimension of SOEP, because religiousness is usually time-invariant, and smoking behaviour also tends to be stable over time. (98% of individuals in our sample do not change their smoking habits over time.) We therefore take the first available observation for each individual in order to avoid any distortion arising from inflating the sample using more than one observation per individual.¹¹

Our final sample consist of 3731 males born in Germany, aged between 16 and 65, and interviewed only once. Table 1 provides a summary description of how we obtained our final sample.

Tables 2 and 3 provide some descriptive statistics of the data. Table 2 compares Germans living in western Germany with those living in eastern Germany along our control dimensions. In addition to religiousness and atheism, Germans who live in the east appear to differ significantly from those living in the west in terms of education and labour market status in post-unification times (Diewald, Goedicke, & Mayer, 2006). Those who live in the east have attained higher levels of education than those who live in the west, although those who live in the east are less likely to be employed (Luy, 2004).

Table 3 compares smokers with non-smokers. Germany has a relatively high percentage of smokers and the highest percentage of female teenaged smokers in Europe (WHO, 1999). Fig. 1 shows that the proportion of smokers is high in both eastern and western states (Länder), displaying no clear ex-regime patterns. In addition to Berlin, the highest incidence of smokers is in Rhineland-Palatinate and Bremen in the West, and Saxony-Anhalt and Brandenburg in the East. The historical smoking trends in West and East Germany is displayed in Fig. 2 that shows how the average per-capita cigarettes consumption at the time of the re-unification was similar in the two areas. Smoking bans were introduced in Germany at the federal level between 2007 and 2008, which is outside our sampling time period. Smokers appear to be younger, less educated, more likely to be unemployed, and more likely

(footnote continued)

or less in the sample helps to overcome this issue.

⁸ Soon after the reunification, the prevalence of smokers among German women living in the former GDR increased, converging to a proportion close to that among women in the former FRG (Luy, 2004).

⁹ In any case, we estimate our model including females as a robustness check.

¹⁰ The number of movers is however very small in our data, as shown in Table 1.

¹¹ Not surprisingly, our results do not change when instead of the first available observation for each respondent we use the last or any other in between.

Table 1

Summary of the main deletions to obtain the final sample.

	Individuals	Percentage
Initial Sample (native born people only)	15193	100%
Individuals born in FRG but living in GDR	185	1.22%
Individuals born in GDR but living in FRG	323	2.13%
Individuals who are older than 65	1518	9.99%
Waves in which there is no information about smoking habits	4242	28.02%
Inconsistencies (i.e. no information about age, gender, parental education etc)	2326	15.36%
Individuals who do not declare smoking habits	19	0.12%
Final Sample	7580	48.89%
Males only	3731	24.56%

to be atheist (Avery, Kenkel, Lillard, & Mathios, 2007; CDC, 2004), as can be seen in Fig. 3.

4. The identification strategy

4.1. The identification problem in evaluating the causal effect of religion

Our aim is to estimate the effect of religious status on smoking status (yes, no). This could be obtained through a logistic regression or a linear probability model including individual controls, German state (Länder) fixed effects, and time fixed effects. This model essentially relies on the cross-sectional variation between religious and non-religious individuals, net of having grown up in the FRG vs GDR. The problem of this approach is that atheists and religious individuals may differ in terms of unobserved characteristics that may cause religiosity and smoking status to be spuriously associated.

More formally, let $Y_i(D)$ define the potential outcome for individual i – that is, whether the individual is a smoker or not – in the religiousness status D , where $D = 1$ defines the individual as atheist and $D = 0$ as religious. For simplicity, as stated above, we define those individuals who do not declare any religious affiliation as atheists, following the literary Greek etymology “without God”. However it should be clear that this class of individuals also include agnostics and in general all respondents that do not declare themselves as religious. In what follow, we refer to the effect of atheism, rather than that of religiousness, because our identification strategy is best defined and exposed along these terms. Since atheism is the reciprocal of religiousness, our choice is merely expositional.

Ideally, we may be able to assess the effect of atheism on smoking if we were to observe the same individual in both statuses, that is, both when $D = 1$ and when $D = 0$. In this way we may easily capture the impact of religiousness on the probability that an individual with characteristics $X = x$ is a smoker, our parameter of interest, by means of the difference:

$$\Delta_D = E[Y_i(1) - Y_i(0)|X = x] \quad (1)$$

However, it is not possible to observe a contemporaneous condition of atheism and religiousness for the same individual, as each respondent is either atheist or religious (Holland, 1986). If we were able to observe a genuinely exogenous change in the respondents’ religiousness over time we could aim at estimating our parameter of interest using a fixed effects model. However, such changes in individual-level religiousness are a very rare event in the data, and in any case we still could not identify Δ_D , as most confounders would also vary over time. Another possible strategy would be to adopt an Instrumental Variable approach, but this would require a valid instrument for religiousness in an equation of smoking, i.e. an exogenous variable that affects smoking only through its effect on religiousness. However such exclusion restrictions are hard to comply with.

Table 2
Descriptive statistics by country of origin.

Sample	Age	Married	Low Educated	Second School Degree	Highly Educated	Depend. Employed	Self-employed	OLF	Unempl.	Smokers	Atheism
FGR											
mean	38.96	0.57	0.20 ***	0.53	0.27 **	0.63 ***	0.09 ***	0.22 ***	0.06 ***	0.38 *	0.13 ***
s.d.	13.11	0.49	0.40	0.50	0.44	0.48	0.28	0.41	0.24	0.49	0.34
N	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300
GDR											
mean	38.45	0.55	0.16	0.55	0.30	0.52	0.06	0.29	0.13	0.42	0.72
s.d.	14.41	0.50	0.36	0.50	0.46	0.50	0.24	0.45	0.33	0.49	0.45
N	1431	1431	1431	1431	1431	1431	1431	1431	1431	1431	1431
Total											
mean	38.77	0.56	0.18	0.54	0.28	0.59	0.08	0.25	0.09	0.40	0.36
s.d.	13.63	0.50	0.39	0.50	0.45	0.49	0.27	0.43	0.28	0.49	0.48
N	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731

"Total" represents the mean for each category, regardless the country of origin. Age is measured in years. The other variables – marital status, education, employment status, smoking, and religious attainment – represent the proportion of individuals for which each dummy is equal to 1. For each variable, we compare the average for Germans living in eastern and western Germany using a *t*-test. The stars represent the statistical significance of the *t*-test with unequal variance. With the term married we include both individuals who define themselves as married or married and separated or individuals who are living together in a relationship. Education is defined according to the ISCED educational level, as the number of years might not be comparable across the two former countries FGR and GDR. With the term Highly Educated we define individuals who hold an higher educational attainment or a higher vocational degree. The term OLF stands for out of labour force. * *p* < 0.10, ** *p* < 0.05, *** *p* < 0.01

Table 3
Descriptive statistics by smoking attitude.

Sample	Age	Married	Low Educated	Second School Degree	Highly Educated	Depend. Employed	Self-employed	OLF	Unempl.	Atheism
Non-smokers										
mean	40.09***	0.60***	0.17***	0.50***	0.33***	0.59	0.08	0.27***	0.06***	0.33***
s.d.	14.19	0.49	0.37	0.50	0.47	0.49	0.27	0.44	0.23	0.47
N	2252	2252	2252	2252	2252	2252	2252	2252	2252	2252
Smokers										
mean	36.74	0.52	0.21	0.59	0.20	0.58	0.08	0.22	0.13	0.40
s.d.	12.46	0.50	0.41	0.49	0.40	0.49	0.26	0.41	0.34	0.49
N	1479	1479	1479	1479	1479	1479	1479	1479	1479	1479
Total										
mean	38.77	0.56	0.18	0.54	0.28	0.59	0.08	0.25	0.09	0.36
s.d.	13.63	0.50	0.39	0.50	0.45	0.49	0.27	0.43	0.28	0.48
N	3731	3731	3731	3731	3731	3731	3731	3731	3731	3731

“Total” represents the mean for each category, regardless the smoking attitude. Age is measured in years. The other variables – marital status, education, employment status, smoking, and religious attainment – represent the proportion of individuals for which each dummy is equal to 1. For each variable, we compare the average for smokers and non-smokers by using a *t*-test. The stars represent the statistical significance of the *t*-test with unequal variance. With the term married we include both individuals who define themselves as married or married and separated or individuals who are living together in a relationship. Education is defined according to the ISCED educational level, as the number of years might not be comparable across the two former countries FGR and GDR. With the term Highly Educated we defined individuals who hold an higher educational attainment or a higher vocational degree. The term OLF stands for out of labour force. * $p < 0.10$, ** $p < 0.05$, ***. $p < 0.01$

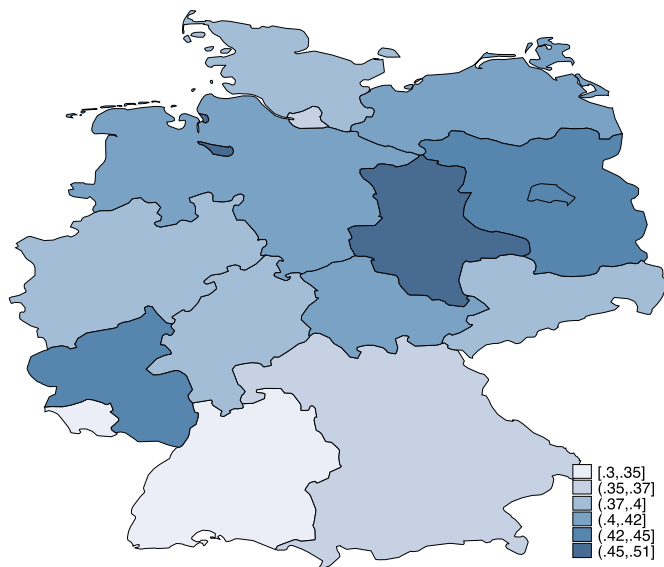


Fig. 1. Proportion of smokers by Länder, Males only.
Source: Authors' elaboration on SOEP data for the period 1990 - 2006.

We propose to address this identification problem, by identifying a counterfactual that must be as close as possible to the unobserved potential outcome, adopting a novel quasi-experimental approach based on the unique setting generated by the German separation. Our objective is identify the effect of religion on smoking on individuals who have similar pre-determined parental education but were subject to different political regimes and therefore to an exogenous shift in religiosity. This approach has the advantage of requiring parental education to be a good predictor of their children religiosity, as typically done in matching, without imposing any strong assumption of the exclusion restrictions.

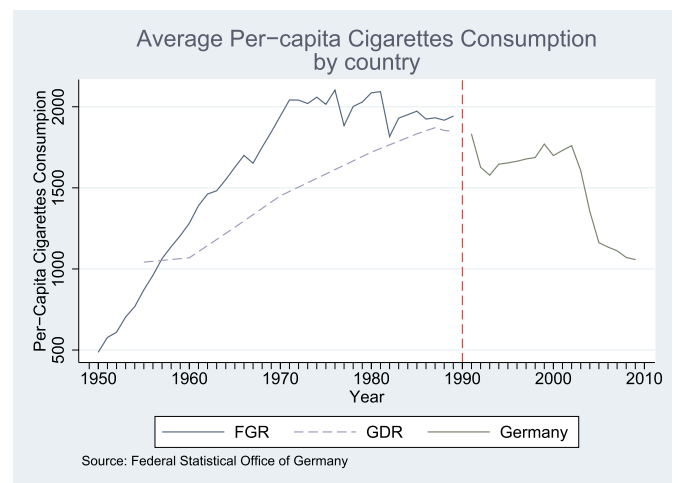


Fig. 2. Historical trends in average per-capita cigarettes consumption.

4.2. A natural experiment of history: Germany's separation

In the final months of World War II, Soviet troops invaded Germany from the east as a result of the Vistula-Oder offensive. US and other Allied troops invaded from the west as a result of the Normandy invasion. After the German capitulation, the country was separated into two independent political entities: West Germany adopted a democratic political system, where citizens were free to profess their religions, if any. The USSR-controlled East Germany adopted instead a Communist-style political system in which religion was strongly opposed. As a result, Eastern Germans were exogenously subject to policies aimed at eradicating religion from society.

Despite no systematic differences between GDR and FGR before the separation (Alesina & Fuchs-Schuendeln, 2007) and a similar pre-war attachment to religion, the two societies resulted in divergent patterns regarding religion and atheism that survived the collapse of the Communist regime in the East and the reunification of the country. Today

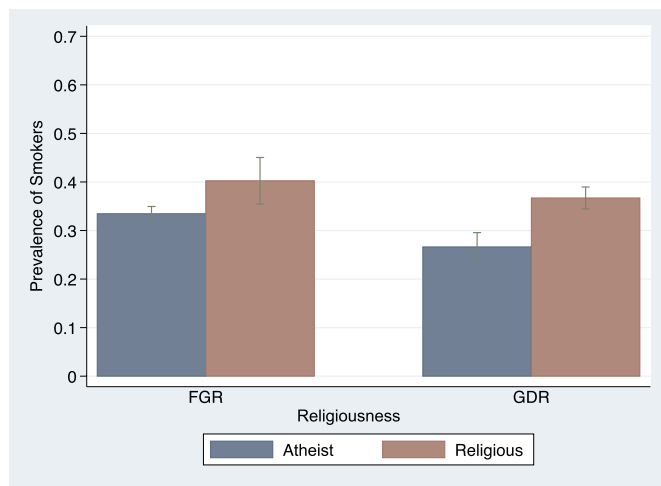


Fig. 3. Prevalence of Smokers by Religiousness, Males only. Source: Authors' elaboration on SOEP data for the period 1990 -2006. As in the rest of the paper by atheists we intend individuals with no religious affiliation, i.e. atheists and agnostics.

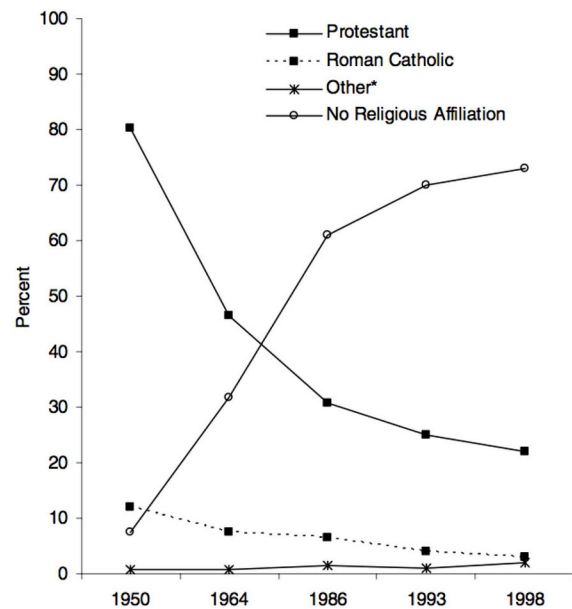
almost 70 percent of those who live in the former GDR are not affiliated to any religious denomination, compared to less than 10 percent of those who live in the former West Germany (Froese & Pfaff, 2005). In other words, today the percentage of atheists in the former West Germany is similar to that in East Germany in the 1950s, soon after the separation. The dramatic shift in atheism in East Germany is clearly depicted in Fig. 4.

As a result, East Germany is to this date one of the most secular countries in the world.¹² This is clearly visible in Fig. 5 that display the much higher proportion of atheists in the East than the West in our data. It is safe to assume that German separation and the GDR state induced some individuals to become atheists when they would have stayed religious had they lived in the West. We can then exploit such exogenous shock to atheism among individuals who were exposed to the former GDR to estimate the implication of religiousness on our outcome of interest, i.e. smoking. Our research design is based on identifying, among the pool of atheists in the former GDR, those individuals who renounced their religious affiliation only as a consequence of the regime change. In order to do this, we match East German atheists with West German religious individuals on the basis of a set of pre-determined family background characteristics that help predict religiousness. The latter group can be used as counterfactuals in a quasi-experimental setting where we evaluate the effect of religion on smoking since the change in beliefs was induced by the exogenous divergence in the political regimes after the separation.

The SOEP asks individuals whether they are affiliated to any religious denomination after reunification, so we observe their beliefs in the absence of intimidation. Let us assume four types of individuals, each characterized by:

1. Their attitudes toward religion, that is, whether they are atheist (A) or religious (R).
2. Their attitudes in light of anti-religious policies and limitations, like

¹² Smith (2012) clearly show that East Germany is the country where atheism is largest among those reported, with 52% respondents declaring they do not believe in God. This figure is lower than the one we find in our data probably because the author refers to people that “don't believe in God”, i.e. excluding agnostics, whereas our figures refer to people with no religious affiliation, i.e. including agnostics, whose number can be sizeable. For example, according to the PEW Research Center Religious Landscape Study (PEW Research Center, 2019), in the US the number of agnostics is actually larger than the number of individuals who do not believe in God.



* “Other” includes members of Protestant sects, Jews, and new religious movements. Compiled from Statistisches Bundesamt 1994; Stat. Jahrbuch der DDR 1990; SB 2000B.

Fig. 4. Membership in Religious Group in Eastern Germany, 1950 - 1998 Source: Froese and Pfaff (2005). The data refer to the total population.

the ones imposed by the former GDR, which reveals the intensity of their beliefs: we define “high” (H) types as those whose beliefs are independent of such policies and “low” (L) types as those whose beliefs are affected.

The combinations of these two dimensions result in four possible individual statuses in our data – A_H , A_L , R_H and R_L – not all of which are directly observed in each part of Germany.¹³ In the former FGR we observe the affiliation that results from a free religious environment. In this case people either freely choose to be atheists (the A_H types) or religious. Among the religious individuals, some would have been atheists had they grown up in the GDR (the R_L types) because they would have complied with the anti-religious policies adopted by the regime. Others would have stayed religious even in the presence of such policies and limitations (the R_H types). Therefore, West Germany is characterized by the following types of individuals: A_H , that is, always atheists; R_H , that is, never atheists even if subject to an anti-religious regime; R_L , that is, those who would have been atheists under an anti-religious regime.

Our data from West Germany reveals A_H types, but we cannot distinguish between R_L and R_H types since religious individuals in West Germany were not exposed to GDR-like anti-religious policies. Note also that $\Pr[A_L(FGR)] = 0$.

We also observe the affiliation that occurs in a formerly repressed religious environment. In the former GDR people are either religious even in the presence of repression (the R_H types) or they are atheists. Among the atheists, some individuals would have remained religious had they grown up in the FGR, i.e. in absence of repression (the A_L types). Others would have been atheist anyway (the A_H types). Therefore, eastern Germany is characterized by three types of individuals: R_H , that is, always religious despite repression; A_H , that is, always atheists, independent of repression; A_L , that is, those who would have been religious in absence of repression.

In this case we observe R_H types only, but we cannot distinguish

¹³ When we use treatment evaluation notation and elaborate on the GDR anti-religious policies, the L types are the compliers, A_H are always takers, and R_H are never takers.

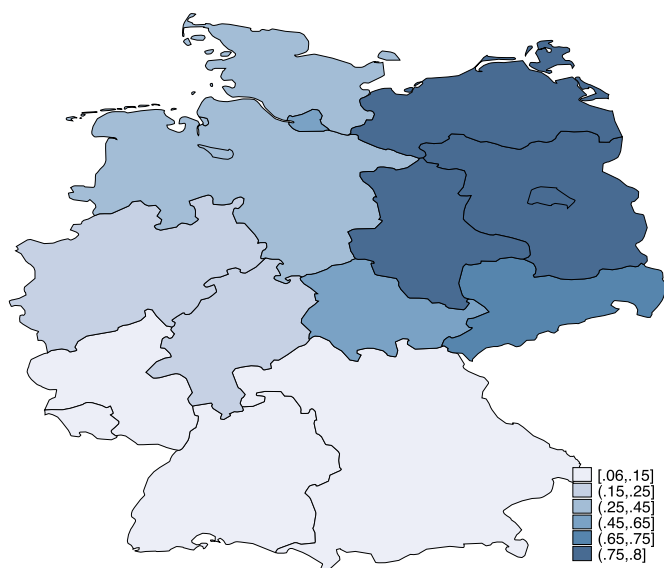


Fig. 5. Proportion of Atheism by Länder, Males only. Source: Authors' elaboration on SOEP data covering the period 1990 - 2006. As in the rest of the paper by atheists we intend individuals with no religious affiliation, i.e. atheists and agnostics.

between A_L and A_H since all atheists were exposed to anti-religious policies and limitations. Note also that $\Pr[R_L(GDR)] = 0$. Each of these statuses is summarised in Table 4.

If we were able to observe all types introduced above (i.e. if we could distinguish between R_L and R_H types in former FGR, and A_L and A_H types in former GDR) we could then adopt a DID-like research design (Ashenfelter & Card, 1985; Heckman, 1997). Slightly changing our notation, the effect of interest becomes:

$$\beta_{DID} = \frac{\overbrace{E[Y|A_L(GDR), X = x] - E[Y|R_L(FGR), X = x]}^{\Delta\text{Atheism}}}{\underbrace{E[Y|R_H(GDR), X = x] - E[Y|R_H(FGR), X = x]}_{\Delta\text{Regime}}} \quad (2)$$

The difference between $E[Y|A_L(GDR), X = x]$ and $E[Y|R_L(FGR), X = x]$, amounts to the effect of exogenous variation in religiousness plus a fixed effect μ implied by having lived in GDR rather than in FGR. This fixed effect can be removed in two alternative ways. The first way consists in using the difference between $E[Y|R_H(GDR), X = x]$ and $E[Y|R_H(FGR), X = x]$, that is, the difference in the probability of smoking between individuals of identical religious types (the resilient religious) who grew up under different political regimes. Alternatively, a more general specification can be adopted where the effect of atheism is estimated comparing individuals who grew up under the same regime, i.e. controlling for unobservable regional characteristics including state (Länder) fixed effects.

4.3. Propensity score matching and conditional difference-in-differences model

The problem with the approach outlined above is that we cannot directly estimate the DID model since four individual types are latent and not revealed in the raw data, i.e. $R_L(FGR)$, $R_H(FGR)$, $A_L(GDR)$ and $A_H(GDR)$. We therefore recur to a matching procedure to identify the four types above using predetermined family background characteristics that help predict religiousness. Once the four types are identified, we proceed with a conditional difference-in-differences (CDID) estimation.

The first step is to distinguish between $R_L(FGR)$ and $R_H(FGR)$ types by matching the R_H religious individuals who live in eastern Germany with the religious individuals who live in western Germany on the basis

of their predetermined family background. As a result, we are able to reveal the $R_H(FGR)$ types. Similarly, we may match the atheist individuals in western Germany (A_H) with their atheist counterparts in eastern Germany (either A_L or A_H) in order to distinguish between $A_L(GDR)$ and $A_H(GDR)$.

When performing the matching, we align the distribution of individuals living in East and West Germany according to parental background information because most evidence suggests that, in the absence of shocks, religiousness tends to be the result of intergenerational transmission. Ideally, we would use parents' religiousness in the matching procedure, but such a variable is missing for a sizeable part (more than 60%) of the sample. We then use pre-determined parental education, given that education has been shown to be consistently negatively associated to religiousness (Hungerman, 2014; Mocan & Pogorelova, 2017). Indeed, our analysis of International Social Survey Programme (ISSP) data on religion across the globe in 1991¹⁴ shows that parents' education is a good predictor of their children's religiousness. Table 5 shows the estimated probability that an individual is atheist as a function of parental education and parents' religiousness. Our findings are consistent in showing that parental education is a good predictor of respondents' atheism. For some countries, parents' education is even more significant than parental religiousness in determining children's religiousness. Therefore, we rely on the pre-determined parents' education as a predictor of their children's religiousness.

We performed the matching procedure on SOEP data using Propensity Score matching (PSM)¹⁵ (Dehejia & Wahba, 2002; Rosenbaum & Rubin, 1983) on a set of pre-determined individual and parental background characteristics (individual's cohort of birth, parents' education, parents' cohort of birth). The covariates that we use for the PSM are either exogenous (birth year) or pre-determined and therefore not affected by the differences in the political regimes (parents' education) since we focus on older cohorts whose parents were likely to have already terminated education before the divergence of the educational systems of the two states. To this end, we focus on those individuals born before 1961, when construction began on the Berlin Wall, and we perform robustness estimations on the older cohort of those born before 1952, i.e. before the East German regime tightened its anti-religious law. In choosing the cut-off year, we balance the need for having older cohorts whose parents' education can be safely considered predetermined with the need for a sufficiently large sample.

The coefficients of the matching estimation are presented in Table 6. Parental education significantly affects their offspring's attitude toward religion, similarly to the findings shown in Table 5. More specifically, using either ISSP or SOEP data, we find that higher-educated fathers are more likely to raise an atheist child than a religious child in an unrepressed environment (the A_H type). In addition, less educated mothers are more likely to raise a religious child in a repressed environment (the R_H type).

Note that the matching procedure only requires parental education to be pre-determined and a good predictor of the respondents's religiousness without imposing any strong assumption of exclusion restrictions as we would do in an instrumental variable setting (Rubin, 1997; Rubin & Thomas, 1996, pp. 249–264). Indeed, if present, any direct effect of parental education on smoking is cancelled out by the conditional Difference-in-Difference procedure that we perform on the matched data.¹⁶ Our model also controls for all the variables used in the

¹⁴ 1991 is the only survey year in which we observe both parents' religiousness and educational attainment for most countries.

¹⁵ In order to implement the PSM, we use the Stata package psmatch2 (Leuven & Sianesi, 2003) and implement a kernel-matching process by imposing a caliper that represents the maximum allowed distance between matched pairs (equal to 0.01) such that pairs whose distance exceed the caliper are discarded.

¹⁶ The evidence on the direct effect of education on the decision to start smoking is actually mixed. Recent quasi-experimental evidence on the causal

Table 4
Definition of the groups of interest.

Group	Description
$A_H(.)$	Atheists "high". Always atheists, independently of repression.
$A_L(.)$	Atheist "low". Would have been religious in absence of repression.
$R_H(.)$	Religious "high". Always religious despite repression.
$R_L(.)$	Religious "low". Would have been atheists under repression.

(.) refers to former FGR or GDR regime. $R_L(GDR)$ and $A_L(FGR)$ do not exist by definition. In the raw data we cannot distinguish between $A_L(GDR)$ and $A_H(GDR)$ and between $R_L(FGR)$ and $R_H(FGR)$.

PSM, as suggested by [Caliendo and Kopeinig \(2008\)](#).

The degree of religiousness we observe for each respondent at the time of the survey is a reflection of their free attitude in absence of religious repression, since the data were collected after the fall of the GDR regime. We determine the geographic affiliation of individual respondents to one of the two former states by using their places of birth and their correspondence with their places of residence in 1989. All individuals who migrated across states are dropped from the sample. In addition, all respondents' parents in our sample reside in the same state (FGR or GDR) where they were born, so that we can exclude any endogenous sorting effect due to migration from the East to the West after the separation.

Our identification strategy is illustrated in Fig. 6. First we match $R_H(GDR)$ (observed) with $R(FGR)$ and identify $R_H(FGR)$ (not observed). Then we match $A_H(FGR)$ (observed) with $A(GDR)$ and identify $A_H(GDR)$ (not observed). The low types can be identified in two ways. One possibility is to consider the residual individuals in western and eastern Germany as $R_L(FGR)$ and $A_L(GDR)$, respectively. Another possibility is to identify $R_L(FGR)$ and $A_L(GDR)$ through PSM, where the match is more precise but we end up with fewer observations.

Simple summary statistics show that those respondents that are identified as $R_H(FGR)$ types are more likely to attend religious events than $R_L(FGR)$ types (69% of respondents versus 64%), as expected. Similarly, $A_H(GDR)$ types are more likely to never attend religious events than $A_L(GDR)$ types (89% of respondents versus 85%).¹⁷

Once we have associated each respondent with a specific religious or atheist type, we estimate the following model:

$$Smoker = \beta \cdot S_j(c) + \gamma \cdot X + \mu_i + \theta_t + \varepsilon \tag{3}$$

where *Smoker* is a dummy variable that equals 1 if the respondent is a cigarette smoker; $S_j(c)$ is religious status (atheist A or religious R) of type $j \in \{H, L\}$ (high or low) in area c (former FGR or GDR); X are the observable individual characteristics of marital status, education, employment status, and age plus the variables used in the PSM; μ_i are state (Länder) dummies (included when estimating the fixed-effect model specification, see below); and θ_t are time dummies.

Model (3) is estimated both with and without state (Länder) dummies in order to provide two alternative strategies to account for the induced differences in smoking caused by regime-related channels other than atheism. The fixed regime effect can be removed as in (2), or adopting a state (Länder) fixed effects specification and estimating the

(footnote continued)

effect of education on smoking seems to exclude any statistically significant effect ([Braakmann, 2011](#); [Koning, Webbink, & Martin, 2014](#)).

¹⁷ Typically, self declared atheists respondents may attend religious events for family reasons, however usually the attendance rate is very low, with 89% of $A_H(GDR)$ never attending religious events, and slightly lower figures for other atheist types. This compares to an average between 31 and 43% of religious types never attending a religious event. In any case, these data should be interpreted with great care, as church attendance is a choice variable that is typically endogenous in any behavioural model and therefore is unlikely to display the true depth of the respondents' religiousness ([Nunziata & Rocco, 2016, 2018](#)).

Table 5
The determinants of atheism in Europe.

	(1)	(2)	(3)
	Atheism	Atheism	Atheism
	b/se	b/se	b/se
Low educated Mother	0.068 (0.042)		0.073* (0.039)
Low educated Father	-0.025 (0.041)		-0.034 (0.039)
High educated Father	0.109*** (0.040)		0.101*** (0.039)
High educated Mother	0.006 (0.032)		0.001 (0.031)
Mother is Atheist		0.403** (0.174)	0.403** (0.169)
Father is Atheist		0.362** (0.146)	0.356** (0.141)
Baseline	Yes	Yes	Yes
<i>N</i>	1132	1132	1132
R-squared	0.0847	0.136	0.151
Adjusted R-squared	0.0665	0.121	0.133
Log-likelihood	-145.4	-112.5	-102.7
F-statistic	4.090	6.858	5.647

Note: Linear Probability Model with robust standard errors (in parentheses) Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data come from the 1991 wave of International Social Survey Programme (ISSP). Data represent males aged 65 or below from West Germany, Ireland and Austria. For other Western European countries (i.e. the Italy, Netherlands, Norway and the UK) no parental education was present. The dependent variable represents a dummy variable equal to 1 for all the Atheists and 0 otherwise. The baseline controls include demographical variables (age, education in dummies, hh size), country of residence (FGR, Austria and Ireland), labour market status (self-employed, unemployed, Out of Labor Force vs. dependent employed as reference). All parental controls (education and religious attainment) are dummies variables.

within state differences between the L types and the religious H types in eastern and western Germany, and then taking the difference in the differences. In what follows we present our empirical findings from adopting both approaches.

5. Empirical findings

5.1. OLS estimations

We first provide some empirical evidence on the correlation between atheism and smoking by estimating a simple linear probability model on our data:

$$Smoker_{it} = \beta_0 + \beta \cdot Atheist_i + \gamma \cdot X_{it} + \mu_i + \theta_t + \varepsilon_{it} \tag{4}$$

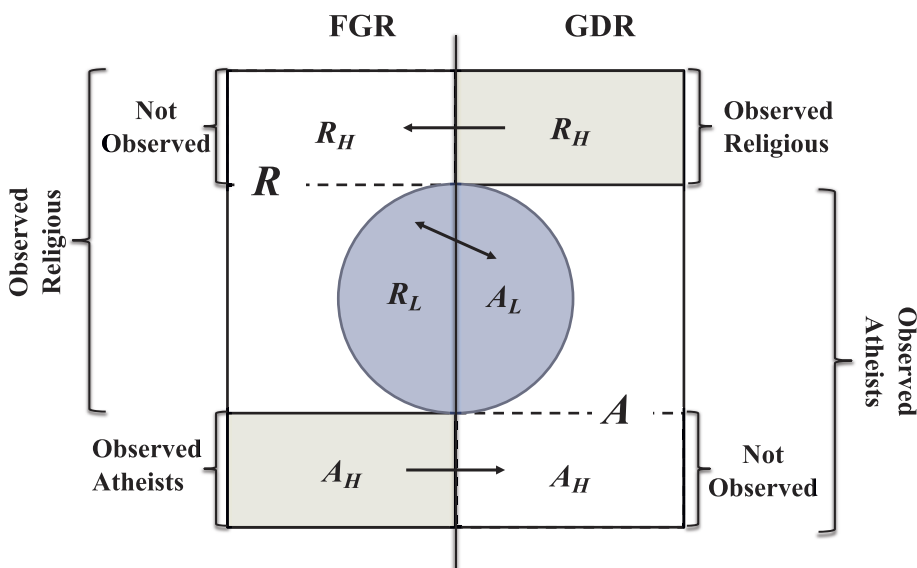
where $Smoker_{it}$ is a dummy variable that takes the value of 1 when individual i is a smoker at time t , and zero otherwise; $Atheist_i$ is a dummy variable that is equal to 1 when individual i is atheist, and zero when individual i is religious; X_{it} is the usual set of individual characteristics; and μ_i and θ_t are Länder and time dummies, respectively.

Table 7 shows that atheism is positively and significantly correlated with smoking. The probability that an individual will be a smoker increases by around 7 percentage points when the individual is an atheist, an effect that is robust to the inclusion of parental educational attainment, which is not statistically different from zero. As regards the controls, the estimated results confirm the descriptive evidence presented in section 3, i.e. smoking is positively associated with unemployment and negatively associated with education and being out of the labour force. The statistical significance of atheism disappears when the model is estimated on older cohorts and the sample is reduced, as displayed in Table 8.

Table 6
Logistic regression for the probability of being Atheist high (left) and religious high (right).

	(1)	(2)
	$A_H(FGR)$	$R_H(GDR)$
Year of birth	0.022 (0.020)	-0.030* (0.016)
Year of Mother's Birth	-0.004 (0.023)	-0.005 (0.020)
Year of Father's Birth	-0.015 (0.019)	0.013 (0.017)
Father is high educated	0.706** (0.298)	-0.208 (0.307)
Father is low educated	-1.780 (2.374)	-0.659 (0.671)
Mother is high educated	0.932 (0.569)	0.401 (0.511)
Mother is low educated	0.386 (2.272)	1.825** (0.902)
Constant	-8.187 (21.154)	41.912** (17.186)
<i>N</i>	663	1170
Log-likelihood	-375.8	-567.3
Pseudo R2	0.041	0.017
Count R2	0.739	0.808

Note: Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust Standard Errors in parentheses. Logistic function used in the Propensity Score Matching function. The sample include only German males individuals born between 1933 and 1960. The dependent variable represents a dummy variable equal to 1 for all the Atheists (Religious) born and living in FGR (GDR), and 0 for all the Atheist (Religious) born and living in GDR (FGR). Birth years are continuous variables, while parental education is measured through dummies. Pseudo R2 is calculated using the McKelvey and Zavoina's procedure. Count R2 is the share of records correctly predicted by the model.



We either take the residual individuals after the procedure above (i.e. those not identified as High type), R 's in the west and A 's in the east, or we match $R(FGR)$'s to $A(GDR)$'s, making sure that each belongs to one category only. The beige areas in the figure indicate the observed types, and the blue area indicates the Low types identified as a result of the matching procedure. The arrows indicate the matching.

The OLS findings show a robust correlation between atheism and smoking that is in line with previous findings of a correlation between religiousness and health (Crowther, Parker, Achenbaum, Larimore, & Koenig, 2002; Deaton, 2009; Ellison, 1991; Ellison & Levin, 1998; Garrusi & Nakhaee, 2012) or smoking (Bowie et al., 2017; Fletcher & Kumar, 2014; Garrusi & Nakhaee, 2012; Gillum, 2005; Hyman et al., 2008; Lillard & Price, 2007; Mellor & Freeborn, 2011; Osoba, 2004; Petersen et al., 2018; Sullivan, 2010; Whooley et al., 2002). However, as in most previous studies, this correlation is likely be influenced by omitted latent factors.

5.2. CDID estimations

We then proceed with our CDID strategy. Our sample consists of male individuals whose parents were likely to have completed their education before the separation of Germany, in order to minimize the possibility that parental education was affected by the differences in the regimes' educational systems. We consider older respondents according to increasing degrees of stringency, that is, we consider (i) individuals born before 1961 and (ii) individuals born before 1952.¹⁸ These two dates correspond to the start of the Berlin Wall's construction and the time at which stricter anti-religious measures were implemented in the former GDR, respectively. In other words, we assume that individuals' parents completed their education before their children's birth, and that this took place before the tightening of the anti-religious repression in the East Germany Communist regime.

Table 9 presents our empirical findings for the cohort of individuals born between 1933 and 1960, that is, our baseline estimates. The upper panel displays the results from a model that does not control for state (Länder) fixed effects, so the direct regime effect is accounted for by the difference in the propensity to smoke between individuals of the same religious type (R_H) who reside in western Germany vs eastern Germany. The lower panel presents instead the estimations that include Länder dummies, so the fixed effects account for the regime effect, and our

Fig. 6. A graphical summary of the identification strategy.

Notes: This figure provides a graphical summary of the identification strategy. It summarizes the religious/atheist types that we observe in the west (FGR) and the east (GDR) and how we use the data to perform the matching at the basis of our CDID estimates. As in the rest of the paper by atheists we intend individuals with no religious affiliation, i.e. atheists and agnostics. In the FGR we observe a large pool of religious individuals R (Low and High types) and a small pool of atheists A (High type). Viceversa, as a consequence of the GDR regime, in the east we observe the opposite, i.e. a large pool of atheists (Low and High types) and a small pool of religious (High type). We then match, using pre-determined parental background variables, the observed small pool of $A_H(FGR)$ to the pool of atheists in the East to identify $A_H(GDR)$ (originally not observed). Similarly, we match the observed small pool of $R_H(GDR)$ to the pool of religious in the West to identify $R_H(FGR)$ (originally not observed). We then use two alternative methods to identify $R_L(FGR)$ and $A_L(GDR)$.

¹⁸ Since we consider only individuals under age 65, the two cohorts are defined as those born between 1933 and 1960 and those born between 1933 and 1951.

Table 7
Probability of being a Smoker: OLS Estimations.

	(1)	(2)	(3)
	Smoker	Smoker	Smoker
	b/se	b/se	b/se
Atheist	0.075*** (0.021)	0.071*** (0.021)	0.071*** (0.021)
Baseline	Yes	Yes	Yes
Mother's characteristics	No	Yes	Yes
Fathers's characteristics	No	No	Yes
<i>N</i>	3731	3731	3731
R-squared	0.0606	0.0638	0.0644
Adjusted R-squared	0.0532	0.0557	0.0555
Log-likelihood	-2509.5	-2503.1	-2502.0

Note: Linear Probability Model with robust standard errors (in parentheses) Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable represents a dummy variable equal to 1 for those who smoke and 0 otherwise. The baseline controls include demographical variables (age, education in dummies, marital status), region of residence (15 Federal Länders dummies), labour market status (self-employed, unemployed, OLF vs. dependent employed as reference), year of the interview, unemployment rate at regional level. Age and unemployment rate are a continuous variables. All the other variables (parental educational and religious attainment) are dummies. The reference dummies are respectively: secondary school degree, single, believe in God, employed.

estimated coefficient of interest is obtained by the difference in the differences between the low types and the highly religious types living in western and eastern Germany. The first row of each panel displays our effect of interest. In column (1) we control for the set of covariates described above and the L types are defined as a residual category after performing PSM to identify the H types. In Column (2) the L types are identified through PSM using the pool of individuals that have never been identified as H types. As a result, the matching is more precise but the sample is reduced by almost half.

Our baseline model suggests that the effect of atheism on the probability of smoking is around 13 percentage points, which is much higher than what found using simple OLS. This finding suggest that the OLS estimates may be significantly biased and suggests the existence of unobservable components that are positively correlated with atheism and negatively correlated with smoking. For example, one relevant cognitive factor that is omitted from our model is analytical thinking, that has been shown to promote religious disbelief through experimental evidence (Gervais & Norenzayan, 2012). It is likely that analytical thinking may be associated with higher awareness of tobacco-related diseases and lower levels of smoking.

In addition, we find that the direct effect on smoking of being exposed to the former GDR regime is negative and significant. When we identify the L type individuals through matching, rather than just considering them as a residual category, we gain accuracy at the expense of ending up with fewer observations (around 56% of the original sample). The number of observations drops consistently because the L types are identified by PSM, and all individuals who do not fall into any of the type categories are dropped from the sample. In this case our estimated effect is even larger, around 17 percentage points. The empirical results obtained using a specification with Länder dummies are very close. Here, the differential effect of being a L type religious versus a H type in FGR is negative, which is an indication that it is the difference between being atheist and being religious that affects the probability than an individual will be a smoker, not religious intensity. Put another way, the L types are characterised by a lower propensity to smoke in a free religious environment, which reinforces our reading of the implications of embracing atheism on smoking.

The results in Table 9 suggest that religiousness matters in reducing smoking, as atheism increases the probability that an individual will be a smoker. This effect is confirmed by both panels. When using a stricter definition of L types, we find that the effect of atheism on the individual's attitude toward smoking is even stronger. Our finding can be considered a local average effect in the sense that it captures the effect of atheism on smoking among low-type individuals, i.e. those respondents whose beliefs are likely to change through government intervention.¹⁹

5.3. Robustness checks

5.3.1. Cigarette prices

The literature has often emphasized the role of prices and/or tobacco taxation at the age of initiation to smoking as a possible predictor of smoking behaviour at later ages (Chaloupka, 1991; Gruber, 2000). In our context, cigarettes prices might be particularly relevant, since West Germany and East Germany faced two different cigarette price regimes, a market based system (FGR) and one fixed by the state (GDR). However, our estimated effect of atheism remains unaffected (not reported) when we control for real cigarettes price at the time the individual was between 15 and 18 years old, the age at which individuals usually start smoking (Lillard & Fumagalli, 2010).

5.3.2. Controlling for parents' years of birth

As discussed above, the SED adopted a compulsory secular ritual, the *Jugendweihe*, that substituted for the Christian confirmation in 1958. Taking this date as a mark of the transition to the GDR regime's more established secular attitude, we estimate our model including only those individuals whose parents were likely to have completed their education before 1958. In other words, we consider only those individuals whose parents were born in 1935 or before. The estimates (not reported) are in line with those presented in Table 9, possibly because the sample selection on the basis of the individuals' year of birth tends to select parents who completed their education before 1958 anyway, as can be noticed from the number of observations, which does not change dramatically.

5.3.3. Alternative definition of cohorts

We perform the same estimation on a set of alternative birth cohorts. In doing so we face a trade-off: the older the cohort the higher the probability that parents' education is truly predetermined to the regime change, but also the lower the number of observations, and vice versa. In Table 10 we consider four benchmark birth years:

Born before 1945, that is, before the German separation;

Born before 1952, that is, before the East German state tightened its anti-religious policies (Peperkamp & Rajtar, 2010);

Born before 1961, that is, before the construction of the Berlin's Wall;

Born before 1973, that is, before the Basic Treaty (Grundlagenvertrag) between FGR and GDR came into effect, when each state recognised the other for the first time.

Neither the 1945 cohort nor the 1973 cohort are ideal for our experiment. In the first case we end up with few observations and only for older individuals, while in the second case respondents may be too young, and their parents' educational attainment may have been affected by the differences in educational regimes, so they may not be considered predetermined and our research design may be invalid. Not surprisingly, our findings presented in Section 5.2 are robust for the two intermediate cohorts, that is, those born before 1952 or 1961; the effects are weaker for those born before 1945 and tend to converge to the OLS estimates for those born before 1973, with sample size increasing by 61 percent.

¹⁹ Using the impact evaluation literature terminology, our finding is a sort of LATE (local average treatment effect on the compliers).

Table 8
Probability of being a Smoker: OLS Estimations by Cohorts.

	(1) Born before 1945 b/se	(2) Born before 1952 b/se	(3) Born before 1961 b/se	(4) Born before 1973 b/se	(5) All Sample b/se
Atheist	0.050 (0.041)	0.054* (0.033)	0.052* (0.027)	0.075*** (0.022)	0.071*** (0.021)
Baseline	Yes	Yes	Yes	Yes	Yes
Mother's characteristics	Yes	Yes	Yes	Yes	Yes
Fathers's characteristics	Yes	Yes	Yes	Yes	Yes
<i>N</i>	725	1132	1833	2956	3731
R-squared	0.0716	0.0983	0.0769	0.0677	0.0644
Adjusted R-squared	0.0287	0.0704	0.0594	0.0565	0.0555
Log-likelihood	-398.6	-667.5	-1176.1	-1962.5	-2502.0

Note: Linear Probability Model with robust standard errors (in parentheses) Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable represents a dummy variable equal to 1 for those who smoke and 0 otherwise. The baseline controls include demographical variables (age, education in dummies, marital status), region of residence (15 Federal Länder dummies), labour market status (self-employed, unemployed, OLF vs. dependent employed as reference), year of the interview, unemployment rate at regional level. Age and unemployment rate are a continuous variables. All the other variables (parental educational and religious attainment) are dummies. The reference dummies are respectively: secondary school degree, single, believe in God, employed.

Table 9
Probability of being a Smoker: CDID Estimations for those Born Before 1961

	(1)	(2)
	Propensity to smoke b/se	Propensity to smoke b/se
Males only Not using Länder Fixed Effects		
$[A_L(GDR) - R_L(FGR)] - [R_H(GDR) - R_H(FGR)]$	0.128*** (0.022)	0.168.. (0.070)
$A_L(GDR) - R_L(FGR)$	0.055.. (0.022)	0.083 (0.054)
$R_H(GDR) - R_H(FGR)$	-0.073*** (0.003)	-0.085*** (0.021)
Males only Using Länder Fixed Effects		
$[A_L(GDR) - R_H(GDR)] - [R_L(FGR) - R_H(FGR)]$	0.128*** (0.022)	0.186.. (0.079)
$A_L(GDR) - R_H(GDR)$	0.099*** (0.022)	0.088 (0.079)
$R_L(FGR) - R_H(FGR)$	-0.030*** (0.001)	-0.098*** (0.002)
<i>N</i>	1,833	1,030
$R_H(FGR)$	190	111
$R_H(GDR)$	225	225
$R_L(FGR)$	755	246
$A_L(GDR)$	356	241
$A_H(GDR)$	131	31
$A_H(FGR)$	176	176

Note: Results from the estimation strategy presented in section 4. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Bootstrapped SE-values in parentheses (1,000 replications), stratifying by country of birth: GDR or FGR. The dependent variable represents a dummy variable equal to 1 for those who smoke and 0 otherwise. Individuals are matched through Propensity Score Matching and their distribution are aligned by year of birth, parental year of birth, parental education. After having aligned the distribution we regress, through a linear probability model, the dependent variable on education (2 dummies: high or low level - secondary school degree as ref.), marital status, employment status (3 dummies: Self-employed, OLF, Unemployed - employed as a ref.), year dummies, and according to the estimation with or without regional dummies (15 federal Länder dummies). In column (1), Low types individuals are identified as those who are never classified as High in the propensity score matching procedure. In column (2) both High and Low types are defined through propensity score matching.

5.3.4. Other robustness checks

In addition to education and employment status, income may play a role in shaping individual smoking preferences (Auld, 2005). Our baseline estimations do not control for income because of possible

structural differences in income support between the former FGR and the former GDR and because income is missing for a sizeable part of our sample (almost 40% of respondents). However, our findings are robust to the inclusion of income when available plus an interaction of income

Table 10
Probability of being a Smoker: CDID Estimations by Cohorts.

	(1)	(2)	(3)	(4)
	Born before 1945 b/se	Born before 1952 b/se	Born before 1961 b/se	Born before 1973 b/se
Males only Not using Länder Fixed Effects				
$[A_L(GDR) - R_L(FGR)] - [R_H(GDR) - R_H(FGR)]$	0.053* (0.031)	0.130*** (0.027)	0.128*** (0.022)	0.081*** (0.018)
Males only Using Länder Fixed Effects				
$[A_L(GDR) - R_H(GDR)] - [R_L(FGR) - R_H(FGR)]$	0.054 (0.032)	0.128*** (0.029)	0.128*** (0.022)	0.078*** (0.018)
<i>N</i>	718	1,127	1,833	2,956
$R_H(FGR)$	85	119	190	259
$R_H(GDR)$	100	150	225	318
$R_L(FGR)$	283	455	755	1,369
$A_L(GDR)$	141	204	356	540
$A_H(GDR)$	48	83	131	203
$A_H(FGR)$	61	116	176	267

Note: Results from the estimation strategy presented in section 4. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Bootstrapped SE-values in parentheses (1,000 replications), stratifying by country of birth: GDR or FGR. The dependent variable represents a dummy variable equal to 1 for those who smoke and 0 otherwise. Individuals are matched through Propensity Score Matching and their distribution are aligned by year of birth, parental year of birth, parental education. After having aligned the distribution we regress, through a linear probability model, the dependent variable on education (2 dummies: high or low level - secondary school degree as ref.), marital status, employment status (3 dummies: Self-employed, OLF, Unemployed - employed as a ref.), year dummies, and according to the estimation with or without regional dummies (15 federal Länder dummies). Low types individuals are identified as those who are never classified as High in the propensity score matching procedure.

with employment status since most observations that are missing income refer to people who are not employed.

Our analyses so far have compared atheist and agnostic versus religious respondents without discriminating between Catholics and Protestants. However, Catholics and Protestants may differ along several ethical dimensions, including attitudes toward sin and pleasure (Becker, Pfaff, & Rubin, 2016; Nunziata & Rocco, 2018, 2016). For example, if Catholics can confess to immoral behaviour and still be assured of salvation, they may be more forgiving to smokers.

We then estimate our model by dropping Catholic respondents from our sample, as the religious denomination with the smaller sample size. Our evidence presented in Table 11 confirms that atheists are more likely to smoke even when compared to Protestants only. The size of the point estimate is actually larger when we consider the more precise model where both High and Low types are identified through matching. However, the confidence intervals do overlap with those of Table 9, and therefore we cannot reject the hypothesis that Protestantism and Catholicism have the same effect on smoking behaviour.

As a further robustness check, we estimate our model including females and movers between East and West. We excluded movers from our baseline specification because these individuals may be not be homogeneous to the rest of the sample, although they are indeed very few as shown in Table 1. In addition, our preferred estimates exclude females from our sample because the literature show that smoking behaviour among females is usually affected by female emancipation (Cavelaars et al., 2000; Schaap et al., 2009), a factor that we cannot control for and that is likely to have been influenced by the former regimes in Germany. In this case it therefore becomes more difficult to disentangle the direct effect of the GDR on smoking from the indirect effect through the surge in atheism. This is confirmed by our estimates that show that when females and movers are included, atheism is still positively associated with smoking. However the point estimates tend to be smaller, especially so when including state fixed effects, a sign

that unobservable components may play a larger role for females than males.

Finally, our findings are robust to the inclusion of regime-specific cohort dummies, defined every five years to control for non-linearities within each sample selection. In other words, our results hold when we account for different trends in smoking consumption between West and East Germany that were driven by regime-specific factors that we do not directly observe in our data.

5.3.5. Interpretation of our findings

Our findings suggest that, first, religiousness significantly affects smoking behaviour. This may take place for at least four orders of reasons. First, less risky individuals may select into religiousness, and therefore may be less inclined to smoke. Second, being a Christian, an individual may join networks that lead an healthier life, therefore suggesting a network/contagion effect. Third, the ethical content of Christianity may induce Christians to restrain from adopting a widely recognised unhealthy behaviour such as smoking, when the body is considered a temple of the Holy Spirit and therefore a believer should glorify God in her/his body.²⁰ Fourth, spirituality may confer extra strength to abstain from pleasurable behaviour, since spiritual individuals may find it easier to forego current consumption in exchange for some future, spiritual reward. Fourth.

We can only speculate as which channel is behind our findings, but a few considerations are in order. In the first place, risk attitude should be accounted for by the difference in difference mechanism behind our identification strategy, and therefore is unlikely to be the most important factor behind our findings. On the contrary, the data suggest that the second mechanism based on a network effect may be present.

²⁰ Corinthians: 6: 19–20. See also the Pope's Bull of Indication of the Great Jubilee of the Year 2000.

Table 11
Probability of being a Smoker: CDID Estimations Without Catholics.

	(1)	(2)
	Propensity to smoke b/se	Propensity to smoke b/se
Males only Not using Länder Fixed Effects		
$[A_L(GDR) - R_L(FGR)] - [R_H(GDR) - R_H(FGR)]$	0.199*** (0.032)	0.073*** (0.021)
$A_L(GDR) - R_L(FGR)$	0.028 (0.0332)	0.028 (0.0222)
$R_H(GDR) - R_H(FGR)$	0.031*** (0.0066)	0.031*** (0.0045)
Males only Using Länder Fixed Effects		
$[A_L(GDR) - R_H(GDR)] - [R_L(FGR) - R_H(FGR)]$	0.197*** (0.033)	0.069*** (0.022)
$Al(GDR) - Rh(GDR)$	0.105*** (0.033)	0.125*** (0.022)
$R_L(FGR) - R_H(FGR)$	-0.091*** (0.005)	0.057*** (0.002)
N	1,324	525
$Rh(FGR)$	140	65
$Rh(GDR)$	189	84
$Rl(FGR)$	332	126
$Al(GDR)$	356	141
$Ah(GDR)$	131	48
$Ah(FGR)$	176	61

Note: Results from the estimation strategy presented in section 4. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Bootstrapped SE-values in parentheses (1,000 replications), stratifying by country of birth: GDR or FGR. The dependent variable represents a dummy variable equal to 1 for those who smoke and 0 otherwise. Individuals are matched through Propensity Score Matching and their distribution are aligned by year of birth, parental year of birth, parental education. After having aligned the distribution we regress, through a linear probability model, the dependent variable on education (2 dummies: high or low level - secondary school degree as ref.), marital status, employment status (3 dummies: Self-employed, OLF, Unemployed - employed as a ref.), year dummies, and according to the estimation with or without regional dummies (15 federal Länder dummies). In column (1), Low types individuals are identified as those who are never classified as High in the propensity score matching procedure. In column (2) both High and Low types are defined through propensity score matching.

Indeed, we do observe that church attendance changes as expected across religious types: between 81% and 89% of atheist types never attend religious events, whereas these figures are reduced to between 31% and 43% among religious types. However, these differences are not dramatic as one would expect, especially considering that only between 9% and 14% of religious types attend religious events every week, as every good Christian should do. We should therefore expect other mechanisms at work.

What about the ethics and the spirituality embodied by being a Christian? In this respect, when we estimate our specification on a model of drinking alcohol rather than smoking, we find milder effects that are not robust across cohorts. This may be related to the social acceptance of drinking alcohol. Indeed, it is commonly believed that a moderate intake of alcohol can have a positive effect on one's health, differently from smoking, perhaps wrongly so (Wood et al., 2018). As a result, individuals tend not to perceive alcohol as harmful as smoking, and even a religious person may find that drinking alcohol is less harmful and therefore less against her/his Christian principles.²¹

However, spirituality should correlate with both less drinking and smoking, since the spiritual individual should be more interested in the transcendental aspect of each person's soul, rather than short-time pleasures. Therefore, spirituality may not be the most important

explanatory factor behind our findings, whereas, on the contrary, the Christian ethical precept of leading an healthy life may be relevant, since smoking is generally perceived as very harmful.

Our conjecture is therefore that our findings are most likely explained by Christian ethics and possibly by the effect of network and peers.

6. Conclusions

This paper aims at estimating the effect of religion on health. Most of the existing literature on the behavioural implications of religion has failed to solve the problem of the potential endogeneity of religion with respect to many of the investigated outcomes. Previous empirical findings have often treated religiousness as exogenous, rather than as determined by omitted latent factors. Our study departs from the existing literature by exploiting a unique natural experiment of history, the division of Germany after World War II, in order to estimate the relationship between religion and smoking using data from the German Socio-Economic Panel (SOEP).

We adopt a conditional Difference-in-Difference approach using the exogenous conversion to atheism and agnosticism (which we name atheism for simplicity throughout the paper) in East Germany that arose from the anti-religious policies adopted in the GDR after the separation. Our research design is based on classifying respondents into four types based on (i) their attitudes toward religion (i.e. whether they are atheist A or religious R); after the separation, i.e. in absence of political

²¹ This is consistent with Mellor and Freeborn (2011) who find that religiousness reduces the consumption of illicit drugs but do not find robust effects on binge drinking.

intimidation, and (ii) their attitudes in light of state-sponsored anti-religious policies, which depends on the intensity of their beliefs (i.e., *H* types, whose beliefs are independent of repression, and *L* types, whose beliefs are affected by it). We then assume that the anti-religious attitude of the GDR regime exogenously affected the *L* types who become atheist or agnostic (A_L) when they were raised in East Germany but stayed religious (R_L) when they were raised in West Germany.

Our procedure consisted in two steps: in order to identify each type, we first used a propensity score matching procedure, where religious individuals living in western Germany are matched with their atheist counterparts living in eastern Germany by using parental background variables that are independent of the shift in regime following the separation. These include parental education, which has been found to be an important predictor of children's religiousness. To this end, we concentrate on older respondents, whose parents are likely to have completed their education before the shift to atheism in the GDR.

In the second step, we estimated the effect of atheism on smoking by comparing the matched groups of low type religious individuals in the former FGR with their low type atheist counterparts in the former GDR. In addition, by using a CDID specification, we were able to clean the effect of interest from the potential East German regime's direct effect on smoking (i.e., not through atheism). The latter is identified by comparing individuals with similar religious propensities who are living in western Germany with those who are living in eastern Germany, that is, individuals who differ only because of the regime under which they were raised, not because their attitude toward religion or religious repression. As an alternative methodology to clean for the direct regime effect we also use a specification that controls for state (Länder) fixed effects.

Our findings, obtained using SOEP data for the period 1998–2006, consistently suggest that atheists are around 13 to 19 percentage points more likely to smoke than are religious individuals. Our results are robust to the inclusion of labour market status, income, regime-specific cohort dummies and regime-specific real cigarettes price at the time the individual was between 15 and 18 years old, the age at which individuals usually start smoking. By providing a direct comparison of our empirical results with simple OLS estimations, we point to a non-negligible bias in the OLS estimations, suggesting that care should be taken when interpreting simple correlations in the data between religiousness and health or between religiousness and general economic

outcomes.

According to our analysis, religion is a relevant conveyor of behavioural precepts, rather than just the product of pre-determined attitudes. Our results point to the existence of a restraining effect of religious ethics on unhealthy behaviour, confirming the view that religion may be an important channel through which societies enforce social norms. From a public health perspective, our findings suggest that an effective policy aimed at preventing tobacco use should take into consideration the cultural aspects attached to the act of smoking and that anti-smoking policies should be designed accordingly. Among other factors, religious affiliation is a relevant element that policymakers should consider when targeting anti-smoking interventions.

Compliance with ethical standards

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Conflict of interest

The authors declare that they have no conflict of interest.

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APPENDIX

Table A.1
Religious distribution.

Religion	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Catholic	41.64	27.91	27.59	27.3	26.86	27.14	27.05	27.36	26.94	26.49	26.24	25.91	25.38	25.73	25.15	24.89	23.98	27.24
Protestant	45.9	38.93	38.08	37.98	37.65	37.42	37.54	38.02	37.75	37.45	36.95	37.29	37.6	37.58	36.97	36.13	36.02	37.93
No denomination	12.37	32.4	32.99	33.15	33.53	33.79	34.23	34.59	34.59	34.97	35.32	35.59	35.99	36.55	36.52	36.45	36.64	33.59
Missing	0.1	0.76	1.34	1.57	1.96	1.66	1.18	0.03	0.73	1.1	1.48	1.21	1.03	0.14	1.36	2.53	3.36	1.24
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

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