

# CULTURE, HUMAN CAPITAL, AND MARITAL HOMOGAMY IN FRANCE\*

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This version: October 10, 2022

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## Abstract

*I present a new model of cultural transmission, in which children are simultaneously socialized to several cultural traits through parental time investments as well as their environment. Using parents–children data on religious affiliation in France, I then analyse the model in reduced form to examine the patterns of intergenerational religious transmission, finding that mothers contribute more to religious transmission to children than fathers; religious minorities more than majorities; and lower-educated parents more than higher-educated ones. To explain this pattern, I embed the cultural transmission model in a collective household problem, in which parents endogenously decide their time investments in their child’s culture on one side, and in their formal education on the other side. I verify that the model’s predictions replicate the stylized facts in the data. Finally, I estimate this model, finding that a systematic difference in preferences across religions and genders is the main factor explaining disparities in transmission patterns, as opposed to an argument of comparative advantage in human capital transmission for higher-educated individuals.*

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\*I am grateful to my advisor Paul Seabright, as well as to Bernard Salanié and François Salanié, who provided extensive guidance for this project. I also thank Ishani Chatterjee, Pierre-André Chiappori, Roberta Dessi, Laurence Iannaccone, Michael McBride, Karine Van Der Straeten, as well as participants at the TSE PhD workshop, ASREC 2022 conference, CIREQ 2022 conference, TSE Applied Micro workshop, TSE Behavior, Institutions and Development workshop, and IRES workshop for helpful comments. All errors are my own.

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# 1 Introduction

What sacrifices are people willing to make to uphold their culture? From relatively mild constraints on clothing and diet, all the way to ritual suicide and martyrdom, the endorsement of a cultural identity can be a costly endeavor.<sup>1</sup> Sometimes this cost carries an explicit price tag, like with the *jizya*, the tax which was collected on non-Muslims by the Ottoman Empire. But for the most part, especially in modern societies which accommodate multiculturalism, the cost of upholding one's culture is one of time: time dedicated to practice a language, to go to a religious service, or to learn a national anthem.

This time concern is especially prevalent when it comes to transmitting culture to children.<sup>2</sup> During the process called *socialization*, children learn the tenets and principles of the previous generation's culture. The socialization process involves not only learners, however, but also teachers, and it is a time-consuming activity for both sides. Time being by essence a limited resource, trade-offs then arise on how to socialize children. Parents play of course a central role here: first because they are involved in the socialization process themselves, but also because they usually have some authority on whom the child can be socialized by. Hence they hold some decision power in how much to emphasize cultural transmission in their child's upbringing, and at what cost.

During the recent decades, one particularly striking illustration of this trade-off between cultural transmission and other activities has been the tension between religion and formal education. Modern schooling emphasizing rationality and the scientific approach has long clashed with religion, in part because their respective teachings are sometimes incompatible, but also because they must compete for children's limited attention.<sup>3</sup> In the United States this clash is still unfolding, for instance with the ever-lasting debates around the inclusion of creationism in the public school curriculum. Some religious groups, such as the Amish or Jehovah's Witnesses, also explicitly discourage their affiliates to pursue college or even high school education – arguably because they implicitly acknowledge these trade-offs. In France, the last 20 years have seen a rapid increase in the number of private Muslim schools: from two in 2001, to several dozens in 2018.<sup>4</sup> Yet, only a small number of those have been sanctioned by the government. This means that most of these schools have free rein to design their curriculum and, for this reason, provide

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<sup>1</sup>On diet, well-known examples include religious or ethnic prohibitions on beef (Hindus) or pork (Muslims, Jews), but also recent trends like veganism, which can be seen as a cultural identity by itself. On clothing restrictions, head covering is a common cultural practice (especially for women); as is wearing a business suit to work, for instance. On ritual suicide, historical examples include the Japanese honor suicide (*seppuku*) or the self-immolation of widows in India (*sati*). On martyrdom, both Christianity and Islam have for instance a history of glorifying individuals who died for advocating their religious beliefs. The list of costly cultural behaviors goes on, of course.

<sup>2</sup>Intergenerational transmission is one of culture's defining feature: following for instance Guiso, Sapienza and Zingales (2006), culture designates “those customary beliefs and values that ethnic, religious, and social groups transmit fairly unchanged from generation to generation.”

<sup>3</sup>See for instance Squicciarini (2020), Chaudhary and Rubin (2011), or Carvalho et al. (2017) for historical examples and evidence of the substitutability between religion and formal education.

<sup>4</sup>Ferrara (2018) estimates this number to be between 45 and 60 active private Muslim schools.

an uncertain added value for their pupils' formal education. Parents who choose to send their children to these private schools may therefore be furthering religious transmission to their children while compromising on their formal education.

In this paper, I investigate the role of parental characteristics in the cultural transmission to children, focusing specifically on the transmission of religious affiliations using 2008 cross-sectional data from France. Both a reduced-form approach and the estimation of a structural model adapted from the Bisin and Verdier (2000) cultural transmission framework provide evidence that mothers contribute more than fathers to the intergenerational transmission of religion, and religious minorities more than majorities.

The reduced-form analysis uses a multi-logit specification to explain children's choice of religious affiliation as a function of their parents' characteristics and of the religious mix of their environment. This choice of variables, which is informed by the Bisin and Verdier (2000) model, proves successful in fitting the data according to usual statistical measures. The results suggest that mothers contribute more to religious transmission to their children than fathers, and parents from religious minorities (Muslims and Jews) more than those from religious majorities (Christians and Nones). Furthermore, higher education is broadly associated with lower contributions to religious transmission. These findings are broadly consistent with an economic explanation involving parental human capital, namely that parents with higher human capital have a higher opportunity cost to spend time socializing their children.

I investigate this potential mechanism by building a structural model in which parents must trade off investments in the child's formal education on the one hand, and in the child's religious socialization on the other hand. To estimate this model, I use variation in children's religious affiliation *and* educational attainment. Both are predicted by the model as non-linear functions of the parents' characteristics and of structural parameters, for which standard logit regression is not suited. For this reason, I develop a maximum likelihood approach which combines elements from both multinomial logit (for religious affiliation) and ordered logit (for educational attainment) estimation. I find that the economic mechanism involving human capital is not sufficient to explain religious socialization disparities between mothers and fathers: instead, the results suggest that systematic disparities in preferences between mothers and fathers regarding the formation of children's religious versus human capital, are responsible for mothers' prominent role in religious transmission. In a similar way, results suggest that the socialization disparities between religious minorities and majorities (minorities socialize more than majorities) must also involve a disparity in preferences for religious socialization across religions. Indeed, neither a human capital explanation as described above (minorities are less educated than majorities, so they have a lower opportunity cost to religious socialization), nor a cultural substitution one (minorities socialize their children more because they cannot rely on the environment to do so; see Bisin and Verdier 2000) can fully account for these disparities. Overall, these results suggest that parental preferences for religious socialization play an

important role in the religious transmission process. While I cannot rule out that these preferences are in fact rooted in an economic value of children’s religious affiliation,<sup>5</sup> a reasonable interpretation is that religious transmission to children seems to matter *per se* to the parents.

**Related literature.** This paper speaks to a recent literature which has explored the link between investments in religious versus formal education, and more broadly to the literature on the economics of religion (see [Iannaccone 1998](#) and [Iyer 2016](#) for reviews). For instance, [Squicciarini \(2020\)](#) shows that in 19th-century France, Catholic education competed with the secular curriculum, ultimately hampering economic development in regions with higher religiosity. [Chaudhary and Rubin \(2011\)](#) document a similar phenomenon for Muslims in colonial India. [Carvalho, Koyama and Sacks \(2017\)](#) and [Carvalho, Koyama and Williams \(2022\)](#) consider models in which cultural minorities protect their culture by resisting formal education, taking as illustration the 19th-century Jewish emancipation in Europe.

As opposed to educational institutions, my paper focuses on the way parents spend their time to invest in religion versus education for their children, and in this respect it fits in the literature on time allocation theory and human capital formation of children ([Becker 1965](#), [Del Boca et al. 2014, 2016](#)). This is important to consider because parental time investments have been shown to be important factors in children’s human capital formation ([Del Bono et al. 2016](#)) as well as cultural capital formation ([Botticini and Eckstein 2007, 2012](#), [Patacchini and Zenou 2016](#)). In particular, my model of cultural socialization takes inspiration from the technology of children’s human capital formation in [Del Boca, Flinn and Wiswall \(2014\)](#). I use a collective household framework ([Chiappori 1992](#)) to model parental time investments decisions, and in that respect the paper closest to mine is [Chiappori, Salanié and Weiss \(2017\)](#). However, while they model trade-offs between time investments in children’s human capital and time spent working, I focus on time investments in children’s religious versus human capital formation. My emphasis on religious capital as an intensive measure of religion<sup>6</sup> which is built by purposeful investments can be traced to [Iannaccone \(1990\)](#).

Finally, this paper relates the most to the literature on the economics of cultural transmission spurred by [Bisin and Verdier \(2000, 2001\)](#) and reviewed twice since then ([Bisin and Verdier 2011, 2022](#)). On the empirical side, it joins other works which use

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<sup>5</sup>For instance, parental preferences for passing cultural affiliation could be rooted in the existence of economic networks based on such affiliations; see [Munshi \(2011, 2019\)](#) on Indian caste-based networks. Starting with [Iannaccone \(1992\)](#), the economics of religion literature has also pointed out the ‘club good’ dimension of religion.

<sup>6</sup>Rather than just religious affiliation, which is a discrete, extensive measure. The literature on cultural transmission has mostly focused on the latter for now, but see [Cheung and Wu \(2018\)](#) who consider a continuous trait and [Patacchini and Zenou \(2016\)](#) who consider discrete intensity (low or high religiosity) of the same trait. This focus on intensity has remained at the expense of a possible multiplicity of traits, however.

cross-sectional data on parental and children’s cultural affiliations to recover values for the primitive parameters of cultural transmission models.<sup>7</sup> Close papers include Bisin, Topa and Verdier (2004), who also study the transmission of religious affiliation but using US data; Patacchini and Zenou (2016) who study parental religious socialization efforts as a function of the child’s religious environment, also in the US; or Bisin and Tura (2020) who study language transmission among Italian migrants. Methodologically however, these papers mostly rely on aggregate moments (probability of transmission or of homogamous marriage) to estimate structural parameters. As far as I know, using discrete choice theory (McFadden 1973) to explain children’s choice of cultural affiliation empirically, as I do in this paper, is a new contribution to this strand of literature. This methodological shift reflects the fact that I also depart from the usual Bisin and Verdier framework, which focuses on discrete cultural affiliations, for an approach which emphasizes cultural capital formation. Another recent effort to include a cultural capital approach in the theory of cultural transmission is Carvalho and McBride (2022), but this remains purely theoretical.

The paper is organized as follows. In section 2 I present the data and describe it along several dimensions of interest: education, religion, and patterns of marriage and of intergenerational transmission along these dimensions. In section 3 I focus on empirical patterns of religious socialization using a reduced-form analysis. In section 4 I introduce the theoretical framework of cultural socialization in the household, in which parents must trade off investments in their child’s culture versus formal education. In section 5 I describe my procedure to estimate this model, and I present the results. Finally, section 6 concludes.

## 2 Data

In order to investigate the relationship between culture and human capital in marriage and transmission to children, I use data from the Trajectories and Origins survey (*Trajectoires et Origines*, or TeO for short; see Beauchemin et al. 2016 for details). The TeO survey was conducted in metropolitan France in 2008. With over 21,000 respondents, it aimed to document the life experiences of migrants living in France and their descendants. Because of this specific aim, the TeO survey is particularly relevant to study intergenerational transmission. First, because it includes questions not only about the respondents, but also about their parents. This information is obviously critical to the study of intergenerational transmission. Second, it is one of a few large-scale surveys in France which collects answers on respondents’ religious affiliation and practices. Indeed, collecting such information is in general prohibited by law in France (*loi informatique et libertés* of 1978) and requires a

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<sup>7</sup>In their review, Bisin and Verdier (2011) label these papers collectively as *structural socialization studies*.

special derogation. For the purpose of this paper, it means that the TeO database is a rare opportunity to study religion as an example of cultural trait in France. Lastly, the TeO survey oversamples migrants and their descendants by design. In doing so, it provides a sizeable sample for several religious minorities in France, most notably Muslims, thus allowing to draw comparisons across different religious groups.

Respondents were between 18 and 60 years old at the time of the survey (cohorts born between 1948 and 1990). The sample is slightly skewed towards women (52.8%). In the following, not only do I use data on the respondents, but I also rely extensively on the answers regarding their parents to study time trends, as well as marriage and transmission patterns. Respondents' parents were born as early as 1900, but I ignore pre-1920 parental cohorts on graphical representations (those have less than 100 observations per cohort). I provide more general statistics about the TeO survey in Table 8 (Appendix B). In the rest of this section, I describe the TeO data and some stylized facts regarding education and religion, both in terms of transmission and marriage patterns.

A note on graphical representations: the data can be quite noisy and graphics difficult to interpret when observations are split across the three dimensions of cohorts, religion, and education. For this reason, graphical representations throughout the paper feature nonparametric predictions (LOESS) of different outcomes of interest on birth cohorts. This allows me to obtain smoothed curves which provide a better picture of the evolution of these outcomes across cohorts (see for instance Figure 1 on education in the sample). These curves are systematically accompanied by representations of the corresponding 95% confidence interval. On some graphs I represent the actual data using dots (such as in Figure 1), but when it hampers readability I only represent the nonparametric predictions (such as in Figure 4).

## 2.1 Education

In the TeO survey, educational attainment is reported using the ISCED 97 classification of the highest diploma obtained. From this variable, I construct three simplified educational attainment categories: (1) “Primary or less,” for individuals who completed at most primary education; (2) “Secondary,” for individuals who obtained a middle- or high-school diploma, or a technical diploma from an age-equivalent training; (3) “Tertiary or more,” for individuals who hold a post-secondary diploma. The proportions of these categories in the respondents' sample are 8% (Primary or less), 64% (Secondary), and 28% (Tertiary or more). Among the respondents' parents, these proportions are 57%, 31%, and 12%, respectively.

**Educational attainment.** Figure 1 shows the evolution of educational attainment by gender for the cohorts 1920–1978, mixing data on respondents and their parents. On this figure I omit the youngest cohorts, who may not yet have completed their education at the time of survey. (I choose the 1978 cohort, who is 30 years old at time of survey, as the

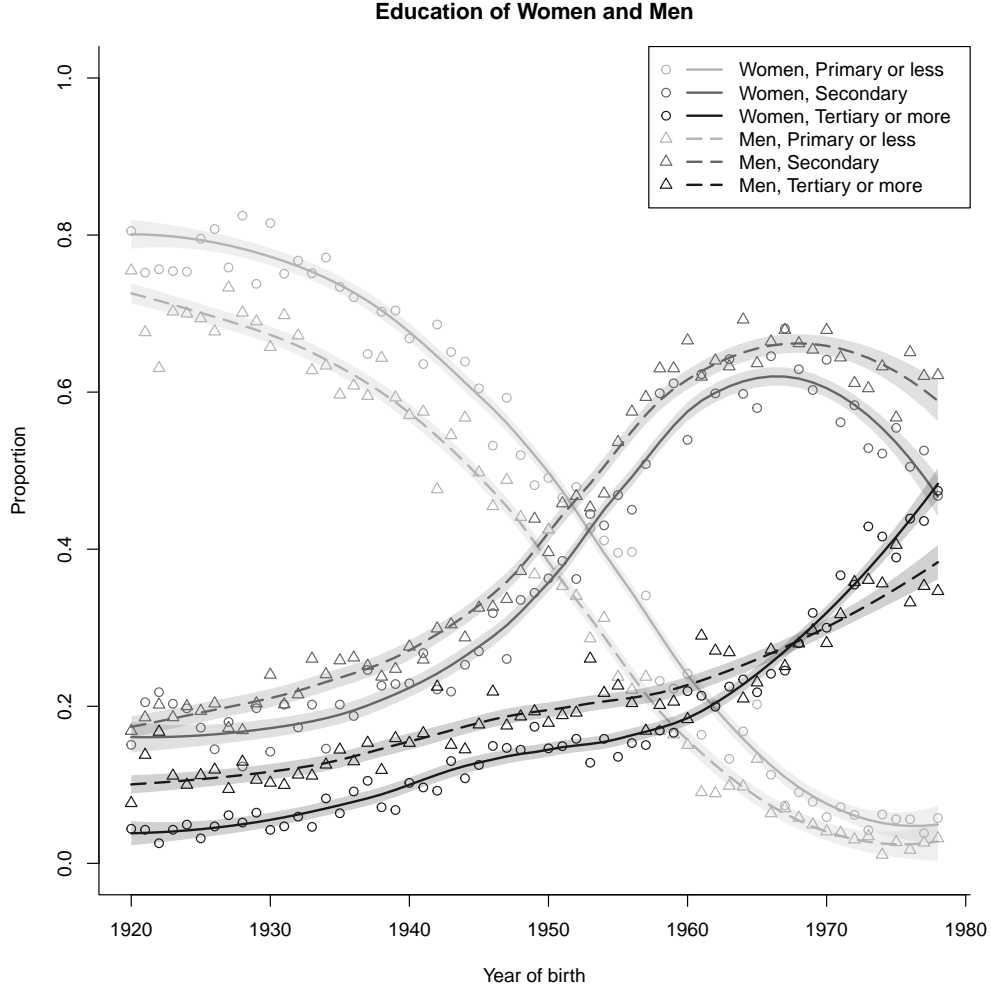


Figure 1: Education of Women and Men.

endpoint.) Educational attainment increases for both genders across the cohorts under study. Starting around the 1970 cohort, women overtake men in tertiary education.

**Marital assortment.** Even though 72.5% of respondents declared having a partner, information on this partner was collected only when they lived in the same house (60.9% of respondents). Once again, I also use answers on the respondents' parents to draw a long-term picture of marital assortment in the sample, which I present in Figure 2. We can discern some time trends in educational homogamy. The proportion of couples with the same educational attainment is high overall. It decreases for the oldest cohorts, from 80% in 1920 to around 65% in 1950. This might simply be a mechanical consequence of the increasing diversification of educational attainments for these cohorts (early cohorts mostly have a primary education only, so there couldn't be many mixed-education couples). After that, this proportion stagnates between 65% and 70%. The proportion of couples with a more educated husband increases slightly across the oldest cohorts, and then starts to decrease around the 1950 cohort to reach 15%. The proportion of couples



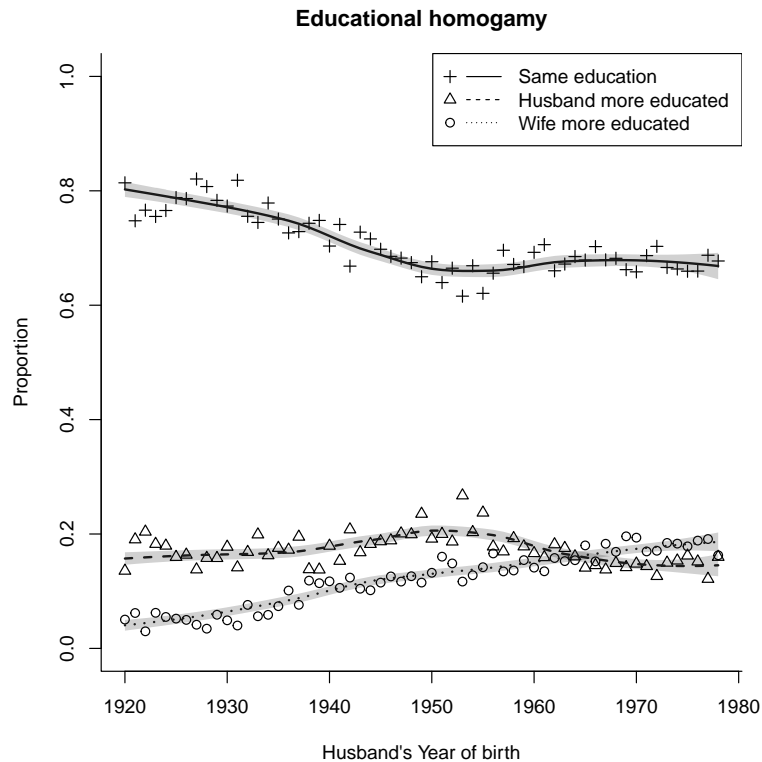


Figure 2: Educational homogamy.

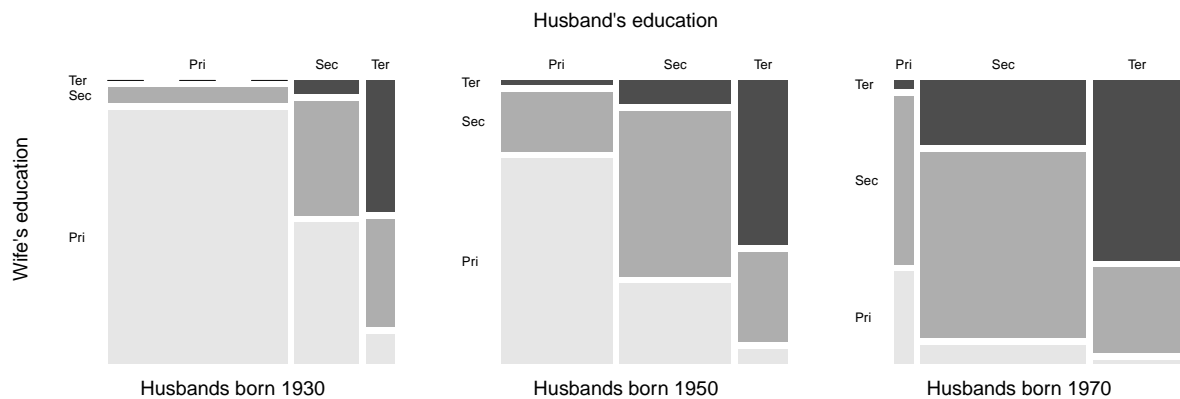


Figure 3: Educational assortment in couples with a husband born in 1930, 1950, and 1970.

with a more educated wife increases across all cohorts, from 5% to almost 20%, overtaking the proportion of couples with a more educated husband by the 1965 cohort.

Could these trends be driven by the simplification of the education variable into three categories? In Figure 17 (Appendix B) I construct the same graph using the detailed diploma categories (8 levels, from no diploma to university graduate). While the proportion of couples with the same educational attainment mechanically falls by considering more education levels, the trends discussed above mostly hold. In particular, the proportion of couples with a more educated wife clearly increases over the cohorts considered, overtaking the proportion of couples with a more educated husband.



Finally, in Figure 3 I report detailed educational assortment patterns for three different cohorts, defined as those couples with a husband born in 1930, 1950, or 1970. (Figure 19 in Appendix B does the same for wives born in 1930, 1950, or 1970.) In accordance with the trends discussed above, we observe that more men marry “up” among younger cohorts (the number of educated women has increased more than the number of educated men). As Figure 2 already suggested, by the 1970 cohort marriage patterns are almost symmetric for men and women: roughly as many women marry up as men do.

In Appendix E I also study educational homogamy using local log-odds ratios, following Siow (2015). Statistical tests of the TP2 criterion (local log-odds ratios are totally positivity of order 2) provide strong evidence of educational homogamy, both on the complete sample and conditional on the religious affiliations of the spouses.

## 2.2 Religion

In the survey, religious affiliation is recorded using 13 possible answers. To simplify the analysis, and because some answers are associated with few observations, I aggregate them into five broad categories: No religion or “Nones” (29% of respondents), Christian (39%), Muslim (27%), Jewish (1%), and Other religion (4%).

**Religious affiliation.** Figure 4 presents religious affiliation across cohorts in the sample by gender (including parents). For both genders, younger cohorts show a higher representation of Muslims and Nones, and less Christians. Representation of Jews and other religious affiliations remains low and stable across cohorts. Interestingly, while Muslims, Jews, and Others are well balanced in terms of gender, there is an important asymmetry among Christians and Nones. Indeed, Christian women are more numerous than Christian men (48% of women vs. 43% of men are Christian). This difference is almost perfectly balanced by the excess of None men compared to None women (24% vs. 19%).

It is worth noting that religious affiliation in the sample is especially not representative of the French religious mix (for instance, 27% of respondents identify as Muslim, even though usual estimates for the share of Muslims in France hover between 5% and 10% for 2008). This is of course a consequence of the TeO survey oversampling individuals with a family history of immigration. Figure 21 (Appendix B) reproduces the graphs of Figure 4 using the sampling weights provided by the survey, providing a better picture (but still imperfect) of the share of each religious affiliation in France.

**Marital assortment.** A common way to measure partner assortativity along one dimension (here, religious affiliation) is to compute the log-odds ratios:

$$\ln \left( \frac{n_{aa} n_{\bar{a}\bar{a}}}{n_{a\bar{a}} n_{\bar{a}a}} \right),$$

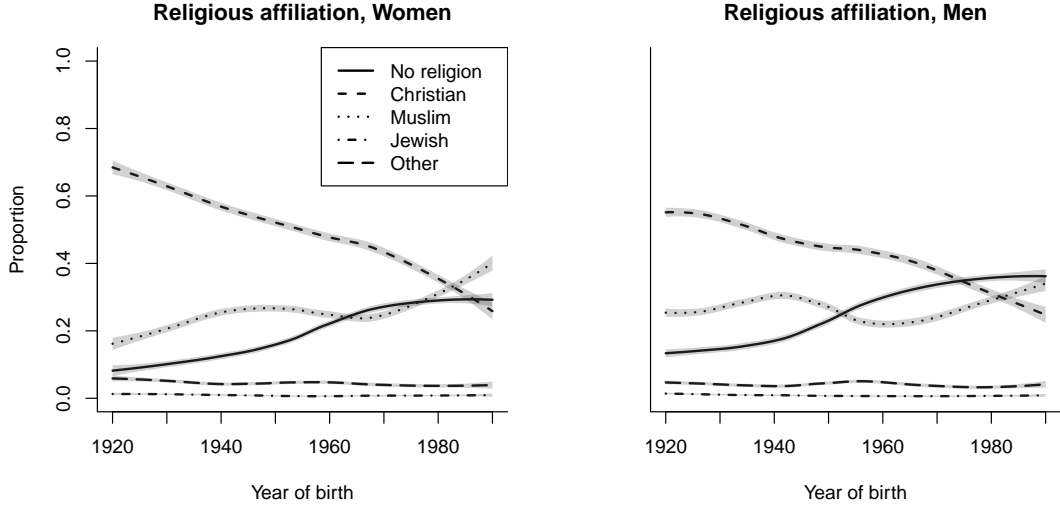


Figure 4: Religious affiliation, Women and Men.

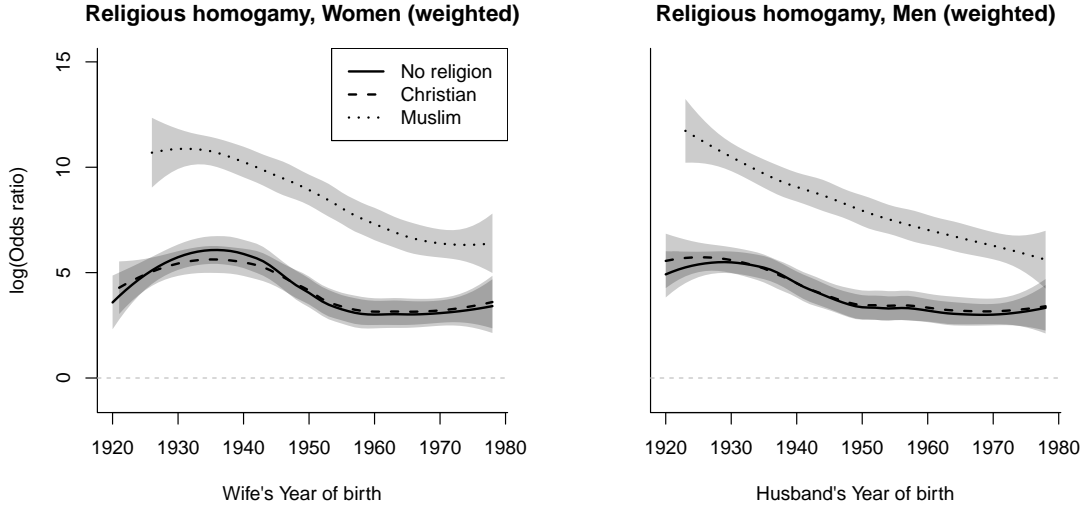


Figure 5: Religious homogamy (log-odds ratios), Women and Men.

where  $n_{aa}$  is the number of individuals from affiliation  $a$  with a partner  $a$ ,  $n_{a\bar{a}}$  that of individuals  $a$  with a partner non- $a$ , and so on. Log-odds ratios are equal to 0 when couples are formed randomly,<sup>8</sup> while positive log-odds ratios are evidence of homogamy (positive assortative matching), and negative log-odds ratios are evidence of heterogamy (negative assortative matching).

Figure 5 presents these log-odds ratios for any birth cohort of husbands and wives,

<sup>8</sup>When couples are formed randomly, individuals  $a$  and non- $a$  have the same odds of being matched with a partner  $a$  over a partner non- $a$ , i.e.

$$\frac{n_{aa}}{n_{a\bar{a}}} = \frac{n_{\bar{a}a}}{n_{\bar{a}\bar{a}}}.$$

taking into account sampling weights. All computed log-odds ratios are positive for the cohorts considered, providing evidence of strong religious homogamy in the sample. Assortativity is stronger among Muslims than among Christians or Nones, although it decreases across cohorts: younger Muslims are less prone to religious homogamy than older ones. Christians and Nones exhibit similar and stable rates of homogamy from the 1950 cohort onwards. (There is a decline of homogamy rates for these affiliations around 1950, but they could be due to selection issues of the parents' generation in the sample.) I have omitted the log-odds ratios for Jewish and Other religion, since these affiliations have few observations per cohort, resulting in noisy patterns. It is however worth noting that despite this noise, both these affiliations exhibit high average assortativity rates, which are closer to Muslims than to Christians or Nones. Figures 22 and 23 (Appendix B) show assortativity patterns for the three cohorts born in 1930, 1950, and 1970, and provide further evidence of strong religious homogamy in the sample. Table 9 (also Appendix B) presents the  $2 \times 2$  matrix of couples by religious affiliation.

**Education by religious affiliation.** Educational attainment is not distributed equally among religions, as shown in Figure 6. While religious Nones and Christians exhibit similar levels of educational attainment for the cohorts considered, Muslims have lower educational attainment throughout. Looking at the interaction between gender and religion, for the oldest cohorts (1920–1950) men are more educated across all religions. Around the 1950 cohort, this gender gap starts to close among Christians and Nones (a slight gender gap in favor of women even appears among Nones), while it persists until 1970 among Muslims. It is only for the very latest cohorts that a discernable gender gap appears in the favor of women for all three religious affiliations.

### 2.3 Marital assortment on education and religion

**On education for given religion.** Figure 7 presents patterns of educational assortment for same-religion couples. Nones and Christians exhibit similar patterns of high educational assortment: partners have the same education level in around 70% of couples, though this rate decreases slightly over the cohorts considered. Muslims show a greater proportion of couples for which the husband is more educated – but this can be expected as a mechanical consequence of the educational gap in favor of men in that population, as discussed above. Again, as in the case of Figure 2 for the complete sample, I verify that these results hold when considering more detailed diploma categories (see Figure 18 in Appendix B).

**On religion for given education.** Figure 8 again shows log-odds ratios, but this time draws a comparison between education levels to see how they might affect religious assortment. In the complete sample (first row of the graph), there appears to be a negative correlation between religious homogamy and educational attainment: religious homogamy

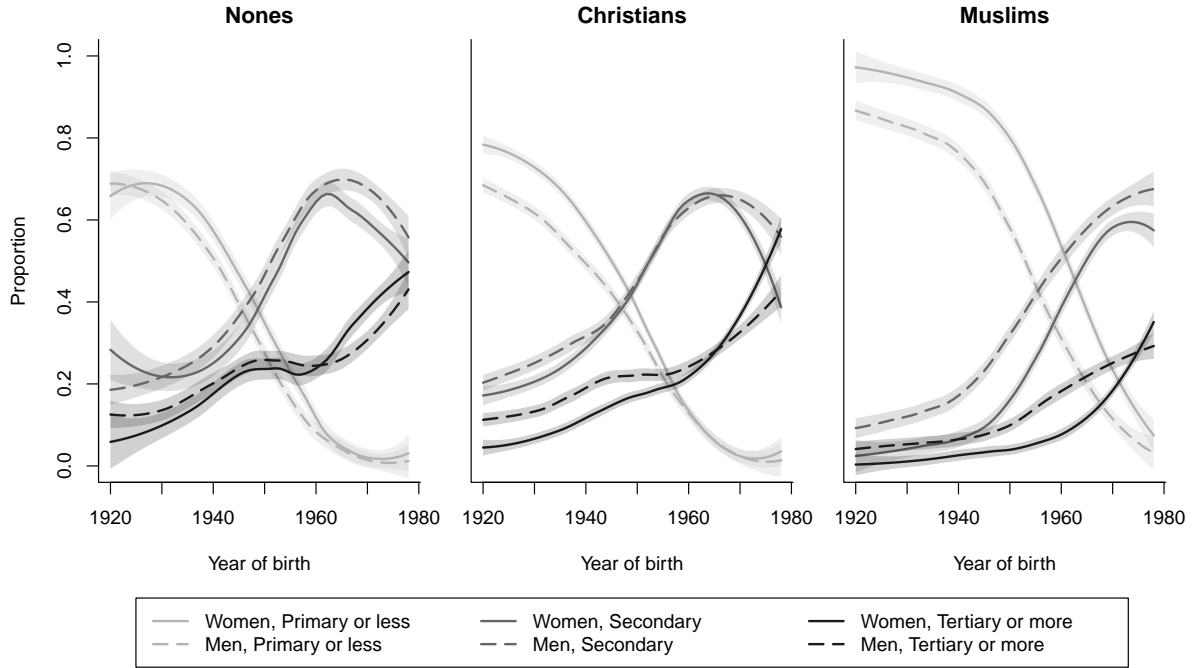


Figure 6: Education by religion and gender.

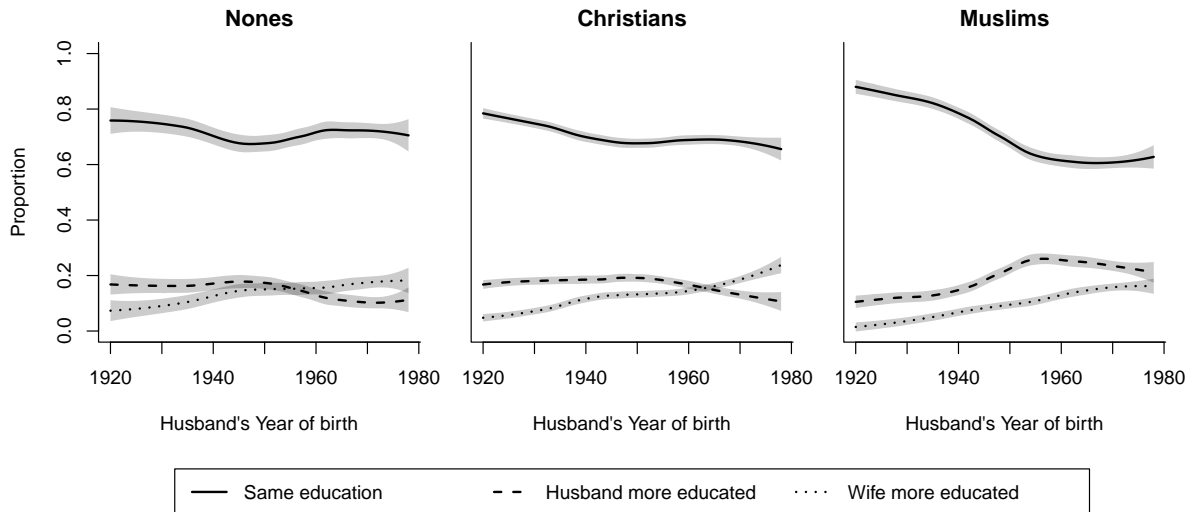


Figure 7: Educational homogamy, same-religion couples.

is strongest among individuals with a “Primary or less” education, and weakest among individuals with a “Tertiary or more” education. This could however be due to a correlation between religious affiliation and educational attainment (we have seen for instance that Muslims in the sample are simultaneously less educated and more homogamous on average). To alleviate this concern, I look at how religious homogamy differs across education levels, but this time within religious affiliations (rows 2 to 4 of the graph). It should be noted that the evidence becomes fragmentary when considering such interac-

Table 1: Religious homogamy and education.

	Religious homogamy	
	(OLS)	(OLS)
<i>Wife's education</i>		
Secondary	−0.05*** (0.01)	−0.03*** (0.01)
Tertiary	−0.06*** (0.01)	−0.04*** (0.01)
<i>Husband's education</i>		
Secondary	−0.04*** (0.01)	−0.03*** (0.01)
Tertiary	−0.04*** (0.01)	−0.04*** (0.01)
<i>Wife's religion</i>		
Christian		−0.30*** (0.01)
Muslim		0.16*** (0.02)
Jewish		0.15*** (0.04)
Other		−0.38*** (0.03)
<i>Husband's religion</i>		
Christian		0.40*** (0.01)
Muslim		−0.06*** (0.02)
Jewish		−0.26*** (0.03)
Other		0.14*** (0.03)
Observations	31150	31150
Sampling weights	Yes	Yes
Adjusted $R^2$	0.01	0.17

Note: Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Reference category for wife/husband education fixed effects is “Primary.”

Reference category for wife/husband religion fixed effects is “No religion.”

tions, because data becomes thinly spread across categories. Yet, the negative correlation between religious homogamy and educational attainment seems to hold within religious affiliations. It is most pronounced for Muslims, as well as for None women and Christian men, and especially for older cohorts. The correlation is less pronounced for Christian women and None men, who have overall lower levels of homogamy because of the asymmetry documented above (there are more Christian women than men, and more None men than women).

Table 1 confirms this negative correlation between religious homogamy and education of the partners with a simple linear regression. According to the specification which includes religion fixed effects for both partners, an increase in the husband's or the wife's educational attainment from Primary to Secondary is associated with a 3 p.p. decrease in the probability that he or she belongs to a homogamous couple. An increase from Secondary to Tertiary leads to a 1 p.p. decrease in the same probability.

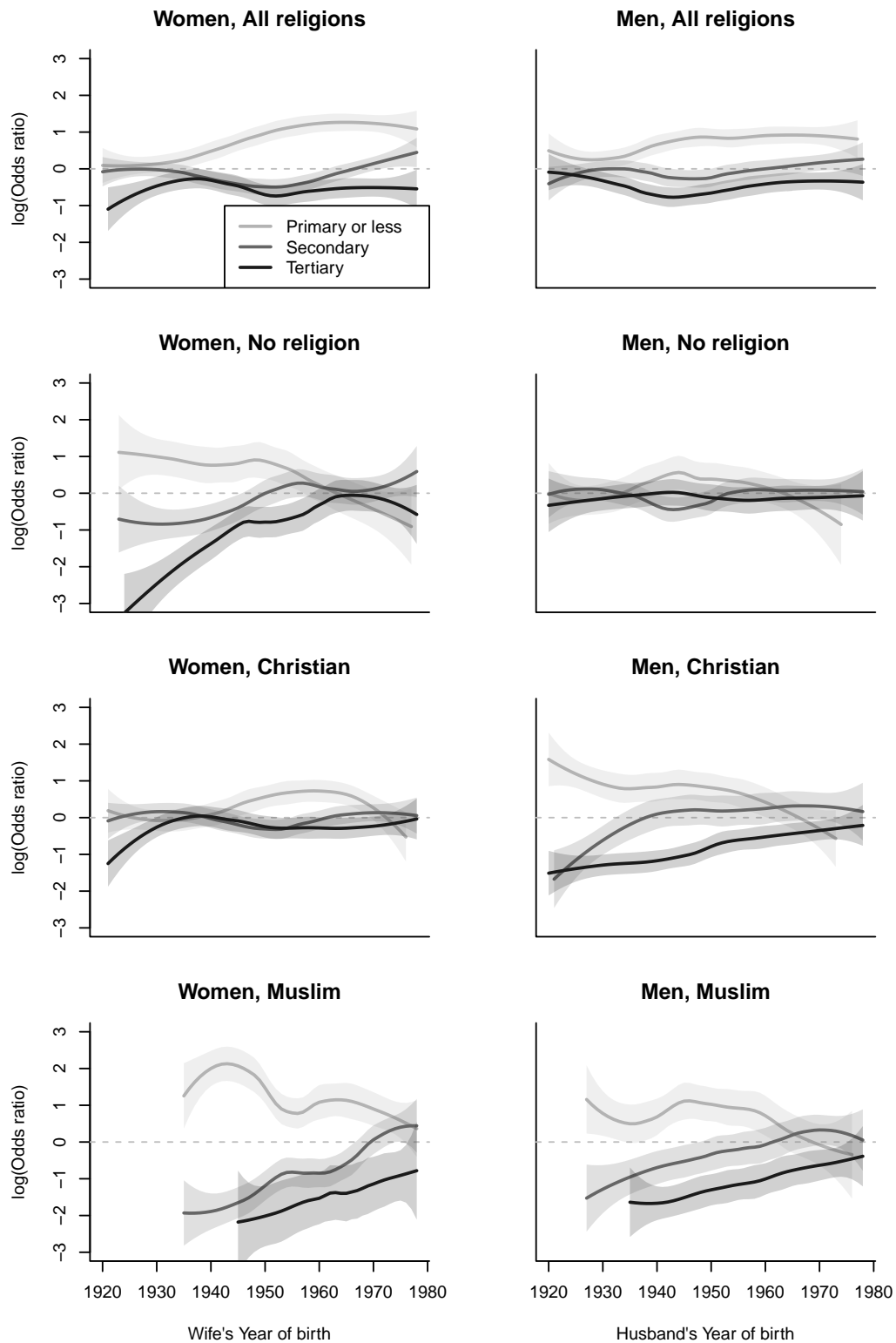


Figure 8: Religious homogamy of Women and Men, by Religion and Education. Here, log-odds ratios are computed within a religion category. For instance, in the “Women, Muslim” graph the “Primary or less” line is obtained by computing the odds of a Primary–Muslim woman being partnered with a Muslim man, divided by the odds of a Secondary– or Tertiary–Muslim woman being partnered with a Muslim man.

## 2.4 Transmission of education

**Education of the parents.** Unsurprisingly, the children of higher-educated parents have higher education themselves, as can be seen in Figure 9. This is confirmed in Table 2 by an ordered logit regression with the child’s education as the outcome, and the education of the parents as the main explanatory variables. Corresponding specifications using a linear model instead of an ordered logit model yield similar results (see Table 11 in Appendix B).

**Religion of the parents.** To see whether religion plays a role in the transmission of education, I add the religion of the parents as an explanatory variable in the previous ordered logit regressions of Table 2. The religious affiliations of the parents do seem to play a role in the transmission of education. Compared to the “No religion” baseline, Christian mothers and Jewish fathers are associated with higher-educated children. Note that these results might be dependent on religious homogamy patterns, for which a regression including interactions between mothers’ and fathers’ religious affiliations is needed. Once I include those interactions effects, the significant effects of the parents’ religious affiliation mostly disappear, with the exception of the positive coefficient for Christian mothers (for lack of space because of the many interactions, I only report these results in Table 10, Appendix B). At this point, it is however impossible to say whether these potential differences in children’s education across parental religious affiliations are driven by trade-offs between religious socialization and education, or (for instance) by different cultural preferences for children’s education.

## 2.5 Transmission of religion

**Homogamous vs. heterogamous couples.** It is well-documented that parents in homogamous couples (i.e. couples in which both parents have the same religious affiliation) pass on their religion more reliably than parents in heterogamous couples (see e.g. Bisin and Verdier 2000, p. 960). This stylized fact remains true for the TeO data, as suggested by Figure 10. The *transmission rate*, defined as the probability that a child has the same religion as their parent, is more than 80% among homogamous couples, and it increases slightly across cohorts. This increase could simply be due to the change in the religious mix of the sample, with more Nones, more Muslims, and less Christians among younger cohorts (cf. Figure 4). But other explanations are possible: younger cohorts could transmit more accurately; or it could also be the result of individuals switching affiliation during their lifetime, so that older individuals would be less likely to still share their parents’ affiliation. On the other hand, the transmission rate for mothers and fathers in heterogamous couples is around 40%, half that of homogamous couples.

Figures 26 and 27 (Appendix B) also describe religious transmission patterns across parental religious affiliations, this time aggregating all cohorts. They provide evidence for



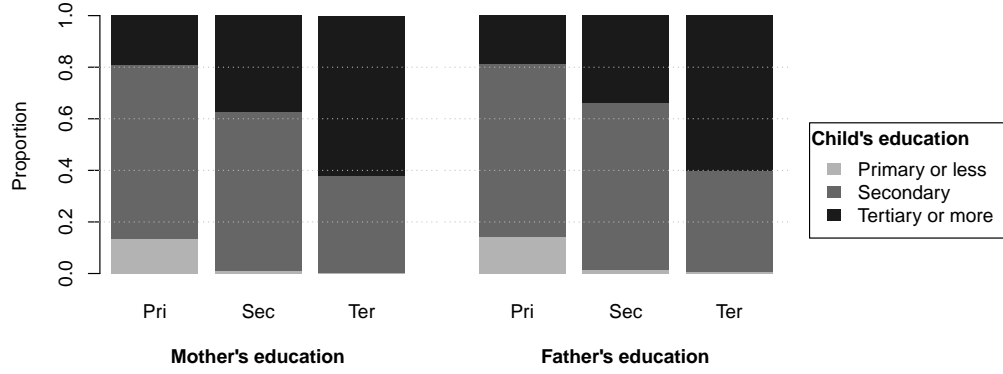


Figure 9: Transmission of education.

Table 2: Transmission of education (Ordered Logit).

	Child's education		
	(Ord. logit)	(Ord. logit)	(Ord. logit)
<i>Mother's education</i>			
Secondary	0.64*** (0.02)	1.04*** (0.03)	0.97*** (0.03)
Tertiary	1.00*** (0.03)	2.60*** (0.10)	2.57*** (0.10)
<i>Father's education</i>			
Secondary	0.63*** (0.02)	0.99*** (0.03)	0.96*** (0.03)
Tertiary	1.56*** (0.03)	1.74*** (0.05)	1.72*** (0.05)
<i>Mother's × Father's education</i>			
Secondary × Secondary		−0.76*** (0.04)	−0.68*** (0.04)
Secondary × Tertiary		−0.40*** (0.06)	−0.36*** (0.07)
Tertiary × Secondary		−2.03*** (0.11)	−2.10*** (0.11)
Tertiary × Tertiary		−1.76*** (0.12)	−1.75*** (0.12)
<i>Mother's religion</i>			
Christian			0.25*** (0.02)
Muslim			0.03 (0.28)
Jewish			−0.02 (0.16)
Other			0.63*** (0.16)
<i>Father's religion</i>			
Christian			0.28*** (0.02)
Muslim			−0.11 (0.28)
Jewish			1.23*** (0.16)
Other			−0.74*** (0.21)
Child's year of birth /100	0.30*** (0.06)	0.40*** (0.06)	1.07*** (0.07)
Cut-off: Primary → Secondary	3.56 (1.24)	5.58 (1.25)	19.03 (1.28)
Cut-off: Secondary → Tertiary	7.70 (1.24)	9.76 (1.25)	23.25 (1.28)
Observations	18793	18793	18222
Sampling weights	Yes	Yes	Yes
Deviance	27098	26947	25901

Note: Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Reference category for mother/father education is "Primary."

Reference category for mother/father religion is "No religion."

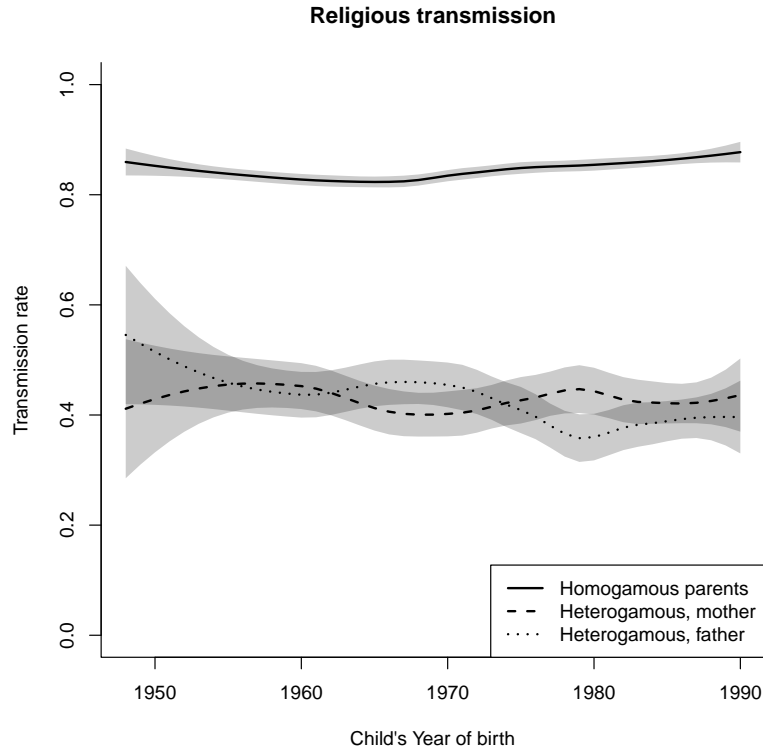


Figure 10: Religious transmission by parents in homogamous and heterogamous couples.

a homogeneity advantage in religious transmission, except for the None affiliation.

**By religion.** Figure 11 presents transmission rates of mothers and fathers of the three main religious affiliations. Muslim transmission rates are higher overall, which might in part be a consequence of stronger homogeneity among Muslims. Yet, Muslim transmission rates are also increasing across recent cohorts, despite decreasing Muslim homogeneity rates (cf. Figure 5). There are at least two possible explanations for this. First, since the population share of Muslims has increased over the period, it is possible that oblique socialization has become a better vector of religious transmission for Muslims. Second, and as already discussed above, older individuals may be more likely to have switched affiliation from the one they inherited from their parents. The transmission rates of None parents follow a similar pattern, and are subject to the same interpretations.

On the other hand, Christian transmission rates are decreasing, falling behind Muslim and None transmission rates starting from the 1960 cohort. Two explanations listed above might contribute to this decrease: the population share of Christians is decreasing (cf. Figure 4), which may worsen oblique socialization; and homogeneity rates among Christians are decreasing for the parental cohorts.

There are also comparisons to draw between mothers' and fathers' transmission rates. First, Christian mothers have lower transmission success than Christian fathers. A possible explanation is the asymmetry in the religious distribution of men and women. Indeed,

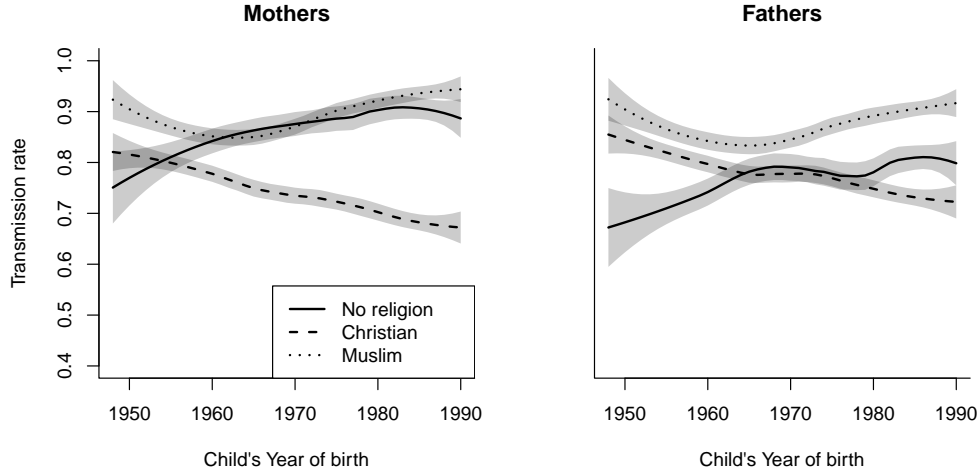


Figure 11: Religious transmission by Mothers and Fathers.

since there is an excess of Christian women compared to Christian men, more Christian women end up partnered in heterogamous couples (most often, with None men), thus hurting their transmission rate. Conversely, None mothers have higher transmission success than None fathers, for the opposite reason: there is an excess of None men compared to None women. For Muslims, for whom there is less distributional gender asymmetry, there is no such stark difference between mothers' and fathers' transmission rates.

**By education attainment.** Does the education of the parents matter in the transmission of religious affiliation? Figure 12 shows the transmission rates of mothers and fathers by educational attainment for all religious affiliations combined, and then separately for Nones, Christians, and Muslims. Despite the noise (data becomes thinly spread across the four dimensions considered: gender, birth cohort, religion, and education), the pattern which seems to emerge is that parents with lower educational attainment have higher transmission rates. This is relatively clear when all religions are combined. When looking within specific affiliations, the educational gap in transmission rate seems to be most pronounced for Muslims, and least for Nones. This closely mirrors the pattern observed for homogamy rates and partner education (cf. Figure 8). For this reason, from Figure 12 it is unclear whether education affects transmission rates directly, or through its effect on religious homogamy. We can alleviate this concern by restricting attention to homogamous households only. In Figure 13 I present the transmission rates for mothers and fathers in homogamous households, excluding Nones. The pattern observed above persists: transmission rates are negatively correlated to parental education.

In order to clarify this I run a simple linear regression, whose results are reported in Table 3. Fathers' educational attainment is negatively correlated with the transmission rate (thus conforming to the pattern observed in Figure 12), consistent with the finding on homogamy: more educated fathers marry less homogeneously, and thus can be expected

Table 3: Religious transmission and education of the parents.

	Transmission rate, Mother			Transmission rate, Father		
	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)	(OLS)
<i>Mother's education</i>						
Secondary	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.01 (0.01)
Tertiary	0.04*** (0.01)	0.04*** (0.01)	0.05*** (0.01)	0.02 (0.01)	0.04*** (0.01)	0.06*** (0.01)
<i>Father's education</i>						
Secondary	-0.03*** (0.01)	-0.02** (0.01)	-0.01 (0.01)	-0.02*** (0.01)	-0.01** (0.01)	-0.01 (0.01)
Tertiary	-0.07*** (0.01)	-0.05*** (0.01)	-0.05*** (0.01)	-0.06*** (0.01)	-0.05*** (0.01)	-0.04*** (0.01)
Child's year of birth /100			-0.13*** (0.03)			-0.11*** (0.03)
Mo.'s × Fa.'s religion FE		✓	✓		✓	✓
Observations	18 343	18 115	18 115	18 175	18 115	18 115
Sampling weights	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted $R^2$	0.00	0.12	0.12	0.00	0.11	0.11

Note: Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Reference category for mother/father education is "Primary."

to transmit religion less accurately. On the other hand, mothers' educational attainment is positively correlated with the transmission rate. This positive correlation might seem puzzling: more educated mothers marry less homogamously, and yet they transmit religion more accurately. Note also that education of the parents by itself has very little explanatory power for the transmission rates, as measured by the adjusted  $R^2$ .

A first step to disentangle the effect of education from the effect of religious homogeneity, is to control for the religious composition of the parents' couple. Yet, the correlations mentioned above persist even after adding these controls. According to the estimates from the last model specification (which also includes the child's year of birth as control), for instance, a father with a tertiary education is 4 p.p. less likely to pass on his religion, compared to a father with primary education; and a mother with a tertiary education is 5 p.p. more likely to pass on hers, compared to a mother with primary education.

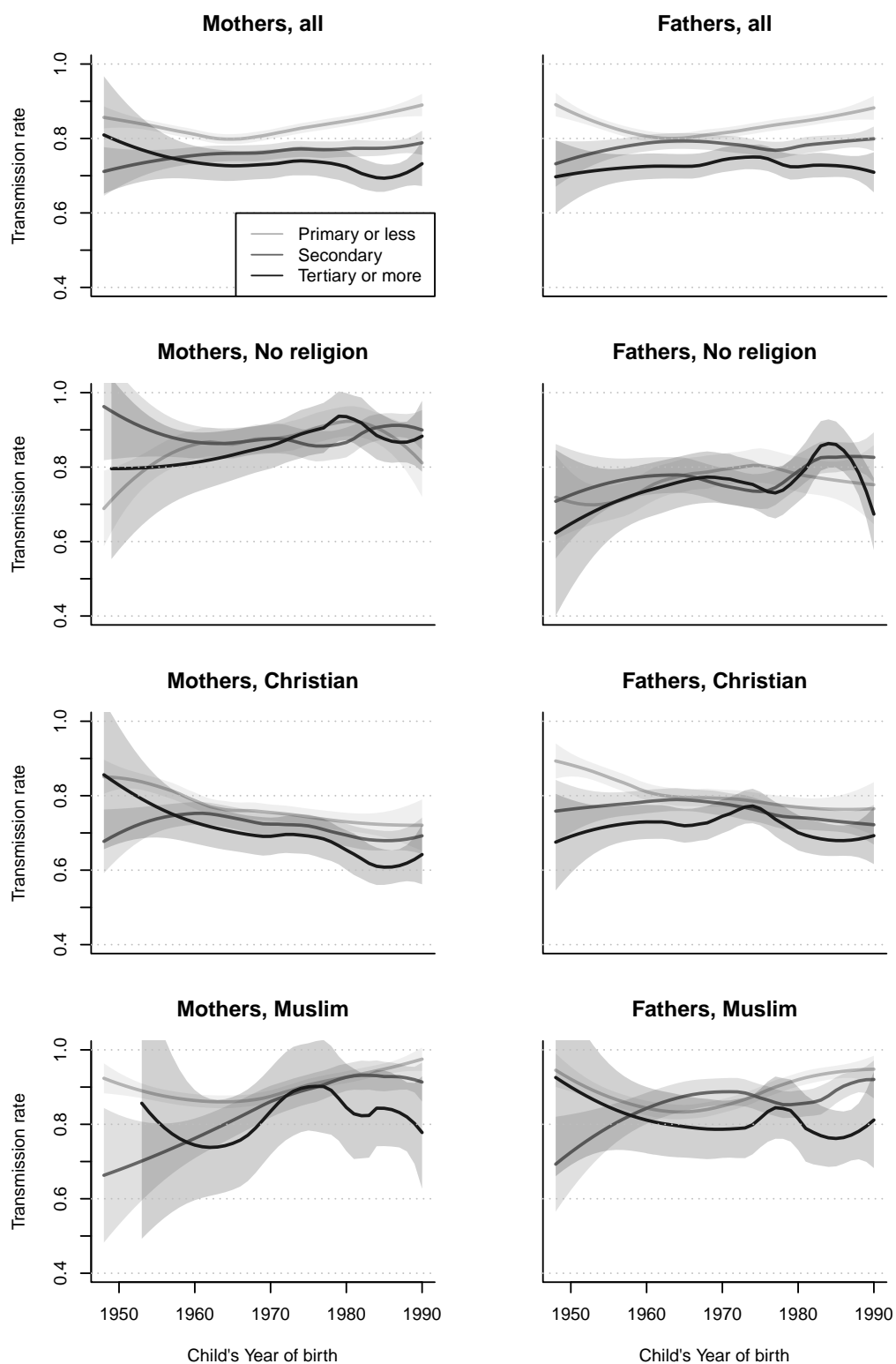


Figure 12: Religious transmission by Mothers and Fathers, by Education.

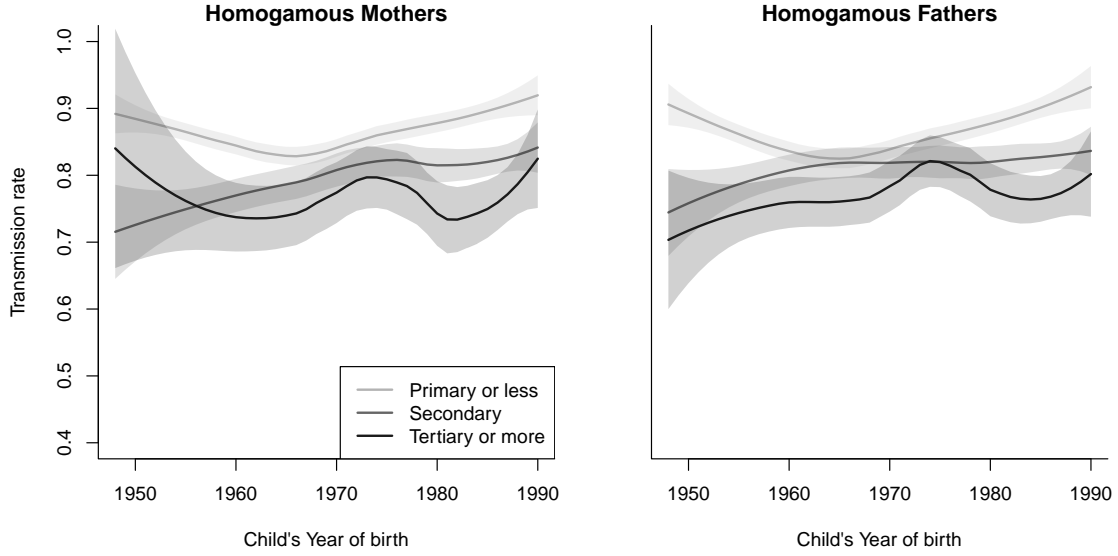


Figure 13: Religious transmission by homogamous Mothers and Fathers, by Education and excluding Nones.

### 3 Reduced-form analysis

The descriptive analysis of section 2 yielded several useful insights regarding the intergenerational transmission of religious affiliations. First, vertical transmission from parents to children is very strong, with around 87% of respondents in the sample sharing the religious affiliation of at least one parent (Figure 10). Second, there is a strong heterogeneity in transmission patterns across parental religious affiliations and genders (Figure 11). Third, parental education seems to have an overall detrimental effect on religious transmission (Figure 12). Yet, it remains unclear to which extent these differences are driven by marriage patterns rather than by different contributions to socialization across affiliations and genders. For instance, Muslims transmit more in average than Christians or Nones (Figure 11), but they also marry more homogamously (Figure 5). In this case, is the higher transmission rate of Muslims driven by higher contributions to their children's religious socialization, or by higher homogamy? And can we quantify these contributions?

In this section I turn to a reduced-form model to analyze the transmission of religious affiliation in the TeO data. Religious affiliation being a discrete trait, I choose a multinomial logit model to investigate its determinants (McFadden 1973). Following the theory of Bisin and Verdier (2000) and subsequent empirical work on cultural transmission,<sup>9</sup> I focus on two main predictors for the probability that an individual reports a given religious affiliation: the affiliations of her parents, and the shares of each religion in the population. This allows me to quantify the importance of parental contributions (vertical socialization) according to their gender, religious affiliation, and educational attainment; versus the role played by the environment (oblique socialization) in determining respondents'

<sup>9</sup>For instance, ...

affiliations. Furthermore, controlling for parents' religious affiliations in the transmission process also allows to disentangle the effect of homogamy from that of heterogeneous parental contributions.

This section is organized in two parts. In section 3.1 I introduce the baseline econometric specification (a multinomial logit model), and estimate it. The results suggest that vertical socialization plays a more important role than oblique socialization in the transmission process. Furthermore, within vertical socialization, mothers contribute more than fathers, and religious minorities contribute more than religious majorities. Overall, I find that this reduced-form model is quite efficient at predicting religious transmission patterns, confirming that the religion of the parents is a very powerful predictor of the religion of the child. In section 3.2 I refine the specification to focus the role of parental education in the transmission process. Results suggest that effects are heterogeneous across religious affiliations, but the general trend indicates that parental contributions to religious socialization rather decrease with their education level.

### 3.1 Multi-logit transmission

**Econometric model.** Consider a sample of individuals indexed by  $i$ , each of whom ultimately chooses one religious affiliation among  $N$  available. The propensity that individual  $i$  chooses religious affiliation  $n$  is measured by a latent variable, which can be written as the product of two components: a component  $K_{in}$ , which depends on her observable characteristics, and a component  $\xi_{in}$ , which is random. Pre-figuring the model of section 4.1, I call the observable component  $K_{in}$  the *religious capital* of individual  $i$  in the religion  $n$ .

As is standard in discrete choice models, assume now that individual  $i$  ultimately chooses to report the affiliation associated with the largest value among all latent variables:

$$\arg \max_n K_{in} \times \xi_{in}.$$

If the  $\xi_{in}$  are i.i.d. Fréchet (that is, if their logarithms  $\ln(\xi_{in})$  are i.i.d. Gumbel), then the probability that  $i$  chooses affiliation  $n$  is

$$\pi_{in} = \frac{K_{in}}{\sum_{\ell=1}^N K_{i\ell}} = \frac{\exp(\ln K_{in})}{\sum_{\ell=1}^N \exp(\ln K_{i\ell})}, \quad (1)$$

where the second expression makes explicit the link with the multi-logit model by using the standard softmax function (generalization of the logistic function to multiple dimensions). Hence, the log-religious capital  $\ln(K_{in})$  plays a role equivalent to mean utility in the usual discrete choice with random utility framework.

To complete the multi-logit model, I must choose an econometric specification for the log-religious capital  $\ln(K_{in})$  as a function of the observable individual characteristics. I consider a simple model, in which the propensity that individual  $i$  chooses affiliation  $n$



depends on whether her parents have affiliation  $n$ , and on the share of affiliation  $n$  in her environment. This choice can be understood as a broad interpretation of the [Bisin and Verdier \(2000\)](#) cultural transmission model, in which transmission is carried out by parents and by role models outside the family (vertical and oblique socialization). To begin with, I suppose that parental contributions to religious socialization depend only on their gender and religious affiliation. Thus, mothers  $n$  (resp. fathers  $n$ ) provide a fixed contribution  $m_n$  (resp.  $f_n$ ) towards individuals' propensity to choose affiliation  $n$ .

To capture the influence of the environment, I use religions' population shares  $q_{in}$  as a proxy. Note that these population shares  $q_{in}$  are individual-specific: this accounts for the fact that individuals are socialized in different cultural environments. Ideally, one could exploit individual variation in two dimensions to explain these differences in oblique socialization. First, the individual's geographical location: the religious mix varies locally, leading to different patterns of oblique socialization. Second, the individual's date of birth: the religious environment also evolved with time. Unfortunately, religions' population shares in France are not comprehensively available at the local level, nor across time. On locality, the available data is insufficient to obtain credible measures: this would require a dense, large-scale collection of individual religious affiliation in France (which is prohibited by law) or, for instance, a comprehensive survey of places of worship of all religions across the country. On time variation however, the TeO data is dense enough to build a credible measure of religious shares in the country across the period of interest. In [Appendix C.1](#) I explain how I reconstruct such a time series of religions' population shares in France. These reconstructed population shares, from 1948 to 1990, are presented in [Figure 14](#). In practice, for  $q_{in}$  I use the countrywide population shares corresponding to the year individual  $i$  turned 18 years old.

To summarize, I use the following econometric specification:

$$\ln K_{in} = k_n + m_n \mathbf{1}_{\{i\text{'s mother is } n\}} + f_n \mathbf{1}_{\{i\text{'s father is } n\}} + \alpha q_{in}. \quad (2)$$

In this expression, the parameters to estimate are  $k_n$ ,  $m_n$ ,  $f_n$  (for each religion  $n$ ), and  $\alpha$ . I have already mentioned that  $m_n$  and  $f_n$  correspond to the contributions to religious socialization by mothers  $n$  and fathers  $n$  respectively. In addition,  $\alpha$  measures the importance of oblique socialization. Finally, the constant  $k_n$  captures religion-specific effects in the socialization process. In an abstract way,  $k_n$  measures the probability of an individual reporting the religious affiliation  $n$  in the hypothetical scenario in which she would not have received any socialization, vertical nor oblique. In practice, a higher  $k_n$  may reflect that the religious affiliation  $n$  demands little in terms of knowledge of its affiliates; or that it makes particular efforts to gain new affiliates (above and beyond the role played by its population share). For this reason, we can expect the "No religion" affiliation to have a high  $k_n$ , because by definition it requires little if any active teaching. On the other hand, we can expect the Jewish affiliation to have a low  $k_n$ , because it is mostly passed

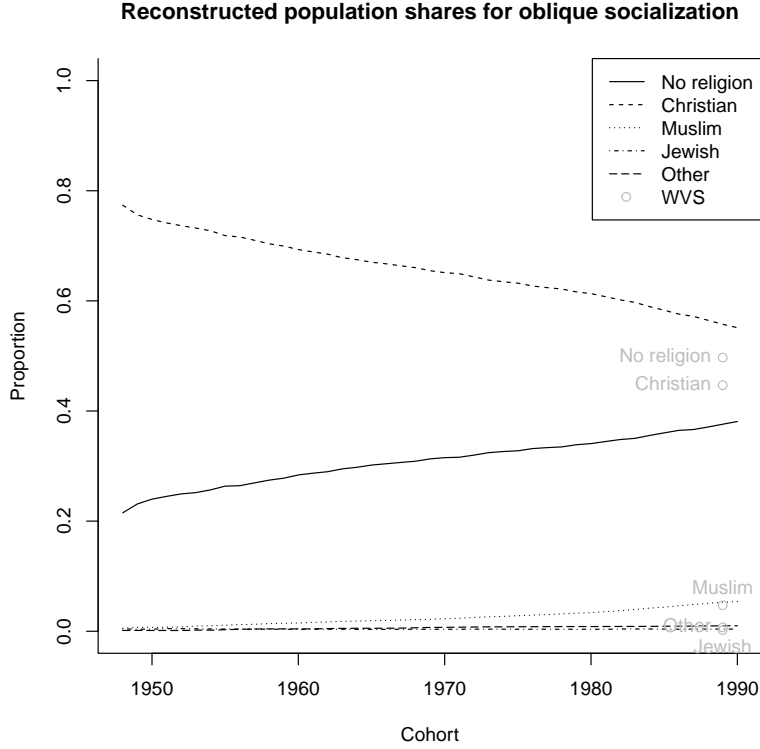


Figure 14: Religions' population shares, reconstructed from the TeO survey. Comparison points are taken from the World Values Survey (5th wave, 2005–2009).

on vertically from the mother.

If we gather all these parameters in a vector  $\beta$  and define vectors of individual characteristics  $\mathbf{z}_{in}$  appropriately, then we can rewrite  $\ln(K_{in})$  concisely as

$$\ln K_{in} = \mathbf{z}_{in} \cdot \beta.$$

Thus equations (1) and (2) together define a conditional logit model (McFadden 1973, Greene 2008). The conditional logit structure means in particular that all the parameters  $m_n$  and  $f_n$  are identified, unlike in the more standard multinomial logit where they are only determined up to a constant. This is because the model (2) imposes restrictions compared to a standard multinomial logit model. Specifically, in a multinomial logit the variable  $\mathbf{1}_{\{i\text{'s mother is } n\}}$  would be allowed to have an effect on any latent variable predictor  $\ln(K_{i\ell})$ ; here this effect is assumed to be zero if  $\ell \neq n$ . The same can be said for the variables  $\mathbf{1}_{\{i\text{'s father is } n\}}$  and  $q_{in}$ , which have no effect on  $\ln(K_{i\ell})$  if  $\ell \neq n$ . On the other hand, the parameters  $k_n$  are identified only up to an additive constant.

**Testable restrictions.** The model imposes restrictions on the transmission probabilities. These restrictions ultimately come from the independence of irrelevant alternatives

assumption inherent to the conditional logit model,

$$\ln \left( \frac{\pi_{in}}{\pi_{i\ell}} \right) = (\mathbf{z}_{in} - \mathbf{z}_{i\ell}) \cdot \boldsymbol{\beta} \quad (\forall n, \ell). \quad (3)$$

Call  $\pi_{in|yab}$  the probability that an individual  $i$  acquires trait  $n$  conditional on belonging to the cohort  $y$ , and having a mother  $a$  and a father  $b$ . We can use the last expression to show (see Appendix C) that (3) implies

$$\ln \left( \frac{\pi_{ia|yaa}}{\pi_{ib|yaa}} \right) - \ln \left( \frac{\pi_{ia|yab}}{\pi_{ib|yab}} \right) - \ln \left( \frac{\pi_{ia|\tilde{y}ba}}{\pi_{ib|\tilde{y}ba}} \right) + \ln \left( \frac{\pi_{ia|\tilde{y}bb}}{\pi_{ib|\tilde{y}bb}} \right) = 0 \quad (\forall a, b, y, \tilde{y}). \quad (4)$$

The issue with formally testing this equality however, is that many of these cells (individuals born in year  $y$  with a mother  $a$  and a father  $b$ ) have very few observations, or even none. For this reason, as an approximation I ignore the role of cohorts  $y$ ,  $\tilde{y}$  and I test whether the equality

$$\ln \left( \frac{\pi_{ia|aa}}{\pi_{ib|aa}} \right) - \ln \left( \frac{\pi_{ia|ab}}{\pi_{ib|ab}} \right) - \ln \left( \frac{\pi_{ia|ba}}{\pi_{ib|ba}} \right) + \ln \left( \frac{\pi_{ia|bb}}{\pi_{ib|bb}} \right) = 0 \quad (\forall a, b) \quad (5)$$

holds in the sample, where  $\pi_{in|ab}$  is the probability that an individual  $i$  acquires trait  $n$  conditional on having a mother  $a$  and a father  $b$  (but no longer conditional on the birth cohort  $y$ ). This simplification relies on the assumption that the population shares  $q_{in}$  are not moving drastically over the period considered (see Figure 14). In total there are  $N^2 = 25$  such tests to perform. Those for which  $a = b$  are trivially verified. Those for which  $b > a$  have a symmetric equivalent with  $a > b$ . This leaves 10 tests to perform. Estimators for  $\pi_{in|ab}$  follow binomial distributions, and I use this to construct 95% confidence intervals by simulation (parametric bootstrap; see Appendix C for details). Out of these 10 tests, 5 tests cannot reject the null hypothesis that (5) holds (None-Christian, None-Jewish, None-Other, Christian-Muslim, Muslim-Other); 3 tests reject the null hypothesis (None-Muslim, Christian-Jewish, and Christian-Other); and the 2 other tests cannot be computed because of lack of observations. Overall, Bonferroni's method for global testing rejects (5), and the multiple testing procedure by Benjamini and Hochberg (1995) leads to the rejection of the same 3 hypotheses as the separate individual tests (see Appendix C).

We cannot rule out that this rejection stems from ignoring cohort effects (i.e. testing (5) instead of (4)), so ultimately from the sparseness of observations along the dimensions considered. Similarly, one would ideally want to test this hypothesis using population shares  $q_{in}$  which vary not only across time, but also across locality. Still, rejection of the restriction (5) might also warrant the inclusion of other explanatory variables in the econometric specification (2). I leave this question open for future work.

**Estimation.** We can now proceed with the estimation of the model defined by equations (1) and (2). Identification comes from the variation in the respondents’ religious affiliation. The mother contributions to socialization  $m_n$  are identified through variation in the father’s religion; the father contributions  $f_n$  are identified symmetrically; and the oblique socialization coefficient  $\alpha$  is identified through cohort variation in population shares. As in a multinomial logit, the intercepts  $k_n$  are only identified up to a constant: I choose the most common affiliation, Christian, as the baseline category. With  $N = 5$  traits under consideration (None, Christian, Muslim, Jewish, and Other), this leaves a total of  $3N - 1 + 1 = 15$  free parameters. I estimate  $\beta$  by maximum likelihood, using the log-likelihood expression

$$\begin{aligned} \ln L &= \sum_i w_i \sum_{n=1}^N \mathbf{1}_{\{i \text{ is } n\}} \times \ln \pi_{in} \\ &= \sum_i w_i \left[ \left( \sum_{n=1}^N \mathbf{1}_{\{i \text{ is } n\}} \ln K_{in} \right) - \ln \left( \sum_{\ell=1}^N K_{i\ell} \right) \right], \end{aligned} \tag{6}$$

where the  $w_i$  are probabilistic sampling weights provided in the TeO survey. For the covariance matrix I compute the BHHH estimator (Berndt et al. 1974), from which I obtain the standard errors reported throughout this section.

Results are presented in Table 4, column 1. First consider the parental contributions  $m_n$  and  $f_n$ , measuring vertical socialization. These parental contributions are highest among minorities (Muslims and Jews, and to a lesser extent, Others), suggesting that the cultural substitution property proposed by Bisin and Verdier (2000) holds here. They are lower for Christians, and close to zero for Nones. Comparing mother and father contributions within a given affiliation, we see that Jewish mothers have significantly higher contributions than Jewish fathers: this is consistent with the fact that being Jewish is transmitted primarily through the mother. Mothers also contribute more than fathers among Nones and Others, although the difference is less striking. Finally, among Muslims and Christians, mothers and fathers contribute almost equally. Second, the magnitude of oblique socialization is comparable to but less than that of vertical socialization. The estimate for  $\alpha$  implies, for instance, that a 50% population share induces an oblique socialization contribution equivalent to half the contribution of a Christian mother, or a quarter of the contribution of a Jewish father. Third and last, the estimates for the intercepts  $k_n$  can be interpreted in the light of the specificities of each affiliation. The intercept for None is the highest, reflecting the fact that while actual religions need to be taught, being non-religious can simply result from the absence of any religious teaching. This makes the “No religion” trait special, as it can be acquired not only through active socialization (to secularism, atheism), but also through lack of socialization in other religions. For this reason, it makes sense that transmission is biased by default towards the “No religion” trait. In the French context specifically, this bias could also account

for the socialization influence of schools, which are in majority secular. The intercept for Jewish, on the other hand, is significantly lower than the others, so that individuals are very unlikely to become Jewish unless they have a Jewish parent. This is consistent with the fact that Judaism is not a proselytic religion and is mostly transmitted from parents to children. The intercepts for Muslim and Other are not significantly different from the Christian reference category, which suggests that no stark structural difference exists in the way these religions are transmitted.

**Model fit.** The specification (2) can be compared to the null model defined by an intercept only,  $\ln(K_{in}) = k_n$ , which has deviance 51 268. With a LR test statistic of  $51\,268 - 20\,948 = 30\,320$  on 11 degrees of freedom (which is significant at any conventional confidence level), the model (2) explains the data significantly better than the null model. The associated pseudo- $R^2$  is 0.46, also indicating a good model fit.

Using the estimated parameters, I simulate transmission rates to see how well the model fits aggregate patterns in the data. Figure 15 presents observed vs. estimated transmission rates for the three main religious affiliations. Overall, estimated rates match observed rates quite closely. Sharp turns in the observed transmission rate which are due to cohort variations in parental homogamy rates (e.g. around 1955 for Muslim fathers) are even well replicated by the simulations, thus suggesting that the model indeed manages to disentangle the effect of homogamy from that of parental contributions.

**Complementarities.** The baseline model (2) rules out complementarities between the affiliations of the parents. I address this by adding interaction effects to the model,

$$\ln K_{in} = k_n + m_n \mathbf{1}_{\{i\text{'s mother is } n\}} + f_n \mathbf{1}_{\{i\text{'s father is } n\}} + b_n \mathbf{1}_{\{i\text{'s mother is } n\}} \times \mathbf{1}_{\{i\text{'s father is } n\}} + \alpha q_{in}, \quad (7)$$

so that  $b_n$  measures the additional effect of having both parents of religion  $n$  on the log-religious capital  $\ln(K_{in})$ .

Estimation results are presented in Table 4, column 2. Compared to the model without interaction effects, the likelihood ratio test statistic is  $21\,937 - 20\,901 = 36$  on 5 degrees of freedom ( $p$ -value  $< 10^{-6}$ ), validating the inclusion of these interaction terms as relevant predictors. The interaction parameters are positive for Nones, Christians, and Jews; and negative for Muslims and Others. Yet, the most precise estimates are for Nones and Christians, pointing towards a complementarity between the parents' religious affiliations in their socialization contributions.

### 3.2 Religious socialization and parental education

[ESTIMATES OF SECTION 3.2 NOT YET UPDATED TO INCLUDE SAMPLING WEIGHTS]

Table 4: Conditional logit transmission, Estimates.

	Conditional logit estimates	
	model (2)	model (7)
Constant $k_n$		
None	2.86*** (0.08)	2.76*** (0.08)
Christian	0 (baseline)	0 (baseline)
Muslim	-1.32*** (0.08)	-1.58*** (0.09)
Jewish	-2.93*** (0.11)	-3.00*** (0.16)
Other	-0.66*** (0.08)	-0.79*** (0.09)
Mother's contribution $m_n$		
None	0.11 (0.08)	-0.61*** (0.13)
Christian	2.24*** (0.08)	1.92*** (0.10)
Muslim	3.80*** (0.21)	4.67*** (0.33)
Jewish	5.33*** (0.28)	5.17*** (0.32)
Other	3.90*** (0.13)	3.85*** (0.13)
Father's contribution $f_n$		
None	0.30*** (0.07)	0.05 (0.08)
Christian	1.30*** (0.07)	0.62*** (0.14)
Muslim	3.22*** (0.22)	3.66*** (0.32)
Jewish	3.45*** (0.43)	2.77** (1.31)
Other	0.78*** (0.18)	1.51 (1.06)
Interaction contribution $b_n$		
None		1.10*** (0.16)
Christian		0.90*** (0.16)
Muslim		-1.20** (0.47)
Jewish		0.93 (1.39)
Other		-0.68 (1.06)
Oblique socialization coefficient $\alpha$	1.36*** (0.08)	1.37*** (0.08)
Observations	20 547	20 547
Sampling weights	Yes	Yes
Deviance ( $-2 \ln L$ )	21 937	21 901
Pseudo- $R^2$	0.46	0.46
LR test $p$ -value	baseline	0.000

Note: Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

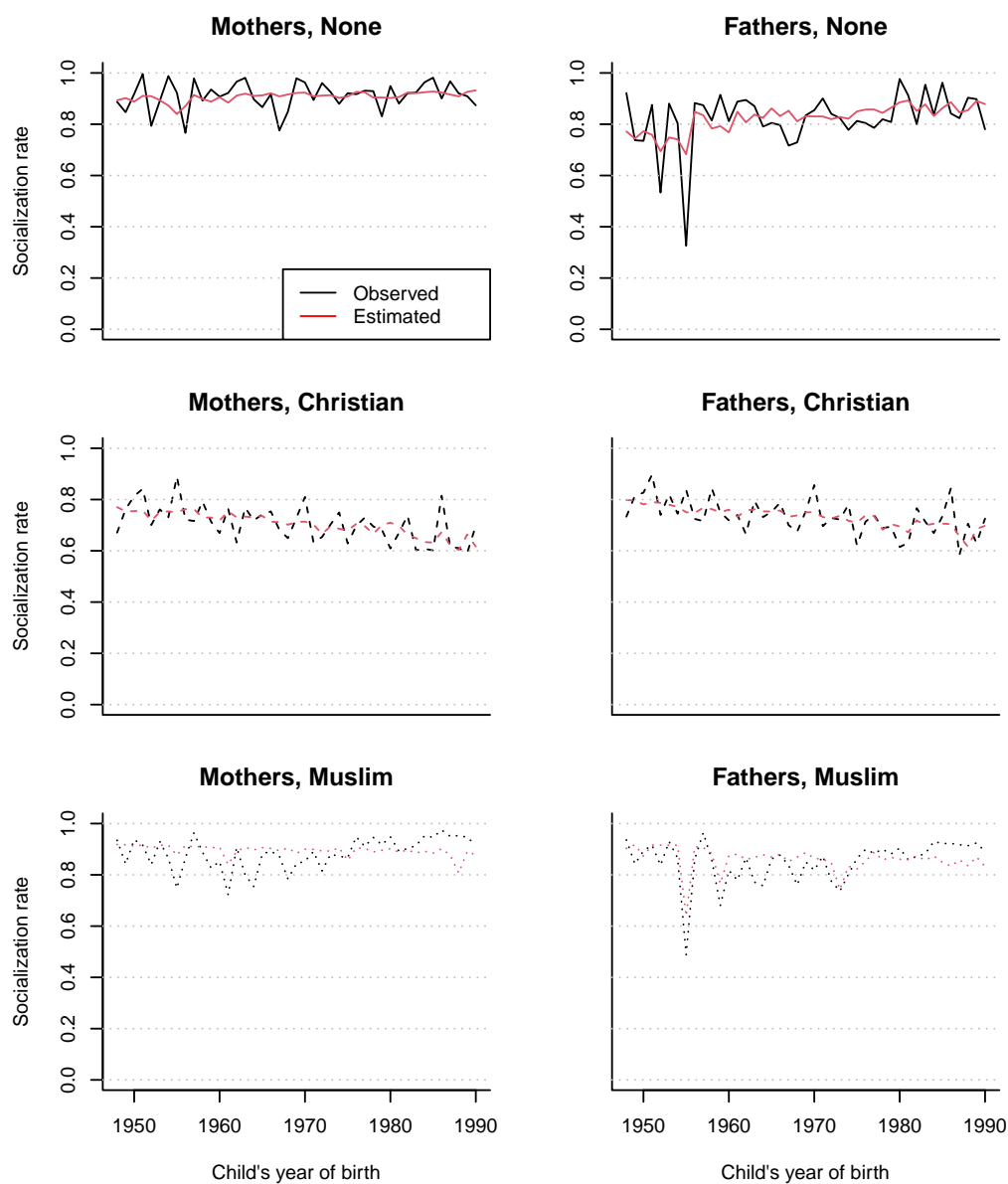


Figure 15: Conditional logit transmission, Observed vs. estimated transmission rates (by Religion).



In order to learn more about the potential effect of the parents' education levels on the transmission of religion, I extend the previous model by allowing socialization contributions to differ across education levels. Suppose that contributions to socialization now depend not only on the parent's religion  $n$ , but also on their education level  $e \in \{1, \dots, E\}$ . Mothers' contributions are thus denoted  $m_{ne}$ , and fathers'  $f_{ne}$ , with  $ne$  the bidimensional trait {religion, education} of the parent. The religious capital of  $i$  in trait  $n$  is now predicted by the equation

$$\ln K_{in} = k_n + \sum_e (m_{ne} \mathbf{1}_{\{i\text{'s mother is } ne\}} + f_{ne} \mathbf{1}_{\{i\text{'s father is } ne\}}) + \alpha q_{in}. \quad (8)$$

The requirement of knowing the educational attainments of the parents on top of their religious affiliation leads to some sample attrition, with 18 155 observations against 20 547 previously. As a baseline, I re-estimate the specification (2) on this subsample (Table 5, column 1). The estimates do not vary significantly from those obtained when using the full sample.

**Primary vs. Secondary vs. Tertiary.** The estimation procedure for the model with education effects remains the same, except that we now have  $2NE + 2$  parameters to estimate. To begin with, I consider the three education levels which I used in section 2: Primary or less, Secondary, and Tertiary or more. Results are presented in Table 5, column 2. The likelihood ratio test statistic is  $18\,308 - 18\,271 = 37$  on 20 degrees of freedom, for a  $p$ -value of 0.011, providing evidence that the parents' education levels matter in predicting transmission rates. Regarding the estimates, there is no clear pattern for the relationship between education and socialization contributions. The estimated parameters remain qualitatively close to the ones estimated in the model without educational effects.

**Primary vs. Secondary.** I attempt to estimate the effect of education more precisely by reducing the number of educational categories to two: Primary or less ( $e = 1$ ), and Secondary or more ( $e = 2$ ). Results are presented in Table 5, column 3. The likelihood ratio test statistic is  $18\,308 - 18\,288 = 20$  on 10 degrees of freedom, for a  $p$ -value of 0.031. Once again, estimated contributions are qualitatively close to their level in the absence of education effects.

With only two education levels, it is also easier to verify whether human capital has a discernable effect on socialization contributions or not. To do so, I test the two hypotheses  $m_{n1} = m_{n2}$  and  $f_{n1} = f_{n2}$  for every religion  $n$ . I use the delta method to recover the distributions of  $\hat{m}_{n1} - \hat{m}_{n2}$  and  $\hat{f}_{n1} - \hat{f}_{n2}$ . In short, these distributions are obtained from the asymptotic normality of the maximum likelihood estimator  $\hat{\beta}$  and from the fact that

Table 5: Conditional logit transmission with education effects, Estimates.

			model (2)	model (8)	model (8)	model (8)	
Parental socialization contributions							
Religion	Parent	Education					
None	Mother		0.41 (0.11)				
		Primary or less		0.31 (0.14)	0.32 (0.13)		
		Secondary (or more / or less)		0.42 (0.13)	0.45 (0.12)	0.37 (0.11)	
	Father	Tertiary or more	0.53 (0.19)		0.54 (0.19)		
		Primary or less	−0.31 (0.10)	−0.32 (0.11)	−0.33 (0.11)		
		Secondary (or more / or less)		−0.26 (0.12)	−0.30 (0.11)	−0.30 (0.10)	
	Tertiary or more	−0.36 (0.14)			−0.34 (0.14)		
	Christian	Mother		1.98 (0.10)			
			Primary or less		2.06 (0.11)	2.06 (0.11)	
Secondary (or more / or less)			2.00 (0.11)		1.97 (0.10)	2.01 (0.10)	
Father		Tertiary or more	1.89 (0.12)		1.88 (0.12)		
		Primary or less	1.95 (0.09)	1.98 (0.10)	1.99 (0.10)		
		Secondary (or more / or less)		1.94 (0.10)	1.91 (0.10)	1.97 (0.10)	
Tertiary or more	1.86 (0.11)			1.84 (0.11)			
Muslim	Mother		3.31 (0.12)				
		Primary or less		3.30 (0.13)	3.29 (0.13)		
		Secondary (or more / or less)		3.55 (0.16)	3.42 (0.15)	3.35 (0.12)	
	Father	Tertiary or more	2.84 (0.28)		2.85 (0.28)		
		Primary or less	3.30 (0.12)	3.24 (0.14)	3.26 (0.13)		
		Secondary (or more / or less)		3.39 (0.16)	3.37 (0.14)	3.26 (0.13)	
Tertiary or more	3.38 (0.21)			3.41 (0.20)			
Jewish	Mother		4.16 (0.32)				
		Primary or less		3.53 (0.68)	3.40 (0.70)		
		Secondary (or more / or less)		4.49 (0.51)	4.48 (0.37)	4.12 (0.40)	
	Father	Tertiary or more	4.64 (0.65)		4.63 (0.66)		
		Primary or less	2.82 (0.38)	2.86 (0.72)	2.96 (0.73)		
		Secondary (or more / or less)		2.33 (0.73)	2.91 (0.46)	2.48 (0.50)	
Tertiary or more	3.65 (0.66)			3.66 (0.66)			
Other	Mother		3.02 (0.16)				
		Primary or less		3.09 (0.18)	3.09 (0.17)		
		Secondary (or more / or less)		2.98 (0.20)	2.90 (0.18)	3.05 (0.16)	
	Father	Tertiary or more	2.54 (0.28)		2.55 (0.28)		
		Primary or less	2.04 (0.16)	2.08 (0.20)	2.09 (0.20)		
		Secondary (or more / or less)		2.01 (0.20)	1.99 (0.17)	2.06 (0.17)	
Tertiary or more	1.91 (0.22)			1.89 (0.22)			
Secularization bias $s_0$			3.35 (0.07)	3.36 (0.08)	3.36 (0.08)	3.35 (0.07)	
Oblique socialization coefficient $\alpha$			2.50 (0.13)	2.44 (0.13)	2.43 (0.13)	2.47 (0.13)	
Observations			18 155	18 155	18 155	18 155	
Sampling weights			No	No	No	No	
Deviance ( $-2 \ln L$ )			18 308	18 271	18 288	18 284	
Pseudo- $R^2$							
LR test $p$ -value			baseline	0.011	0.031	0.008	

Note: Standard errors in parentheses.

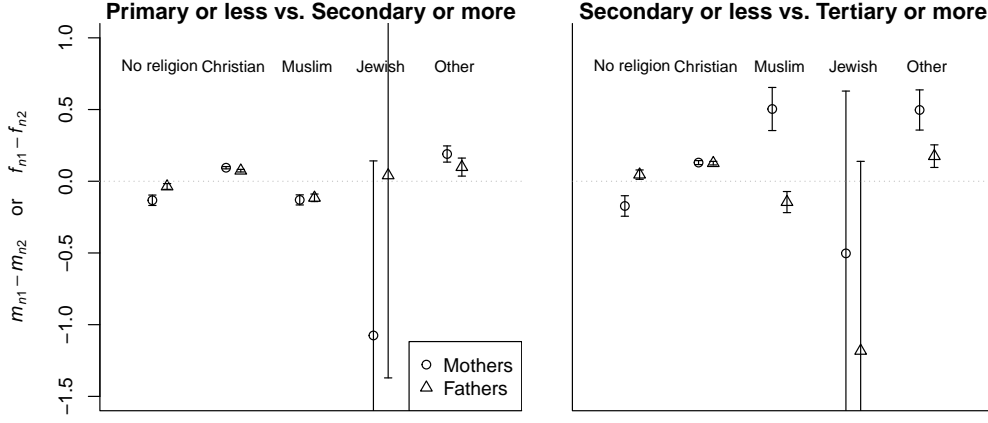


Figure 16: Differences in socialization contributions by education. 95% confidence intervals for  $m_{n1} - m_{n2}$  and  $f_{n1} - f_{n2}$  are reported for each religion  $n$ . Left panel: Primary or less ( $e = 1$ ) vs. Secondary or more ( $e = 2$ ). Right panel: Secondary or less ( $e = 1$ ) vs. Tertiary or more ( $e = 2$ ).

we can write

$$m_{n1} - m_{n2} = \Delta_n^m \beta$$

$$f_{n1} - f_{n2} = \Delta_n^f \beta$$

for every  $n$ , where  $\Delta_n^m$  and  $\Delta_n^f$  are row vectors of the form  $(0, \dots, 0, 1, -1, 0, \dots, 0)$ . In this way I obtain 95% confidence intervals for  $m_{n1} - m_{n2}$  and  $f_{n1} - f_{n2}$  (Figure 16, left panel). Differences between the socialization contributions of Primary or less parents and Secondary or more parents are statistically significant, except for Jewish parents. There is no clear direction for this effect however: half of the differences are positive (Christian and Other parents, and Jewish mothers), and half are negative (Nones and Muslim parents, and Jewish fathers).

It is difficult to say whether these differences across religions are structural, or if they are the result of a model misspecification. For instance, it might be the case that higher-educated Nones contribute more to the transmission of their affiliation than lower-educated ones, because they value secularism more. Or that higher-educated Christians contribute less because they value formal education more than religious socialization. But it might also be the case that the actual transmission pattern is not captured well enough by the model to accurately measure interaction effects between religion and education.

**Secondary vs. Tertiary.** Finally, I replicate this exercise with the following two education levels: Secondary or less, and Tertiary or more (Table 5, column 4). The likelihood ratio test statistic is  $18\,308 - 18\,284 = 24$  on 10 degrees of freedom, for a  $p$ -value of 0.008. Again, I test whether education has a significant effect on socialization contributions (Figure 16, right panel). Differences are still statistically significant except for Jewish parents. In this specification, a majority of the differences are positive. In other

words: the socialization contributions from lower-educated parents are higher than those from higher-educated parents in a majority of cases.

### 3.3 Alternative model for influence of education

Suppose instead that education has a uniform multiplicative effect on contributions across religious affiliations, so that

$$\begin{aligned} \ln K_{in} = & k_n + (1 + \kappa_1 \mathbf{1}_{\{i\text{'s mother has } e \geq 2\}} + \kappa_2 \mathbf{1}_{\{i\text{'s mother has } e \geq 3\}}) \times m_n \mathbf{1}_{\{i\text{'s mother is } n\}} \\ & + (1 + \rho_1 \mathbf{1}_{\{i\text{'s father has } e \geq 2\}} + \rho_2 \mathbf{1}_{\{i\text{'s father has } e \geq 3\}}) \times f_n \mathbf{1}_{\{i\text{'s father is } n\}} + \alpha q_{in}. \end{aligned} \quad (9)$$

This model is still linear in the observables, but it imposes more structure than the previous model from section 3.2. Indeed, here I impose  $m_{n2} = (1 + \kappa_1)m_{n1}$  and  $m_{n3} = (1 + \kappa_1 + \kappa_2)m_{n1}$  for all religions  $n$ , where the parameters  $\kappa_1$  and  $\kappa_2$  do not depend on  $n$  (and similarly for the  $f_{ne}$  with  $\rho_1$  and  $\rho_2$ ). The goal is to see the effects of education by measuring  $\kappa_1$ ,  $\kappa_2$ ,  $\rho_1$ , and  $\rho_2$ . If they were negative for instance, this would provide evidence of lower contributions in average for more-educated parents.

Results are presented in Table 6. In column 1 I re-estimate the baseline model on the subsample of individuals for whom the educational attainment of both parents is available. Results remain comparable to the estimation on the full sample. Next, I estimate the new model with multiplicative education effects. The estimates for  $\kappa_1$ ,  $\kappa_2$ ,  $\rho_1$ , and  $\rho_2$  suggest that education has an opposite effect on contributions to socialization across genders: positive for mothers, and negative for fathers. For mothers, more education is associated with higher contributions: mothers with a Tertiary education or more have contributions which are 10% higher than mothers who have a Primary education or less. For fathers it is the opposite: a Tertiary education is associated with contributions which are 13% lower. The effect of having a Secondary education goes in the same direction (1% higher contributions for mothers, 2% lower for fathers), but it is not statistically significant. The LR test value is 10 on 4 degrees of freedom ( $p$ -value = 0.033), so the added parameters provide significative explanatory power to the model.

Table 6: Conditional logit transmission with education effects, Estimates.

	Conditional logit estimates	
	(2)	(9)
Constant $k_n$		
None	2.82*** (0.09)	2.87*** (0.09)
Christian	0 (baseline)	0 (baseline)
Muslim	-1.37*** (0.09)	-1.32*** (0.10)
Jewish	-2.72*** (0.12)	-2.70*** (0.12)
Other	-0.72*** (0.09)	-0.67*** (0.10)
Mother's contribution $m_n$		
None	0.07 (0.09)	0.14 (0.09)
Christian	2.26*** (0.09)	2.15*** (0.09)
Muslim	3.82*** (0.23)	3.75*** (0.23)
Jewish	5.79*** (0.32)	5.60*** (0.31)
Other	3.76*** (0.16)	3.70*** (0.16)
Father's contribution $f_n$		
None	0.39*** (0.07)	0.30*** (0.07)
Christian	1.24*** (0.07)	1.37*** (0.07)
Muslim	3.28*** (0.23)	3.38*** (0.24)
Jewish	3.04*** (0.48)	3.17*** (0.49)
Other	1.13*** (0.23)	1.20*** (0.23)
Multiplicative education effets		
Secondary or more mother $\kappa_1$		0.01 (0.01)
Tertiary or more mother $\kappa_2$		0.09*** (0.02)
Secondary or more father $\rho_1$		-0.02 (0.02)
Tertiary or more father $\rho_2$		-0.11*** (0.02)
Oblique socialization coefficient $\alpha$	1.41*** (0.08)	1.48*** (0.09)
Observations	18 115	18 115
Sampling weights	Yes	Yes
Deviance $(-2 \ln L)$	19 198	19 188
Pseudo- $R^2$	0.47	0.47
LR test $p$ -value	baseline	0.033

Note: Standard errors in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## 4 Model

Section 3 mostly confirmed the patterns documented by the descriptive analysis of section 2: mothers contribute more to religious socialization of their children than fathers, religious minorities more than majorities, and the education levels of the parents are relevant predictors of their contributions to religious socialization. It also provided a first quantified measure of these various heterogeneities in the transmission process. Because mothers are less educated than fathers in the data, and religious minorities less than majorities, it is tempting to use an economic argument involving education to explain these differences in socialization patterns. The estimates from the reduced-form analysis are indeed broadly consistent with an economic explanation, namely: higher-educated individuals have a higher opportunity cost to socialize their children, and therefore they socialize them less. In particular, in light of the possible substitution between culture and education discussed in the introduction, we can wonder if higher-educated parents reallocate resources from cultural socialization towards formal education, because they have a comparative advantage in the latter.

To investigate this potential mechanism, in this section I construct a model of intergenerational cultural socialization and human capital formation. First, I focus on modelling the technology available to parents for the cultural socialization of their child. Similar to Iannaccone (1990) in the case of religion, I take a human capital approach to culture, introducing the notion of *cultural capital* as an intensive and multi-dimensional measure of culture for individuals.<sup>10</sup> This approach considers that culture is not simply a static affiliation, but a gradually-built ensemble of knowledge and practices in which individuals can invest. Here, I consider specifically the role that parental time investments play in building children's cultural capital: this is the socialization process.

Second, I embed this model of socialization in a collective household framework where parents care about passing on both human capital and cultural capital to their child. To do so, they can allocate their time between two activities: human capital production, and cultural socialization. The goal of the model is to describe a simple trade-off between these two activities. Crucially, the human capital of the parents is assumed to be productive in the human capital formation of the child, but not in cultural socialization. Thus by construction, parents with higher human capital have a comparative advantage in human capital formation, relative to cultural socialization. Because of this, an increase in the human capital of the parents will lead to a reallocation of time in favor of the child's human capital formation, and at the expense of her cultural socialization. This mechanism also interacts with the main idea developed by Bisin and Verdier (2000) on cultural transmission: cultural minorities must make more effort to transmit their culture than majorities, because majorities can rely on the public provision of cultural socialization,

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<sup>10</sup>This terminology has of course a long tradition in sociology (Bourdieu 1979), which was itself influenced by the work of Gary Becker. Yet, its adoption here is rather a generalization of the concept of an intensive religious capital developed in economics by Iannaccone (1990).

or *oblique socialization*. In my framework this happens at the expense of human capital formation, thus creating an imbalance between minorities and majorities: all else equal, minorities devote less time to their child’s human capital formation than majorities.

This section is divided into three parts. In section 4.1 I present a time allocation theory of cultural socialization. In section 4.2 I describe the household’s decision framework. Finally, in section 4.3 I solve the model and provide a short analysis of the trade-offs involved.

#### 4.1 A time allocation theory of socialization

In order to model socialization inside the household, I start with the technology of cultural socialization available to the parents. My theoretical approach is grounded in the seminal work on cultural transmission by Bisin and Verdier (2000). In particular, I adopt the distinction between *vertical socialization*, done by the parents, versus *oblique socialization*, done by the rest of the population. Yet, it departs from it several ways, and in so doing bridges the gap with other strands of literature.

In their model Bisin and Verdier consider culture as a discrete, exclusive trait, which is transmitted probabilistically. Instead, I model the culture transmitted to children as multi-dimensional and with an intensive measure, and I label this the cultural capital of children. Behind this label is the idea that culture is an example of a task-specific human capital (Gibbons and Waldman 2004), an approach which was already adopted in the economics of religion by Iannaccone (1990). As such, cultural capital associated with Christianity for instance, serves a different purpose from cultural capital associated with Islam.<sup>11</sup> Furthermore, rather than considering all the different possible channels of cultural capital formation, here I focus on the role of parental time investments in their child’s cultural socialization. Keeping religion as an illustrative example, the child’s cultural capital is then a measure of the intensity of her socialization to Christianity, Islam, Atheism... This modelling choice proves important in order to disentangle the different influences involved in the cultural socialization process. It is also particularly convenient to transpose to the empirical analysis – indeed, I will show how it maps naturally to the reduced-form analysis from section 3. Finally, because I consider cultural capital as a specific modality of human capital, I adapt existing insights from the literature on children’s human capital formation (Del Boca et al. 2014, 2016, Chiappori et al. 2017) and the theory of time allocation (Becker 1965) to represent the production of children’s cultural capital. Doing so provides tractable solutions to the collective household model in section 4.2, while maintaining the intuitive results which would derive from a more

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<sup>11</sup>This example also emphasizes a possible complementarity between the different dimensions of cultural capital: as Abrahamic religions, there is significant overlap between Christianity and Islam in terms of religious knowledge or practice. If we consider the example of language, the same could be said about languages which share a common script, vocabulary, or grammatical structure. While I won’t consider it here for the sake of simplicity, this complementarity between different dimensions of cultural capital could easily be added to the model, at the cost of additional complexity in the number of parameters.



agnostic approach.

**The formation of cultural capital.** Consider a household formed by two parents, indexed by  $i \in \{1, 2\}$ . For simplicity, I assume that each household has one child. Parent  $i$  possesses a single cultural trait  $n_i$  among  $N$  possible ones. In this model, parents domestically produce the child’s cultural capital by spending time on cultural socialization.

To model the accumulation of the child’s cultural capital, I adapt an existing model from the literature on human capital formation. Specifically, [Del Boca et al. \(2014, 2016\)](#) consider that time investments in the human capital of children are intertemporal complements, in the sense that past investments increase the returns of current investments. The idea is of course that human capital builds on itself. In practice, this feature is simply obtained by supposing that the returns of current investments depend on the current stock of human capital. As a specific type of human capital, it is reasonable to assume that cultural capital is produced in a similar way. Interpreted here in a continuous time setting, it means that the cultural capital returns  $dK$  to a marginal time investment  $ds$  are proportional to the stock of cultural capital already produced. Following this logic, the law of accumulation of the cultural capital  $K$  is

$$dK = K \times a \, ds \quad (10)$$

where  $a$  is a positive parameter denoting the time productivity of the individual.<sup>12</sup> Integrating equation (10), we find that the log-cultural capital is produced from the time investment  $s$  by a linear technology:

$$\ln K = k + a \, s. \quad (11)$$

Equation (11) thus describes the accumulation of cultural capital when one individual is involved in the child’s socialization. In reality however, the cultural socialization of children involves several individuals, and most notably the parents. Here, I follow the literature on cultural transmission by assuming that the child is subject to *vertical* and *oblique* socialization ([Bisin and Verdier 2000, 2011](#)). Vertical socialization, on the one hand, results from “purposeful socialization decisions inside the family.” In my time allocation framework, it is carried out in the form of (endogenous) parental time inputs  $s_i$  spent socializing the child. Oblique socialization, on the other hand, summarizes other socialization processes which happen outside of the family. To model oblique socialization, first I assume that the child has a fixed time attention span for being socialized, which I normalize to 1. (Hence I ignore the extensive margin of socialization here.) Deducting the

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<sup>12</sup>This is equivalent to the way that an investment  $I$  grows with time under an interest rate  $r$ ,

$$dI = I \times r \, dt \implies I = I_0 e^{rt}.$$

time taken by the parents, this leaves time  $1 - s_1 - s_2$  during which the child is subject to oblique socialization. Second, I assume that this remaining socialization time is spent randomly with the rest of the population. It means that if a culture has a population share  $q$ , the child spends time  $(1 - s_1 - s_2)q$  being socialized to that culture. Thus, as in the standard [Bisin and Verdier](#) model, oblique socialization to a given culture is proportional to that culture's share in the population: more widespread cultures have a stronger influence. Taking these different socialization channels into account, the child's cultural capital is produced via the technology

$$\ln K = k + a_1 s_1 + a_2 s_2 + a_0 (1 - s_1 - s_2)q \quad (12)$$

where  $a_1$  and  $a_2$  are the productivities of parents 1 and 2 respectively; and  $a_0$  is the productivity of oblique socialization.

The socialization technology (12) still describes a unidimensional accumulation process. Culture, however, is multidimensional: the child receives socialization in all  $N$  cultural traits present in the population. This constitutes a  $N$ -dimensional vector  $(K_n)_{1 \leq n \leq N}$ , where each  $K_n$  corresponds to the child's cultural capital in a different trait. The component  $K_n$  is increasing in the parental time investments in the child's socialization to trait  $n$ , and in the population share  $q_n$  of trait  $n$ . In the most general case, parents would be able to contribute to the child's socialization to any trait. Yet, to simplify the analysis, it is useful to consider that a parent can only socialize the child to their own trait. There are at least two reasons to justify this assumption. First, a parent is likely to want to transmit their own culture first and foremost, and therefore to use their available time to do so. Second, they might simply not have the capacity to transmit another culture if they are not affiliated or familiar with it themselves (e.g. ethnicity, but also language, religion). For this reason, here I will assume that the time  $s_i$  devoted by parent  $i$  is fully counted towards the socialization of the child to that parent's trait,  $n_i$ . Thus the child's cultural capital in the trait  $n$  is formed according to

$$\ln K_n = k_n + a_1 s_1 \mathbf{1}_{\{n_1=n\}} + a_2 s_2 \mathbf{1}_{\{n_2=n\}} + a_0 (1 - s_1 - s_2) q_n \quad (13)$$

where  $\mathbf{1}_{\{n_i=n\}}$  is an indicator equal to 1 if and only if parent  $i$  has the trait  $n$ .

**Examples.** For fixed parental time inputs  $s_1, s_2$ , a child with homogamous parents of culture  $n$  will receive the cultural capital

$$\ln K_n = k_n + a_1 s_1 + a_2 s_2 + a_0 (1 - s_1 - s_2) q_n, \quad \ln K_\ell = k_\ell + a_0 (1 - s_1 - s_2) q_\ell \quad (\forall \ell \neq n),$$

while a child with heterogamous parents of cultures  $n_1 \neq n_2$  will receive

$$\ln K_{n_1} = k_{n_1} + a_1 s_1 + a_0 (1 - s_1 - s_2) q_{n_1}, \quad \ln K_{n_2} = k_{n_2} + a_2 s_2 + a_0 (1 - s_1 - s_2) q_{n_2},$$

$$\ln K_\ell = k_\ell + a_0(1 - s_1 - s_2)q_\ell \quad (\forall \ell \neq n_1, n_2).$$

*The model is also readily extendable to single-parent families: for instance, a child with parent 1 only will receive*

$$\ln K_{n_1} = k_{n_1} + a_1 s_1 + a_0(1 - s_1)q_{n_1}, \quad \ln K_\ell = k_\ell + a_0(1 - s_1)q_\ell \quad (\forall \ell \neq n_1).$$

Below I will introduce the decision framework in which parents choose their time inputs  $s_i$  endogenously. Before that however, we can already imagine how the functional form (13) will impact the socialization decisions of the household. First, if the parental productivities  $a_1$  and  $a_2$  are different, one parent has a comparative advantage over the other in the child's socialization. This feature of the model opens up the possibility of productivity-driven specialization in the household, which is one possible way to explain disparities in transmission rates between mothers and fathers. Second, the model assumes that vertical socialization comes at the expense of oblique socialization. In consequence, parents who belong to a more widespread culture have lower returns on the time they spend socializing their children. This point relates to the *cultural substitution* property introduced by Bisin and Verdier (2001) – I will come back to this during the analysis.

**Relationship with the reduced-form.** In the theory above, individuals have a complex cultural identity which is represented by a multi-dimensional cultural capital. Empirically however, this multi-dimensional approach of culture can prove problematic. Indeed, in order to take this theoretical framework directly to data, the researcher should ideally have an intensive measure of culture along multiple dimensions (e.g. the level of proficiency in several languages). Yet, in most cases, surveys do not report this kind of measure of the respondents' culture(s). Rather, survey respondents are often categorized into a single, exclusive affiliation (e.g. religion, ethnicity). This is notably the case for the respondents' religious affiliation in the TeO data.

In section 3 we have seen that the multinomial logit model addresses this issue by mapping the multi-dimensional, intensive measure of culture from the theory, into an extensive, discrete cultural affiliation as reported in the data. This amounts to considering the reporting of a single cultural affiliation as a choice between coexisting cultural identities. Following the discrete choice theory logic, individuals are then more likely to report a cultural affiliation in which they have a higher cultural capital. Moreover, we have seen how the linear form of the log-cultural capital naturally fits into a multi-logit regression framework.

Notice that equation (13) bears a striking resemblance to the econometric specification (2) used in the reduced-form analysis of section 3. It provides a theoretical foundation for the log-religious capital  $\ln(K_{in})$  being a linear function of the observables  $\mathbf{1}_{\{i's \text{ mother is } n\}}$ ,  $\mathbf{1}_{\{i's \text{ father is } n\}}$ , and  $q_{in}$ . Furthermore, it suggests to use measures of parental time use on religious socialization to predict individuals' choice of religious affiliation. Unfortunately,

there is no such measure in the TeO data. In its absence, we can interpret the estimated socialization contributions from section 3 as proxies of parental socialization time investments. Recall that according to the reduced-form estimates, religious minorities contribute more to the socialization of their children than majorities, and mothers more than fathers. The model can rationalize the difference between mothers and fathers in two ways: mothers are more productive at socialization ( $a_1 > a_2$ ), or they simply spend more time on religious socialization than fathers ( $s_1 > s_2$ ).<sup>13</sup> Regarding the difference between religious minorities and majorities however, the model can only rationalize it with higher socialization time investments on the part of minorities. Because the econometric specification (2) ignored the adverse role of vertical socialization on oblique socialization present in the model (13), there is no such direct interpretation of the oblique socialization coefficient. Finally, the constant  $k_n$  from the reduced-form analysis could be understood as a measure of the initial stock of religious capital across the different religious affiliations.

**Decreasing returns to socialization.** Until now, and in order to keep the exposition simple, I have assumed that socializing individuals have a constant productivity of socialization, equal to  $a_1$ ,  $a_2$ , or  $a_0$ . In fact, it may be more accurate to assume that the socialization time investments of the parents exhibit decreasing returns, in the sense that the marginal productivity of their time declines as they spend more time socializing the child. (See for instance Chiappori et al. 2017 for children’s human capital formation). This could be due to the fact that parents eventually run out of new knowledge to transmit, or that children progressively lose attention when taught by a single teacher.

To account for this, I assume that individuals’ socialization productivity decreases with the time  $s$  spent socializing the child. In order to keep the model tractable, I consider that productivity decreases linearly: after having spent time  $s$  on socialization, an individual has marginal productivity  $a \times (1 - \gamma s)$ . Under this assumption,  $a$  is the initial socialization productivity at  $s = 0$ , and  $\gamma$  is a positive parameter representing how quickly productivity declines. (Note also that above  $s > 1/\gamma$ , socialization becomes counter-productive.) The law of accumulation of cultural capital (10) is modified to

$$dK = K \times a \times (1 - \gamma s) ds. \quad (14)$$

By integrating this equation we obtain the total cultural capital output produced from a socialization time investment  $s$ ,

$$\ln K = a \left( s - \frac{\gamma}{2} s^2 \right).$$

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<sup>13</sup>If we denote by  $s_{1n}$  and  $s_{2n}$  the socialization time investments of mothers  $n$  and fathers  $n$  respectively, then  $m_n$  and  $f_n$  are defined as

$$m_n = a_1 s_{1n}, \quad f_n = a_2 s_{2n}.$$

Since they spend a significant amount of time with their children, it is reasonable to assume that parents are subject to this decline in socialization productivity. Oblique socialization, on the other hand, is by assumption carried out by many different individuals who each spend a marginal amount of time socializing the child. For this reason, the time  $1 - s_1 - s_2$  dedicated to oblique socialization still produces cultural capital at a constant rate and does not suffer from a decrease in productivity. To summarize, incorporating decreasing returns in socialization yields to the following production of cultural capital:

$$\ln K_n = k_n + a_1 \left( s_1 - \frac{\gamma_1}{2} s_1^2 \right) \mathbf{1}_{\{n_1=n\}} + a_2 \left( s_2 - \frac{\gamma_2}{2} s_2^2 \right) \mathbf{1}_{\{n_2=n\}} + a_0 (1 - s_1 - s_2) q_n. \quad (15)$$

Note that compared to equation (13), this time I also included the constant  $k_n$ . This is the functional form that I will use in the the household model below, and in section 5 for the structural econometric model.

## 4.2 Household model

After describing the technology of socialization, I now turn to the trade-offs faced by the parents when choosing their socialization time investments. As mentioned above, the parents' human capital will play a role here. In addition to the cultural trait  $n_i$ , parent  $i$  is now also characterized by a human capital level  $h_i$  (continuous). Parents have a fixed time budget, which they must allocate between the production of the child's human capital and cultural capital.

The child's cultural capital is produced from the parents' socialization time inputs  $s_i$  according to the technology (15). I assume that the child's human capital is produced with a fundamentally similar technology from time inputs  $t_i$  of the parents. Unlike for cultural socialization however, I assume that the parental human capital  $h_i$  increases the productivity of parent  $i$  during human capital production.<sup>14</sup> These two assumptions are consistent with existing models of children's human capital formation (Del Boca et al. 2016, Chiappori et al. 2017). Thus the child's human capital  $H$  is produced from parental inputs and characteristics according to

$$\ln H = (b_1 + h_1) \left( t_1 - \frac{\gamma_1}{2} t_1^2 \right) + (b_2 + h_2) \left( t_2 - \frac{\gamma_2}{2} t_2^2 \right). \quad (16)$$

As for  $a_1$  and  $a_2$  in the case of cultural capital production, the parameters  $b_1$  and  $b_2$  denote the baseline productivities of parent 1 and 2 respectively. Note also that I have taken a constant equal to 0 in the production function – this is without loss of generality for the model. (For this reason, one could also add a source of “oblique” production of human capital, without consequence on the model's insights.)

Parents care about their child's human capital and cultural capital. To simplify, I assume that parent  $i$  values only the cultural capital of the child in their own trait,  $n_i$ .

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<sup>14</sup>Results would still hold if, instead of parental human capital having no effect of the production of cultural capital, it simply had a lesser effect.

Based on this assumption, I consider a Cobb–Douglas utility for parent  $i$  of the form:

$$u_i = \nu_i \ln(K_{n_i}) + \ln H.$$

The parameter  $\nu_i$  is an important primitive of the model, representing the value of the child’s cultural capital (relative to her human capital) for parent  $i$ .

I use a collective household model ([Chiappori 1992](#)) to represent the parents’ decision-making, so that parental decisions lead to an outcome on the Pareto frontier of the household. In other words, the intrahousehold decisions must maximize a weighted sum of the parents’ utilities:

$$\max_{t_i, s_i} \{ \mu u_1 + u_2 = \mu \nu_1 \ln K_{n_1} + \nu_2 \ln K_{n_2} + (\mu + 1) \ln H \}, \quad (17)$$

where  $\mu$  is the relative power (Pareto weight) of parent 1, fixed exogenously. The constraints concern the time available to the parents: I assume a fixed time budget  $T_i$  for parent  $i$ , so that the household constraints are

$$t_i + s_i \leq T_i, \quad i = 1, 2. \quad (18)$$

These constraints must be saturated at the optimal time allocation as long as  $\gamma$  is small enough compared to  $T_i$ .

**Discussion.** This framework shares similar features with existing models of cultural transmission and human capital formation. The seminal model of cultural transmission was proposed by [Bisin and Verdier \(2000\)](#), in which parents also care about passing on their culture to their children, and can contribute to their child’s cultural socialization to their own trait. In particular, the fact that parents might want to transmit a different culture than their own is therefore not considered in their model nor in mine. A reason for this to happen could be discriminations against or in favor of a given culture. Such a phenomenon has been documented for instance by [Saleh \(2016\)](#), who shows how differential taxation in medieval Egypt incentivized Coptic Christians (who faced higher taxes) to adopt the Muslim affiliation. The crucial feature of the [Bisin and Verdier](#) model, namely the substitution between vertical and oblique socialization, is also embedded in my model through the cultural capital production technology (section 4.1).

My model also departs from [Bisin and Verdier](#) in several ways. First, in their model, parents’ efforts to socialize the child have an abstract convex cost. In my model, these efforts are specified as time allocations, which are made at the expense of the child’s human capital production.

Second, in my model parents care about the cultural capital in their own trait, as opposed to the transmission probability to every trait in [Bisin and Verdier \(2000\)](#). The two formulations are in fact theoretically equivalent in the case with two traits (which

is the case considered by Bisin and Verdier). This is because with only two traits, an increase in the population share of trait 1 mechanically leads to a decrease in the share of trait 2. Thus, a parent who cares about the population share of trait 1 must indirectly care about that of trait 2 as well. This is not true anymore, however, when there are three traits or more in the population. Indeed, in my model any change in the population shares which holds the share of the parent's trait constant will have no effect on that parent's utility and decision. This is unlike the Bisin and Verdier framework, in which a parent could for instance decrease their socialization effort if a trait which they prefer becomes more widespread (e.g. a Catholic might prefer that their child becomes Protestant rather than Muslim). But then again, fewer theoretical results exist in the case with three traits or more (see Montgomery 2010). Assuming that parents care about the cultural capital, and not the transmission probability, greatly facilitates the analysis when there are three traits or more, and is therefore well-suited to an empirical framework.

Third and last, in my model the socialization technology extends to both culturally homogamous and heterogamous households. This is not possible in the Bisin and Verdier model, which uses a unitary framework and for this reason assumes that heterogamous households do not have no available socialization technology (because then it would be unclear which culture the representative agent would want to transmit). Instead, in my model the technology of cultural capital production extends naturally to heterogamous households, yielding a trade-off between the socialization to the two parents' traits.

Regarding the production of the child's human capital, as in Chiappori et al. (2017) parents produce the human capital of their child using time inputs which are complements. Furthermore, parental human capital improves the productivity of these time inputs. In their model, time investments into the child's human capital production are made at the expense of the household's income – in my model, they are made at the expense of the child's cultural socialization.

### 4.3 Model analysis

With the technologies (15) and (16), the household problem (17)–(18) has closed-form solutions  $s_i^*$ ,  $t_i^*$ . For the sake of clarity in the exposition, I make the following simplifying assumption.

**ASSUMPTION 1:**  $\gamma_i = \frac{1}{T_i}$ .

This assumption imposes that a parent's time productivity in socialization or human capital formation reaches exactly 0 when they spend all of their time budget on only one activity. It guarantees interior solutions, and at the same time provides simpler formulas for the solutions  $s_i^*$  and  $t_i^*$ . I now describe these solutions as well as some of their properties, first for homogamous households, and then for heterogamous ones.



**Homogamous households.** In a homogamous household the two parents have aligned interests. They both wish to transmit their common culture as well as human capital to the child, although they may disagree on how much to favor one over the other. Denoting by  $n$  the common trait of the two parents, the first-order conditions are

$$(\mu \nu_1 + \nu_2)(a_i(1 - \gamma_i s_i^*) - a_0 q_n) = (\mu + 1)(b_i + h_i)(1 - \gamma_i t_i^*) \quad (i = 1, 2).$$

At the optimum, parent  $i$ 's marginal returns from investing time in cultural capital or human capital formation should be equal. On the left-hand side, the marginal return from the socialization time  $s_i$  is increasing in the two parents' relative preference for cultural capital  $\nu_1$  and  $\nu_2$ , and in parent  $i$ 's productivity  $a_i$ ; and is decreasing in the productivity and intensity of oblique socialization,  $a_0$  and  $q_n$ . On the right-hand side, the marginal return from the time  $t_i$  spent on human capital formation is increasing in the productivity  $b_i$  and the human capital of parent  $i$ ,  $h_i$ .

The solution is obtained by using the saturated time constraint (18) as well as Assumption 1:

$$s_i^* = T_i \times \frac{(\mu \nu_1 + \nu_2)(a_i - a_0 q_n)}{(\mu \nu_1 + \nu_2)a_i + (\mu + 1)(b_i + h_i)} \quad (19)$$

whenever this expression is positive (i.e. when  $a_i > a_0 q_n$ , so that parent  $i$  has an incentive to vertical socialization), and  $s_i^* = 0$  otherwise. Note that the ratio in expression (19) is always inferior to 1, so that parent  $i$  never devotes their whole time budget to socialization. The following proposition describes how this optimal time allocation changes with the characteristics of the parents and of the population.

**PROPOSITION 1:** In homogamous households, the time that parent  $i$  spends on cultural socialization is decreasing in his or her human capital level,  $h_i$ ; and in the population share of the parents' common trait,  $q_n$ ; and it is increasing in both parents' relative preference for cultural capital,  $\nu_1$  and  $\nu_2$ . Furthermore, it is increasing in parent's 1 relative power  $\mu$  if and only if  $\nu_1 > \nu_2$ , and decreasing otherwise.

The proof is simply obtained by differentiating the solution (19) with respect to the parameters of interest. Proposition 1 confirms that the model encapsulates the trade-offs between human capital formation and cultural socialization mentioned at the beginning of this section. Taking parental preferences as fixed, two types of time substitution occur in the model: higher-human capital parents reallocate their time towards human capital formation, and cultural-majority parents as well. The first kind of substitution results from the comparative advantage of higher-human capital parents in the child's human capital production. The second kind is a consequence of vertical socialization coming at the expense of oblique socialization: this relates to the *cultural substitution* property introduced by Bisin and Verdier (2001).

If the preference for cultural capital changes for one parent, both parents respond to that change by reallocating their time in the same direction. This is a consequence



of the cooperativeness implied by the collective household framework. The same is true for changes in the power balance. Finally, the comparative statics with respect to the parental productivities  $a_i$  and  $b_i$  are straightforward: if their productivity in one activity increases, parents reallocate their time towards that activity.

**Heterogamous households.** In a heterogamous household, parents have different objectives: parent 1 wants to socialize the child to trait  $n_1$ , and parent 2 to trait  $n_2$ . Compared to the homogamous case, this divergence in the parents' interests modifies how they react to changes in the model's parameters. First, changes in parental preferences or in the power balance lead them to reallocate their time in opposite directions: when one parent increases their socialization time investment, the other parent reduces it. Second, a higher population share for any parents' trait decreases the incentive to vertical socialization for both parents. This is because vertical socialization happens at the expense of oblique socialization in all traits. Thus, if oblique socialization becomes better for one of the two parents, the household's incentive to vertical socialization decreases.

Formally, the first-order conditions are

$$\begin{aligned}\mu \nu_1 (a_1(1 - \gamma_1 s_1^*) - a_0 q_{n_1}) - \nu_2 a_0 q_{n_2} &= (\mu + 1)(b_1 + h_1)(1 - \gamma_1 t_1^*) \\ \nu_2 (a_2(1 - \gamma_2 s_2^*) - a_0 q_{n_2}) - \mu \nu_1 a_0 q_{n_1} &= (\mu + 1)(b_2 + h_2)(1 - \gamma_2 t_2^*).\end{aligned}$$

These conditions are mostly similar to the homogamous case. The novelty is the adverse effect of vertical socialization from parent  $i$  on the oblique socialization to parent  $-i$ 's trait (in the first line for instance, this effect is represented by the term  $-\nu_2 a_0 q_{n_2}$ ).

Once again, the solution is obtained by using the time constraint (18):

$$s_1^* = T_1 \times \frac{\mu \nu_1 (a_1 - a_0 q_{n_1}) - \nu_2 a_0 q_{n_2}}{\mu \nu_1 a_1 + (\mu + 1)(b_1 + h_1)} \quad (20)$$

$$s_2^* = T_2 \times \frac{\nu_2 (a_2 - a_0 q_{n_2}) - \mu \nu_1 a_0 q_{n_1}}{\nu_2 a_2 + (\mu + 1)(b_2 + h_2)}. \quad (21)$$

The following proposition describes the mechanisms at hand in heterogamous households: on top of the two kinds of substitution occurring in homogamous household, parents must also adapt their time investments to suit their diverging interests.

**PROPOSITION 2:** In heterogamous households, the time that parent  $i$  spends on cultural socialization is decreasing in his or her human capital level,  $h_i$ ; in the population shares of the two parents' traits,  $q_{n_1}$  and  $q_{n_2}$ ; and in the relative preference for cultural capital of the other parent,  $\nu_{-i}$ ; and it is increasing in his or her relative power, and in his or her relative preference for cultural capital  $\nu_i$ .

Contrarily to the homogamous case, here a concession is made between the two parents on producing the child's human capital, which is a public good, versus producing cultural

capital in the parents' respective traits, which is a private good enjoyed by each parent separately. The power balance notably determines the importance of socializing the child to parent 1's trait versus parent 2's trait. As a parent gets more power, they dedicate more time to the cultural socialization of the child (their private good), while the other parent reallocates time towards human capital production (the public good).

[CHECK THIS] Comparing the solutions (19) and (20)–(21) we also obtain the following result.

**PROPOSITION 3:** Call  $K_n^{ab}$  the level of cultural capital in dimension  $n$  which results from optimal socialization time investments by a household with mother  $a$  and father  $b$ . Homogamous households socialize their children more than heterogamous ones, in the sense that

$$\ln K_a^{aa} + \ln K_a^{bb} > \ln K_a^{ab} + \ln K_a^{ba}. \quad (22)$$

This concludes the short analysis of the model. In Appendix D I discuss implications for household formation using a matching framework, as well as for population dynamics.

## 5 Estimation

In this section I estimate the structural model developed in section 4. This estimation is very similar in spirit to that of the reduced-form model from section 3. Indeed, I still exploit the variation in the traits of the respondents and their parents as a source of identification. This time however, I use not only the respondents' religious affiliation as an explained variable, but also their educational attainment. This is now possible because the structural model predicts both the religious socialization and the human capital of individuals. As I will explain in this section, the estimation framework can thus be understood as a mixture of a multinomial logit and an ordered logit model.

In section 5.1 I present the framework for the estimation. In section 5.2 I present the results.

### 5.1 Methodology

This section describes how I take the model to the data. The religious affiliation of respondents in the data is explained by their predicted level of religious capital in the model, using a multinomial logit framework. Similarly, their educational attainment is explained by their predicted level of human capital in the model, using an ordered logit framework. I then combine these two frameworks in the log-likelihood function for the estimation.

**Measuring the parents' human capital.** Before delving into the estimation, an inconsistency between the model and the data needs to be addressed. In the model, the parents have a human capital trait  $h$ , which is continuous. In the data however, I measure this level of human capital using the educational attainment variable, which is discrete. Thus, when solving the household program for two parents with observed educational attainments  $e_1$  and  $e_2$ , I must decide how  $e_1$  and  $e_2$  translate into human capital levels  $h_1$  and  $h_2$ .

As a simple solution, I assume that each educational attainment  $e$  is associated with a fixed human capital level  $\tilde{h}_e$ . Rather than choosing the  $\tilde{h}_e$  exogenously however, I consider them as parameters to be estimated. In the model, any parent with educational attainment  $e$  is thus assumed to have the human capital level  $\tilde{h}_e$ .

**Religious affiliation.** For each individual  $i$ , the model predicts the cultural capital of  $i$  in any religion  $n$ ,  $K_{in}$ , as a function of her parents' religious and educational traits and of the religions' population shares. To map this onto the data, assume as in section 3 that  $i$  ultimately picks the religious affiliation

$$\arg \max_n \ln(K_{in}) + \varepsilon_{in}, \quad (23)$$

where the  $\varepsilon_{in}$  are distributed i.i.d. Gumbel. Again, the probability that  $i$  picks each religion  $n$  is then given by

$$\pi_{in} = \frac{\exp(\ln K_{in})}{\sum_{\ell=1}^N \exp(\ln K_{i\ell})}. \quad (24)$$

This is a nonlinear multinomial logit model, in the sense that the probability  $\pi_{in}$  takes the standard softmax form, but the  $\ln(K_{in})$  are nonlinear functions of the model's primitive parameters through the optimal time allocations (19)–(20)–(21).

**Educational attainment.** Similarly, for each individual  $i$  the model also predicts the level of human capital of  $i$ ,  $H_i$ . To map this onto the data, I consider  $H_i$  as the deterministic component of a latent variable which, in turn, predicts the educational level of  $i$ . Precisely, suppose that the actual level of (log-)human capital of individual  $i$  is  $\ln(H_i) + \eta_i$ , where  $\eta_i$  is a random shock. Suppose further that  $i$  attains the educational level  $e_i$  according to the rule

$$e_i = \begin{cases} 1 & \text{if } \ln(H_i) + \eta_i \leq \bar{h}_1, \\ 2 & \text{if } \bar{h}_1 < \ln(H_i) + \eta_i \leq \bar{h}_2, \\ \vdots & \\ E & \text{if } \ln(H_i) + \eta_i > \bar{h}_{E-1}, \end{cases} \quad (25)$$

where  $E$  is the number of possible educational levels and  $\bar{h}_1, \dots, \bar{h}_{E-1}$  are parameters to be estimated. If the  $\eta_i$  are distributed i.i.d. logistic this is an ordered logit model, so that the probability that  $i$  reaches the educational level  $e$  is given by

$$\phi_{ie} = \begin{cases} \frac{1}{1 + \exp(\ln(H_i) - \bar{h}_1)} & \text{if } e = 1, \\ \frac{1}{1 + \exp(\ln(H_i) - \bar{h}_2)} - \frac{1}{1 + \exp(\ln(H_i) - \bar{h}_1)} & \text{if } e = 2, \\ \vdots & \\ 1 - \frac{1}{1 + \exp(\ln(H_i) - \bar{h}_{E-1})} & \text{if } e = E. \end{cases} \quad (26)$$

Again, this model is nonlinear because  $H_i$  is a nonlinear function of the model's parameters.

**Log-likelihood function and parametrization.** Suppose finally that the error terms  $\varepsilon_{in}$  and  $\eta_i$  are independent as well. Then the probability that  $i$  picks the religious affiliation  $n$  and reaches the educational level  $e$  is simply  $\pi_{in} \times \phi_{ie}$ . I can then construct the log-likelihood function

$$\ln L = \sum_i w_i \sum_{n=1}^N \sum_{e=1}^E \mathbf{1}_{\{i \text{ is } ne\}} \ln(\pi_{in} \times \phi_{ie}), \quad (27)$$

where the probabilities  $\pi_{in}$  and  $\phi_{ie}$  implicitly depend on the model's parameters, and the  $w_i$  are sampling weights.

For the estimation, I make two restrictions on the parametrization of the model as exposed in section 4. First, I assume that relative preferences for religious capital versus human capital are homogeneous within a gender–religion category. In other words, all mothers of religion  $n$  are assumed to have the same preference, denoted by  $\nu_{1n}$ . Similarly, all fathers of religion  $n$  have the same preference  $\nu_{2n}$ . This is consistent with the model by Bisin and Verdier (2000), who assume that preferences are culture-specific constants. I extend their approach by supposing that within a culture, preferences may differ between men and women (which Bisin and Verdier could not do because they used a unitary model of the household). Second, I assume away the productivity difference between mothers and fathers, both in cultural socialization and human capital formation:  $a_1 = a_2 = a$  and  $b_1 = b_2 = b$ . The reason is that differences in preferences between mothers and fathers are not precisely identified from differences in productivity between them, as can be seen from the solutions to the household problem (19)–(20)–(21). Identifying one from the other relies on the variation in the population shares  $q_{in}$ , which in practice does not seem sufficient to obtain robust estimates on different specifications. Thus a choice has to be made to allow for gender heterogeneity in preferences or in productivity: here I choose the former.

I summarize the parametrization of the model under these additional assumptions, also taking into account Assumption 1:

$$\begin{aligned}\ln K_n &= k_n + a \left( s_1 - \frac{s_1^2}{2T_1} \right) \mathbf{1}_{\{n_1=n\}} + a \left( s_2 - \frac{s_2^2}{2T_2} \right) \mathbf{1}_{\{n_2=n\}} + a_0 (1 - s_1 - s_2) q_n \\ \ln H &= (b + h_1) \left( t_1 - \frac{t_1^2}{2T_1} \right) + (b + h_2) \left( t_2 - \frac{t_2^2}{2T_2} \right) \\ u_i &= \nu_{in_i} \ln(K_{n_i}) + \ln H.\end{aligned}$$

For now, I fix exogenously the power balance in the couple by setting  $\mu = 1$ , so that the spouses have equal power. The parameters to estimate are thus the following:

- the relative preference for religious capital,  $\nu_{1n}$  for mothers of religion  $n$  and  $\nu_{2n}$  for fathers of religion  $n$ ,
- the cultural adoption constants  $k_n$  for all  $n$ ,
- the time productivities of religious socialization,  $a$  for vertical socialization by mothers and fathers, and  $a_0$  for oblique socialization,
- the time productivity of human capital formation,  $b$ ,
- the total time budgets of the parents,  $T_1$  for mothers and  $T_2$  for fathers,
- the human capital levels  $\tilde{h}_e$  associated with the educational attainments  $e$ ,
- the ordered logit thresholds  $\bar{h}_e$ .

With  $N = 5$  religions and  $E = 3$  education levels, this makes a total of  $3N + 5 + 2E - 1 = 25$  parameters. Out of those, two are not identified. First, as in the reduced-form analysis

of section 3, the  $k_n$  are identified only up to an additive constant. Again, I choose the normalize this constant to 0 for the most common denomination, Christians:  $k_2 = 0$ . Second, the contribution from the lowest human capital level cannot be distinguished from the baseline time productivity of human capital formation.<sup>15</sup> As such, I normalize to 0 the added productivity of having a primary school diploma or less:  $\tilde{h}_1 = 0$ . This leaves 23 free parameters to estimate. Again I compute the maximum likelihood estimator of these parameters, using the log-likelihood expression (27). As in section 3, the covariance matrix is obtained using the BHHH estimator.

## 5.2 Results

Table 7 presents the estimation results. The fit can be compared to the null model with an intercept only for each religion–education type ( $N \times E - 1 = 14$  free parameters), which has a deviance of 75 735. This yields a pseudo- $R^2$  of 0.39.

I now turn to the estimated parameters. First, the estimates for the cultural adoption constants  $k_n$  are broadly consistent with the corresponding estimates in the reduced-form analysis. By default, individuals are most likely to pick up the No religion affiliation, followed by Christian, Muslim, Other, and finally Jewish. (In the reduced-form results, Other was a more likely adoption than Muslim.) As discussed in section 3, this reflects to some extent the specificities of religious affiliations: for instance, while adopting the No religion trait requires little investment in religious capital, becoming Jewish without a Jewish ascendancy is very rare.

Second, the relative values of religious capital for mothers and fathers,  $\nu_{1n}$  and  $\nu_{2n}$ , exhibit wide differences across gender and religions. Overall, the estimates suggest that mothers have stronger preferences for religion versus education than fathers do, except among Nones. Furthermore, they suggest that Muslims and Jews value religious capital the most relative to education-oriented human capital, followed by Others, Nones, and finally Christians. These differences seem to explain in a large way the differences in contributions to religious socialization found in the reduced-form analysis.

Third, the estimates of the productivity in religious socialization,  $a$  and  $a_0$ , suggest that vertical and oblique socialization operate on a similar magnitude of productivity, albeit with an advantage for oblique socialization.

Moving to the estimates related to human capital formation, the measures of added productivity from parental human capital  $\tilde{h}_e$  are, reassuringly, increasing in the associated educational attainment  $e$ . The added productivity obtained from having a Secondary diploma is approximately the same as that from having a Tertiary diploma. This confirms that more educated parents are more productive when spending time to transmit human capital to their children. This is of course driven by the fact that higher-educated parents have higher-educated children in the data. Yet, even the productivity in human capital

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<sup>15</sup>The time allocation solutions depend on the sum  $b_i + \tilde{h}_i$ . Therefore, choosing the parameters  $(b_1, b_2, \tilde{h}_e)$  or  $(b_1 + \kappa, b_2 + \kappa, \tilde{h}_e - \kappa)$  leads to the same model outcomes.

Table 7: Structural model of cultural socialization and human capital formation, Estimates

	Estimates
	model (27)
<i>Religious socialization</i>	
Cultural adoption constants $k_n$ , by religion $n$	
None	0.33 (0.11)
Christian	0 (baseline)
Muslim	-2.37 (0.21)
Jewish	-3.66 (0.27)
Other	-2.78 (0.22)
Value of religious capital for mothers $\nu_{1n}$ , by religion $n$	
None	5.05 (1.85)
Christian	1.28 (0.40)
Muslim	21.66 (10.08)
Jewish	15.88 (14.1)
Other	5.08 (1.47)
Value of religious capital for fathers $\nu_{2n}$ , by religion $n$	
None	5.01 (1.44)
Christian	0.00 (0.32)
Muslim	14.69 (5.58)
Jewish	4.74 (1.72)
Other	0.00 (1.52)
Vertical religious socialization time productivity, $a$	2.66 (0.22)
Oblique religious socialization time productivity, $a_0$	3.81 (0.29)
<i>Human capital formation</i>	
Human capital formation time productivity, $b$	0.15 (0.04)
Added productivity $\tilde{h}_e$ , by education level $e$	
Primary	0 (baseline)
Secondary	1.05 (0.09)
Tertiary	2.13 (0.18)
Human capital threshold $\bar{h}_1$ : Primary $\rightarrow$ Secondary	-2.29 (0.03)
Human capital threshold $\bar{h}_2$ : Secondary $\rightarrow$ Tertiary	1.81 (0.03)
<i>Other</i>	
Total time budget of mothers, $T_1$	1.24 (0.11)
Total time budget of fathers, $T_2$	1.34 (0.12)
Observations	18 155
Sampling weights	Yes
Deviance ( $-2 \ln L$ )	45 927
Pseudo- $R^2$	0.39

Note: Standard errors in parentheses.

formation of Tertiary-educated parents remains lower than their productivity in cultural socialization.

Note finally that the lower human capital threshold which determines the child's educational attainment in the ordered logit model,  $\bar{h}_1$ , is negative, even though the child's log-human capital in the model is always positive (by assumption  $b$  is positive, which is confirmed by the estimation). This reflects the fact that 92% of the respondents have at least a Secondary education (which has been compulsory in France since 1959), such that any education level below that must be explained by a negative shock on the child's human capital.



## 6 Conclusion

In this paper I have primarily studied how the religious affiliations and the education levels of the parents interact in predicting the religious affiliation of their children. I find that higher-educated parents marry less homogamously, and that they transmit their religious affiliation less accurately than lower-educated parents. Using a reduced-form model of religious transmission, I quantify the contributions to religious socialization of parents based on their gender, religious affiliation, and education level. I find that mothers contribute in general more than fathers, and than religious minorities (Muslims and Jews) contribute more than majorities (Nones and Christians). I show that oblique socialization plays a non-trivial role in the transmission process and that there is a strong trend of secularism for the cohorts considered. Moreover, I provide evidence that the education levels of the parents are relevant factors in the socialization process, though it remains unclear whether their effect is unidirectional or if it is heterogeneous across religious affiliations. Finally, I describe a structural, collective household model of cultural socialization and human capital formation of the child, and I derive preliminary results on this model in the single-parent case. I present a roadmap for the estimation of this model and to embed it in a matching framework.

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# Appendix

## A Proofs

*Proof of comparative statics, homogamous household.*

The first-order conditions to the homogamous household problem are

$$\begin{aligned}\frac{\delta h_1}{1 + h_1 t_1^*} &= \nu \frac{\partial \ln S}{\partial s_1} \Big|_{s_1^*, s_2^*, q_n} \\ \frac{(1 - \delta) h_2}{1 + h_2 t_2^*} &= \nu \frac{\partial \ln S}{\partial s_2} \Big|_{s_1^*, s_2^*, q_n}.\end{aligned}$$

The second-order condition is that the Hessian matrix

$$\mathcal{H} = \begin{pmatrix} \frac{-\delta h_1^2}{(1 + h_1 t_1^*)^2} + \nu \frac{\partial^2 \ln S}{\partial s_1^2} \Big|_{s_1^*, s_2^*, q_n} & \nu \frac{\partial^2 \ln S}{\partial s_1 \partial s_2} \Big|_{s_1^*, s_2^*, q_n} \\ \nu \frac{\partial^2 \ln S}{\partial s_1 \partial s_2} \Big|_{s_1^*, s_2^*, q_n} & \frac{-(1 - \delta) h_2^2}{(1 + h_2 t_2^*)^2} + \nu \frac{\partial^2 \ln S}{\partial s_2^2} \Big|_{s_1^*, s_2^*, q_n} \end{pmatrix}$$

must be negative semi-definite. Note that since  $S$  is concave in  $s_1$  and  $s_2$  (and positive) by assumption,  $\ln S$  is also concave in  $s_1$  and  $s_2$ . Thus the second-order derivatives  $\frac{\partial^2 \ln S}{\partial s_i^2}$  are negative.

Let's first see how the optimal time allocation changes with parent 1's human capital  $h_1$ . The total differentiation of the two first-order conditions with respect to  $h_1$  can be written

$$\mathcal{H} \begin{pmatrix} dt_1^*/dh_1 \\ dt_2^*/dh_1 \end{pmatrix} = \begin{pmatrix} -\frac{\delta}{(1 + h_1 t_1^*)^2} \\ 0 \end{pmatrix}.$$

Since  $\mathcal{H}$  is negative semi-definite, this notably implies

$$0 \geq \begin{pmatrix} dt_1^*/dh_1 \\ dt_2^*/dh_1 \end{pmatrix}^\top \mathcal{H} \begin{pmatrix} dt_1^*/dh_1 \\ dt_2^*/dh_1 \end{pmatrix} = -\frac{\delta}{(1 + h_1 t_1^*)^2} \frac{dt_1^*}{dh_1} \implies \frac{dt_1^*}{dh_1} \geq 0.$$

The second row of the second-order condition then provides

$$\text{sign} \left( \frac{dt_2^*}{dh_1} \right) = \text{sign} \left( \frac{\partial^2 \ln S}{\partial s_1 \partial s_2} \Big|_{s_1^*, s_2^*, q_n} \right).$$

The changes with respect to  $h_2$  are of course symmetric.

Now let's see the effect of  $\nu$  on the optimal allocation. Total differentiation of the first-order conditions with respect to  $\nu$  yields

$$\mathcal{H} \begin{pmatrix} dt_1^*/d\nu \\ dt_2^*/d\nu \end{pmatrix} = \begin{pmatrix} \frac{\partial \ln S}{\partial s_1} \Big|_{s_1^*, s_2^*, q_n} \\ \frac{\partial \ln S}{\partial s_2} \Big|_{s_1^*, s_2^*, q_n} \end{pmatrix}.$$

Since  $\mathcal{H}$  is negative semi-definite, this implies

$$0 \geq \frac{dt_1^*}{d\nu} \times \frac{\partial \ln S}{\partial s_1} \Big|_{s_1^*, s_2^*, q_n} + \frac{dt_2^*}{d\nu} \times \frac{\partial \ln S}{\partial s_2} \Big|_{s_1^*, s_2^*, q_n}.$$

Since  $\ln S$  is increasing in  $s_1$  and  $s_2$ , this inequality guarantees that at least one of  $\frac{dt_1^*}{d\nu} \leq 0$  or  $\frac{dt_2^*}{d\nu} \leq 0$  holds, but we cannot say more. However, given that  $\frac{dt_i^*}{d\nu} = -\frac{ds_i^*}{d\nu}$ , this last inequality also directly implies

$$\frac{d \ln S_n^*}{d\nu} = \frac{ds_1^*}{d\nu} \times \frac{\partial \ln S}{\partial s_1} \Big|_{s_1^*, s_2^*, q_n} + \frac{ds_2^*}{d\nu} \times \frac{\partial \ln S}{\partial s_2} \Big|_{s_1^*, s_2^*, q_n} \geq 0,$$

which completes the comparative statics results in the homogamous case.  $\square$

*Proof of comparative statics, heterogamous household.*

The first-order conditions to the heterogamous household problem are

$$\begin{aligned} (\mu + 1) \frac{\delta h_1}{1 + h_1 t_1^*} &= \mu \nu_1 \frac{\partial \ln S}{\partial s_1} \Big|_{s_1^*, 0, q_{n_1}} \\ (\mu + 1) \frac{(1 - \delta) h_2}{1 + h_2 t_2^*} &= \nu_2 \frac{\partial \ln S}{\partial s_2} \Big|_{0, s_2^*, q_{n_2}}. \end{aligned}$$

The second-order condition is that the Hessian matrix

$$\mathcal{H} = \begin{pmatrix} -(\mu + 1) \frac{\delta h_1^2}{(1 + h_1 t_1^*)^2} + \mu \nu_1 \frac{\partial^2 \ln S}{\partial s_1^2} \Big|_{s_1^*, 0, q_{n_1}} & 0 \\ 0 & -(\mu + 1) \frac{(1 - \delta) h_2^2}{(1 + h_2 t_2^*)^2} + \nu_2 \frac{\partial^2 \ln S}{\partial s_2^2} \Big|_{0, s_2^*, q_{n_2}} \end{pmatrix}$$

must be negative semi-definite, which is always true since it is diagonal negative (since  $S$  is concave in  $s_1$  and  $s_2$ ).

Let's first see how the optimal time allocation changes with parent 1's human capital  $h_1$ . The total differentiation of the two first-order conditions with respect to  $h_1$  can be written

$$\mathcal{H} \begin{pmatrix} dt_1^*/dh_1 \\ dt_2^*/dh_1 \end{pmatrix} = \begin{pmatrix} -\frac{\delta}{(1 + h_1 t_1^*)^2} \\ 0 \end{pmatrix},$$

which, since  $\mathcal{H}$  is diagonal negative, immediately yields

$$\frac{dt_1^*}{dh_1} \geq 0, \quad \frac{dt_2^*}{dh_1} = 0.$$

The changes with respect to  $q_{n_1}$ ,  $\nu_1$ ,  $h_2$ ,  $q_{n_2}$ , and  $\nu_2$  are obtained in a similar fashion.

Now let's see how the optimal allocation changes with the power  $\mu$ . Denoting  $\mathcal{H}_{11}$  and  $\mathcal{H}_{22}$  the (negative) diagonal elements of  $\mathcal{H}$ , total differentiation of the first-order conditions with

respect to  $\mu$  yields

$$\begin{aligned}\frac{\delta h_1}{1 + h_1 t_1^*} + \frac{dt_1^*}{d\mu} \times \mathcal{H}_{11} &= \nu_1 \frac{\partial \ln S}{\partial s_1} \Big|_{s_1^*, 0, q_{n_1}} \\ \frac{(1 - \delta)h_2}{1 + h_2 t_2^*} + \frac{dt_2^*}{d\mu} \times \mathcal{H}_{22} &= 0.\end{aligned}$$

The second line immediately yields

$$\frac{dt_2^*}{d\mu} > 0.$$

For the first line, remark that by first-order condition we have

$$\nu_1 \frac{\partial \ln S}{\partial s_1} \Big|_{s_1^*, 0, q_{n_1}} = \left(1 + \frac{1}{\mu}\right) \frac{\delta h_1}{1 + h_1 t_1^*}$$

so that

$$\frac{dt_1^*}{d\mu} \times \mathcal{H}_{11} = \frac{1}{\mu} \frac{\delta h_1}{1 + h_1 t_1^*} \implies \frac{dt_1^*}{d\mu} < 0$$

which completes the comparative statics results in the heterogamous case. □

## B Descriptive statistics for the TeO survey

### B.1 General descriptives

Table 8: General descriptive statistics of the TeO survey.

	Mean	StdDev	Min	Max	Obs.
Age	36	11.5	17	60	21,761
Female (%)	52.8				21,761
<i>Education (%)</i>					21,761
Primary or less	8.0				—
Secondary	63.6				—
Tertiary or more	28.4				—
<i>Religion (%)</i>					21,443
No religion	29.3				—
Christian	39.2				—
Muslim	26.6				—
Jewish	0.8				—
Other	4.1				—
<i>Partner</i>					
Has partner (%)	72.5				21,761
Same-sex partner <sup>1</sup> (%)	0.7				13,242
<i>Raised by... (%) , several may apply)</i>					21,761
Both parents	86.1				
Mother only	14.9				
Father only	2.3				
<i>Mother's education (%)</i>					20,239
Primary or less	59.3				—
Secondary	30.4				—
Tertiary or more	10.2				—
<i>Father's education (%)</i>					19,239
Primary or less	54.2				—
Secondary	31.2				—
Tertiary or more	14.7				—
<i>Parents' religion</i>					
Homogamous parents (same religion, %)	89.3				20,671
Shares religion with at least one parent (%)	84.9				20,988

Notes: <sup>1</sup> Information only available if the partner lives in the same house.



## B.2 Education

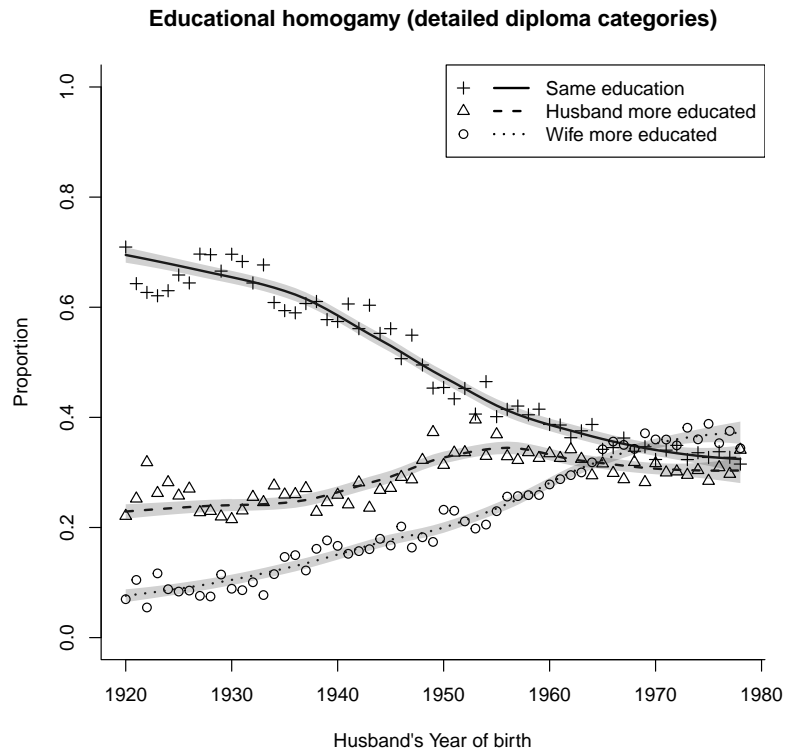


Figure 17: Educational homogamy with detailed diploma categories.



Figure 18: Educational homogamy with detailed diploma categories, same-religion couples.

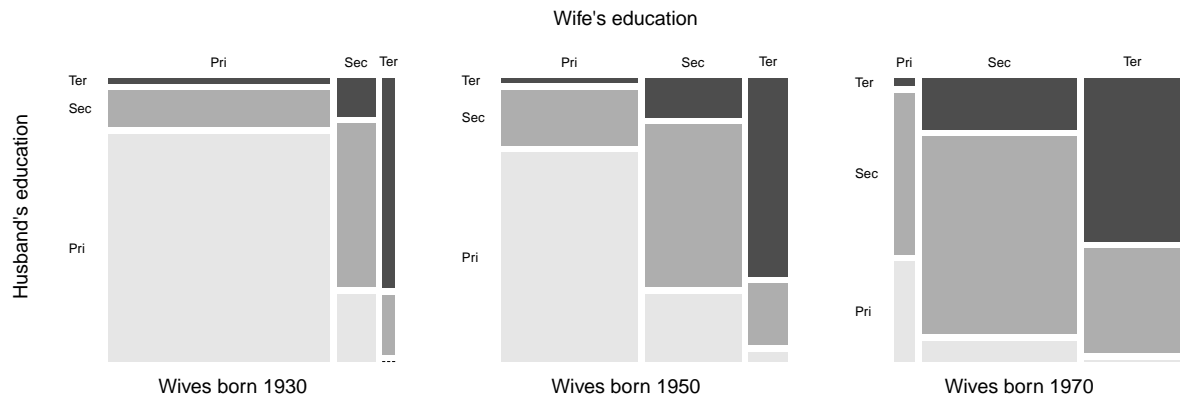


Figure 19: Educational assortment in couples with a wife born in 1930, 1950, and 1970.

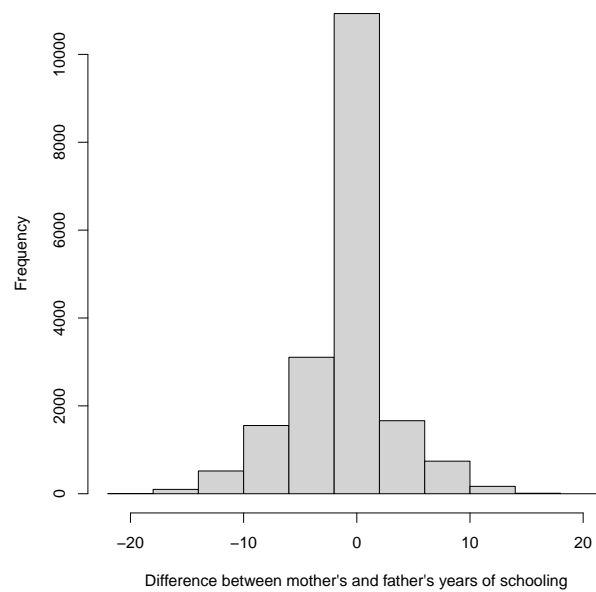


Figure 20: Distribution of the difference in years of schooling between mothers and fathers.

### B.3 Religion

See Figures 21, 22, 23; and Table 9.

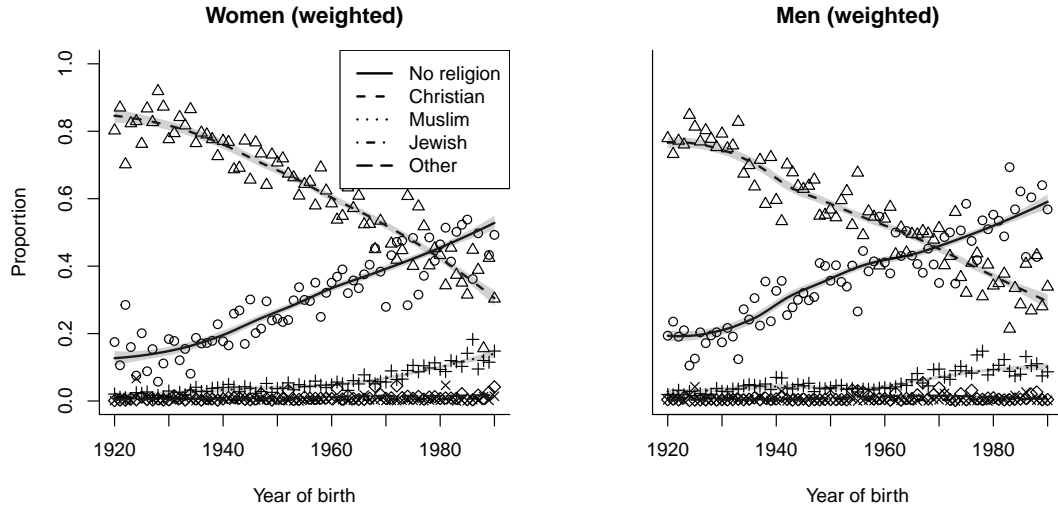


Figure 21: Religious affiliation, Women and Men (using sampling weights).

Table 9: Religious affiliations and homogamy.

Mother's religion	Father's religion					Total	Homogamy
	None	Christian	Muslim	Jewish	Other		
None	2448	221	105	8	28	2810	0.87
Christian	1071	9044	240	32	89	10476	0.86
Muslim	118	42	5905	0	3	6068	0.97
Jewish	9	25	4	149	1	188	0.79
Other	110	76	19	1	923	1129	0.82
Total	3756	9408	6273	190	1044	20671	
Homogamy	0.65	0.96	0.94	0.78	0.88		

*Note:* For each line, homogamy is computed as the ratio of mothers in a homogamous union divided by the total number of mothers in that line (idem for fathers in each column). Homogamy rates can thus differ within a single religion between mothers and fathers because of they have different distributions regarding religion.

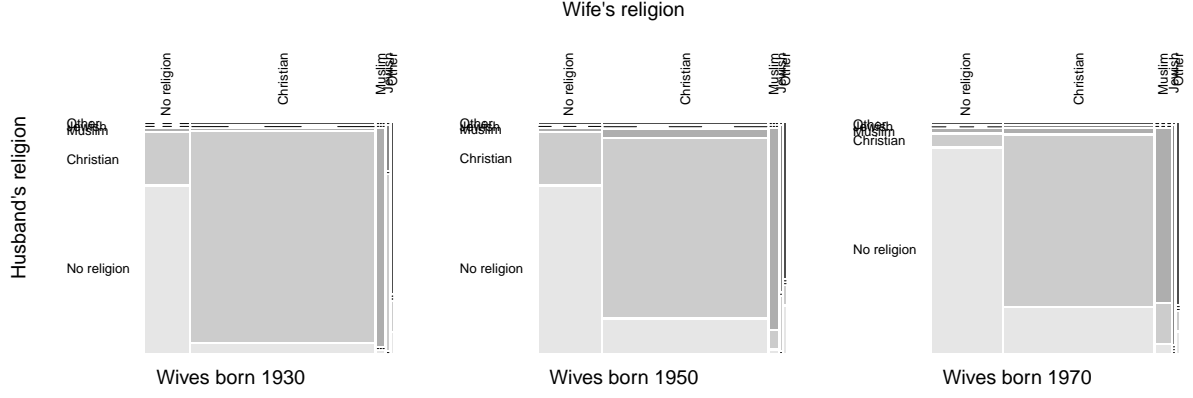


Figure 22: Religious assortment in couples with a wife born in 1930, 1950, and 1970 (using sampling weights).

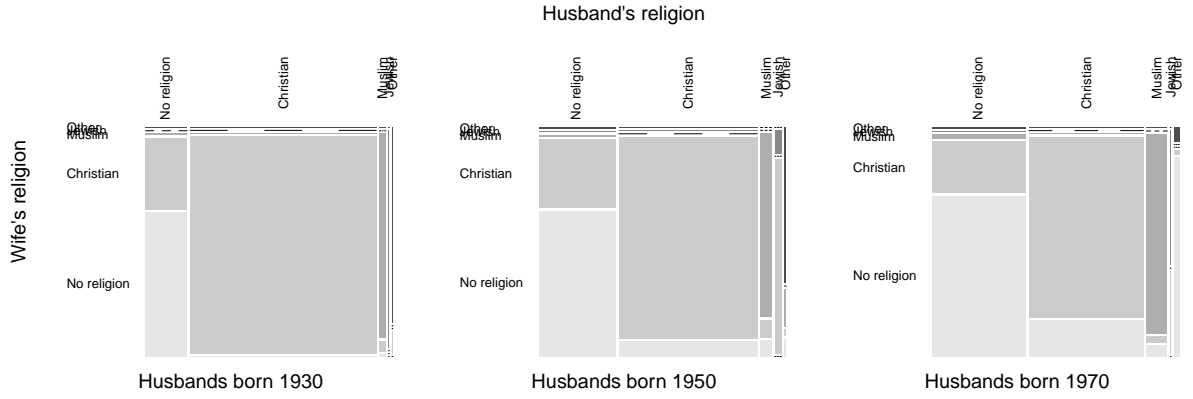


Figure 23: Religious assortment in couples with a husband born in 1930, 1950, and 1970 (using sampling weights).

#### B.4 Transmission of education

See Tables 10 and 11 for additional regressions.

Let's investigate further the interaction between the mother's and the father's education levels,  $e_m$  and  $e_f$ , in determining the education of the child  $e_c$ . To do this, let's simplify the education variable even more than above, by defining  $e_i$  as

$$e_i = \mathbf{1}_{\{i \text{ has (at least) a Secondary diploma}\}}.$$

Call  $\mu_{h_m h_f} = \mathbb{P}(e_c = 1 \mid e_m, e_f)$  the probability that a child has (at least) a Secondary diploma, conditional on her mother and father having education levels  $e_m$  and  $e_f$  respectively. A simple measure of the interaction effect between the parents' education levels is then

$$\mu_{11} - \mu_{10} - \mu_{01} + \mu_{00}. \quad (28)$$

(For instance, in the linear probability model  $\mu_{h_m h_f} = \alpha + \beta_m e_m + \beta_f e_f + \gamma e_m e_f$ , we have  $\mu_{11} - \mu_{10} - \mu_{01} + \mu_{00} = \gamma$ .) I estimate the expression (28) on the whole sample first. The estimator

Table 10: Transmission of education (Ordered Logit).

	Child's education			
	(Ord. logit)	(Ord. logit)	(Ord. logit)	(Ord. logit)
<i>Mother's education</i>				
Secondary	0.65 (0.04)	1.10 (0.07)	1.00 (0.07)	1.00 (0.07)
Tertiary	1.16 (0.07)	2.04 (0.20)	1.84 (0.21)	1.84 (0.21)
<i>Father's education</i>				
Secondary	0.59 (0.04)	0.91 (0.05)	0.85 (0.05)	0.85 (0.05)
Tertiary	1.27 (0.06)	1.50 (0.12)	1.47 (0.12)	1.47 (0.12)
<i>Mother's × Father's education</i>				
Secondary × Secondary		−0.78 (0.09)	−0.76 (0.09)	−0.76 (0.09)
Secondary × Tertiary		−0.61 (0.15)	−0.61 (0.15)	−0.61 (0.15)
Tertiary × Secondary		−1.23 (0.23)	−1.18 (0.23)	−1.17 (0.24)
Tertiary × Tertiary		−1.05 (0.24)	−0.99 (0.25)	−0.99 (0.25)
<i>Mother's religion</i>				
Christian			0.25 (0.07)	0.27 (0.08)
Muslim			−0.02 (0.11)	0.06 (0.21)
Jewish			0.35 (0.28)	−0.30 (0.77)
Other			0.10 (0.14)	0.30 (0.22)
<i>Father's religion</i>				
Christian			0.05 (0.06)	0.19 (0.16)
Muslim			−0.19 (0.11)	0.01 (0.23)
Jewish			0.60 (0.27)	1.24 (0.77)
Other			−0.07 (0.14)	−0.78 (0.42)
<i>Mother's × Father's religion</i>				
Christian × Christian				−0.15 (0.17)
Christian × Muslim				−0.33 (0.28)
Christian × Jewish				−0.77 (0.88)
Christian × Other				1.20 (0.49)
Muslim × Christian				−0.70 (0.43)
Muslim × Muslim				−0.27 (0.31)
Muslim × Jewish				no data
Muslim × Other				1.36 (1.23)
Jewish × Christian				0.53 (0.90)
Jewish × Muslim				1.75 (1.47)
Jewish × Jewish				0.05 (1.11)
Jewish × Other				no data
Other × Christian				−0.12 (0.37)
Other × Muslim				−0.97 (0.63)
Other × Jewish				−3.24 (2.21)
Other × Other				0.49 (0.48)
Child's year of birth /100	0.96 (0.14)	0.93 (0.14)	1.53 (0.15)	1.53 (0.15)
Cut-off: Primary → Secondary	17.03 (2.79)	16.55 (2.79)	28.39 (2.95)	28.40 (2.96)
Cut-off: Secondary → Tertiary	20.65 (2.79)	20.19 (2.79)	32.07 (2.96)	32.08 (2.96)
Observations	18793	18793	18222	18222
Sampling weights	No	No	No	No
Residual Deviance	29642	29540	28438	28419

*Note:* Standard errors in parentheses.

Reference category for mother/father education is “Primary.”

Reference category for mother/father religion is “No religion.”

Table 11: Transmission of education (OLS).

	Child's education		
	(OLS)	(OLS)	(OLS)
Mother's education	0.13*** (0.01)	0.21*** (0.02)	0.20*** (0.02)
Father's education	0.18*** (0.01)	0.25*** (0.01)	0.24*** (0.02)
Mother's $\times$ Father's education		-0.04*** (0.01)	-0.04*** (0.01)
Mother's religion. . .			
Christian			0.06*** (0.01)
Muslim			0.01 (0.05)
Jewish			-0.01 (0.07)
Other			0.15** (0.05)
Father's religion. . .			
Christian			0.06*** (0.01)
Muslim			-0.02 (0.04)
Jewish			0.30*** (0.07)
Other			-0.18** (0.06)
Child's year of birth /100	0.11** (0.03)	0.08* (0.03)	0.23*** (0.03)
Observations	18793	18793	18222
Sampling weights	Yes	Yes	Yes
Adjusted $R^2$	0.14	0.15	0.16

*Note:* Standard errors in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$   
Reference category for wife/husband religion fixed effects is "No religion."

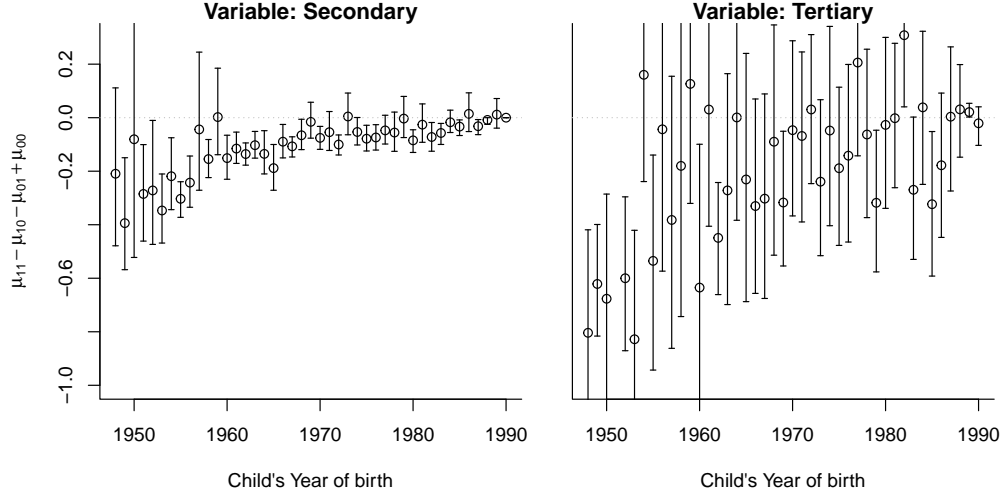


Figure 24: Interaction effects of parents' education levels for the child's education. 95% confidence intervals for  $\mu_{11} - \mu_{10} - \mu_{01} + \mu_{00}$  are reported for each cohort. Left panel uses Secondary diplomas to define the binary education variable  $e_i$ , right panel uses Tertiary diplomas.

$\hat{\mu}_{e_me_f}$  of  $\mu_{e_me_f}$  is the sample mean of  $e_c$  on the subsample of respondents with a mother  $e_m$  and a father  $e_f$ . The point estimate for (28) is then simply  $\hat{\mu}_{11} - \hat{\mu}_{10} - \hat{\mu}_{01} + \hat{\mu}_{00}$ . The confidence interval is obtained by simulation, knowing that each  $\hat{\mu}_{e_me_f}$  follows a binomial distribution. I obtain the point estimate  $-0.120$ , with  $[-0.132, -0.108]$  for the 95% confidence interval. This estimate can be interpreted in the following way: the gain from having an additional Secondary-educated parent is 12 p.p. less for children who already have one Secondary-educated parent, compared to children who have none. This result provides a strong indication that interaction effects are in fact negative. Next I perform the same exercise within cohorts. Results are shown in Figure 24. Again, estimates for (28) are negative, even within cohorts.

As a last control, I perform the same exercise but instead defining  $e_i$  as

$$e_i = \mathbf{1}_{\{i \text{ has a Tertiary diploma}\}}.$$

Estimation of (28) on the full sample yields the point estimate  $-0.122$  with 95% confidence interval  $[-0.178, -0.066]$ . Estimation within cohorts is again reported in Figure 24. Most point estimates remain negative, although many cannot be statistically distinguished from 0.

## B.5 Migration

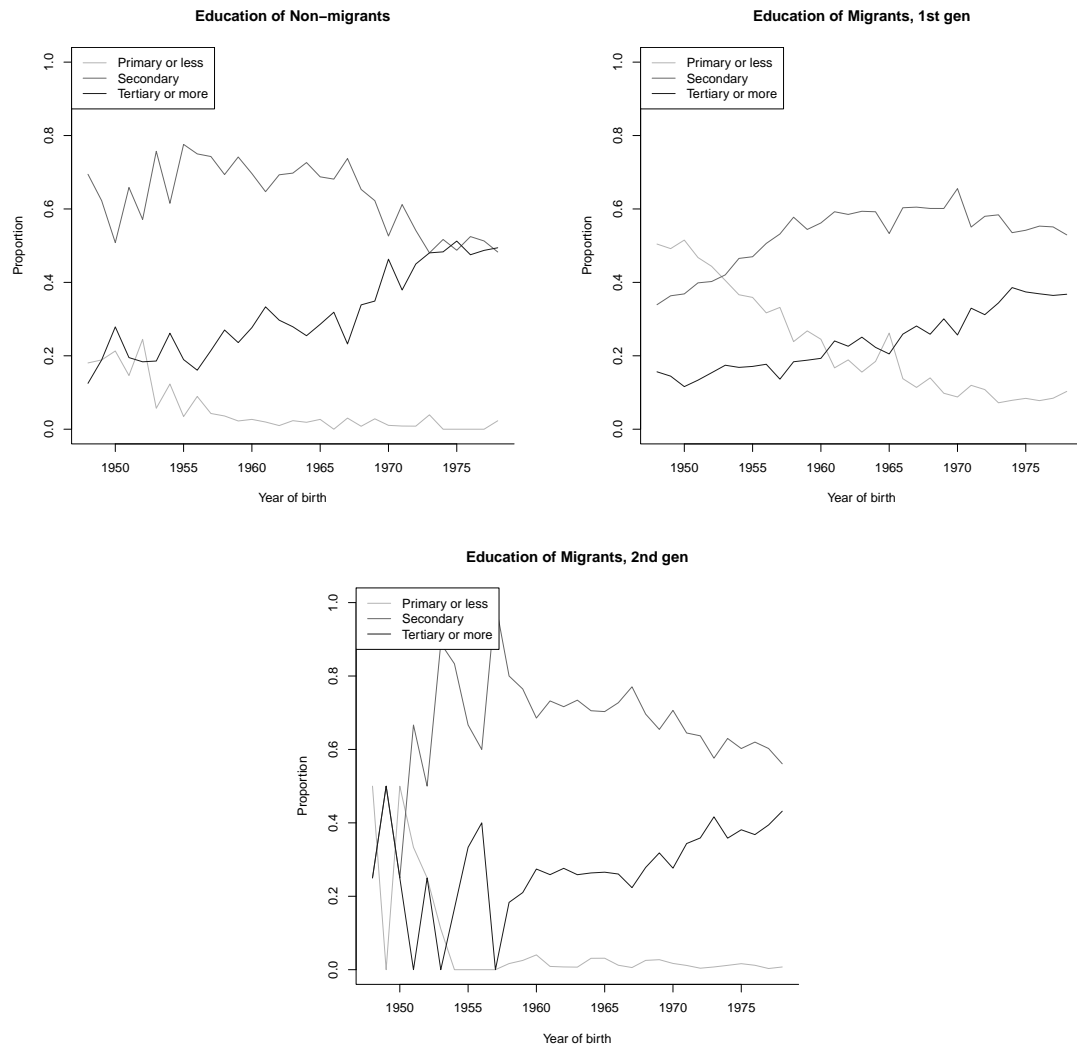


Figure 25: Education by Migration status.



## B.6 Transmission of religion

**Homogamy advantage.** When focusing on households without a None parent, homogamous households perform significantly better than heterogamous households in passing on religious traits (Figure 26).

This is also confirmed when looking at transmission rates for any combination of parental religious affiliations (Figure 27).

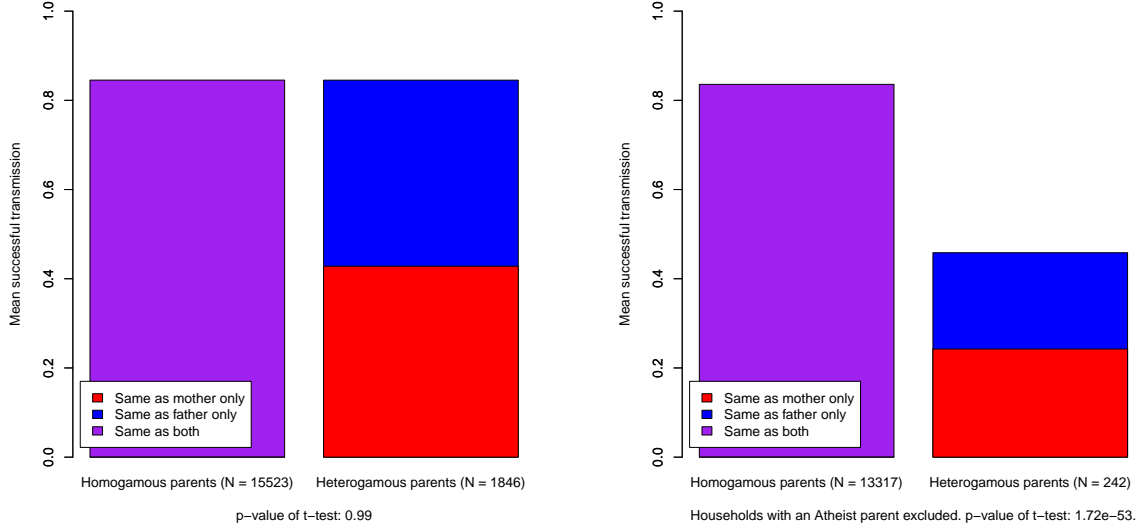


Figure 26: Transmission rates for homogamous and heterogamous households. The right-hand graph omits the respondents who declared having a ‘No religion’ parent.

**Gender asymmetry.** Another documented fact is that mothers pass on their cultural trait with a higher rate than fathers do. This is somewhat visible on Figure 27, where mothers’ transmission rates (in red) seem overall more prominent than fathers’ (in blue). However, no clear pattern emerges from the aggregated evidence. This is because the distribution of religious traits is different for mothers and fathers in the sample: in particular, there are more None fathers than mothers, which biases transmission success in the favor of fathers given the trend towards No religion mentioned above. For this reason, we need to look at how mothers and fathers perform when they are in comparable situations. I systematically investigate this mother–father asymmetry in Figure 28, by comparing the respective religious transmission rates of mothers and fathers in symmetric household configurations. Specifically, for any religious traits  $a$  and  $b$ , I compute the difference between the transmission rate of mothers in households  $ab$  (i.e. when the mother has religion  $a$  and the father religion  $b$ ) and the transmission rate of fathers in households  $ba$  (i.e. when the father has religion  $a$  and the mother religion  $b$ ). I find that an argument can indeed be made for mothers playing a larger role in religious transmission: in five cases this difference in transmission rates is significant at the 95% level in favor of mothers (None vs. Christian, None vs. Muslim, Christian vs. None, Jewish vs. Christian, Other vs. Christian). The Jewish vs. Christian case is notable as it reflects that Jewish affiliation is passed down from the mother and not the father. On the other hand, there is no significant advantage for fathers at

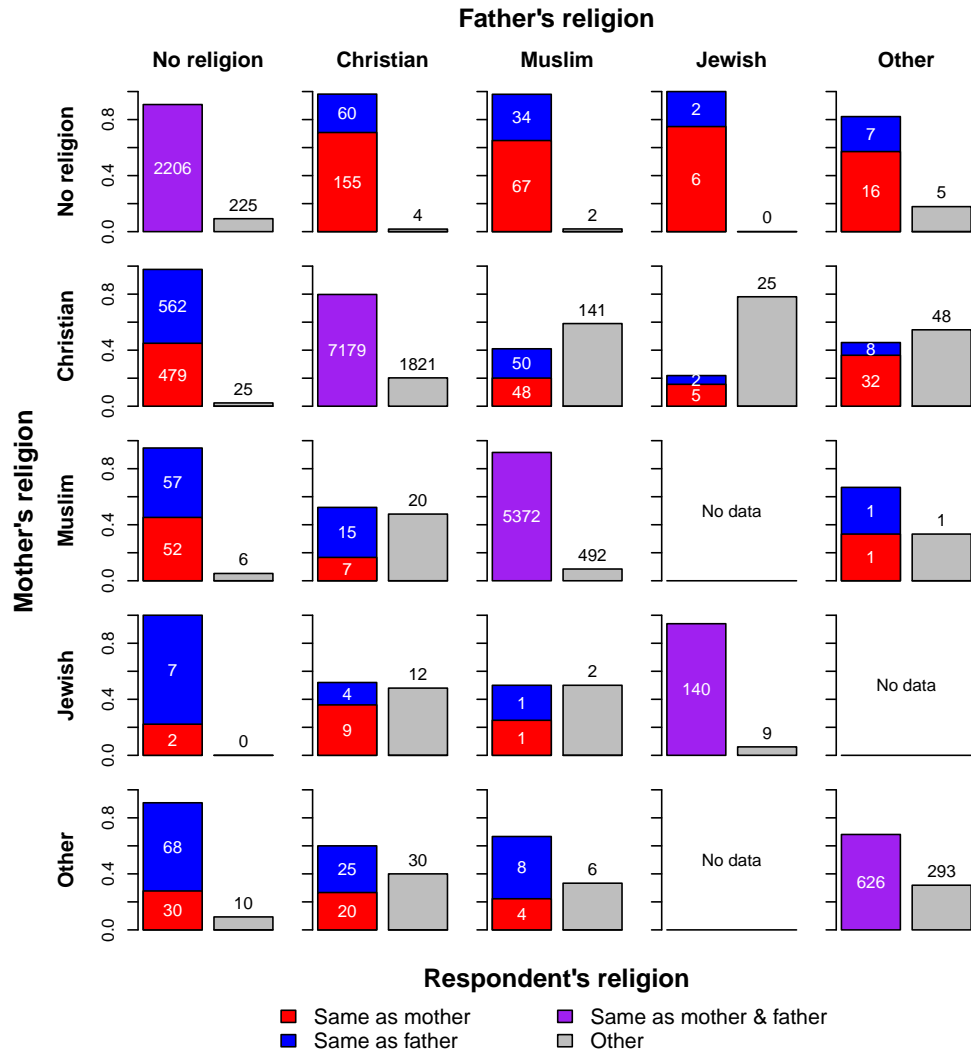


Figure 27: Transmission rates for all combinations of the parents' religions (number of observations reported for each bar).

the 95% level. If we broaden the confidence interval to the 90% level, mothers gain a significant advantage in the Muslim vs. None case, while fathers gain a significant advantage in the Christian vs. Muslim case (maybe reflecting the fact that Muslim affiliation is primarily passed down from the father).

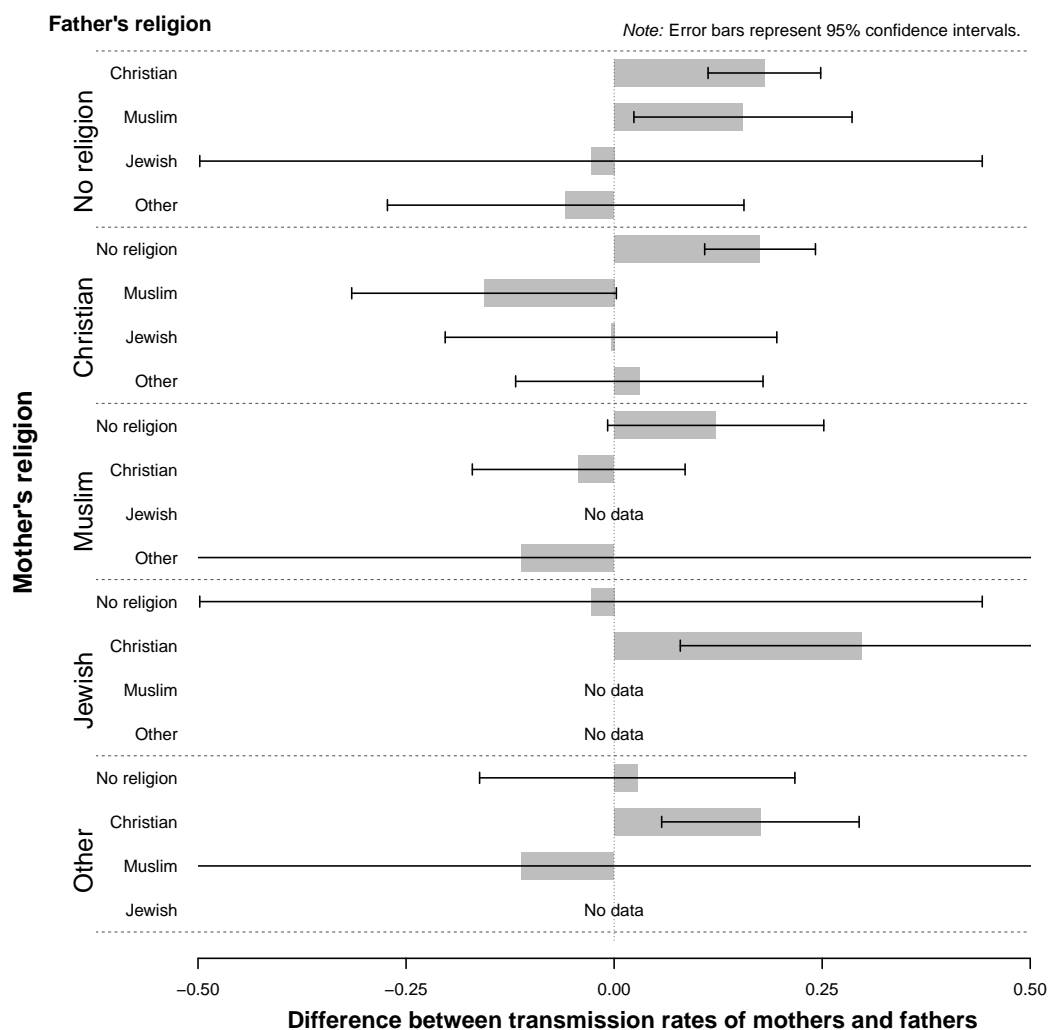


Figure 28: Mothers' advantage in religious transmission. Plotted are the differences between the transmission rate of mothers in households  $ab$  and the transmission rate of fathers in households  $ba$  for any religions  $a \neq b$ .

## C Reduced-form models of transmission

### C.1 Reconstructing population shares

Finding which population shares to use is not straightforward. Ideally, one should use a time series of religious shares in France over the period considered. Unfortunately, this information is not consistently available for every year. Instead, I resort to using the TeO survey data in order to reconstruct these population shares. I assume that for a given birth cohort  $y$ , the population which contributes to oblique socialization for that cohort consists of all individuals born between  $y - 1$  and  $y - 60$  and who were residents of metropolitan France no later than  $y + 18$ . Population shares for each trait  $n$  are computed accordingly in that subsample (which includes respondents' parents) using sampling weights. The limit of  $y - 60$  means that individuals born more than 60 years before a given cohort do not affect that cohort's oblique socialization. This limit is chosen somewhat arbitrarily to account for deaths among older individuals, given that dates of death are not available. Furthermore, behind the decision to count only residents at  $y + 18$  is the implicit assumption that religious affiliation is decided by age 18. The resulting population shares involved in oblique socialization for every birth cohorts are shown in Figure 14. As a point of comparison, on the same figure I also show the corresponding estimates from the 2005 World Values Survey, based on 996 respondents. (The 2005 population shares correspond to those involved in the oblique socialization of cohort  $2005 - 18 = 1992$ ). The estimates for the shares of Nones and Christians differ, with about 12 p.p. more Nones in the World Values Survey than in the reconstructed shares. Yet, these shares are consistent with estimates from other studies.

### C.2 Derivation of testable restrictions

Following on equation (3), here the independence of irrelevant alternatives assumption of the conditional logit model takes the form

$$\begin{aligned} \ln \left( \frac{\pi_{in}}{\pi_{i\ell}} \right) &= \ln K_{in} - \ln K_{i\ell} = k_n + m_n \mathbf{1}_{\{i\text{'s mother is } n\}} + f_n \mathbf{1}_{\{i\text{'s father is } n\}} + \alpha q_{y_i n} \\ &\quad - k_\ell - m_\ell \mathbf{1}_{\{i\text{'s mother is } \ell\}} - f_\ell \mathbf{1}_{\{i\text{'s father is } \ell\}} - \alpha q_{y_i \ell} \end{aligned}$$

where I have made explicit that  $q_{in}$  depends on  $i$  only through her year of birth  $y_i$ .

Call  $\pi_{in | yab}$  the probability that  $i$  adopts trait  $n$  conditional on belonging to birth cohort  $y$ , and having a mother  $a$  and a father  $b$ . Then for any two traits  $a$  and  $b$  and two birth cohorts  $y$  and  $\tilde{y}$ , we have:

$$\ln \left( \frac{\pi_{ia | yaa}}{\pi_{ib | yaa}} \right) = k_a + m_a + f_a + \alpha q_{ya} - k_b - \alpha q_{yb} \quad (29)$$

$$\ln \left( \frac{\pi_{ia | yab}}{\pi_{ib | yab}} \right) = k_a + m_a + \alpha q_{ya} - k_b - f_b - \alpha q_{yb} \quad (30)$$

$$\ln \left( \frac{\pi_{ia | \tilde{y}ba}}{\pi_{ib | \tilde{y}ba}} \right) = k_a + f_a + \alpha q_{\tilde{y}a} - k_b - m_b - \alpha q_{\tilde{y}b} \quad (31)$$

$$\ln \left( \frac{\pi_{ia | \tilde{y}bb}}{\pi_{ib | \tilde{y}bb}} \right) = k_a + \alpha q_{\tilde{y}a} - k_b - m_b - f_b - \alpha q_{\tilde{y}b}. \quad (32)$$

It follows that

$$\ln \left( \frac{\pi_{ia} | y_{aa}}{\pi_{ib} | y_{aa}} \right) - \ln \left( \frac{\pi_{ia} | y_{ab}}{\pi_{ib} | y_{ab}} \right) - \ln \left( \frac{\pi_{ia} | \tilde{y}_{ba}}{\pi_{ib} | \tilde{y}_{ba}} \right) + \ln \left( \frac{\pi_{ia} | \tilde{y}_{bb}}{\pi_{ib} | \tilde{y}_{bb}} \right) = 0. \quad (33)$$

Note that we cannot take a reference trait  $n_0$  as pivot, in the sense that if equation (33) is true for the traits  $an_0$  and  $bn_0$ , it does not imply that it is true for the traits  $ab$ . This is because this equation involves different subpopulations depending on the choice of the two traits:

- if we consider the property (33) for the traits  $a$  and  $n_0$ , then the subpopulation involved consists of all individuals with parents  $aa$ ,  $an_0$ ,  $n_0a$ , or  $n_0n_0$ ;
- for the traits  $b$  and  $n_0$ , it is the individuals with parents  $bb$ ,  $bn_0$ ,  $n_0b$ , or  $n_0n_0$ ;
- for the traits  $a$  and  $b$ , it is the individuals with parents  $aa$ ,  $ab$ ,  $ba$ , or  $bb$ .

Since the first two points do not involve individuals with parents  $ab$  or  $ba$ , there is no way that any combination of the two associated equations would yield results on this subpopulation, and therefore that they could imply (33) for traits  $a$  and  $b$ .

We can however take a birth cohort  $y_0$  as pivot. That is, equation (33) is true for all  $a$ ,  $b$ ,  $y$ , and  $\tilde{y}$ , if and only if it is true for all  $a$ ,  $b$ , and  $y$ , but taking  $\tilde{y} = y_0$  fixed. In practice this is not useful however, as I do not have enough observations to perform the test for every cohort. This is why I consider instead the approximate test

$$\ln \left( \frac{\pi_{ia} | aa}{\pi_{ib} | aa} \right) - \ln \left( \frac{\pi_{ia} | ab}{\pi_{ib} | ab} \right) - \ln \left( \frac{\pi_{ia} | ba}{\pi_{ib} | ba} \right) + \ln \left( \frac{\pi_{ia} | bb}{\pi_{ib} | bb} \right) = 0 \quad (34)$$

where  $\pi_{in | ab}$  is the probability that  $i$  adopts  $n$  conditional on having a mother  $a$  and a father  $b$  (but not conditioning on birth cohorts anymore). This simplification relies on almost-constant population shares over the period considered. Test results are presented in Figure 29, using 100,000 parametric bootstrap simulations to obtain confidence intervals. The  $\pi_{in | ab}$  are computed taking into account sampling weights. There are 10 tests to perform, 2 of which cannot be computed because of lack of observations. Out of 8 computable tests, 5 do not reject the restriction at the 5% level, and 3 do.

As a next step, I test these hypotheses simultaneously using both global and multiple testing procedures. First, I have to compute the individual  $p$ -value for each test corresponding to a trait combination  $ab$ . This is not straightforward since it is not *a priori* clear which distribution the left-hand term of equation (34) follows under the null. Here I rely on a result from Katz et al. (1978), who show that a log-ratio of binomial distributions is approximately normally distributed. Since the  $\pi_{in | ab}$  follow binomial distributions, it means that each logarithm term in (34) is approximately normally distributed, and therefore that the left-hand side of equation (34) is approximately normally distributed (as a sum of normal distributions). I compute the  $p$ -value for the test  $ab$  by checking how the empirical estimate of the statistic compares to the normal distribution with mean zero and standard deviation equal to the one recovered by parametric bootstrap (although it is not clear whether the null (34) would also modify the standard deviation of the distribution). There are 8 such computable  $p$ -values (corresponding to the 8 computable tests).

Once  $p$ -values are computed, I can follow Bonferroni's method for global testing. Out of 8 tests, 3 have a  $p$ -value below  $.05/8$  (the 3 tests which reject the null individually), so that

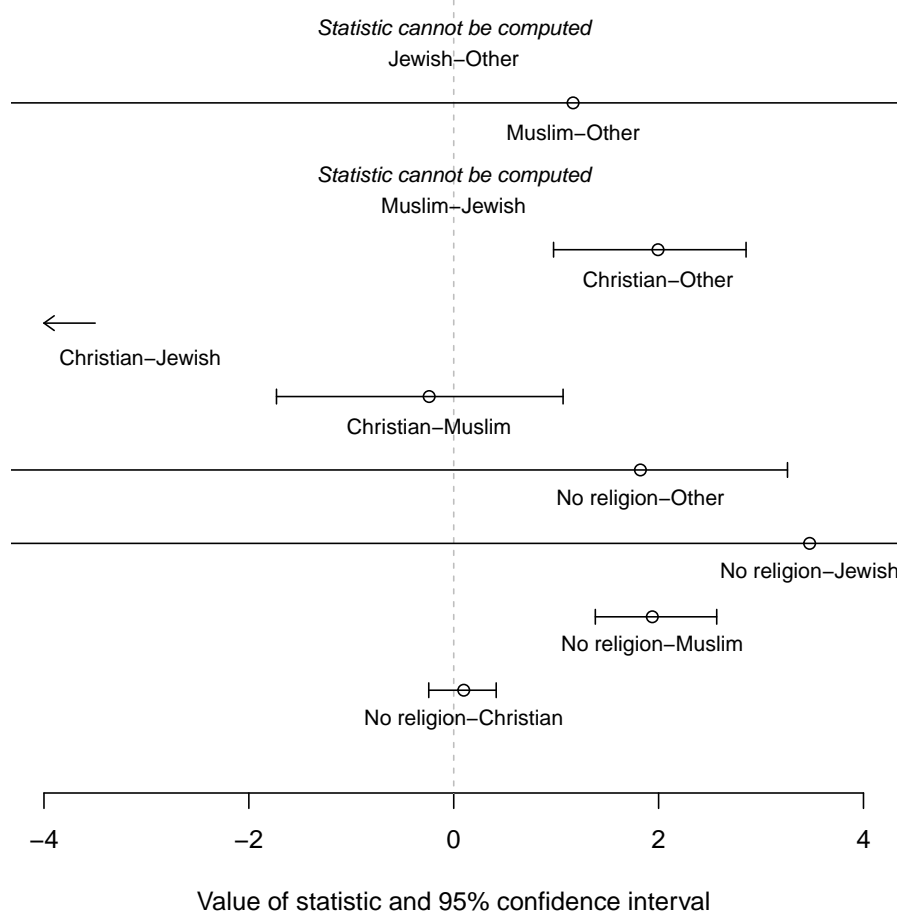


Figure 29: Statistical tests of equation (34) for all trait combinations  $ab$ .

Bonferroni's method leads to reject (34). I can also follow the procedure of Benjamini and Hochberg (1995) for multiple testing, to control for the false discovery rate (FDR). In Figure 30 I plot the  $p$ -values corresponding to each test, ordered from smallest to largest, along with the threshold line of slope  $j\gamma/S$ , with  $S$  the total number of tests,  $j$  the index variable, and  $\gamma = 5\%$  the level of the multiple test. This procedure leads to rejecting the same 3 tests which were rejected above.

### C.3 Observed vs. simulated transmission rates by religion and education categories

See Figure 31.

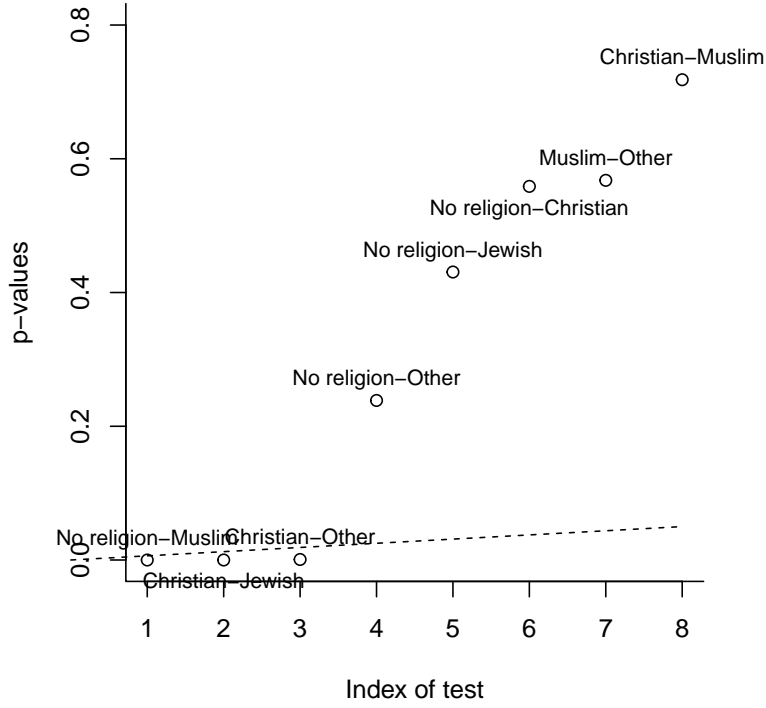


Figure 30: Benjamini–Hochberg procedure for multiple testing.  $p$ -values under the dashed line imply rejection of the corresponding test.

#### C.4 Socialization with Fréchet errors

**Transmission model.** Consider a slightly different model from section 3, in which

$$\mathbb{P}(i \text{ acquires } n) = \frac{S_{in}}{\sum_{k=1}^N S_{ik}}, \quad (35)$$

and  $S_{in}$  is still defined according to (2).

As in the model from section 3, the probability (35) can be motivated by a random socialization model. Suppose that socialization of  $i$  to trait  $n$  is  $S_{in} \times \eta_{in}$ , where the  $\eta_{in}$  are now distributed i.i.d. Fréchet (EVII). Again,  $i$  acquires the trait to which she is socialized the most. Then she acquires  $n$  which maximizes  $S_{in} \times \eta_{in}$ , or equivalently,  $\ln(S_{in}) + \ln(\eta_{in})$ , and the  $\ln(\eta_{in})$  are distributed i.i.d. Gumbel (EVI) by property of the Fréchet distribution. The expression (35) follows.

In this model, parental contributions to socialization are substitutes, in the sense that

$$\frac{\partial^2 \mathbb{P}(i \text{ acquires } n)}{\partial m_n \partial f_n} \leq 0. \quad (36)$$

As above, this model also imposes restrictions on the transmission probabilities, namely

$$\frac{\mathbb{P}(a \mid yaa) \mathbb{P}(a \mid ybb)}{\mathbb{P}(a \mid yab) \mathbb{P}(a \mid yba)} - \frac{\mathbb{P}(b \mid yaa) \mathbb{P}(b \mid ybb)}{\mathbb{P}(b \mid yab) \mathbb{P}(b \mid yba)} = 0. \quad (37)$$

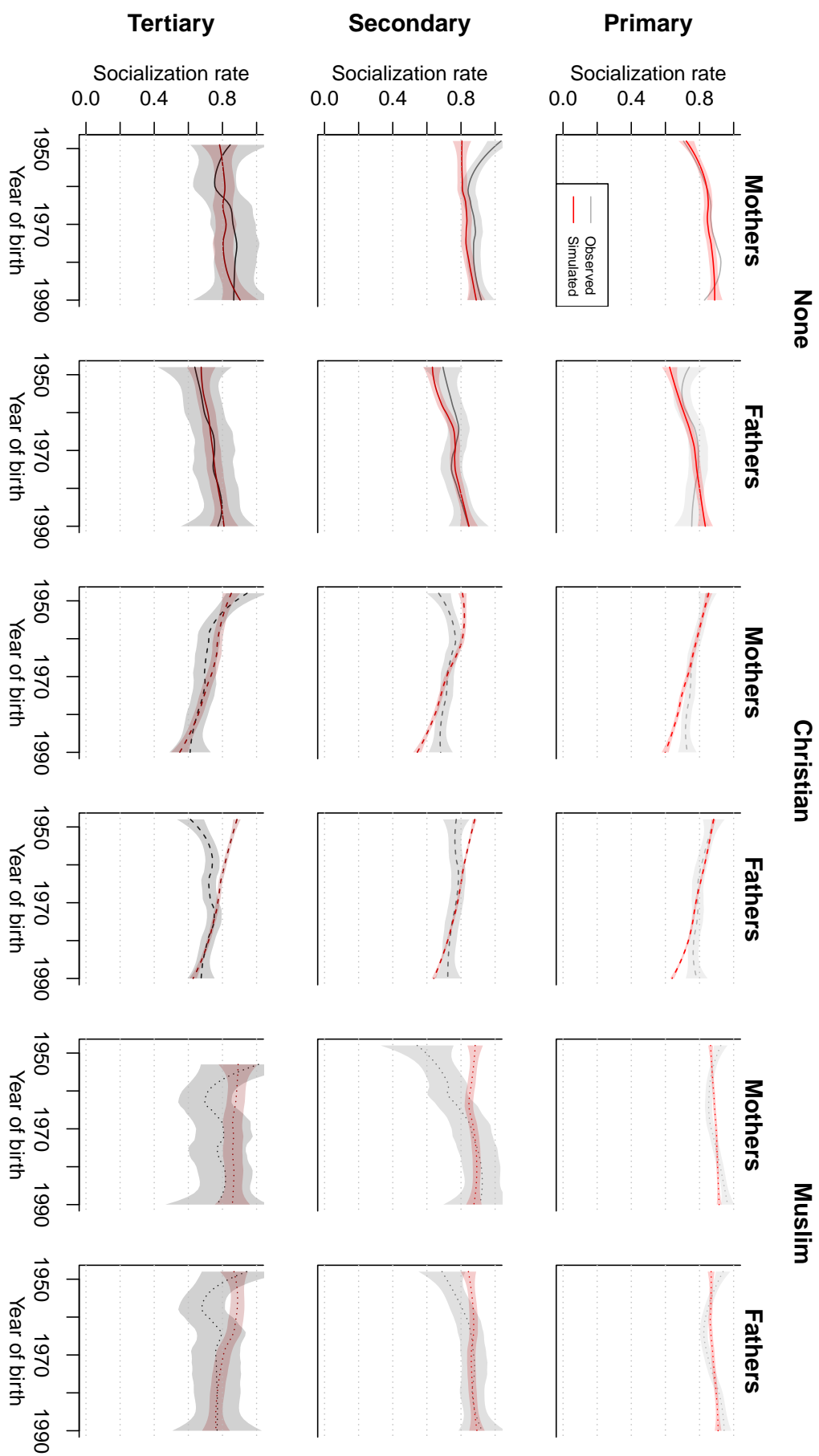


Figure 31: Conditional logit transmission, smoothed Observed vs. simulated transmission rates (by Religion & Education).



Because of lack of observations for many cohorts, I again test the approximation

$$\frac{\mathbb{P}(a | aa) \mathbb{P}(a | bb)}{\mathbb{P}(a | ab) \mathbb{P}(a | ba)} - \frac{\mathbb{P}(b | aa) \mathbb{P}(b | bb)}{\mathbb{P}(b | ab) \mathbb{P}(b | ba)} = 0. \quad (38)$$

Out of 10 tests, 6 tests cannot reject the null hypothesis (None–Christian, None–Jewish, Christian–Muslim, Christian–Jewish, Christian–Other, and Muslim–Other); 2 tests reject the null hypothesis (None–Muslim, None–Other); and the 2 other tests cannot be computed.

**Estimation.** In this model, parameters are only identified up to multiplication by a constant. For this reason, I normalize the oblique socialization coefficient  $\alpha$  to 1, and the vector of parameters to estimate is just  $\beta = (m_1, \dots, m_N, f_1, \dots, f_N)$ . Estimation of  $\beta$  can again be performed by maximizing the log-likelihood (6), which now takes the form

$$\ln L = \sum_i w_i \left[ \left( \sum_{n=1}^N \mathbf{1}_{\{i \text{ is } n\}} \ln(S_{in}) \right) - \ln \left( \sum_{k=1}^N S_{ik} \right) \right].$$

Standard errors are again obtained using the BHHH estimator. Results are presented in Table 12. As in the model with Gumbel errors, mothers contribute to socialization more than fathers, except among Christians. A notable difference however, is the much higher relative difference between mothers’ and fathers’ contributions to socialization (roughly by a factor 2 in the previous model, and by a factor 10 here). This can be explained, at least in part, by the fact that contributions are substitutes in this model, whereas they involved some complementarity in the previous model; mechanically, the disparity must be evened out when contributions are complements. The hierarchy of contributions to socialization across religions also changes somewhat: Muslims now contribute the most, significantly more than Jews and Nones; Others follow, and finally Christians remain the lowest socializers.

**Model fit.** The overall fit of this model is slightly better than for the version with Gumbel errors, with a pseudo- $R^2$  of 0.55 (against 0.51). As above, I use the parameter estimates to compare observed vs. simulated transmission rates by religion (Figure 32), by education (Figure 33), and by religion and education (Figure 34). This model matches the fall in Christian socialization better than the linear one. On the other hand, it predicts slower growth of None mothers’ transmission rates than observed. Other predictions remain very close to those of the previous model.

**Extensions.** I extend the baseline model in the same way as in section 3, first by introducing a secularization bias, and second by allowing complementarities between the parents’ religious traits. See columns 2 and 3 of Table 12 for the estimation results.

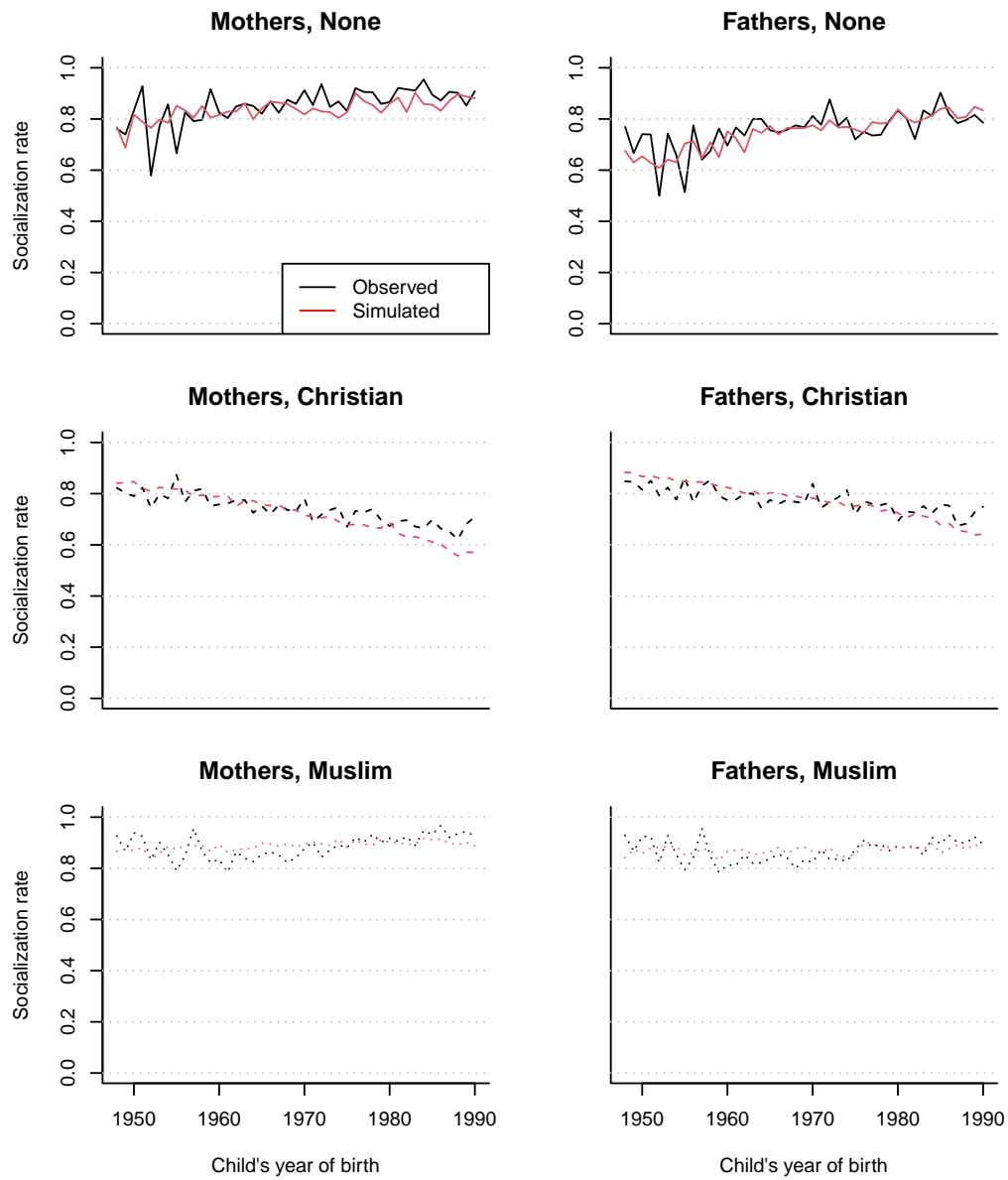


Figure 32: Nonlinear conditional logit transmission, Observed vs. simulated transmission rates (by Religion).

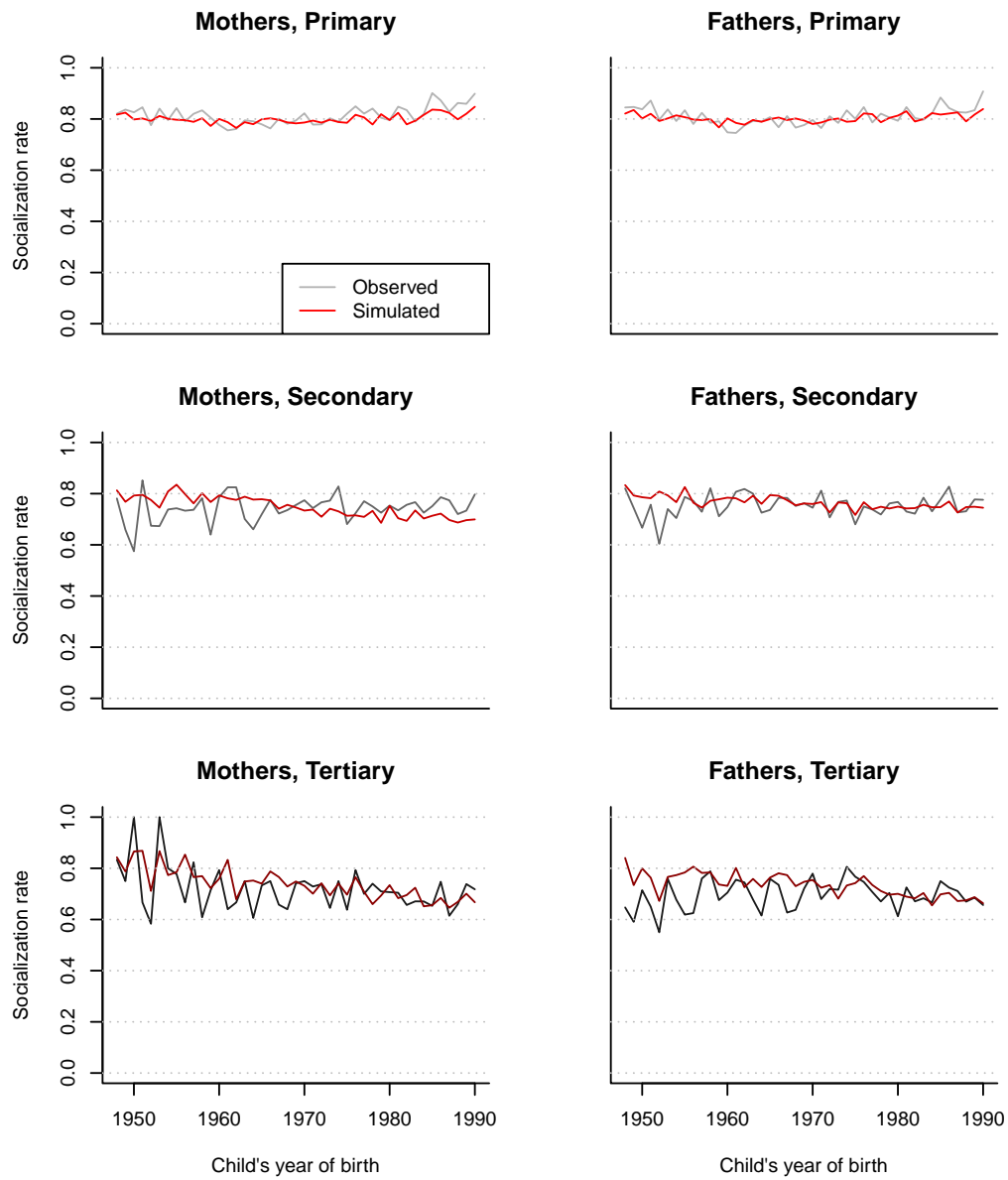


Figure 33: Nonlinear conditional logit transmission, Observed vs. simulated transmission rates (by Education).

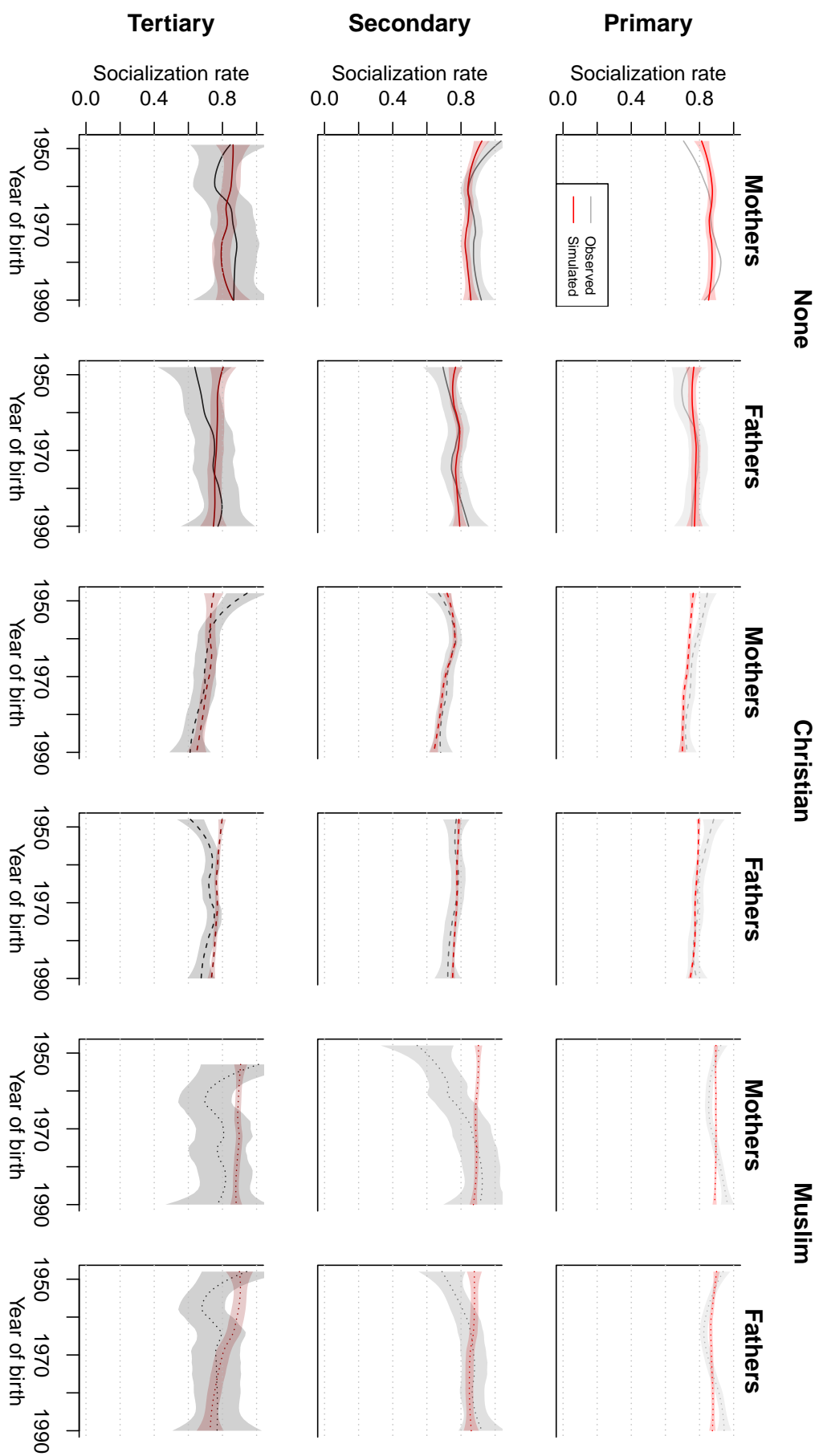


Figure 34: Nonlinear conditional logit transmission, smoothed Observed vs. simulated transmission rates (by Religion and Education).

Table 12: Conditional logit transmission (Fréchet errors), Estimates.

	Estimates		
	(Cond. logit)	(Cond. logit)	(Cond. logit)
Mother’s contribution $m_n$			
None	4.27*** (0.32)	4.50*** (0.50)	0.87 (0.54)
Christian	0.05 (0.05)	1.82*** (0.22)	0.77*** (0.15)
Muslim	8.47*** (0.40)	23.26*** (1.72)	1.64*** (0.31)
Jewish	4.71*** (0.95)	14.17*** (3.08)	1.85** (0.63)
Other	1.33*** (0.12)	3.36*** (0.40)	1.13*** (0.20)
Father’s contribution $f_n$			
None	0.82*** (0.09)	1.33** (0.27)	−0.86*** (0.21)
Christian	0.67*** (0.06)	5.36*** (0.43)	0.87*** (0.24)
Muslim	0.52*** (0.06)	1.93*** (0.25)	1.38*** (0.20)
Jewish	0.16* (0.08)	0.62* (0.33)	0.44 (0.24)
Other	0.38*** (0.09)	1.54*** (0.34)	0.63*** (0.18)
Interaction contribution $b_n$			
None			3.96*** (0.75)
Christian			8.19*** (0.66)
Muslim			32.86*** (2.75)
Jewish			51.27** (18.76)
Other			5.31*** (0.65)
Secularization bias $s_0$		1.74*** (0.13)	2.32*** (0.18)
Observations	20 547	20 547	20 547
Sampling weights	No	No	No
Deviance ( $-2 \ln L$ )	23 275	22 112	21 689
Pseudo- $R^2$	0.55	0.57	0.58
LR test $p$ -value	baseline	0.000	0.000

Note: Standard errors in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

## D Household formation and population dynamics

**Household formation.** The next step is to embed the collective household model into a matching framework, in which men and women match on the two characteristics {religion, education}. In the classical framework, women and men meet on a bilateral, frictionless marriage market. Households are formed endogenously based on the indirect utility provided by the match to each of the spouses. The associated equilibrium concept is stability: a matching is stable if and only if no two individuals would rather match together than stay in their current match.

The matching models usually fall in one of three categories: transferable utility (TU), imperfectly transferable utility (ITU), and non-transferable utility (NTU) (Chiappori 2017). Here, the homogamous household problem has the NTU property (under the assumption that the individual value of culture is homogeneous within a given culture), while the heterogamous household problem has the ITU property. The NTU case is well-documented (Roth and Sotomayor 1990). Recent works provide both theoretical and empirical results for the ITU case (Galichon et al. 2019, Galichon and Salanié 2022).

The first step to analyze matching in the ITU framework is to describe the Pareto frontier of the household by expressing the utility of parent 1 as a decreasing function of the utility of parent 2,

$$u_1 = \Phi(\theta_1, \theta_2, u_2)$$

where  $\theta_i = (n_i, h_i) \in \Theta$  is the bidimensional type of parent  $i$ , and  $\Phi$  is decreasing in  $u_2$ . A match is then characterized by a measure  $\psi$  over  $\Theta^2$  and utility functions  $u_1(\theta_1)$  and  $u_2(\theta_2)$  such that

$$u_1(\theta_1) = \Phi(\theta_1, \theta_2, u_2(\theta_2)) \quad \forall (\theta_1, \theta_2) \in \text{supp } \psi.$$

Stability requires

$$u_1(\theta_1) \geq \Phi(\theta_1, \theta_2, u_2(\theta_2)) \quad \forall (\theta_1, \theta_2) \in \Theta^2$$

which implies

$$u_1(\theta_1) = \max_{\vartheta_2} \Phi(\theta_1, \vartheta_2, u_2(\vartheta_2))$$

and similarly for  $u_2(\theta_2)$ . One can then use first-order conditions to analyze the matching problem.

In my case, even though the function  $\Phi$  exists, I cannot find a closed-form expression for it. Instead, I can parametrize the Pareto frontier by the power  $\mu$ ,

$$\begin{aligned} u_1 &= \Phi_1(\theta_1, \theta_2, \mu) \\ u_2 &= \Phi_2(\theta_1, \theta_2, \mu), \end{aligned}$$

where  $\Phi_1$  is increasing and  $\Phi_2$  is decreasing in  $\mu$ . A match must then be characterized by a measure  $\psi$  over  $\Theta^2$ , utility functions  $u_1(\theta_1)$  and  $u_2(\theta_2)$ , and a power function  $\mu(\theta_1, \theta_2)$  such that

$$\begin{aligned} u_1(\theta_1) &= \Phi_1(\theta_1, \theta_2, \mu(\theta_1, \theta_2)) \\ u_2(\theta_2) &= \Phi_2(\theta_1, \theta_2, \mu(\theta_1, \theta_2)) \end{aligned}$$

for all  $(\theta_1, \theta_2) \in \text{supp } \psi$ . Stability requires

$$\begin{aligned} u_1(\theta_1) &\geq \Phi_1(\theta_1, \theta_2, \mu(\theta_1, \theta_2)) \\ u_2(\theta_2) &\geq \Phi_2(\theta_1, \theta_2, \mu(\theta_1, \theta_2)) \end{aligned}$$

for all  $(\theta_1, \theta_2) \in \Theta^2$ , implying

$$\begin{aligned} u_1(\theta_1) &= \max_{\vartheta_2} \Phi_1(\theta_1, \vartheta_2, \mu(\theta_1, \vartheta_2)) \\ u_2(\theta_2) &= \max_{\vartheta_1} \Phi_2(\vartheta_1, \theta_2, \mu(\vartheta_1, \theta_2)). \end{aligned}$$

First-order conditions with respect to  $h_2$  and  $h_1$  write

$$\begin{aligned} \frac{\partial \Phi_1}{\partial h_2}(\theta_1, \theta_2, \mu(\theta_1, \theta_2)) + \frac{\partial \mu}{\partial h_2}(\theta_1, \theta_2) \times \frac{\partial \Phi_1}{\partial \mu}(\theta_1, \theta_2, \mu(\theta_1, \theta_2)) &= 0 \\ \frac{\partial \Phi_2}{\partial h_1}(\theta_1, \theta_2, \mu(\theta_1, \theta_2)) + \frac{\partial \mu}{\partial h_1}(\theta_1, \theta_2) \times \frac{\partial \Phi_2}{\partial \mu}(\theta_1, \theta_2, \mu(\theta_1, \theta_2)) &= 0 \end{aligned}$$

which is a partial differential equation for  $\mu$ .

The following issues arise compared to the usual framework:

- There is no explicit form for the function  $\Phi$  which allows to describe the Pareto frontier with  $u_1$  as a function of  $u_2$ . As a consequence, I have to rely on parametrizing the Pareto frontier by the Pareto weight  $\mu$ , thus introducing a new function into the equilibrium. A consequence is that  $\mu$  must be recovered using a system of partial differential equations, rather than a standard differential equation for recovering utilities.
- The type of individuals is bidimensional, with the first dimension discrete. This means that the solution cannot be characterized entirely by first-order conditions.

The empirical analysis might however be easier. The bidimensional type is now  $(n, e)$ , which takes a finite number  $N \times E$  of values. Index these types by  $I$  for women and  $J$  for men. The goal is to find the Pareto weights  $\mu^{IJ}$  which best explain the empirical matching patterns, according to the discrete choices of the individuals. Denoting women by  $i \in I$  and men by  $j \in J$ , these discrete choice problems are

$$\begin{aligned} u_i &= \max_j \{ \Phi_1(I, J, \mu^{IJ}) + \alpha_i^J \} \\ u_j &= \max_i \{ \Phi_2(I, J, \mu^{IJ}) + \beta_j^I \} \end{aligned}$$

where  $\alpha_i^J$  and  $\beta_j^I$  are random shocks which depend exclusively on the type of the partner, as in the [Choo and Siow \(2006\)](#) framework. These translate into probability for each individual  $i$  or  $j$  to marry with a partner of type  $J$  or  $I$ . In this case, estimation has to be performed simultaneously on marriage patterns and transmission patterns to jointly estimate the Pareto weights  $\mu^{IJ}$  and the parameters of the utilities and production functions that I estimated previously.

**Population dynamics.** The last contribution of this paper will be to study the population dynamics implied by the model. This can be done either empirically or theoretically. Empirically: once the model's primitive parameters are estimated, one can iterate the model to simulate the evolution of the population along the two dimensions of interest (religion and education). This simply requires to solve for the ITU matching equilibrium, for which a solution was proposed by [Galichon and Salanié \(2022\)](#). From the matching equilibrium, we can infer the joint distribution of religious traits and educational levels in the next generation using the collective household model. It might be possible to do the same exercise theoretically for distributions of traits which are simple enough.

The dynamic implications could be interesting. For instance, if the cultural minority starts with lower average human capital than the majority (as is for instance the case with immigrants in many countries), the need to safeguard their culture could happen at the expense of their human capital development, so that the human capital gap between cultural minority and majority could widen with time. (Or at least, this mechanism could delay the catch-up of the minority with the majority, compared to the baseline case wherein people do not care about cultural transmission.) Intuitively, this could lead to a higher-educated, little-socialized cultural majority on one side, and a lower-educated, highly-socialized cultural minority on the other side.

## E Educational homogamy: local log odds ratios analysis

In this section I follow the methodology of [Siow \(2015\)](#) to study educational homogamy using local log odds ratios. As pointed out by [Siow](#), simply computing correlations of spouses' education levels remains a weak test of homogamy since we don't know how high the correlation should be to infer that the data indeed exhibits homogamy. A stronger tests consists in verifying that all local log odds ratios are positive.

To begin with, Table 13 provides the sample distribution of marriages according to the spouses' education levels. The repartition of marriages is thus represented by a  $3 \times 3$  matrix  $(n_{ij})_{1 \leq i, j \leq 3}$ , for a total number of observations  $N$ . The local log odds ratios are defined for  $i, j \leq 2$  as

$$\ln \left( \frac{n_{ij} n_{i+1, j+1}}{n_{i, j+1} n_{i+1, j}} \right) \quad (39)$$

which constitutes a measure of local homogamy in the submatrix  $\begin{pmatrix} n_{ij} & n_{i, j+1} \\ n_{i+1, j} & n_{i+1, j+1} \end{pmatrix}$ . In particular if random matching is occurring, one should expect all these log odds ratios to be equal to 0.

[Siow \(2015\)](#) shows that supermodularity of the marital surplus implies that all local log odds ratios should be positive, i.e. that the matrix  $(n_{ij})_{1 \leq i, j \leq 3}$  should be totally positive of order 2, or TP2 for short. I test this TP2 criterion statistically by following the method prescribed by [Garre et al. \(2002\)](#), which [Siow \(2015\)](#) also follows. First define three different hypotheses:  $H_0$  corresponds to the restricted model where all local log odds ratios are equal to 0;  $H_1$  the model where they are positive; and  $H_2$  the unrestricted model. Hypothesis  $H_0$  also means that the matrix  $(n_{ij})_{1 \leq i, j \leq 3}$  is totally null of order 2, which I call TN2 for short. Call  $L_0$ ,  $L_1$ , and  $L_2$  the models' respective likelihoods: for instance,

$$L_1 = \max_{\nu_{ij}} \sum_{ij} n_{ij} \ln(\nu_{ij}) \quad (40)$$

subject to the constraints

$$\ln \left( \frac{\nu_{ij} \nu_{i+1, j+1}}{\nu_{i, j+1} \nu_{i+1, j}} \right) \geq 0 \quad (\forall i, j \leq 2) \quad (41)$$

and

$$\sum_{ij} \nu_{ij} = N. \quad (42)$$

The likelihood  $L_0$  is obtained by using an equality constraint in (41), and  $L_2$  by removing

Mother's education	Father's education			Total
	Primary or less	Secondary	More than secondary	
Primary or less	8998	1968	298	11264
Secondary	1136	3428	1023	5587
More than secondary	97	428	1417	1942
Total	10231	5824	2738	18793

Table 13: Parental education and homogamy.



Mother's education	Father's education				Local log odds ratios	
	Pri	Sec	Sec+	Total	Pri, Sec	Sec, Sec+
TP2 probabilities					TP2 log odds	
Pri	0.479 (0.004)	0.105 (0.002)	0.016 (0.001)	0.600	Pri, Sec	2.624 (0.039)      0.678 (0.068)
Sec	0.060 (0.002)	0.182 (0.003)	0.054 (0.002)	0.296	Sec, Sec+	0.380 (0.119)      2.406 (0.061)
Sec+	0.005 (0.001)	0.023 (0.001)	0.075 (0.002)	0.103	LR <sub>01</sub> statistic: 10 352 <i>p</i> -value: 0	
Total	0.544	0.310	0.145	1		
TN2 probabilities						
Pri	0.326 (0.003)	0.186 (0.002)	0.087 (0.002)	0.599		
Sec	0.162 (0.002)	0.092 (0.001)	0.043 (0.001)	0.297		
Sec+	0.056 (0.001)	0.032 (0.001)	0.015 (0.000)	0.103		
Total	0.544	0.310	0.145	1		

*Note:* Standard errors in parentheses (parametric bootstrap, 100 replications).

Table 14: Estimated probabilities and local log odds ratios – full sample.

constraint (41) entirely. The statistics of interest are log-likelihood ratio (LR) test statistics,

$$\text{LR}_{01} = 2(L_1 - L_0) \quad \text{and} \quad \text{LR}_{12} = 2(L_2 - L_1). \quad (43)$$

The statistic LR<sub>12</sub> indicates to what extent TP2 fits the data, and LR<sub>01</sub> tests whether positive local log odds ratios are a better fit than if they are null. When samples obey TP2, I test  $H_1$  versus  $H_0$ . When they do not, I test  $H_1$  versus  $H_2$ . I report estimates of the probabilities  $p_{ij} = \frac{\nu_{ij}}{N}$  for a marriage observation to fall in the  $ij$  category. The  $p$ -values and standard errors are obtained by parametric bootstrap with 100 replications.

**Analysis on the full sample.** Table 14 presents the estimated probabilities and the associated local log odds ratios for the full sample. The local log odds ratios are all positive, so the data obeys TP2. For this reason, the estimates from the unrestricted problem are the same as the TP2 estimates, which is why I only report the latter. In this case, the relevant hypothesis test is  $H_1$  versus  $H_0$ : is there evidence for positive local log odds ratios, rather than them being all zeros? The associated test statistic is LR<sub>01</sub>.

The value of the LR<sub>01</sub> test statistic is very large in this case, at 10 352. Accordingly, the  $p$ -value is extremely small – in fact, it cannot be differentiated from 0 at the precision level which I use. This provides strong evidence to reject the null hypothesis  $H_0$  that local log odds ratios are all zeros, in favor of  $H_1$  and TP2. In turn, this provides strong evidence of homogamy and of the supermodularity of the marital surplus in the full sample.

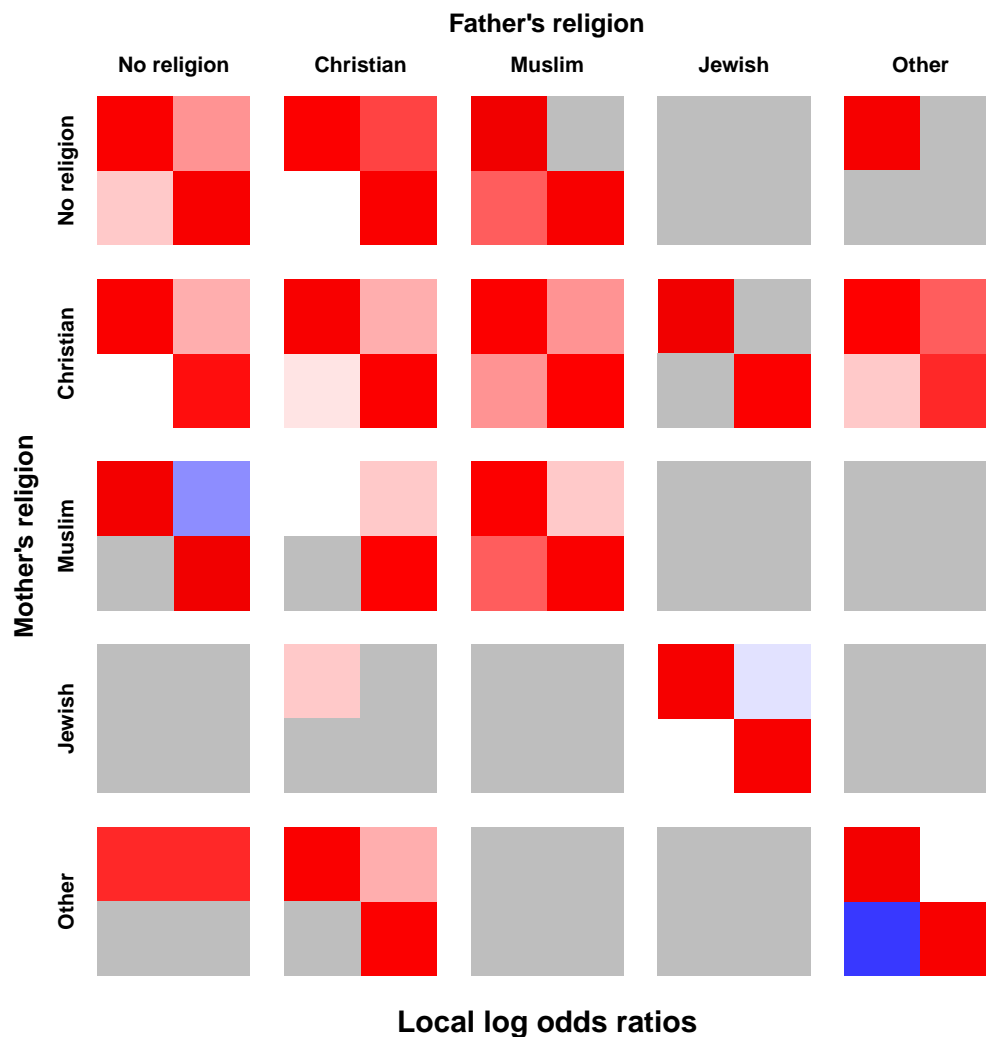


Figure 35: Local log odds ratios conditional on spouses' religious affiliation. Red indicates positive values, and blue negative ones. Lighter shades indicate values closer to 0. Gray indicates missing values.

**Analysis conditional on spouses' religious affiliations.** Figure 35 presents the empirical local log odds ratios conditional on spouses' religious affiliation using a color chart. Red indicates positive values, and blue negative ones (gray indicates missing data). A glimpse at the figure shows that most of the local log odds ratios which can be computed are positive. I test TP2 for each configuration of the spouses' religious affiliation, using the same method as for the full sample.

Mother: No religion				Father: No religion		
Mother's education	Father's education				Local log odds ratios	
	Pri	Sec	Sec+		Pri, Sec	Sec, Sec+
	Unrestricted probabilities				Unrestricted log odds	
Pri	0.342 (0.011)	0.094 (0.007)	0.009 (0.002)	Pri, Sec	2.425 (0.134)	0.860 (0.300)
Sec	0.085 (0.006)	0.264 (0.010)	0.059 (0.006)	Sec, Sec+	0.531 (0.322)	2.657 (0.162)
Sec+	0.006 (0.002)	0.034 (0.004)	0.107 (0.007)			
	TP2 probabilities				TP2 log odds	
Pri	0.342 (0.011)	0.094 (0.007)	0.009 (0.002)	Pri, Sec	2.425 (0.119)	0.860 (0.301)
Sec	0.085 (0.006)	0.264 (0.009)	0.059 (0.005)	Sec, Sec+	0.531 (0.318)	2.657 (0.161)
Sec+	0.006 (0.002)	0.034 (0.004)	0.107 (0.006)			
	TN2 probabilities			$N = 2033$		
Pri	0.193 (0.007)	0.175 (0.005)	0.078 (0.004)	LR <sub>12</sub> statistic: 0 $p$ -value: 1		
Sec	0.176 (0.005)	0.160 (0.005)	0.071 (0.004)	LR <sub>01</sub> statistic: 1211 $p$ -value: 0		
Sec+	0.064 (0.004)	0.058 (0.004)	0.026 (0.002)			
<i>Note:</i> Standard errors in parentheses (parametric bootstrap, 100 replications).						

Note: Standard errors in parentheses (parametric bootstrap, 100 replications).

Table 15: Estimated probabilities and local log odds ratios – No religion, No religion.

Mother: No religion				Father: Christian		
Mother's education	Father's education			Local log odds ratios		
	Pri	Sec	Sec+	Pri, Sec	Sec, Sec+	
Unrestricted probabilities				Unrestricted log odds		
Pri	0.175 (0.026)	0.079 (0.021)	0.005 (0.005)	Pri, Sec	2.212 (0.462)	1.427 (38.636)
Sec	0.069 (0.020)	0.286 (0.028)	0.079 (0.017)	Sec, Sec+	0.042 (7.964)	2.454 (0.404)
Sec+	0.016 (0.010)	0.069 (0.018)	0.222 (0.027)			
TP2 probabilities				TP2 log odds		
Pri	0.175 (0.031)	0.079 (0.021)	0.005 (0.005)	Pri, Sec	2.212 (0.496)	1.427 (23.882)
Sec	0.069 (0.019)	0.286 (0.033)	0.079 (0.017)	Sec, Sec+	0.042 (13.175)	2.454 (0.389)
Sec+	0.016 (0.007)	0.069 (0.019)	0.222 (0.030)			
TN2 probabilities				$N = 189$		
Pri	0.067 (0.011)	0.112 (0.015)	0.080 (0.013)	LR <sub>12</sub> statistic: 0 $p$ -value: 1		
Sec	0.112 (0.015)	0.188 (0.022)	0.133 (0.017)	LR <sub>01</sub> statistic: 109 $p$ -value: 0		
Sec+	0.080 (0.012)	0.133 (0.019)	0.094 (0.015)			

Note: Standard errors in parentheses (parametric bootstrap, 100 replications).

Note: Standard errors in parentheses (parametric bootstrap, 100 replications).

Table 16: Estimated probabilities and local log odds ratios – No religion, Christian.

Mother: No religion				Father: Muslim		
Mother's education	Father's education				Local log odds ratios	
	Pri	Sec	Sec+		Pri, Sec	Sec, Sec+
Unrestricted probabilities				Unrestricted log odds		
Pri	0.375 (0.057)	0.011 (0.012)	0.000 (0.000)	Pri, Sec	3.561 (20.911)	+Inf (20.160)
Sec	0.170 (0.038)	0.182 (0.042)	0.045 (0.022)	Sec, Sec+	1.322 (22.206)	2.639 (9.429)
Sec+	0.011 (0.012)	0.045 (0.024)	0.159 (0.043)			
TP2 probabilities				TP2 log odds		
Pri	0.375 (0.049)	0.011 (0.013)	0.000 (0.000)	Pri, Sec	3.561 (13.546)	26.579 (5.671)
Sec	0.170 (0.043)	0.182 (0.045)	0.045 (0.021)	Sec, Sec+	1.322 (14.614)	2.639 (0.914)
Sec+	0.011 (0.011)	0.045 (0.022)	0.159 (0.043)			
TN2 probabilities				$N = 88$		
Pri	0.215 (0.036)	0.092 (0.022)	0.079 (0.022)	LR <sub>12</sub> statistic: 0 $p$ -value: 1		
Sec	0.221 (0.042)	0.095 (0.023)	0.081 (0.019)	LR <sub>01</sub> statistic: 71 $p$ -value: 0		
Sec+	0.120 (0.027)	0.052 (0.017)	0.044 (0.013)			

*Note:* Standard errors in parentheses (parametric bootstrap, 100 replications).

Table 17: Estimated probabilities and local log odds ratios – No religion, Muslim.

Mother: No religion				Father: Jewish		
Mother's education	Father's education				Local log odds ratios	
	Pri	Sec	Sec+		Pri, Sec	Sec, Sec+
Unrestricted probabilities				Unrestricted log odds		
Pri	0.250 (0.163)	0.000 (0.000)	0.000 (0.000)	Pri, Sec	– (9.925)	– (11.615)
Sec	0.375 (0.190)	0.000 (0.000)	0.125 (0.115)	Sec, Sec+	– (4.953)	– (14.785)
Sec+	0.000 (0.000)	0.000 (0.000)	0.250 (0.162)			
TP2 probabilities				TP2 log odds		
Pri	0.250 (0.132)	0.000 (0.000)	0.000 (0.000)	Pri, Sec	7.410 (3.095)	13.921 (5.022)
Sec	0.375 (0.161)	0.000 (0.000)	0.125 (0.123)	Sec, Sec+	15.385 (4.501)	8.021 (8.117)
Sec+	0.000 (0.000)	0.000 (0.000)	0.250 (0.144)			
TN2 probabilities				$N = 8$		
Pri	0.156 (0.105)	0.000 (0.000)	0.094 (0.079)	LR <sub>12</sub> statistic: 0 $p$ -value: 0.750		
Sec	0.312 (0.139)	0.000 (0.000)	0.187 (0.103)	LR <sub>01</sub> statistic: 6.086 $p$ -value: 0.010		
Sec+	0.156 (0.114)	0.000 (0.000)	0.094 (0.074)			

*Note:* Standard errors in parentheses (parametric bootstrap, 100 replications).

Table 18: Estimated probabilities and local log odds ratios – No religion, Jewish.

Mother: No religion				Father: Other		
Mother's education	Father's education				Local log odds ratios	
	Pri	Sec	Sec+		Pri, Sec	Sec, Sec+
Unrestricted probabilities				Unrestricted log odds		
Pri	0.250 (0.163)	0.000 (0.000)	0.000 (0.000)	Pri, Sec	– (9.925)	– (11.615)
Sec	0.375 (0.190)	0.000 (0.000)	0.125 (0.115)	Sec, Sec+	– (4.953)	– (14.785)
Sec+	0.000 (0.000)	0.000 (0.000)	0.250 (0.162)			
TP2 probabilities				TP2 log odds		
Pri	0.250 (0.132)	0.000 (0.000)	0.000 (0.000)	Pri, Sec	7.410 (3.095)	13.921 (5.022)
Sec	0.375 (0.161)	0.000 (0.000)	0.125 (0.123)	Sec, Sec+	15.385 (4.501)	8.021 (8.117)
Sec+	0.000 (0.000)	0.000 (0.000)	0.250 (0.144)			
TN2 probabilities				$N = 24$		
Pri	0.156 (0.105)	0.000 (0.000)	0.094 (0.079)	LR <sub>12</sub> statistic: 0 $p$ -value: 1		
Sec	0.312 (0.139)	0.000 (0.000)	0.187 (0.103)	LR <sub>01</sub> statistic: 25.125 $p$ -value: 0		
Sec+	0.156 (0.114)	0.000 (0.000)	0.094 (0.074)			

*Note:* Standard errors in parentheses (parametric bootstrap, 100 replications).

Table 19: Estimated probabilities and local log odds ratios – No religion, Other.