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Risk aversion and religious behaviour. Analysis using a sample of Danish twins

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Abstract

Economics offers an analytical framework to consider human behaviour including religious behaviour. Within the realm of Expected Utility Theory, religious belief and activity could be interpreted as an insurance both for current life events and for afterlife rewards. Based on that framework, we would expect that risk averse individuals would demand a more generous protection plan which they may do by devoting more effort and resources into religious activities such as church attendance and prayer, which seems to be in accordance with previous empirical results. However, a general concern regards the problems of spurious correlations due to underlying omitted or unobservable characteristics shaping both religious activities and risk attitudes. This paper examines empirically the demand for religion by analysing the association between risk attitudes on the one hand, and church attendance and prayer frequency on the other controlling for unobservable variables using survey data of Danish same-sex twin pairs. We verify the correlation between risk preferences and religion found previously by carrying out cross-sectional analyses. We also show that the association between risk attitudes and religious behaviour is driven by the subgroup of individuals who believe in an afterlife. In addition, when re-analysing our results using panel data analyses which cancel out shared factors among twin pairs, we find that the correlation found between risk aversion and religious behaviour is no longer significant indicating that other factors might explain differences in religious behaviour. Caution is needed in the interpretation of our results as the insignificant association between risk aversion and religious behaviour in the panel data analyses potentially might be due to measurement error causing attenuation bias or lack of variation within twin pairs rather than the actual absence of an association.

Keywords; risk preferences; religious behaviour; religious belief; twins; survey; expected utility

JEL classification; Z12

1. Introduction

Religion and religious institutions are important in many societies (Iannaccone 1998; Iyer 2016) and economic theory suggests that uncertainty and risk are important components of religious choice (Iannaccone 1998, Noussari et al., 2013, Durkin and Greeley 1991, Pingle and Melkonyan 2012). However, one crucial element distinguishes an analysis of religious participation from participation in other activities since most religions promise their members some form of afterlife. As such, the model for household religious participation introduced by Azzi and Ehrenberg (1975) allows for "afterlife consumption" which is partially a function of the household's investment of members' time in religious activities during their lifetimes (Azzi and Ehrenberg 1975). Within an Expected Utility (EU) framework, one can consider individuals' choice of religious beliefs and behaviour as an optimization of total expected utility from present and afterlife utility and one can interpret religious beliefs and behaviour as an insurance for the uncertainty of the presence of an afterlife and one's status in afterlife but also an insurance for events in current life (Durkin and Greeley 1991; Pingle and Melkonyan 2012).

As emphasised in Augenblick et al. (2016), faith (i.e. religious belief) is one of the key drivers of the demand side of religion. Afterlife rewards, which Azzi and Ehrenberg (1975) have argued to be the main goal of religious participation, may be thought of as a function depending on the accumulated religious activities of individuals. By interpreting religious orientation in an EU framework and considering the demand for religious beliefs and activities as the demand for an insurance both for current life events and for afterlife rewards, risk averse individuals will demand a more generous protection plan. They may do so by devoting more effort and resources into religious activities which seems to be in accordance with empirical results (Iannaccone 1998; Miller 2000; Bartke and Schwarze 2008; Mellor and Freeborn 2011; Noussair 2013). However, a general concern regards the problems of spurious correlation due to underlying omitted or unobservable characteristics shaping both religious beliefs and risk attitudes, e.g. family background of individuals.

This paper aims to examine the association between risk attitudes and religious behaviour controlling for unobservable variables using twin pairs. The paper thereby adds to the literature studying the demand side for religion by looking at the association between risk aversion and religion to establish whether risk aversion could be a driver for demand for religious participation. In addition, our paper complements the literature that utilises survey data to analyse the relationship between economics and religious behaviour (see eg. Barro et al.,

(2010); Huber(2005)). Our hypothesis is that more risk averse individuals put more effort into their religious participation. Based on the discussion in the literature, we hypothesise that this relationship will be stronger for those who believe in afterlife due to the salvation motive. Finally, exploiting survey data of Danish twins in the age group 19-39 we will investigate whether this correlation will be robust to the control for observable and unobservable common factors using within twin pair regressions.

The following sections will first provide background on the relationship between risk attitudes and religious beliefs and behaviour, a brief discussion of twin studies in general and a short introduction to religion in the Danish society. Secondly, the data and methods are presented followed by a description of the analytical strategy. The results from cross-sectional models are presented followed by the results from the panel data analyses and robustness checks. This is followed by a discussion and the final section concludes.

2. Background

2.1. The literature

Modern economics of religion began with the household production model of church attendance by Azzi and Ehrenberg (1975). In their model, participation in church-related activities can be motivated by three factors; 1) salvation motive by which individuals view their expected afterlife consumption as being related to their accumulated religious activities; 2) consumption motive where individuals derive current satisfaction from church membership and activities because of inherent religious beliefs or purely social reasons; 3) social pressure motive where church membership and participation will increase the probability of an individual's succeeding in business. Later models de-emphasise the salvation motive and the expectations from afterlife, and Hull (1989) lists benefits of church attendance such as the "temporal bliss" (the entertainment value of the church similar to other commodities bringing happiness to life) and the church as a social good (which among other things encourages income redistribution and health standards).

“Choosing to be religious” can be considered as a classic risk management strategy (see e.g. Yates (1992); Pingle and Melkonyan (2012)) which is often related to what is called “Pascal’s wager” named after Blaise Pascal’s argument for believing in God (Hajek 2004). Pascal argued that accepting Christianity made good sense since the cost is relatively small and the potential

gain is great, assuming that belief in God results in infinite utility if God exists. It pays off to believe in God in an EU sense, as long as the probability that God exists is greater than zero (Osterdal 2004). Tabarrok (2000) argues that this means that a believer would be willing to pay any finite payment of money in return for any increase in the probability of reaching God. In other words, becoming a Christian is a good way to hedge ones bets concerning an afterlife, even if one has doubts as to the ultimate truth of Christianity's claims. This is analogous to looking at religious acceptance as risk averse behaviour and the rejection of religious beliefs as risk taking behaviour (Miller and Hoffmann 1995). However, as emphasised in Montgomery (1996), applying the EU framework to religion might not be so simple since objective religious "information" may simply not exist, leaving no rational way to assign probabilities to most religious claims. Pingle and Melkonyan (2012) have investigated these issues by developing a model with a Bayesian updating process whereby individuals update their assigned truth probability to particular religions dependent on signals that the individual perceive to be valid information about the true probability.

Previous research on the correlation between risk aversion and religious beliefs and behaviour has found that females are more risk averse (in terms of self-reported adventure seeking) and more religious than males (Iannaccone 1998; Miller and Hoffmann 1995; Noussair et al., 2013; Mellor and Freeborn 2011). Miller and Hoffmann (1995) found that approximately half of the difference between male and female religious levels was due to differences in their risk attitudes. In a comparative study of German immigrants and native Germans, Bartke and Schwarze (2008) found that individuals with a religious affiliation are more risk averse (on a scale from 1 to 10) compared to atheists. From a cross-national (US, Italy, Turkey, India and Japan) perspective, Miller (2000) found that being irreligious only represents risk-taking (10-point scale measuring general risk attitudes) behaviour in Western (i.e. Christian and Muslim) societies whereas in Eastern (i.e. Hindu and Buddhist) societies non-participation in the mainstream religion does not necessarily constitute risk-taking behaviour. Hence according to Miller (2000), being irreligious in the sense of not belonging to a religion and not participating in religious behaviour only represents risk-taking behaviour to the extent that the religious culture in a society defines that behaviour as risky. As emphasised in Roth (2007), a risk preference theory of religion assumes that all individuals perceive or calculate costs and rewards of religious involvement. Being irreligious is not risky unless an individual believes that an undesirable consequence of not believing is possible. Honest disbelief in the existence of an afterlife eliminates the connection between individuals' risk preferences and their belief

and behaviour. Accordingly, based on the salvation motive proposed by Azzi and Ehrenberg (1975) there is an important distinction between those who believe in an afterlife and hence perceive a risk to irreligiousness from nonbelievers who perceive no risk associated with the judgement after death. When controlling for belief in afterlife and using the same data set as Miller (2000), Roth (2007) found that differences in risk preferences is not the mechanism that causes women's generally higher religiosity. This result highlights the importance of distinguishing between religious behaviour and religious belief, an argument presented in Miller (2000) and Iyer (2016). Miller argues that risk attitudes will increase certain types of behaviours but it is less clear how it will affect beliefs (i.e. whether belief in afterlife should have any relationship to risk attitudes).

In the present study, we will investigate the association between risk attitudes and religious behaviour. We expect that more risk averse individuals put more effort into their religious participation and are more inclined to be members of a religious community. Based on the discussion in the literature, we also hypothesise that this relationship will be stronger for those who believe in afterlife compared to those not believing in an afterlife due to the salvation motive. Finally, we will investigate whether this correlation will be robust to the control for observable and unobservable common factors using within twin pair regressions.

2.2. Twin data techniques and results

Several studies have used schooling and wage variation between twins to estimate the wage return to schooling see e.g. Ashenfelter and Krueger (1994); Behrman et al. (1999); Bound and Solon (1999). One problem with a standard cross-sectional comparison of workers with different years of schooling would be that if the more educated workers have a tendency to be more intelligent, motivated, or blessed with advantageous family backgrounds then the more educated workers typically would have received higher wages even without their additional schooling (Bound 1999). Insofar as siblings resemble each other in terms of family background, intelligence etc., relating differences between siblings' incomes to differences in years of schooling could potentially eliminate or reduce the bias by controlling for shared unobservable factors.

In economics, there is a small but growing research field using behaviour genetic techniques (Bowles et al., 2005) and twin studies indicate that both genes and environment have a significant impact on most items of religiousness (Kirk et al. 1999; Hvidtjørn et al., 2013; Eaves et al., 1990). However this way of decomposing the variation within twin pairs has also been criticised, see e.g. Stenberg (2013).

2.3. Religiousness in Denmark

As a final background information before presenting the methods and data from the present study, we will briefly introduce the religious community in Denmark. Denmark is seen as one of the most secular societies in the world (Zuckerman 2008) with very low rates of church attendance (2.4% go to church every week (Gallup 2008)) and very limited religious discourse in public life. However, despite the low rate of church attendance, around 80% of the total population are members of the Danish National Evangelical Lutheran Church (Statistics Denmark 2009). The proportion is around 60-70% for the 20-40 year olds (Kleinbeck 2007). Since the establishment of the Danish Constitution of 1849 the Evangelical Lutheran Church in Denmark has been regarded as "the church of the people" as well as an official national church. One becomes a member of the Danish National Evangelical Lutheran Church, by being baptised into it, mostly as an infant. A member has the right to make use of the church for baptisms, weddings and funerals. The membership subscription is paid via tax returns which are on average 0.89% of a person's taxable income¹. In light of the fact that a very high proportion of Danes are members of the Danish National Evangelical Lutheran Church, the choice to be a member might arguably be as much a cultural heritage as a religious choice. Based on that, we have chosen not to use this variable in the analyses presented in the next section.

3. Data

This study applies data from a survey from the Danish Twin Registry focusing on health behaviour and religiousness. The survey was carried out in Denmark in 2009-2010 as an online survey². Respondents in the age group 19-39 were surveyed. For the present analysis we will focus on questions related to religious behaviour represented by two variables: how often the respondent prays and church attendance. These will be the left-hand side variables in our

¹ see also www.lutheranchurch.dk

² Respondents were given the option to request a paper version of the survey, but only 34 respondents chose to use a paper version.

analyses. The respondents were asked about the frequency in definite categories ranging from the highest frequency being every day (prayer) or week (church attendance) to lowest frequency being seldom or never. Based on the definite categories the two variables were recoded into continuous variables [0; 365 prayers per year] and [0; 52 church visits per year]. Respondents were also asked about whether they believed in an afterlife (yes/no).

The primary right-hand side variable is a measure of risk attitudes in the context of health. The empirical measurement of individuals' risk attitudes is not straight forward, and various measures have been suggested in the literature (Dohmen et al., 2012). Information about respondents' risk attitudes was obtained by asking the respondent to state on a ten-point rating scale, their personal attitudes towards risk especially with respect to health. Respondents were asked the following question; "How would you describe your personal attitude to health and risk?" They could respond on a scale from 1 to 10, with 1 being; "I focus mostly on having a healthy behaviour and will rather avoid a risk" and 10; "I focus mostly on enjoying life now and do not worry about the health risk". Finally, respondents were asked whether they have experienced a severe personal crisis.

4. Analytical strategy and hypothesis.

We design our analytical strategy around a key hypothesis;

H_0 : Religious behaviour is independent of risk aversion

H_A : Religious behaviour is positively associated with risk aversion

If H_0 is rejected and the alternative accepted, we would expect the association between risk aversion and religion to be stronger for those believing in an afterlife in accordance with the salvation motive (Azzi and Ehrenberg 1975).

Firstly, using OLS regression models, we carry out cross-sectional analyses on twin pairs acknowledging the correlation structure between twins by estimating robust standard error clustered at the twin level. We carry out separate regressions on the two religious variables. In addition to risk aversion in the context of health and an interaction term between belief in afterlife and risk aversion, the right-hand side variables will include age, gender, education, marital status, number of children, and whether the respondent has experienced a major crisis.

Many of these variables have shown in previous studies to influence religious behaviour (Iannaccone 1998; Mellor and Freeborn 2011) and to be related to risk seeking behaviour (Anderson and Mellor 2008; Dohmen et al., 2011). Following this, we exploit the twin data structure to assess whether any correlation found between risk preferences and religious behaviour might suffer from omitted variable bias. Accordingly, the OLS results are re-analysed using fixed-effects regression models that cancel out shared factors among twin pairs, such as early family environmental factors, age etc. The initial choice of a fixed-effects model is motivated by a prior expectation that the strong assumption of the alternative random-effects model (i.e. that the right-hand side variables and the unobserved twin-specific heterogeneity are uncorrelated) is not met, in which case a random-effects model would be inconsistent. The twin pair fixed-effects control for unobserved heterogeneity that may have been correlated with the right-hand side variables. We check our prior expectation by estimating a random effects model and comparing this to the fixed-effects model using a Hausman test. Finally, we estimate a correlated random effects model (also known as a Mundlak model), which is essentially a random effects model including twin-means of the right-hand side variables (Greene 2008; Mundlak 1978). This model relaxes the assumption of the random effects model by specifying a particular form of correlation between the right-hand side variables and the unobserved heterogeneity. The statistical significance of the estimated coefficients for the twin-means provides a test of whether the random effects assumption holds for the individual right-hand side variables.

Since the impact of risk aversion on religious behaviour potentially varies by gender (Iannaccone 1998), only same-sex twins are included in all parts of the analyses and hence gender cancels out in the fixed-effects analyses.

5. Results

Of the 6,707 panel members invited to participate in the survey, 3,686 completed the questionnaire (response rate of 55%). In total, we received responses from 909 complete same-sex twin pairs (1,818 individuals). Respondents were given the opportunity to decline responding to the religious part of the questionnaire and the analyses below are carried out on a balanced sample using same-sex twin pairs where both siblings answered all questions (a total of 585 twin pairs (1,170 individuals)).

5.1. Descriptive statistics

Table 1 presents descriptive statistics for the variables used in the analyses. The average annual number of prayers is 21.27 whereas average annual number of church attendances is 2.59.

TABLE 1 AROUND HERE

The distribution of responses for the risk aversion variable as well as the two religious variables are depicted in the Appendix in addition to within twin correlation for these variables. From the diagrams it is clear that 26% of the sample never goes to church and 53% never prays. A small proportion of the respondents goes to church more than once per month ($< 5\%$) and a small proportion prays every day ($< 4\%$). To test for the sensitivity to these comparatively very religious respondents, we will present results both with and without responses from this group of respondents. Within twin pair correlations are significant and high (reported in the Appendix). In addition, it can be seen that 45% of the twins reported the same level of prayer frequency, 43% the same level of church attendance and 17% the same level of risk aversion. Whereas these correlations are high, it still leaves more than 50% of within twin differences to further explore.

5.2. Test of hypothesis

Table 2 presents the results from the regression analyses on the dependent variables on church attendance whereas Table 3 presents the results from the analyses on prayer frequency. Models 1-3 present the results from the OLS model with robust standard errors clustered at the twin level. Model 1 only includes risk aversion as explanatory variable whereas Model 2 includes additional covariates as well as an interaction between risk aversion and whether or not the respondent believes in an afterlife. Model 3 excludes the group of respondents who are very religious as described above. Model 4-5 report regression results using fixed-effects panel models. The estimated coefficients from the fixed-effects model provide a within pair estimate of the effects of changes in the difference for individuals from the twin pair average. Model 6 reports the results from the correlated random-effects model (Mundlak).

TABLE 2 AROUND HERE

TABLE 3 AROUND HERE

From Model 1 it is clear that there is a positive correlation between higher risk aversion and church attendance as well as prayer frequency. We thereby reject H_0 . In Models 2-3, the interaction between believing in afterlife and risk aversion is significant and positive which indicates that the relation between church and risk aversion is primarily driven by the respondents who believe in an afterlife. Although significant in both models, the size of the coefficient on the interaction term is very sensitive to the exclusion of the very religious respondents in Model 3. The overall effect of risk aversion is also significant as the sum of the two coefficients are statistically significantly different from 0 (reported in Table 2-3). Hence, more risk averse respondents are putting more effort into their religious behaviour. Being married is positively associated with church attendance and frequency of prayers (only in Model 2) and women have a significantly higher church attendance. Finally, having experienced a personal crisis has a significantly positive impact on prayer frequency (in Model 3) whereas children have a significantly positive impact on church attendance (Model 3).

The results from Models 4-6 show that the risk aversion variable as well as the interaction term are insignificant in all regressions indicating that based on that we cannot reject H_0 implying that the correlation between risk aversion and religious behaviour to a large extent is driven by common unobservable and early family environmental factors. Controlling for family environmental factors, having experienced a crisis has a positive influence on church attendance and prayer frequency which means that a sibling who has experienced a crisis will attend church more often and pray more compared to the sibling who has not experienced any crises. For both dependent variables, a Hausman test for random effects was carried out. This test was rejected ($p < 0.01$) for the test relating to Model 5 and ($p < 0.1$) for the test relating to Model 4) implying that the random effect was rejected. In addition, the F-tests for fixed-effects reject the null hypothesis (that all twin specific intercepts are zero), which means that the twin fixed-effects models are preferred over the cross sectional analyses. For both dependent variables in Model 6, we find a statistical significance of the estimated coefficients for the twin-means for the interaction variables between risk aversion and afterlife as well as the variable for crises which indicates that the random effects assumption doesn't hold for these right-hand side variables. For all panel data analyses the within, between and overall R^2 are reported.

5.3. Robustness check

To check the robustness of the results with respect to the distributions of the dependent variables, we re-estimated Models 1-3 using ordered probit models (combining the three top

categories in both variables). In addition, we estimated separate probit regressions on dichotomous variables (i.e. whether respondents pray and go to church). Our main findings are robust to these different model specifications. The correlation between prayer frequency and church attendance is highly correlated ($\rho=0.48$). To take into account that the error terms of the church attendance and prayer models are likely to be correlated, we estimated seemingly unrelated regressions (SUR). This model reveals that the error terms are in fact correlated, and that taking this correlation into account increased efficiency somewhat but did not change our main conclusions³. Likewise, the findings from re-estimating Models 4-6 are robust to excluding the very religious respondents.

To validate the risk aversion variable, we use survey information about the respondent's actual health behaviour. With respondent's risk aversion as the dependent variable, we carried out three separate OLS regressions as well as three fixed-effects regressions with risk aversion as the dependent variable to test for the effect of being 1) smoker, 2) obese (as measured by their Body Mass Index) and 3) unit of alcohol consumption, respectively. All regressors are significant and negative as expected and hence the health measure is correlated with health behaviour in cross-sectional analyses and within twins. The coefficients have been included in the Appendix (table A1).

6. Discussion

We set out to examine the demand side for religion by looking at the association between risk aversion and religion to establish whether risk aversion could be a driver for the demand for religion. Based on the cross-sectional results we can reject our hypothesis that religious behaviour is independent of risk aversion. We also show that the association between risk attitudes and religious behaviour is driven by the subgroup of individuals who do believe in an afterlife. This is in accordance with the expectation that the salvation motive (Azzi and Ehrenberg 1975) is determining the connection between individuals' risk attitudes and their religious behaviour. In addition, we find that males have lower church attendance which is similar to other results in the literature (Iannaccone 1998).

³ Results are available from the authors upon request

The results of the fixed-effect models show that the risk aversion variable is insignificant in all regressions indicating that we cannot reject that the correlation between risk aversion and religious behaviour to a large extent is driven by early family environmental factors and thus that the association obtained within the cross-sectional framework suffers from omitted variables bias. Controlling for family environmental factors, having experienced a crisis has a positive influence on church attendance and prayer frequency which means that a sibling who has experienced crises will attend church more often and pray more compared to the sibling who hasn't experienced any crises. One could argue, that the increase in church attendance and prayer frequency after experiencing a crises might be motivated by an urge to find comfort in current life (and not by consideration about afterlife). Hence, in the terminology of Azzi and Ehrenberg (1975), differences in religious behaviour found within twin pairs seem to be driven by a consumption rather than a salvation motive.

In this paper we have applied a rating scale as a measure of risk preferences. Whereas this may not be a perfect measure of risk preferences, it has the advantage of being less cognitively demanding than the standard lottery measures used by among others (Hartog et al., 2000; Holt et al., 2002). Moreover, rating scale measures of risk preferences were found to have behavioural validity and outperform a standard lottery measure in terms of predicting risky behaviour in Dohmen et al. (2011; 2012). However, it could be argued that the reason for the insignificant risk aversion parameter found in our panel data analyses could be due to the risk aversion scale measure not having the sufficient level of precision to capture within twin pair differences in risk aversion. The mean within twin pair difference in risk aversion in our sample was found to be 1.9 with 17% stating the exact same level of risk aversion. This does indicate that the risk aversion scale measure has been able to capture some degree of within twin pair variation. However, another related concern regarding the risk aversion measure is measurement error and the resulting attenuation bias, which is exacerbated using twin fixed-effects models. According to Dillman (2007), measurement error in survey questions occur “when a respondent’s answer to a survey question is inaccurate, imprecise, or cannot be compared in any useful way to other respondents’ answers” (quote p. 9). By taking differences in scores (as in the fixed-effect regressions) a considerable fraction of the variability in the reported differences in twins' risk aversion could be due to measurement error (Ashenfelter and Krueger 1994, McGue et al., 2010). Hence, due to the compounding of error inherent in taking a difference in risk attitudes, measurement error could bias the within twin pair estimates to a

greater degree than the individual level association. Accordingly, measurement error in the within twin pair differences in risk aversion might also partly explain the insignificant relationship found in the panel data analyses. In addition, twins are alike in many respects and twin fixed-effects can therefore lead to insignificant estimates due to a lack of variation within twin pairs. Hence, there is a risk that our finding of an insignificant association between risk aversion and religious behaviour is due to a lack of variation within twin pairs rather than the actual absence of an association. While we present evidence on differences within twin pairs with respect to risk aversion as well as church attendance and prayer frequency and also estimate correlated random-effects models, we cannot rule out that the estimated coefficients are biased towards zero due to insufficient within twin pair differences.

The paper by Miller et al. (1995) contains a discussion of the causality of religiousness and risk preferences. They argue that risk preferences precede personal religiosity for most people because risk preferences are required very early and tend to remain constant throughout one's life. Individual religiosity on the other hand, does not typically develop until one's early teens since it requires a higher level of cognitive development, see also Epstein (1994) for a discussion. Our results add an extra dimension to this discussion on causality by suggesting that the correlation between religious behaviour and risk attitudes could in fact be driven by unobservable early family environmental factors. In this paper, risk aversion in the context of health is examined which thereby complements research analysing the relationship between health and religion, see eg. Hvidt et al., (2017), Mellor and Freeborn (2011). Analysing the association between other risk aversion measures and religion could be a topic for future research.

In the present paper, it has been argued that religious behaviour and activity can be seen as a form of an insurance. From this model follows an expectation about a positive correlation between risk aversion and religious behaviour. Considerations about afterlife are primarily driving this way of perceiving religious behaviour and activity and the subsequent positive correlation between risk aversion and religiousness. However, it is not our intention to suggest that religious behaviour is exclusively or even principally a matter of risk analysis. The findings in this paper supports this since when controlling for family environment, risk aversion is insignificant whereas whether the respondent has experienced a crises is significant. This suggests that other factors might influence religious behaviour to a greater extent than risk preferences. It is a question for future research to examine whether for example time

preferences could be an additional factor and to analyse the combined effect of risk aversion and time preferences (see eg. Rieger 2015) and how that affects religious behaviour.

7. Conclusion

In this paper, we analyse the demand for religion and verify the expected correlation between risk preferences and religious behaviour (prayer frequency and church attendance) previously found in the literature. We also show that the association between risk attitudes and religious behaviour is driven by the subgroup of individuals who believe in an afterlife which is in agreement with the salvation motive (Azzi and Ehrenberg 1975). However, when re-analysing our results using fixed-effects and correlated random effects regression models, we find that the correlation found between risk aversion and religious behaviour becomes insignificant. It might be that other factors (such as whether respondents have experienced a crisis) are explaining differences in religious behaviour. Our results come with the caveat that the insignificant association between risk aversion and religious behaviour in the panel data analyses potentially might be due to measurement error causing attenuation bias or lack of variation within twin pairs rather than the actual absence of an association.

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TABLES

Table 1. Descriptive statistics. Same-sex twin pairs

Variable name	Variable description	Mean (SD)	N
Left-hand side variables			
PRAY	Prayer frequency (prayers per year (from 0 to 365))	21.27(2.08)	1170
CHURCH	Church attendance (visits per year (from 0 to 52))	2.59(0.21)	1170
Right-hand side variables			
RISK AVERSION	Risk aversion (health) (1 risk loving; 10 risk averse)	6.21 (0.06)	1170
AGE	Age (years)	30.2 (0.17)	1170
MALE	Male (1 if male; else 0)	0.36 (0.01)	1170
HIGH EDUCATION	High education (1 if higher education; else 0)	0.26 (0.01)	1170
MARRIED	Marriage (1 if married; else 0)	0.34 (0.01)	1170
CRISES	Have experienced (self-assessed) personal crises (1 if the respondent has experienced a crises; else 0)	0.68 (0.01)	1170
CHILDREN	Number of children	0.80 (0.03)	1170
AFTERLIFE	Believe in life after death (1 if believe; else 0)	0.33(0.01)	1170

Table 2. Regression results. Church attendance (per year)

Left-hand side variable: Church attendance	Model 1: OLS	Model 2: OLS	Model 3: OLS ^a	Model 4: FE	Model 5: FE	Model 6: Mundlak
	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)
Risk_aversion	0.261 ** (0.125)	0.063 (0.101)	-0.009 (0.019)	0.039 (0.095)	-0.002 (0.097)	-0.002 (0.097)
Afterlife*risk_aversion		0.501 *** (0.131)	0.053 ** (0.014)		0.097 (0.065)	0.097 (0.065)
Age		-0.043 (0.056)	0.005 (0.009)			
Male		-0.888 ** (0.444)	-0.359 *** (0.091)			
High education		-0.359 (0.388)	-0.124 (0.095)		-0.042 (0.553)	-0.042 (0.553)
Children		-0.470 (0.414)	0.101 * (0.061)		-0.270 (0.281)	-0.270 (0.281)
Crises		-0.552 (0.618)	-0.063 (0.085)		0.730 * (0.415)	0.730 * (0.415)
Married		1.717 ** (0.707)	0.216 * (0.120)		0.679 (0.517)	0.679 (0.517)
Mean: Risk aversion						0.150 (0.204)
Mean: Afterlife*risk_aversion						0.659 *** (0.130)
Mean: High education						-0.520 (0.917)
Mean: Children						-0.724 (0.524)
Mean: Crises						-1.948 ** (0.839)
Mean: Married						2.134 * (1.159)
Constant	0.973 (0.681)	3.139 * (1.828)	1.115 *** (0.268)	2.352 *** (0.600)	1.916 *** (0.711)	1.048 (1.193)
H ₀ : Risk + Afterlife*risk = 0		F(1, 584)	F(1, 566)		F(1, 579)	Chi ² (1)
p-value		0.003	0.042		0.361	0.361
N	1170	1170	1088	1170	1170	1170
No. of groups				585	585	585
F-test (model)	6.240**	4.380***	3.600***	0.170	1.220	70.460***
d.f.	1, 584	8, 584	8, 566	1, 584	6, 579	12 (Chi ²)
F-test (fixed-effect)				5.770***	5.430***	
d.f.				584, 584	584, 579	
R ² overall	0.005	0.065	0.068	0.005	0.024	0.086
R ² within				0.000	0.013	0.013
R ² between				0.009	0.032	0.099

Notes: ^a Excluding observations with extreme values on the left-hand side variable. * Significance at 10% level; ** Significance at 5% level; *** Significance at 1% level.

Table 3. Regression results. Prayer frequency (per year)

Left-hand side variable: Prayer frequency	Model 1: OLS	Model 2: OLS	Model 3: OLS ^a	Model 4: FE	Model 5: FE	Model 6: Mundlak
	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)	Coef. (s.e.)
Risk_aversion	2.506 ** (1.003)	0.045 (0.886)	0.282 (0.341)	0.292 (1.346)	-0.118 (1.380)	-0.118 (1.380)
Afterlife*risk_aversion		6.276 *** (1.093)	1.238 *** (0.291)		1.201 (0.925)	1.201 (0.925)
Age		0.200 (0.469)	-0.015 (0.161)			
Male		-1.649 (4.230)	-1.311 (1.323)			
High education		0.887 (4.565)	-1.361 (1.478)		-0.807 (7.836)	-0.807 (7.836)
Children		-2.016 (3.414)	0.285 (0.896)		-2.392 (3.983)	-2.392 (3.983)
Crises		4.596 (4.207)	3.079 ** (1.234)		15.093 ** (5.875)	15.093 ** (5.875)
Married		9.112 * (5.353)	-0.027 (1.884)		2.920 (7.331)	2.920 (7.331)
Mean: Risk						0.286 (2.038)
Mean: Afterlife*risk_aversion						7.978 ** (1.321)
Mean: High education						4.804 (9.942)
Mean: Children						-0.962 (5.433)
Mean: Crises						-16.136 ** (8.469)
Mean: Married						14.209 (11.360)
Constant	5.710 (5.797)	-1.374 (12.096)	2.009 (4.809)	19.454 ** (8.516)	10.495 (10.072)	-0.851 (9.978)
H ₀ : Risk + Afterlife*risk = 0		F(1, 584)	F(1, 566)		F(1, 579)	Chi ² (1)
p-value		0.000	0.001		0.465	0.465
N	1170	1170	1088	1170	1170	1170
No. of groups				585	585	585
F-test (model)	6.240**	4.380***	3.600***	0.050	1.480	116.610***
d.f.	1, 584	8, 584	8, 566	1, 584	6, 579	12 (Chi ²)
F-test (fixed-effect)				2.140***	1.930***	
d.f.				584, 584	584, 579	
R ² overall	0.005	0.081	0.043	0.005	0.026	0.112
R ² within				0.000	0.015	0.015
R ² between				0.011	0.033	0.157

Notes: ^a Excluding observations with extreme values on the left-hand side variable. * Significance at 10% level;

** Significance at 5% level; ***

Appendix. Descriptive statistics

Within twin pair correlation: 0.25***

Within twin pair correlation: 0.37***

Within twin pair correlation: 0.71***

Table A1. Test for significant association between risk aversion and health behaviour

		OLS		Fixed effect	
Risk aversion (health)		Coef. (Robust Std. errors)	Const (Robust Std. errors)	Coef. (Robust Std. errors)	Const (Robust Std. errors)
Obese	1 if BMI [†] >25; else 0	-0.7 (0.14)***	6.40(0.07)***	-0.67(0.25)***	6.39(0.08)***
Smoker	1 if currently smoker; else 0	-1.12(0.14)***	5.30(0.13)***	-0.73(0.24)***	5.61(0.02)***
Alcohol	unit	-0.05(0.16)***	6.48(0.10)***	-0.03(0.02)***	6.36(0.10)***

[†] weight in kg/(height in m)²