

CULTURE, HUMAN CAPITAL, AND MARITAL HOMOGAMY IN FRANCE*

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Abstract

What economic sacrifices are people willing to make to transmit their culture? Using data on religious affiliation in France, I study the intergenerational transmission of religion and how it interacts with children's educational outcomes. A reduced-form analysis suggests that mothers contribute to religious transmission more than fathers; religious minorities more than majorities; and lower-educated parents more than higher-educated ones. A mechanism that can explain these patterns is that higher-educated parents have a higher opportunity cost to transmit their religion to their children. I investigate this mechanism using a structural model, 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. The analysis suggests that heterogeneities in transmission patterns are in fact driven primarily by heterogeneities in preferences for religious transmission across genders and religious groups, rather than by differences in the parents' education. Furthermore, religious minorities pay a higher price for religious transmission in terms of their children's educational outcomes. For instance, by measuring this cost in terms of probability that the child gets a college education, Muslim parents pay a cost between 8 and 13 times greater than Christians.

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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, embracing a cultural identity can be a costly endeavor.¹ 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.² 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.³ 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 2018.⁴ 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

¹On 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.

²Intergenerational 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.”

³See for instance Squicciarini (2020), Chaudhary and Rubin (2011), or Carvalho, Koyama and Sacks (2017) for historical examples and evidence of the substitutability between religion and formal education.

⁴Ferrara (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 parents in the cultural transmission to children and its cost on their educational attainment, 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. Furthermore, the structural approach suggests that these differences are primarily driven by heterogeneous preferences across parents of different religious affiliations. Finally, I measure the cost of religious transmission in terms of children's educational attainment for different types of households, finding for instance that Muslim parents pay a cost to religious transmission 8 to 13 times greater than Christians parents.

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 at fitting the data. Results suggest that mothers contribute more to religious transmission than fathers, and parents from religious minorities (Muslims and Jews) more than those from religious majorities (Christians and Nones). Furthermore, higher parental education is associated with lower contributions to religious transmission. These findings are 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 disparities in religious transmission between mothers and fathers: instead, results suggest that systematic heterogeneity 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 transmission disparities between religious minorities and majorities (minorities transmit religion more accurately than majorities) must also involve heterogeneity in those preferences across religious affiliations. A log-likelihood decomposition analysis confirms that heterogeneous parental

preferences are the main driver behind the heterogeneity in religious transmission patterns, above the human capital mechanism described above (minorities are less educated than majorities, so they have a lower opportunity cost to religious socialization), and a cultural substitution explanation (minorities socialize their children more because they cannot rely on the environment to do so; see [Bisin and Verdier 2000](#)). While I cannot rule out that these preferences are in fact rooted in an economic value of children’s religious affiliation,⁵ a reasonable interpretation is that religious transmission to children seems to matter *per se* to the parents. Finally, the structural model allows me to measure the cost of religious transmission for different households, in terms of the child’s educational attainment. I find that Muslim parents pay the highest cost for religious transmission, far above Christians and other denominations.

Related literature. By documenting how parents transmit their religion and human capital to their children in the context of contemporary France, this paper speaks to a recent literature which has explored the link between investments in religious versus formal education in various settings, 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 in schools, ultimately hampering economic development in regions with higher religiosity. [Chaudhary and Rubin \(2011\)](#) and [Saleh \(2016\)](#) document a similar phenomenon for Muslims in colonial India and 20th-century Egypt, respectively. [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. Here, I contribute by exploring new reasons why parents may decide to invest in religion versus education, and by quantifying their effects.

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](#), [Cunha and Heckman 2007](#)). Indeed, 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 \(2014, 2016\)](#). I use a collective household framework ([Chiappori 1992](#)) to model parental time investments decisions. In that respect, a paper close to mine is [Chiappori, Salanié and Weiss \(2017\)](#), which models trade-offs between time investments in children’s human capital and time

⁵For 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.

spent working in order to explain the evolution of the marital college premium. Here, I aim to explain heterogeneities in the patterns of religious and human capital transmission, and to that end I adapt this model to focus instead on time investments in children’s religious versus human capital formation. My emphasis on religious capital as an intensive measure of religion⁶ which is built by purposeful investments can also traced to Iannaccone (1990), who initially considered this human capital approach to religion.

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 cross-sectional data on parental and children’s cultural affiliations to recover values for the primitive parameters of cultural transmission models.⁷ 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), although their model differs from mine in that parental socialization investments still contribute to determining the child’s cultural type (extensive margin) while individuals themselves build their cultural capital (intensive margin) – in my model, parental investments directly contribute to the cultural capital, from which individuals derive their type. Furthermore, starting with Bisin and Verdier (2000) the cultural transmission literature has mostly considered costs to cultural socialization efforts in an abstract way. Here I contribute by considering a very concrete cost, namely, the time opportunity cost of socialization on investments in children’s education. This allows me to measure the cost of religious transmission in terms of children’s educational attainment, an economic outcome of primary concern. Finally, by using a collective household model to explain socialization decisions I depart from the standard unitary model used in the cultural transmission literature (an approach also taken recently by Bisin and Tura 2020). Most notably, this modelling choice lets me model

⁶Rather 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.

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

the behavior of heterogamous households in a non-trivial way, and identify the separate contributions and characteristics of mothers and fathers in the transmission process – something which is not possible with the unitary model.

The paper is organized as follows. In section 2 I describe the data along several dimensions of interest: education, religion, and patterns of marriage and of intergenerational transmission. 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 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 A1 (Appendix A). 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.

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.⁸ 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 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 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 A1 I construct the same graph using the detailed diploma categories

⁸A 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).

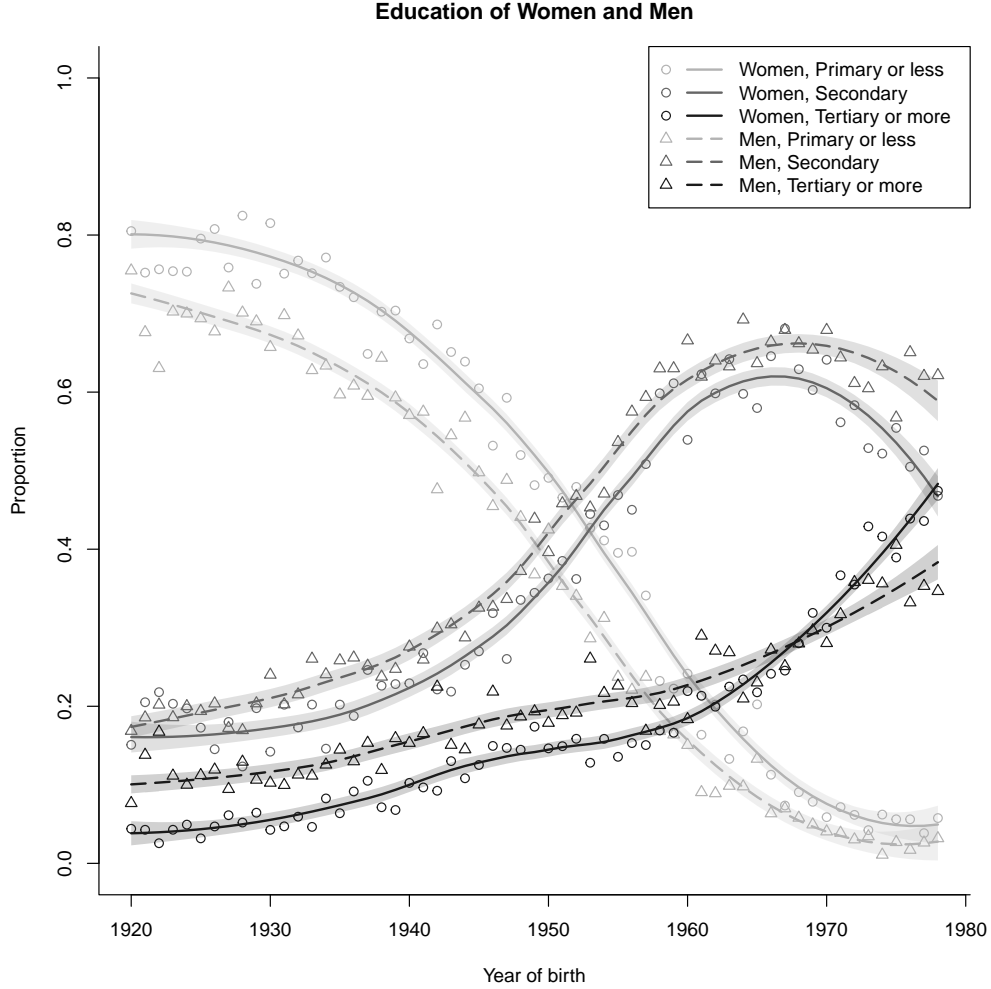


Figure 1: Education of Women and Men.

(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 A3 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

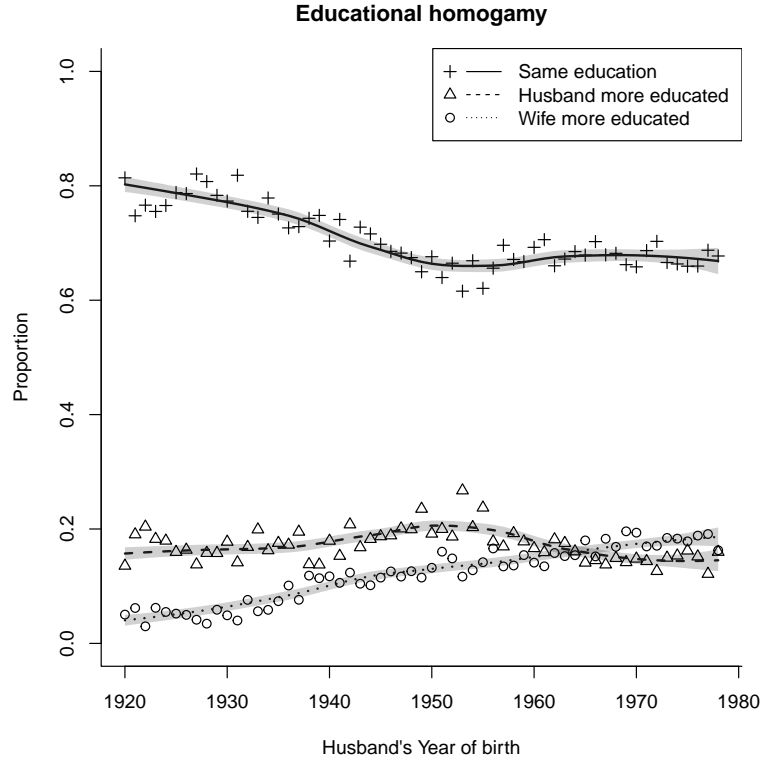


Figure 2: Educational homogamy.

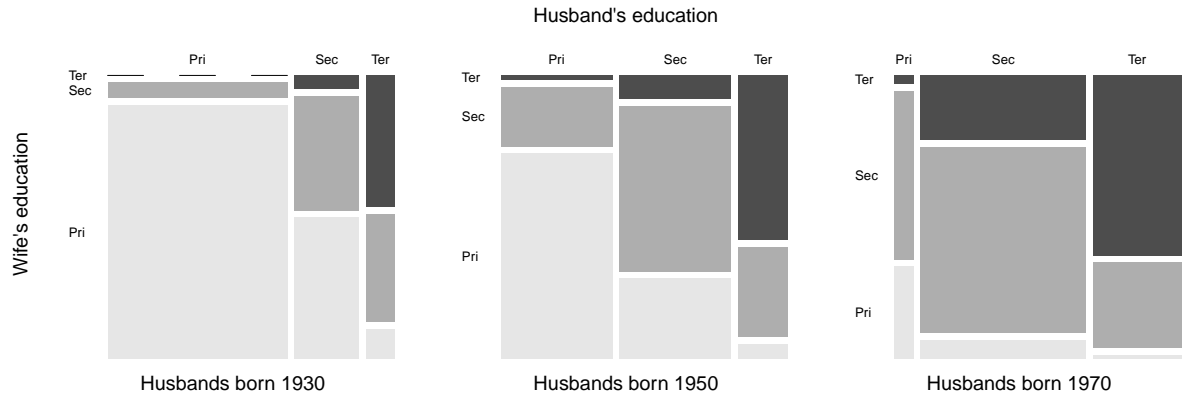


Figure 3: Educational assortment in couples with a husband born in 1930, 1950, and 1970.

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 A5 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:

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

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,⁹ 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, 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

⁹When 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.

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

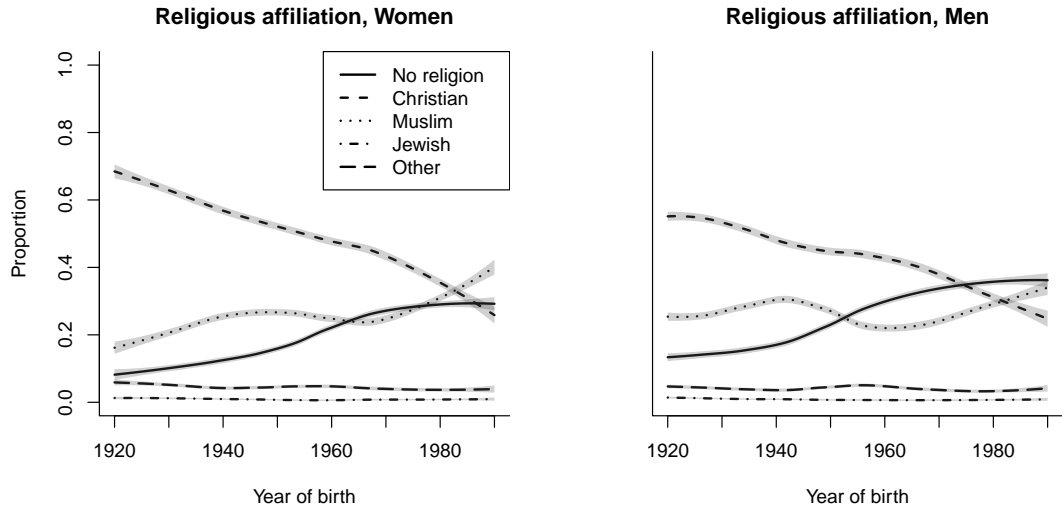


Figure 4: Religious affiliation, Women and Men.

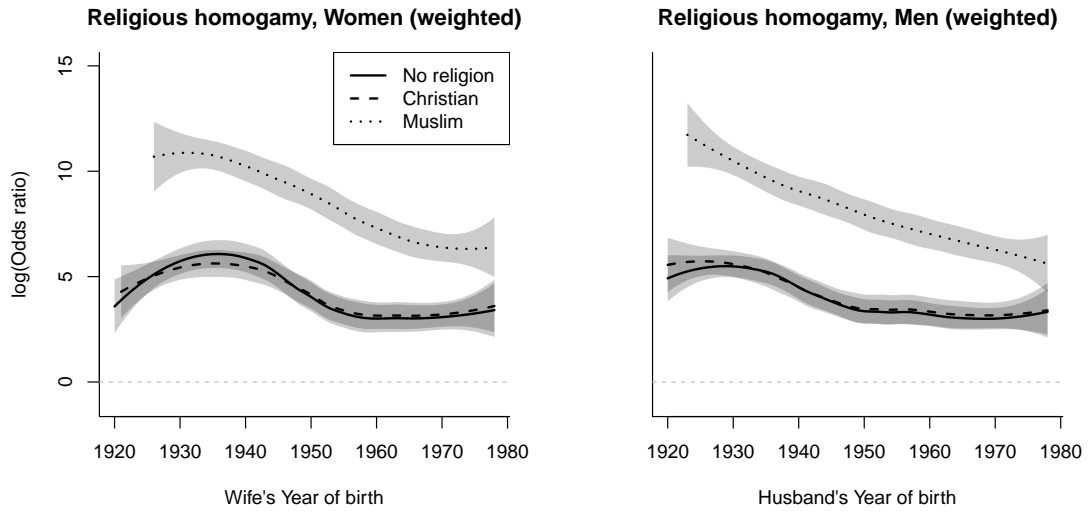


Figure 5: Religious homogeneity (log-odds ratios), Women and Men.

despite this noise, both these affiliations exhibit high average assortativity rates, which are closer to Muslims than to Christians or Nones. Figures A6 and A7 show assortativity patterns for the three cohorts born in 1930, 1950, and 1970, and provide further evidence of strong religious homogeneity in the sample. Table A2 presents the 2×2 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,

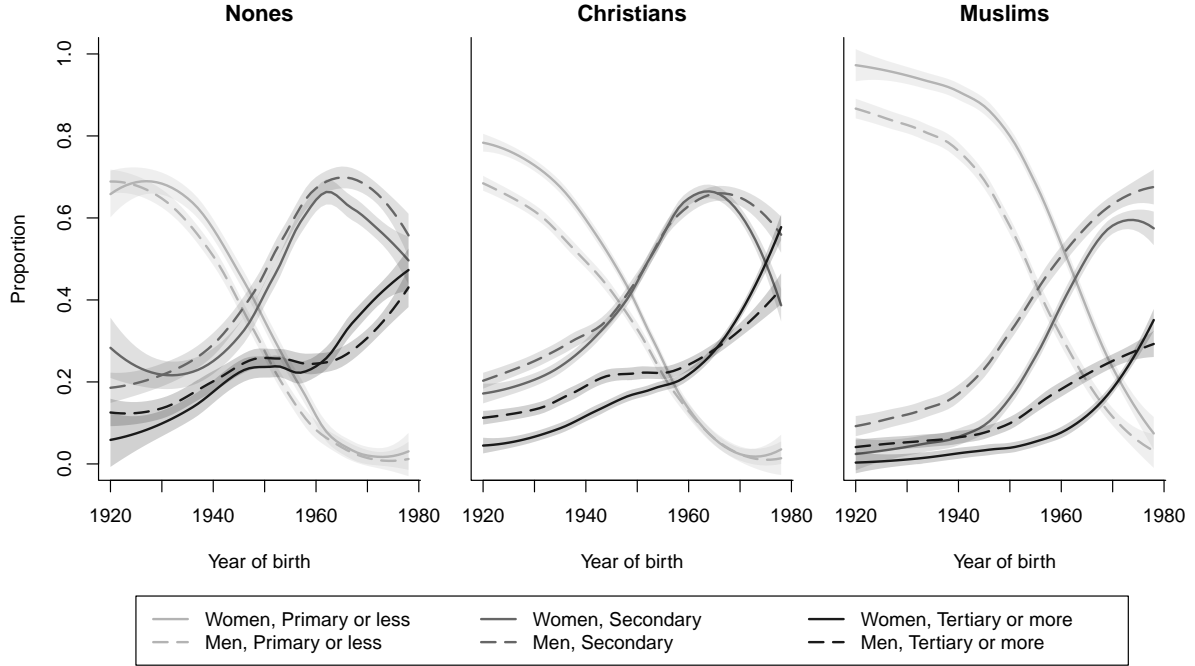


Figure 6: Education by religion and gender.

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 A2).

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 is strongest among individuals with a “Primary or less” education, and weakest among



Figure 7: Educational homogamy, same-religion couples.

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 interactions, 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.

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

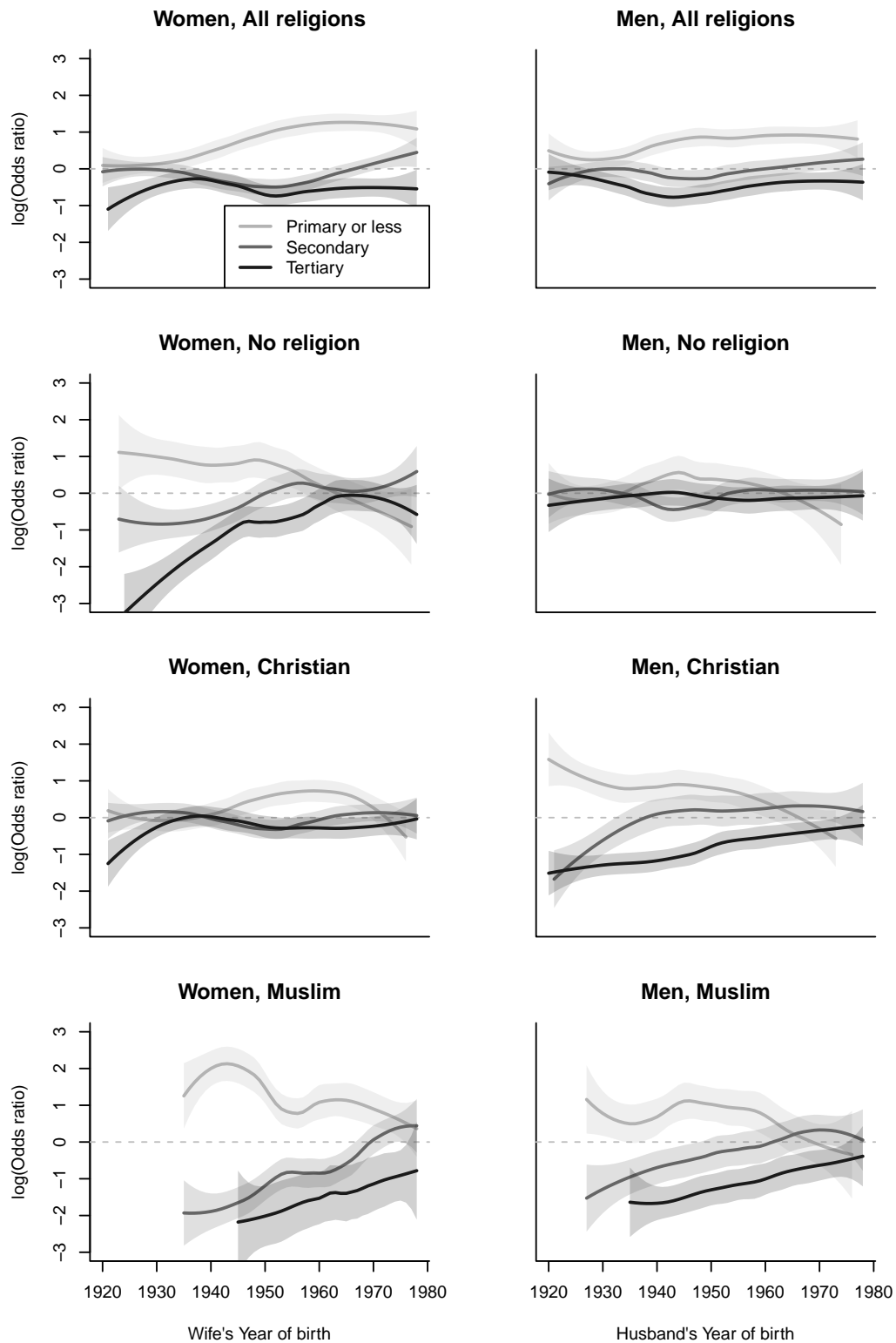


Figure 8: Religious homogamy of Women and Men, by Religion and Education. Here, log-odds ratios are computed within a religion category. For instance, in the “Women, Muslim” graph the “Primary or less” line is obtained by computing the odds of a Primary–Muslim woman being partnered with a Muslim man,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

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.”

using a linear model instead of an ordered logit model yield similar results (see Table A4).

Religion of the parents. To see whether religion plays a role in the transmission of education, in Figure 10 I plot the educational attainment of children as a function of both parental religion and parental education (focusing on parents who have the same religion and education). It shows that even if we hold the education of the parents fixed, the children from Christian parents tend to be more educated in average, as well as the children from Jewish parents (although the sample size is much smaller for them). On the other hand, children from None parents and Muslim parents seem to have lower education.

To inquire further, 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 and Other mothers, and Christian and Jewish fathers, are associated with higher-educated children. Conversely, Other fathers are associated with lower-educated children. Note that these results might be dependent on religious homogamy patterns. For this reason, I add interactions between mothers’ and fathers’ religious affiliations as explanatory variables (for lack of space because of the many interactions, I only re-

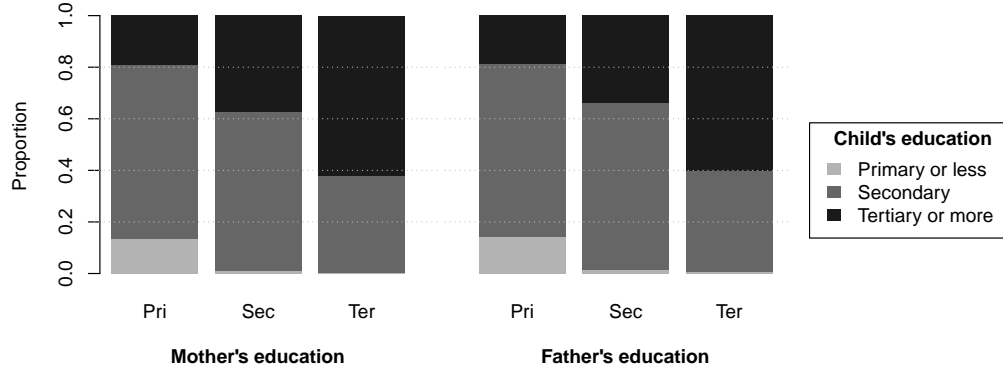


Figure 9: Transmission of education.

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	18 793	18 793	18 222
Sampling weights	Yes	Yes	Yes
Deviance ($-2 \ln L$)	27 098	26 947	25 901

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."

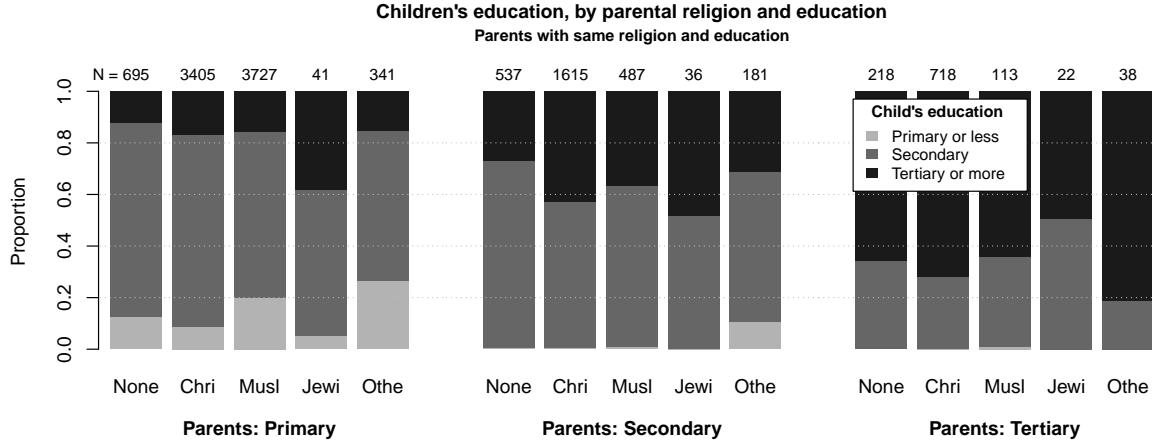


Figure 10: Transmission of education by parental characteristics.

port these results in the Appendix, Table A3). The estimates of Table 2 remain robust when adding these interactions, while the estimated coefficients for these interactions are mostly not statistically significant. 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. The structural model will address this question in section 4.

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 11. 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 A10 and A11 also describe religious transmission patterns across parental religious affiliations, this time aggregating all cohorts. They provide evidence for a homogeneity advantage in religious transmission, except for the None affiliation.

By religion. Figure 12 presents transmission rates of mothers and fathers of the three main religious affiliations. Muslim transmission rates are higher overall, which might in

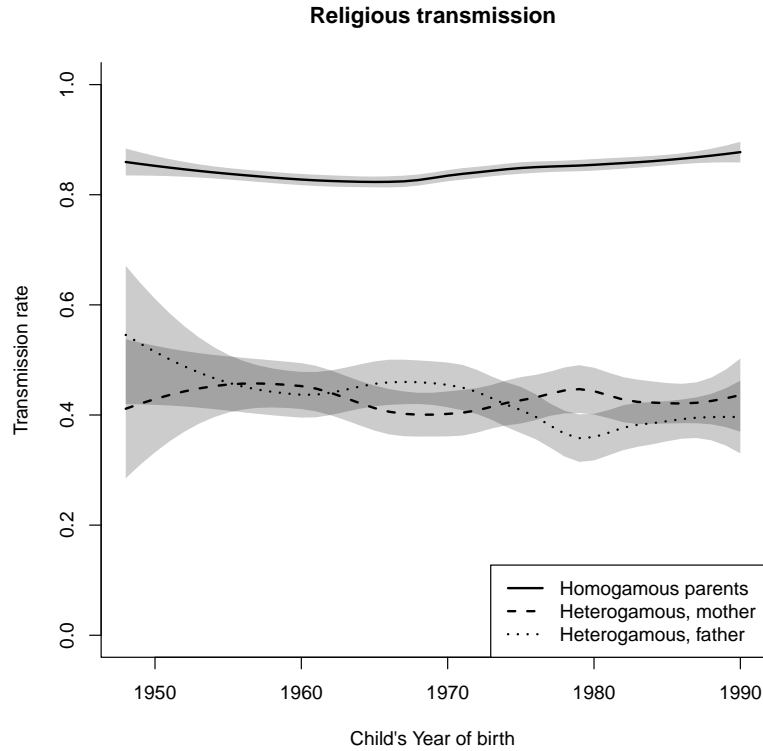


Figure 11: Religious transmission by parents in homogamous and heterogamous couples.

part be a consequence of stronger homogamy among Muslims. Yet, Muslim transmission rates are also increasing across recent cohorts, despite decreasing Muslim homogamy 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 homogamy 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, 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

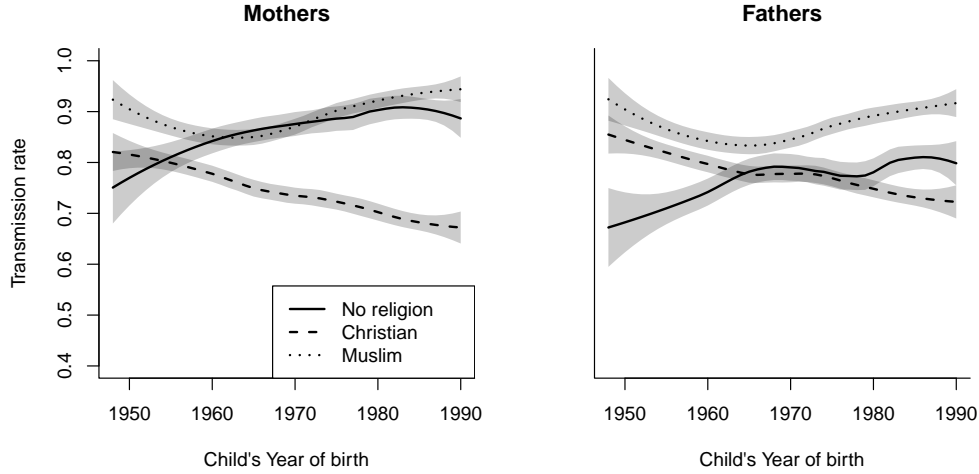


Figure 12: Religious transmission by Mothers and Fathers.

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 13 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 13 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 14 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 13), consistent with the finding on homogamy: more educated fathers marry less homogamously, and thus can be expected 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

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 \times 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."

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 homogamy, 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.

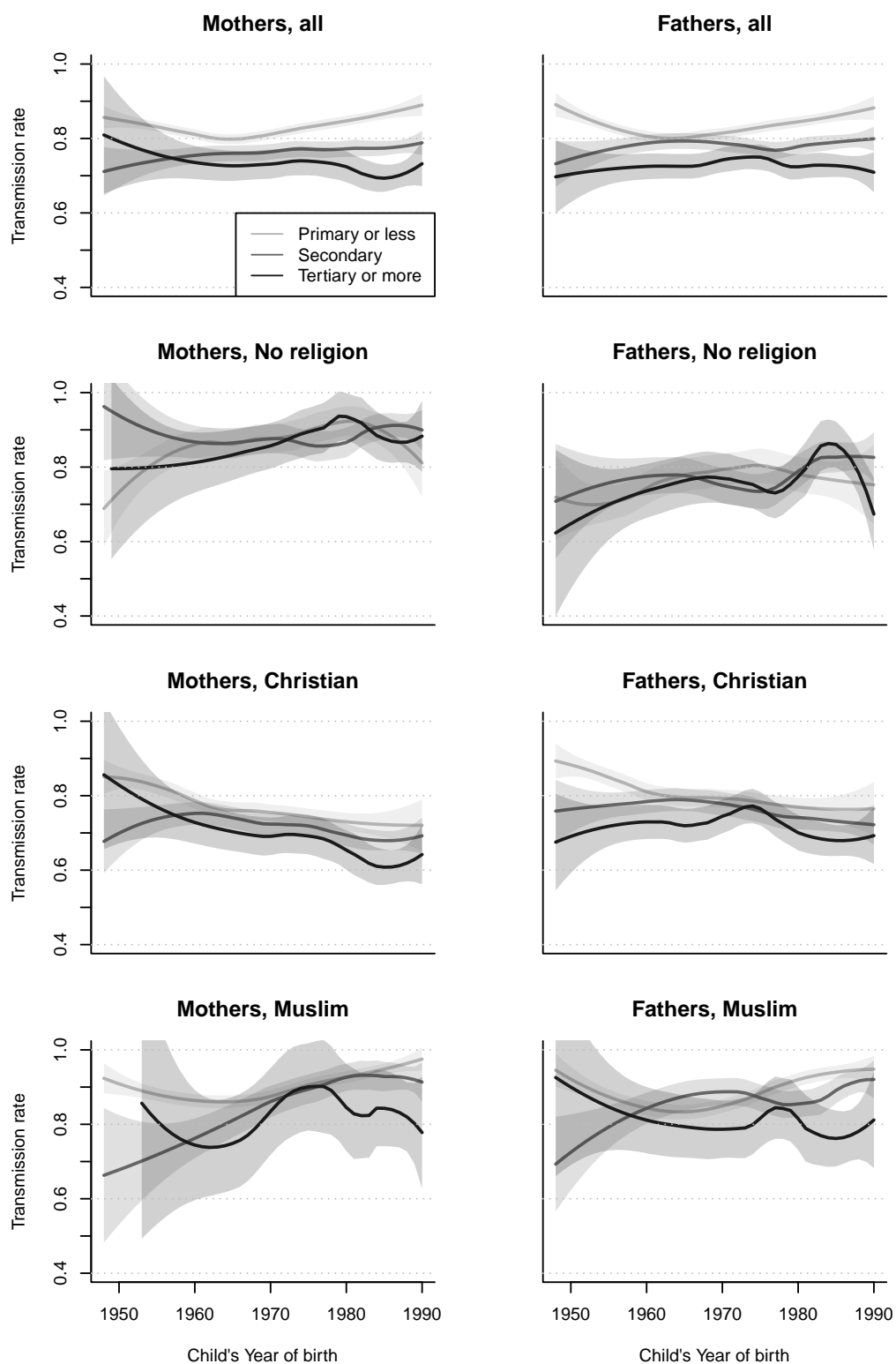


Figure 13: Religious transmission by Mothers and Fathers, by Education.

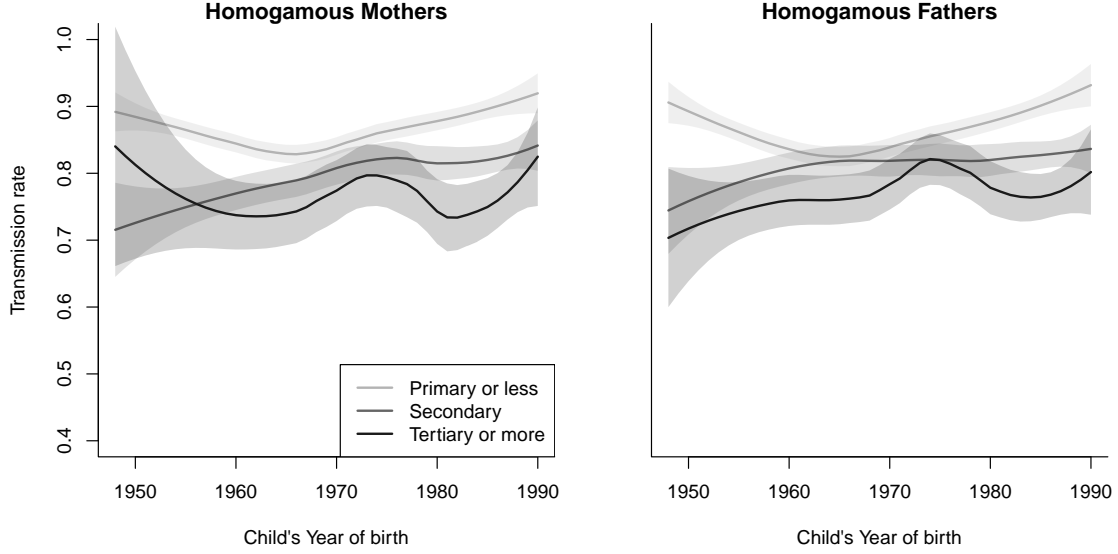


Figure 14: Religious transmission by homogamous Mothers and Fathers, by Education and excluding Nones.

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 11). Second, there is a strong heterogeneity in transmission patterns across parental religious affiliations and genders (Figure 12). Third, parental education seems to have an overall detrimental effect on religious transmission (Figure 13). 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 12), 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,¹⁰ 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'

¹⁰See for instance Bisin and Topa (2003), Bisin, Topa and Verdier (2004), Patacchini and Zenou (2016), Bisin and Tura (2020).

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 ξ_{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 ξ_{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 B.1](#) I explain how I reconstruct such a time series of religions' population shares in France: the idea is to consider the religious shares in the subsample of individuals (respondents and their parents) who were alive in a given year. These reconstructed population shares, from 1948 to 1990, are presented in [Figure 15](#). 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 α . 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, α 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

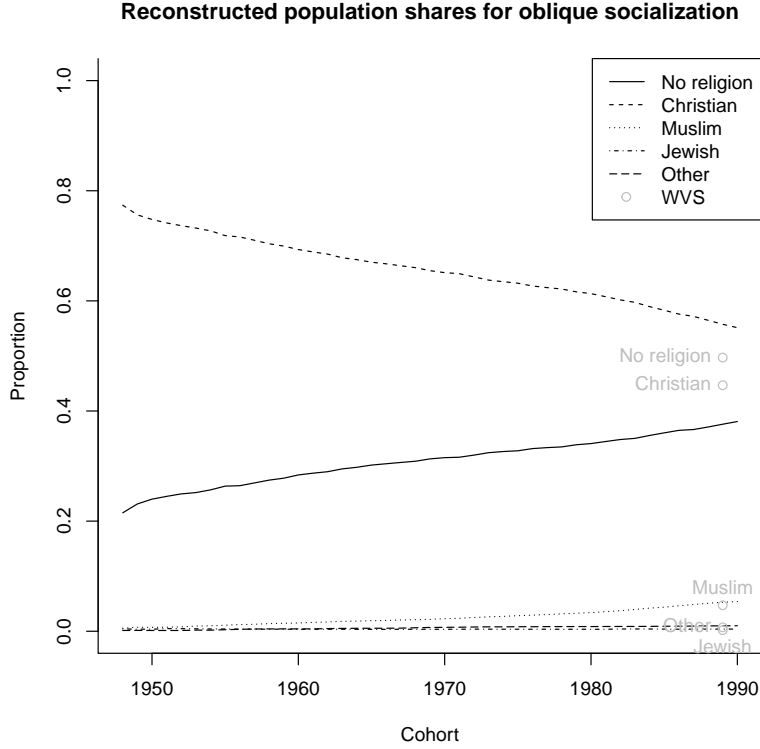


Figure 15: Religions' population shares, reconstructed from the TeO survey. Comparison points are taken from the World Values Survey (5th wave, 2005–2009).

hand, we can expect the Jewish affiliation to have a low k_n , because it is mostly passed on vertically from the mother.

If we gather all these parameters in a vector β 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 B) 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 15). 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 B 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 B).

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 tackle this issue below by adding an interaction term to the model (2), and by considering the effect of parental education on socialization contributions.

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 α 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 β 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, Hall, Hall and Hausman 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 α 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 16 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 $\simeq 10^{-6}$), 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

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 contribu-

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 α	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. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

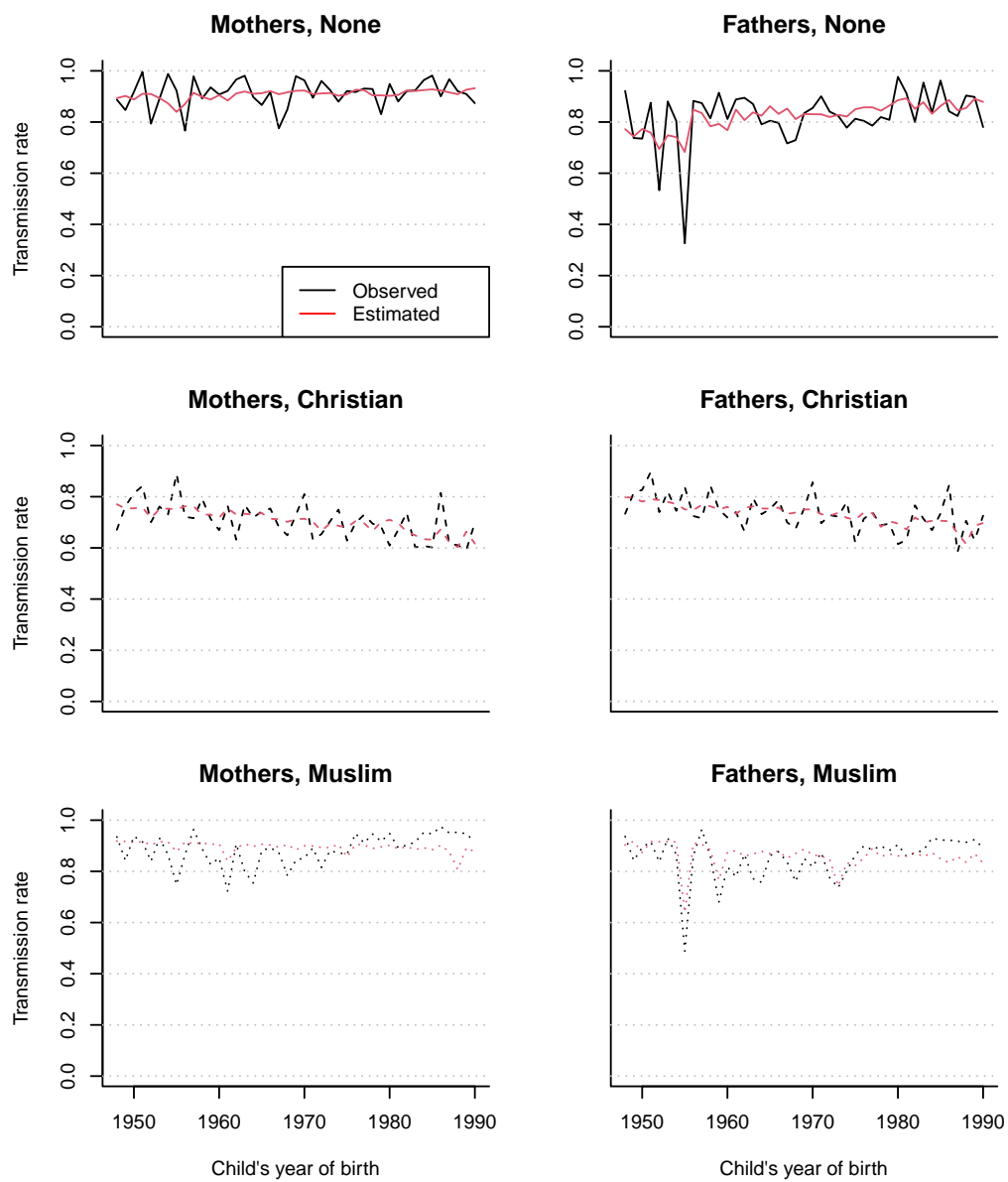


Figure 16: Conditional logit transmission, Observed vs. estimated transmission rates (by Religion).

tions 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 $N + 2NE = 35$ free 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 $19\,198 - 19\,139 = 59$ on 20 degrees of freedom, for a p -value smaller than 10^{-5} , 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 $19\,198 - 19\,174 = 24$ on 10 degrees of freedom, for a p -value of 0.007. 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 recover the distributions of $\hat{m}_{n1} - \hat{m}_{n2}$ and $\hat{f}_{n1} - \hat{f}_{n2}$ by the delta method, which I use to construct 95% confidence intervals for $m_{n1} - m_{n2}$ and $f_{n1} - f_{n2}$ (Figure 17, left panel). Differences between the socialization contributions of Primary or less parents and Secondary or more parents are not statistically significant at the 5% level, except for Other parents. This is consistent with the estimates from the linear model of Table 3 in the descriptives, which showed that a Secondary education had little to no significant effect on transmission rates, both

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

		model (2)	model (8) $E = \{1, 2, 3\}$	model (8) $E = \{1, 2 \text{ or } 3\}$	model (8) $E = \{1 \text{ or } 2, 3\}$
Constant k_n					
	None	2.82 (0.09)	2.80 (0.14)	2.76 (0.14)	2.83 (0.13)
	Christian	0.00 (base)	0.00 (base)	0.00 (base)	0.00 (base)
	Muslim	-1.37 (0.09)	-1.42 (0.21)	-1.48 (0.21)	-1.35 (0.20)
	Jewish	-2.72 (0.12)	-2.83 (0.47)	-2.85 (0.44)	-2.76 (0.46)
	Other	-0.72 (0.09)	-0.76 (0.22)	-0.83 (0.22)	-0.70 (0.21)
Mother's contributions m_{ne}					
	None	0.07 (0.09)			
	Primary or less		-0.09 (0.13)	-0.11 (0.13)	
	Secondary (or more / or less)		0.16 (0.14)	0.22 (0.12)	0.03 (0.11)
	Tertiary or more		0.36 (0.19)		0.35 (0.19)
	Christian	2.26 (0.09)			
	Primary or less		2.21 (0.11)	2.23 (0.11)	
	Secondary (or more / or less)		2.23 (0.11)	2.27 (0.11)	2.22 (0.10)
	Tertiary or more		2.52 (0.12)		2.52 (0.12)
	Muslim	3.82 (0.23)			
	Primary or less		3.80 (0.13)	3.79 (0.13)	
	Secondary (or more / or less)		4.26 (0.16)	3.98 (0.15)	3.90 (0.12)
	Tertiary or more		2.74 (0.28)		2.83 (0.28)
	Jewish	5.79 (0.32)			
	Primary or less		4.71 (0.78)	4.66 (0.79)	
	Secondary (or more / or less)		5.58 (0.64)	6.06 (0.49)	5.26 (0.55)
	Tertiary or more		6.53 (0.80)		6.52 (0.79)
	Other	3.76 (0.16)			
	Primary or less		3.97 (0.18)	3.97 (0.18)	
	Secondary (or more / or less)		3.21 (0.20)	3.23 (0.19)	3.78 (0.17)
	Tertiary or more		3.27 (0.28)		3.45 (0.28)
Father's contributions f_{ne}					
	None	0.39 (0.07)			
	Primary or less		0.41 (0.11)	0.41 (0.11)	
	Secondary (or more / or less)		0.34 (0.11)	0.38 (0.10)	0.37 (0.10)
	Tertiary or more		0.59 (0.14)		0.60 (0.14)
	Christian	1.24 (0.07)			
	Primary or less		1.32 (0.10)	1.31 (0.10)	
	Secondary (or more / or less)		1.23 (0.10)	1.18 (0.09)	1.28 (0.09)
	Tertiary or more		1.00 (0.11)		1.01 (0.11)
	Muslim	3.28 (0.23)			
	Primary or less		3.19 (0.14)	3.20 (0.14)	
	Secondary (or more / or less)		3.54 (0.16)	3.48 (0.15)	3.22 (0.14)
	Tertiary or more		3.70 (0.21)		3.69 (0.21)
	Jewish	3.04 (0.48)			
	Primary or less		3.34 (0.78)	3.24 (0.80)	
	Secondary (or more / or less)		2.86 (0.72)	3.39 (0.51)	3.06 (0.52)
	Tertiary or more		5.65 (0.79)		5.65 (0.79)
	Other	1.13 (0.23)			
	Primary or less		0.86 (0.19)	0.86 (0.19)	
	Secondary (or more / or less)		1.20 (0.19)	1.53 (0.17)	1.09 (0.17)
	Tertiary or more		1.60 (0.21)		1.34 (0.21)
Oblique socialization coefficient α		1.41 (0.08)	1.37 (0.28)	1.25 (0.28)	1.46 (0.27)
Observations		18 155	18 155	18 155	18 155
Sampling weights		Yes	Yes	Yes	Yes
Deviance ($-2 \ln L$)		19 198	19 139	19 174	19 158
Pseudo- R^2		0.47	0.47	0.47	0.47
LR test p -value		baseline	0.000	0.007	0.000

Note: Standard errors in parentheses.

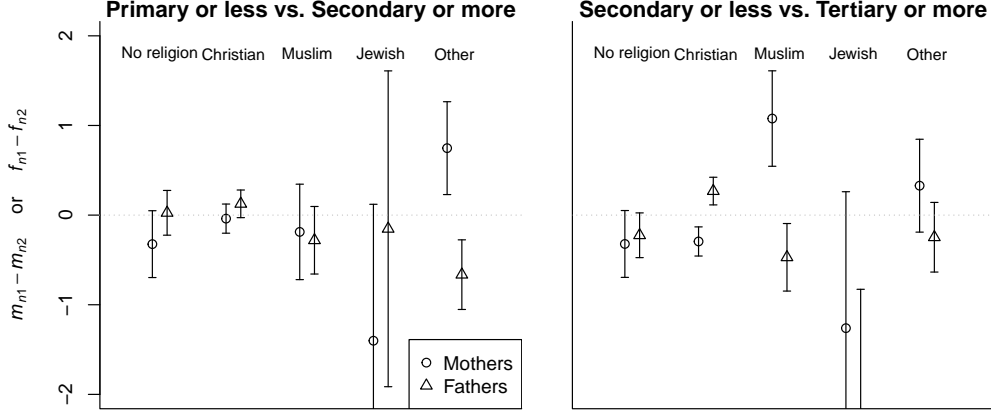


Figure 17: Differences in socialization contributions across education levels. 95% confidence intervals for $m_{n1} - m_{n2}$ and $f_{n1} - f_{n2}$ are reported for each religion n . Left panel: Primary or less ($e = 1$) vs. Secondary or more ($e = 2$). Right panel: Secondary or less ($e = 1$) vs. Tertiary or more ($e = 2$).

for mothers and fathers. Furthermore, note that among Others the effect of education on socialization contributions goes in opposite directions for mothers and fathers.

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 $19\,198 - 19\,158 = 40$ on 10 degrees of freedom, for a p -value around 10^{-5} . Again, I test whether education has a significant effect on socialization contributions for mothers and fathers of all religions (Figure 17, right panel). However, the effect of education remains heterogeneous across mothers and fathers, and across religions.

It is difficult to say whether these differences across religions are structural, or if they are the result of a model misspecification. The education of the parents could impact their opportunity cost of socializing their child. It could also shift the power balance in the couple, or be associated with different preferences for religious socialization. The estimation of the structural model in section 5 will allow me to shed some light on the possible mechanisms at play.

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 κ_1 and κ_2 do not depend on n (and similarly for the f_{ne} with ρ_1 and ρ_2). The goal is to see the effects of education by measuring κ_1 , κ_2 , ρ_1 , and ρ_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 the first column 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. In the second column, I estimate the new model with multiplicative education effects. The estimates for κ_1 , κ_2 , ρ_1 , and ρ_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 κ_1		0.01 (0.01)
Tertiary or more mother κ_2		0.09*** (0.02)
Secondary or more father ρ_1		-0.02 (0.02)
Tertiary or more father ρ_2		-0.11*** (0.02)
Oblique socialization coefficient α	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 Structural 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.¹¹ 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 one of the main ideas 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,

¹¹This 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. But my approach also builds upon this work, most notably by considering a continuous, multi-dimensional *cultural capital* for the child, and by incorporating insights from the literature on human capital formation.

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.¹² 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

¹²This 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.

in section 4.2, while maintaining the intuitive results which would derive from a more 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 rely on existing results from the literature on human capital formation. Specifically, Cunha and Heckman (2007) and Aizer and Cunha (2012) provide evidence that investments in the human capital of children are dynamic complements, in the sense that existing human capital increases the returns of current investments. (Thus, past investments indirectly increase the returns of current investments, hence the “dynamic” complementarity.) This model feature was for instance adopted in an empirical structural framework by Del Boca et al. (2014, 2016). 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, the dynamic complementarity 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

$$dK = K \times a \, ds \tag{10}$$

where a is a positive parameter denoting the time productivity of the individual.¹³ Integrating equation (10), we find that the log-cultural capital is produced from the time investment s by a linear technology:

$$\ln K = k + a \, s. \tag{11}$$

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,

¹³This is equivalent to the way that an investment I grows with time under an interest rate r ,

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

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 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.

Link 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 $\mathbf{1}_{\{i\text{'s mother is } n\}}$, $\mathbf{1}_{\{i\text{'s father is } n\}}$, 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 ($s_1 > s_2$).¹⁴ 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 γ 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

¹⁴If 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

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

socialization time investment s ,

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

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 the following production function for 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), here 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.¹⁵ 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

¹⁵Results would still hold if, instead of parental human capital having no effect of the production of cultural capital, it simply had a lesser effect.

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 . 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 ν_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 μ 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 γ 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 \(2018\)](#), who shows how differential taxation in medieval Egypt incentivized Coptic Christians (who faced higher taxes) to adopt the Muslim affiliation. [Botticini and Eckstein \(2007, 2012\)](#) also show how economic incentives had an impact on conversions from Judaism to Christianity across history. 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](#)), but not in the case with three traits or more.¹⁶ But then, fewer theoretical results exist beyond the two-traits case (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

¹⁶This 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. When there are more than two traits, this is not true anymore. For instance, in the [Bisin and Verdier](#) framework Catholics could reduce their socialization effort if the population share of Protestants increases at the expense of Muslims'. This is not the case in my model.

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 ν_1 and ν_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, ν_1 and ν_2 . Furthermore, it is increasing in parent's 1 relative power μ 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, ν_{-i} ; and it is increasing in his or her relative power, and in his or her relative preference for cultural capital ν_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).

This concludes the short analysis of the model. In Appendix C 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

$$\arg \max_n \ln(K_{in}) + \varepsilon_{in}, \quad (22)$$

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

$$\pi_{in} = \frac{\exp(\ln K_{in})}{\sum_{\ell=1}^N \exp(\ln K_{i\ell})}. \quad (23)$$

This is a nonlinear multinomial logit model, in the sense that the probability π_{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 . Compared to the model of section 4, I add a few parameters to describe this predicted level of human capital. These parameters intervene as additive constants in the log-human capital of children, and therefore they do not modify the optimal allocation of time in the structural model: the solutions (19)–(20)–(21) remain unchanged. The first addition is simply a time trend parameter λ , which accounts for the fact that educational attainment has been rising over the period considered (c.f. Figure 1).

Second, I introduce parameters which reflect the baseline contributions of parents from different religious affiliations to the human capital formation of their children. These parameters are meant to capture religion-specific heterogeneity in the way parents transmit human capital, which is unrelated to the specific trade-off between investments in human capital and cultural capital. The idea that religious ideology might influence human capital outcomes goes back at least to Weber's *The Protestant Ethic and the Spirit of Capitalism* (2013) [1905]. More recently, Botticini and Eckstein (2007) and Becker and Woessmann (2009) provided evidence that the comparatively higher educational outcomes of, respectively, Jews during the Middle-Ages, and Protestants during the late-19th century, could be attributed to a religious incentive to educate children. Becker et al. (2020) also provided evidence that parents with a history of forced migration have more-educated children, which they explain by a stronger preference of such parents for mobile assets. In a historically Christian-majority country like France, religious affiliation is of course correlated with migration ascendancy, thus suggesting that patterns of investments in human capital could be dependent upon the religion of the parents. In practice, I account for this heterogeneity by adding parental religion fixed-effects, h_{1n} for mothers n and h_{2n} for fathers n , in the (log-)human capital of children. These fixed-effects capture systematic differences in educational outcomes of children across parental religious affiliations, while leaving space to identify trade-offs at the margin between investments in human versus religious capital as described in the model.

To map the predicted level of human capital 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 η_i is a random shock. Suppose further that i attains the educational

level e_i according to the rule

$$e_i = \begin{cases} 1 & \text{if } \ln(H_i) + \eta_i \leq \bar{h}_1, \\ 2 & \text{if } \bar{h}_1 < \ln(H_i) + \eta_i \leq \bar{h}_2, \\ \vdots & \\ E & \text{if } \ln(H_i) + \eta_i > \bar{h}_{E-1}, \end{cases} \quad (24)$$

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 η_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

$$\phi_{ie} = \begin{cases} \frac{1}{1 + \exp(\ln(H_i) - \bar{h}_1)} & \text{if } e = 1, \\ \frac{1}{1 + \exp(\ln(H_i) - \bar{h}_2)} - \frac{1}{1 + \exp(\ln(H_i) - \bar{h}_1)} & \text{if } e = 2, \\ \vdots & \\ 1 - \frac{1}{1 + \exp(\ln(H_i) - \bar{h}_{E-1})} & \text{if } e = E. \end{cases} \quad (25)$$

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 ε_{in} and η_i are independent as well.¹⁷ 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

$$\ln L = \sum_i w_i \sum_{n=1}^N \sum_{e=1}^E \mathbf{1}_{\{i \text{ is } ne\}} \ln(\pi_{in} \times \phi_{ie}), \quad (26)$$

where the probabilities π_{in} and ϕ_{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 ν_{1n} . Similarly, all fathers of religion n have the same preference ν_{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

¹⁷In Appendix D I examine this hypothesis by analyzing the deviance residuals of the estimated model. I find that residuals on the religion and education dimensions are not strongly correlated, providing suggesting evidence that error terms are indeed independent.

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:

$$\begin{aligned}\ln K_n &= k_n + a \left(s_1 - \frac{s_1^2}{2T_1} \right) \mathbf{1}_{\{n_1=n\}} + a \left(s_2 - \frac{s_2^2}{2T_2} \right) \mathbf{1}_{\{n_2=n\}} + a_0 (1 - s_1 - s_2) q_n \\ \ln H &= \lambda(y - 1948) + h_{1n_1} + h_{2n_2} + (b + h_1) \left(t_1 - \frac{t_1^2}{2T_1} \right) + (b + h_2) \left(t_2 - \frac{t_2^2}{2T_2} \right) \\ u_i &= \nu_{in_i} \ln(K_{n_i}) + \ln H.\end{aligned}$$

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, ν_{1n} for mothers of religion n and ν_{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 ,
- the religion-specific contributions to human capital, h_{1n} for mothers n and h_{2n} for fathers n ,
- the time trend parameter in human capital formation, λ .

With $N = 5$ religions and $E = 3$ education levels, this makes a total of $5N + 2E + 5 = 36$ parameters. Out of those, four 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 to normalize this constant to 0 for the most common denomination, Christians: $k_2 = 0$. Second, the time productivity in human capital formation of the lowest human capital level cannot be distinguished from the baseline time productivity of human capital formation.¹⁸

¹⁸The 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.

As such, I normalize to 0 the added productivity of having a primary school diploma or less: $\tilde{h}_1 = 0$. Third, the religion-specific contributions to human capital are only identified up to a constant:¹⁹ I also normalize those for Christian mothers and fathers, $h_{12} = h_{22} = 0$. This leaves 32 free parameters to estimate. Again I compute the maximum likelihood estimator of these parameters, using the log-likelihood expression (26). 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 64 510. This yields a pseudo- R^2 of 0.30.

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, Other, Muslim, and finally Jewish. 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 ascendency is very rare.

Second, the relative values of religious capital for mothers and fathers, ν_{1n} and ν_{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. Note that the estimates for Jewish mothers and fathers are very large, but remain very imprecisely estimated. This is because data is scarce for Jewish parents, in particular in the context of heterogamous households which are used to identify the difference in preferences between mothers and fathers. Overall, 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 socialization operates on a larger order of magnitude than oblique socialization, confirming the important roles that parents play in the socialization process.

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 in fact approximately the same as that from having a Tertiary diploma. This

¹⁹The parameters (h_{1n}, h_{2n}) and $(h_{1n} + \kappa, h_{2n} - \kappa)$ lead to the same human capital outcomes for any constant κ , so we need to anchor one of these parameters. Furthermore, the parameters (h_{2n}, \tilde{h}_e) and $(h_{2n} - \kappa, \tilde{h}_e + \kappa)$ also lead to the same human capital outcomes, so one of them also needs to be fixed constant.

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

<i>Human capital formation</i>	
Contributions to human capital from mothers h_{1n} , by religion n	
None	-0.45 (0.08)
Christian	0 (baseline)
Muslim	1.85 (0.28)
Jewish	4.82 (1.19)
Other	1.16 (0.19)
Contributions to human capital from fathers h_{2n} , by religion n	
None	-0.48 (0.07)
Christian	0 (baseline)
Muslim	0.88 (0.22)
Jewish	5.01 (0.74)
Other	-0.81 (0.16)
Human capital formation time productivity, b	
Added productivity \tilde{h}_e , by education level e	14.68 (3.99)
Primary	0 (baseline)
Secondary	1.85 (0.44)
Tertiary	3.75 (0.88)
Human capital threshold \bar{h}_1 : Primary \rightarrow Secondary	
Human capital threshold \bar{h}_2 : Secondary \rightarrow Tertiary	6.90 (0.95)
<i>Other</i>	
Total time budget of mothers, T_1	11.07 (0.95)
Total time budget of fathers, T_2	0.66 (0.15)
Total time budget of fathers, T_2	0.68 (0.16)
Time trend, λ	0.01 (0.00)
Observations	18 155
Sampling weights	Yes
Deviance $(-2\ln L)$	45 247
Pseudo- R^2	0.30

<i>Religious socialization</i>	
Cultural adoption constants k_n , by religion n	
None	2.08 (0.13)
Christian	0 (baseline)
Muslim	-1.91 (0.22)
Jewish	-3.19 (0.32)
Other	-1.29 (0.21)
Value of religious capital for mothers ν_{1n} , by religion n	
None	0.08 (0.04)
Christian	0.68 (0.10)
Muslim	2.13 (0.46)
Jewish	36.22 (55.60)
Other	1.59 (0.33)
Value of religious capital for fathers ν_{2n} , by religion n	
None	0.14 (0.05)
Christian	0.09 (0.05)
Muslim	1.98 (0.35)
Jewish	17.07 (10.15)
Other	0.00 (0.24)
Vertical religious socialization time productivity, a	
Oblique religious socialization time productivity, a_0	11.74 (2.90)
	1.60 (0.33)

Note: Standard errors in parentheses.

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. The baseline time productivity in human capital formation, b , is similar in magnitude but greater than the time productivity of vertical socialization, a .

Regarding the religion-specific parental contributions of human capital, I find that relative to Christians, Jewish mothers and fathers contribute the most to the human capital formation of children, confirming the documented strong emphasis on human capital among Jews (Botticini and Eckstein 2007, 2012). Muslims also contribute more than Christians by default, and therefore their lower educational rates must be attributable to the trade-off between investments in religion versus education. Non-religious parents contribute less than Christians. Finally, among Other parents, mothers contribute more than Christian ones, while fathers contribute less.

5.3 Interpretation of the estimates

With Cobb–Douglas preferences, the parameter ν_i can be interpreted in this way: parent i is indifferent between the child’s religious capital K_{n_i} increasing by 1%, and the child’s human capital H increasing by $\nu_i\%$. However, since both H and K_{n_i} are latent variables with no obvious measure scale, this interpretation is not immediately helpful to understand the trade-offs that parents are making in terms of religious transmission and education. Instead, another way to understand this trade-off is to ask a question of the type: what loss in their children’s educational attainment are parents accepting in exchange of a 1% increase in the chance that they transmit their religious affiliation? With this question we finally tackle the motivating question of the paper, that is, the cost that parents pay to transmit their religion.

Note that a parent’s transmission probability (the probability that the child shares his or her religious affiliation) depends not only on that parent’s gender and religion, but also on their education level, on the spouse’s characteristics, and on the religions’ population shares which are relevant for the socialization of the child. All these factors will play in determining how costly religious transmission is for a given parent. In order to keep the illustration simple, I therefore focus on parents in homogamous households, and I take as baseline the religions’ population shares in the year 2008, corresponding to the year of the survey. Furthermore, I consider households in which the two parents share the same education level. Finally, since preference parameters for Jewish parents are very imprecisely estimated, I do not include them in this analysis.

Figure 18 shows, for homogamous households in which both parents have a Secondary education, what this trade-off looks like. The cost of religious transmission is measured in terms of foregone probability that the child obtains a Tertiary education, through a marginal rate of transformation. At their predicted transmission profile (the white dots on the graph), Christian parents for instance are renouncing a 0.41 percentage point (p.p.)

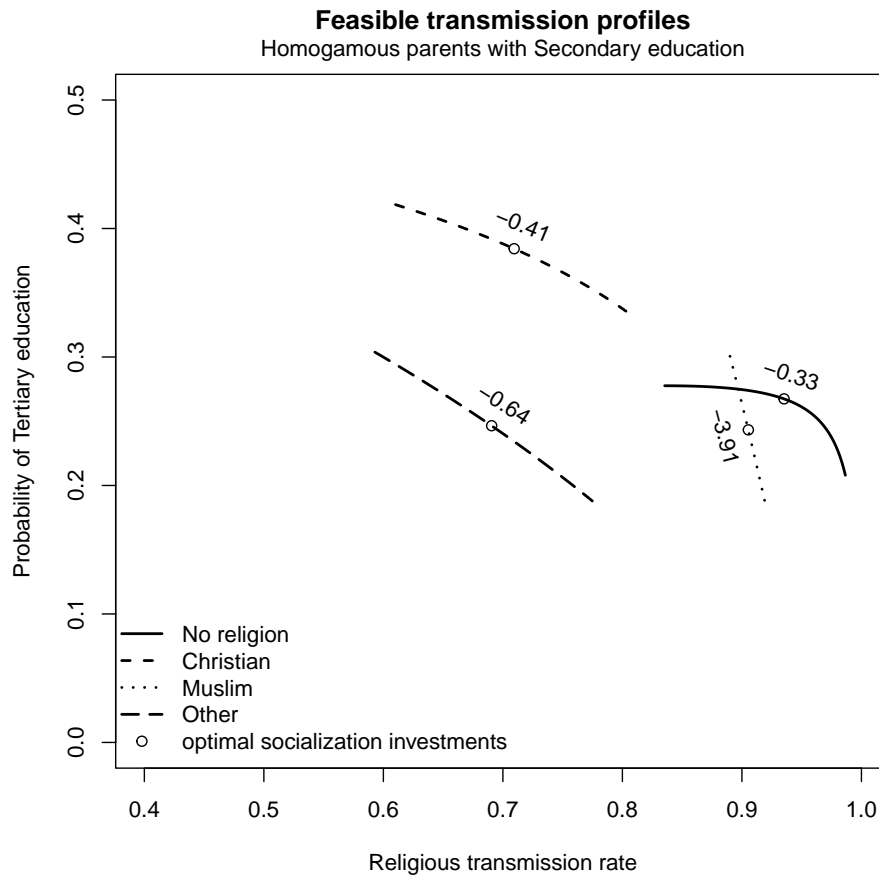


Figure 18: Trade-off between the religious transmission rate and the probability of the child having a Tertiary education. The lines depict the feasible transmission profiles (technology frontier) for households with Secondary-educated parents in religiously-homogamous households. The white dots correspond to the profile chosen by parents as predicted by the model. The marginal rate of transformation at this chosen profile is reported for each household type. (I do not report the corresponding results for Jews given the imprecision of the estimates.)

chance that their child gets a Tertiary education, in order to increase by 1 p.p. the chance that they transmit their religious affiliation. This number is to 0.33 for Nones, rising to 0.64 for Others – and 3.91 for Muslims. Thus, Muslims are paying a marginal price around 10 times greater than Christians in terms of their child’s educational attainment, in order to ensure the transmission of their religious affiliation.

In Table 8 I summarize this information on marginal rates of transformation for different levels of parental education. As suggested by the evidence on Secondary-educated parents, I find that Muslim parents of all educational levels face higher costs than other denominations overall. Keeping the example of Muslims and Christians for illustration, the ratio of their marginal rates of transformation varies between 8 and 13. This strongly suggests that Muslims do indeed pay a significantly larger price than other denominations to transmit their religious affiliation. The difference between other affiliations isn’t quite as striking, although I find that Others pay a steeper cost than Christians, who themselves

Parents' education	Parents' religion					Musl./Chri. ratio
	None	Christian	Muslim	Jewish	Other	
<i>Marginal rate of transformation</i>						
Primary or less	0.16	0.25	2.09	–	0.30	8.4
Secondary	0.33	0.41	3.91	–	0.64	9.5
Tertiary or more	0.38	0.35	4.59	–	0.78	13.1

Table 8: Cost of religious transmission, in terms of child's probability of Tertiary education.

have a cost comparable to Nones.

5.4 Log-likelihood decomposition

Even though the estimated parameters from Table 7 provide a rough idea of the magnitude of the different mechanisms at play in the model, a more detailed analysis is needed to understand their respective importance. Here I delve deeper into this issue with a log-likelihood decomposition, which allows me to rank the three mechanisms at play in the model by order of importance in terms of explanatory power. These three mechanisms are (1) heterogeneous parental preferences across gender and religious affiliations, (2) the role of parental human capital in the substitution effect, and (3) oblique socialization. In order to measure the respective explanatory power of these three mechanisms, I consider three corresponding restrictions on the model parameters. Such restrictions allow me to shut down the three mechanisms separately, and as a result to measure their respective ability to explain the variation in the data. The mechanisms and associated restrictions are the following.

Parental preferences. What if parents had homogeneous preferences? I restrict all preference parameters to take the same value, $\nu_{1n} = \nu_{2n} = \nu$ for all n and for some constant ν . For ν , I choose the value of which is associated with the maximum log-likelihood under this constraint and while keeping other parameter estimates constant.

Parental human capital. What if parental human capital did not affect time productivity in the child's human capital formation? In this case I set the added time productivity due to parental human capital, \tilde{h}_1 and \tilde{h}_2 , to 0.

Oblique socialization. What if oblique socialization played no role in the transmission process? In order to cancel this effect I set the oblique socialization parameter a_0 to 0.

I then use the log-likelihood to obtain a measure of explanatory power for each of these mechanisms. Specifically, I consider as a baseline the difference between the log-likelihood evaluated at the actual estimator $\hat{\beta}$ (the one reported in Table 7), and the log-likelihood of

the null model: $L(\hat{\beta}) - L_0$.²⁰ We saw that the structural model performs better than the null model at explaining the data (pseudo- R^2 equal to 0.30), and therefore this difference is positive. Then, for each mechanism I modify the vector of estimated parameters $\hat{\beta}$ by applying the associated parameter restriction, yielding a new vector of parameters $\hat{\beta}_{\text{restr}}$. I can then compute the difference $L(\hat{\beta}_{\text{restr}}) - L_0$ and compare it to the baseline difference $L(\hat{\beta}) - L_0$ (this baseline is necessarily larger by definition of the maximum likelihood estimator). If $L(\hat{\beta}_{\text{restr}}) - L_0$ is close to $L(\hat{\beta}) - L_0$ it means that the mechanism which was shut down has little explanatory power. Conversely, if the two are distant to each other, it means that the mechanism which was shut down actually matters a lot to explain variation in the data. Having noted this, a possible statistic to measure the explanatory power of the different mechanisms is therefore

$$1 - \frac{L(\hat{\beta}_{\text{restr}}) - L_0}{L(\hat{\beta}) - L_0}. \quad (27)$$

A higher value of this statistic means a larger explanatory power for the associated mechanism.

The values of this statistic for the three mechanisms considered are presented in Figure 19. I find that the dominant mechanism in terms of explanatory power is parental preferences, with a decrease of 42% in log-likelihood when shutting it down. Parental human capital comes second, with a decrease of 27% in log-likelihood when ignoring its effect. Finally, oblique socialization seems to play a minimal role, with a decrease of only 2% in log-likelihood when shutting it down. This may however be due in part to the rough measure of oblique socialization used in the model, namely population shares at the national level.

²⁰Recall that the null model is defined by an intercept only for each religion–education type of the child.

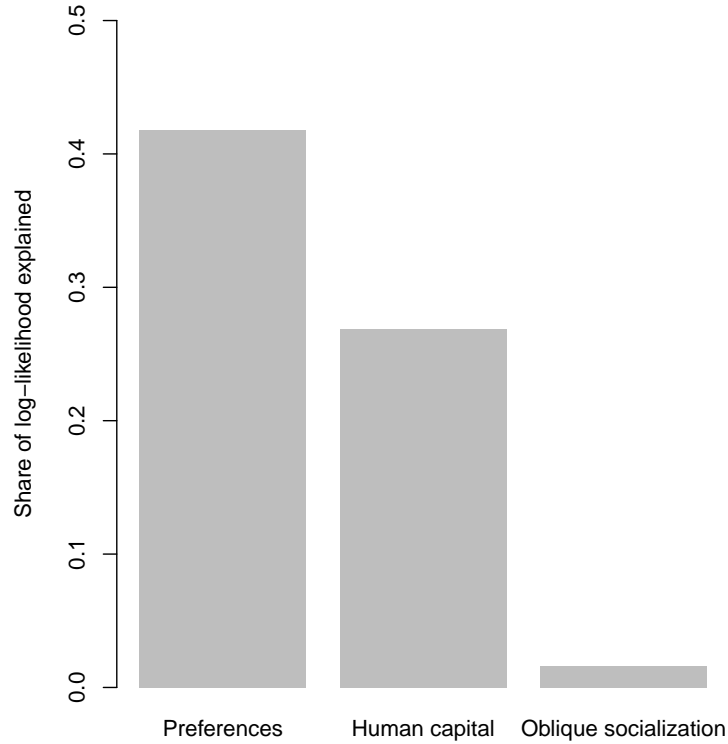


Figure 19: Three mechanisms ranked in terms of explanatory power.

6 Conclusion

While there is historical evidence of investments in religious transmission to children coming at the expense of their human capital outcomes, research has not really tackled this issue in a contemporary context. This is despite strong anecdotal evidence that such trade-offs take place, especially among religious minorities – in the US for instance, among the Amish, Jehovah’s Witnesses, or Hasidic Jews. In this paper, I have used data on religious affiliation in contemporary France to study this trade-off. I first documented how parents from different affiliations contribute to the religious transmission to their children, finding that mothers transmit more than fathers, religious minorities more than majorities, and higher-educated parents less than lower-educated ones. To explain these stylized facts, I built a structural model which illustrates the trade-offs between investments in religious versus human capital. The estimates of the structural model suggest, for instance, that Muslims pay a cost that can be more than 10 times greater than that paid by Christians in order to transmit their religion, in terms of the educational attainment of their children.

More work remains to understand how this trade-off occurs across different contexts, such as other countries, different religious affiliations not well represented in the French context, and even for other cultural traits such as language or ethnicity. Additional data on religion and how parents allocate their time could also help to refine the estimates obtained from the new methodology developed here. In particular, the

model would benefit a lot from local measures of religions' population shares, in order to understand better the religious environment in which individuals grow up; intensive measures of individuals' religion, such as the intensity of their religious practices, in order to better gauge their involvement with their declared religious affiliation; or measures of parental investments in the culture or formal education of their children, to better understand how parents substitute their investments in various dimensions. Overall, this lays out an interesting research program to better understand the costs that parents pay in order to transmit their culture.

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Appendix

A Descriptive statistics for the TeO survey

A.1 General descriptives

Table A1: 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 ¹ (%)	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: ¹ Information only available if the partner lives in the same house.

A.2 Education

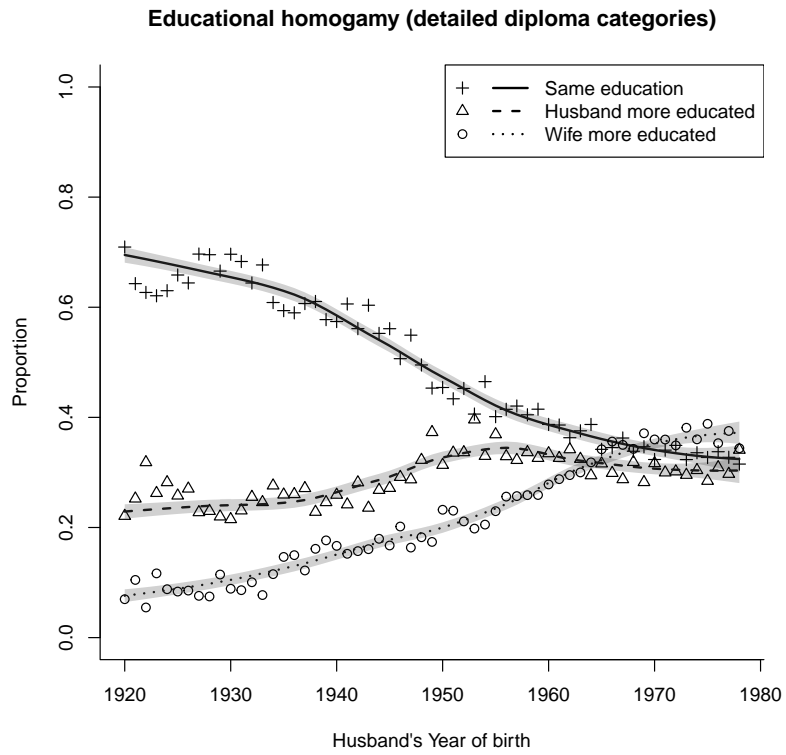


Figure A1: Educational homogamy with detailed diploma categories.



Figure A2: Educational homogamy with detailed diploma categories, same-religion couples.

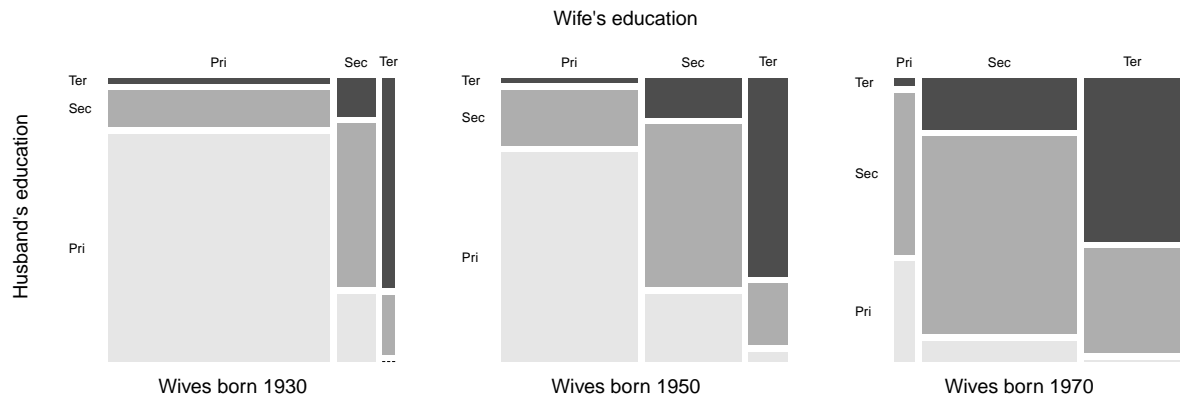


Figure A3: Educational assortment in couples with a wife born in 1930, 1950, and 1970.

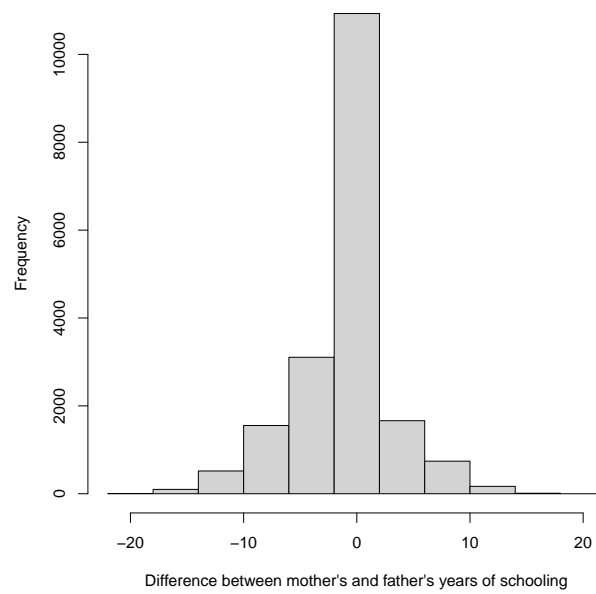


Figure A4: Distribution of the difference in years of schooling between mothers and fathers.

A.3 Religion

See Figures A5, A6, A7; and Table A2.

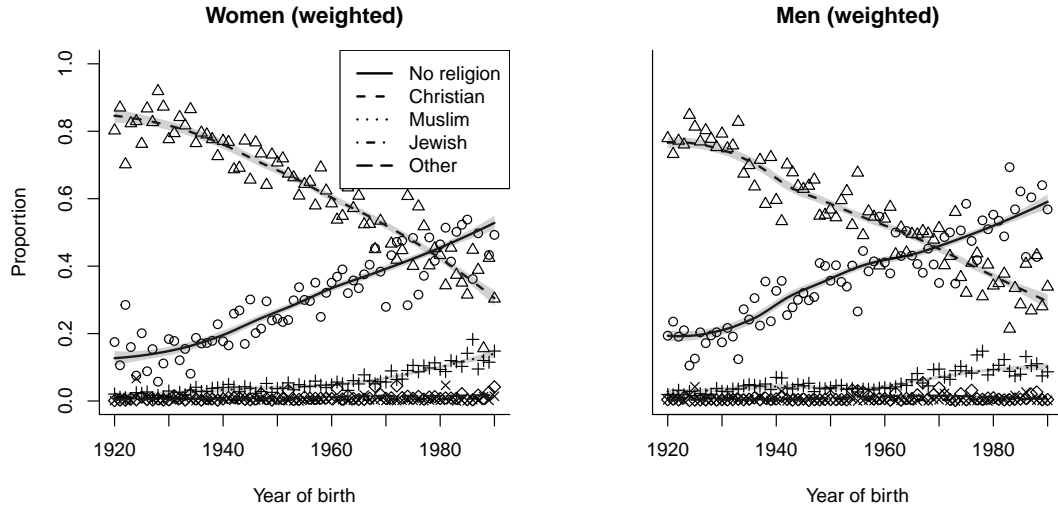


Figure A5: Religious affiliation, Women and Men (using sampling weights).

Table A2: 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.

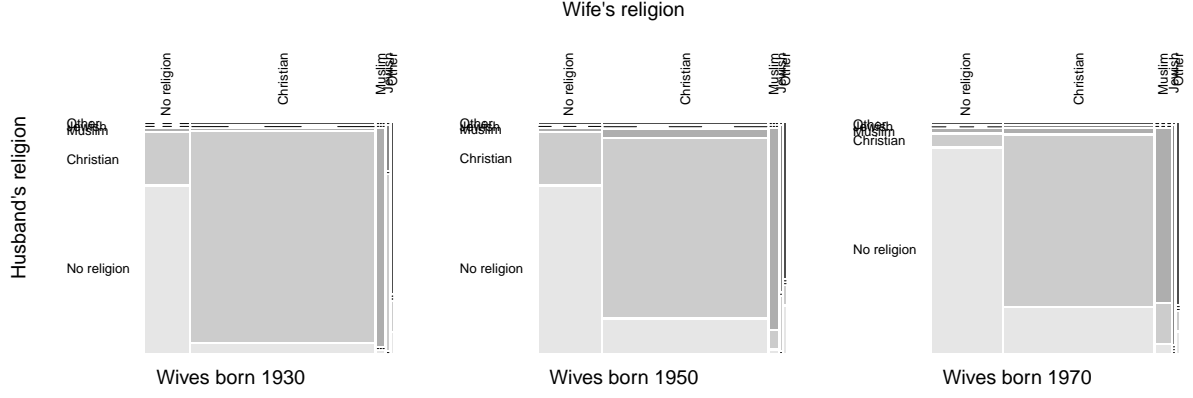


Figure A6: Religious assortment in couples with a wife born in 1930, 1950, and 1970 (using sampling weights).

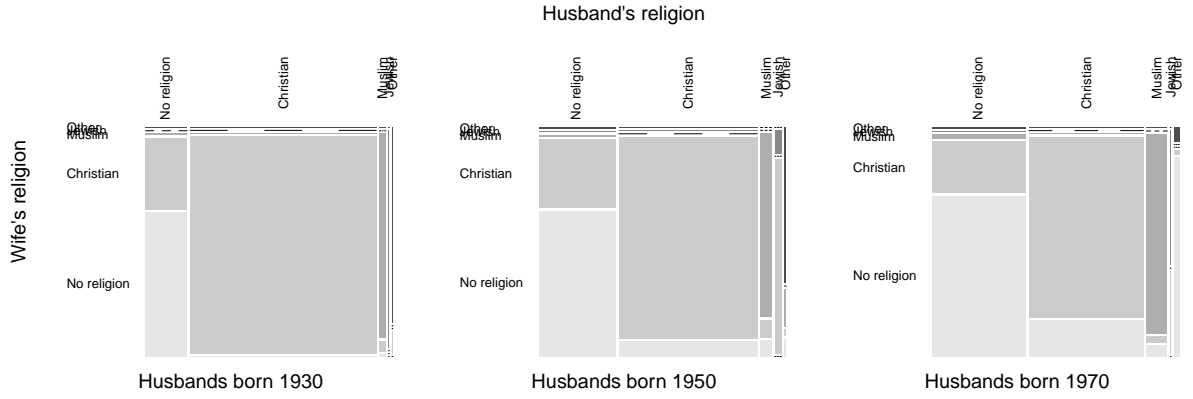


Figure A7: Religious assortment in couples with a husband born in 1930, 1950, and 1970 (using sampling weights).

A.4 Transmission of education

See Tables A3 and A4 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 A3: Transmission of education (Ordered Logit).

	Child's education			
	(Ord. logit)	(Ord. logit)	(Ord. logit)	(Ord. logit)
<i>Mother's education</i>				
Secondary	0.64 (0.02)	1.04 (0.03)	0.97 (0.03)	0.98 (0.03)
Tertiary	1.00 (0.03)	2.60 (0.10)	2.57 (0.10)	2.57 (0.10)
<i>Father's education</i>				
Secondary	0.63 (0.02)	0.99 (0.03)	0.96 (0.03)	0.96 (0.03)
Tertiary	1.56 (0.03)	1.74 (0.05)	1.72 (0.05)	1.72 (0.05)
<i>Mother's × Father's education</i>				
Secondary × Secondary		−0.76 (0.04)	−0.68 (0.04)	−0.67 (0.04)
Secondary × Tertiary		−0.40 (0.06)	−0.36 (0.07)	−0.36 (0.07)
Tertiary × Secondary		−2.03 (0.11)	−2.10 (0.11)	−2.10 (0.11)
Tertiary × Tertiary		−1.76 (0.12)	−1.75 (0.12)	−1.76 (0.12)
<i>Mother's religion</i>				
Christian			0.25 (0.02)	0.24 (0.03)
Muslim			0.03 (0.28)	0.02 (0.49)
Jewish			−0.02 (0.16)	1.47 (1.18)
Other			0.63 (0.16)	0.59 (0.43)
<i>Father's religion</i>				
Christian			0.28 (0.02)	0.28 (0.05)
Muslim			−0.11 (0.28)	0.03 (0.66)
Jewish			1.23 (0.16)	1.05 (0.31)
Other			−0.74 (0.21)	−1.03 (1.49)
<i>Mother's × Father's religion</i>				
Christian × Christian				0.00 (0.06)
Christian × Muslim				−0.19 (0.78)
Christian × Jewish				0.35 (0.43)
Christian × Other				1.98 (2.04)
Muslim × Christian				−0.13 (1.41)
Muslim × Muslim				−0.13 (0.82)
Muslim × Jewish				no data
Muslim × Other				1.52 (15.83)
Jewish × Christian				−1.76 (1.21)
Jewish × Muslim				−1.36 (5.92)
Jewish × Jewish				−1.35 (1.23)
Jewish × Other				no data
Other × Christian				0.55 (0.48)
Other × Muslim				−1.15 (2.00)
Other × Jewish				no data
Other × Other				0.21 (1.55)
Child's year of birth /100	0.30 (0.06)	0.40 (0.06)	1.07 (0.07)	1.08 (0.07)
Cut-off: Primary → Secondary	3.56 (1.24)	5.58 (1.25)	19.03 (1.28)	19.10 (1.28)
Cut-off: Secondary → Tertiary	7.70 (1.24)	9.76 (1.25)	23.25 (1.28)	23.33 (1.28)
Observations	18 793	18 793	18 222	18 222
Sampling weights	Yes	Yes	Yes	Yes
Residual Deviance	27098	26947	25901	25888

Note: Standard errors in parentheses.

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

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

Table A4: 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."

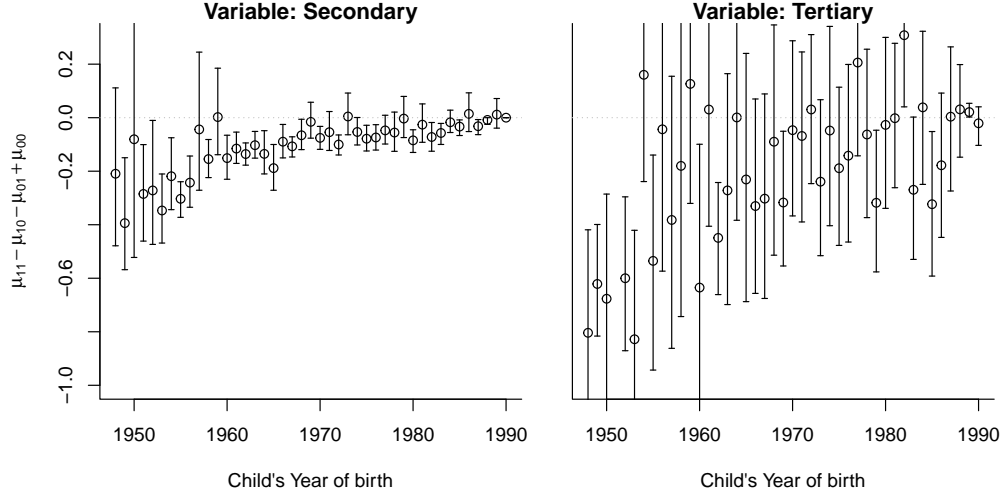


Figure A8: Interaction effects of parents' education levels for the child's education. 95% confidence intervals for $\mu_{11} - \mu_{10} - \mu_{01} + \mu_{00}$ are reported for each cohort. Left panel uses Secondary diplomas to define the binary education variable e_i , right panel uses Tertiary diplomas.

$\hat{\mu}_{e_me_f}$ 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 A8. 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 A8. Most point estimates remain negative, although many cannot be statistically distinguished from 0.

A.5 Migration

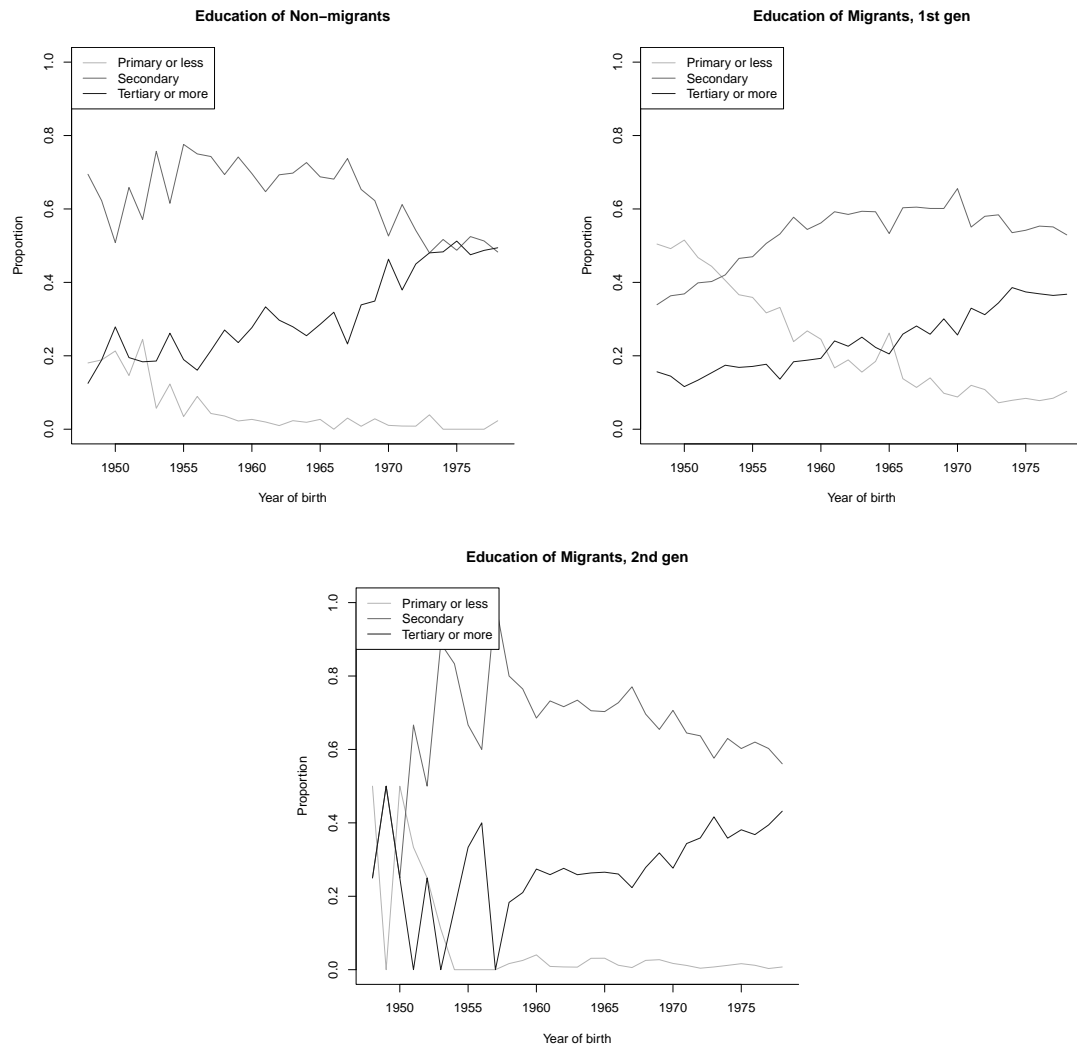


Figure A9: Education by Migration status.

A.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 A10).

This is also confirmed when looking at transmission rates for any combination of parental religious affiliations (Figure A11).

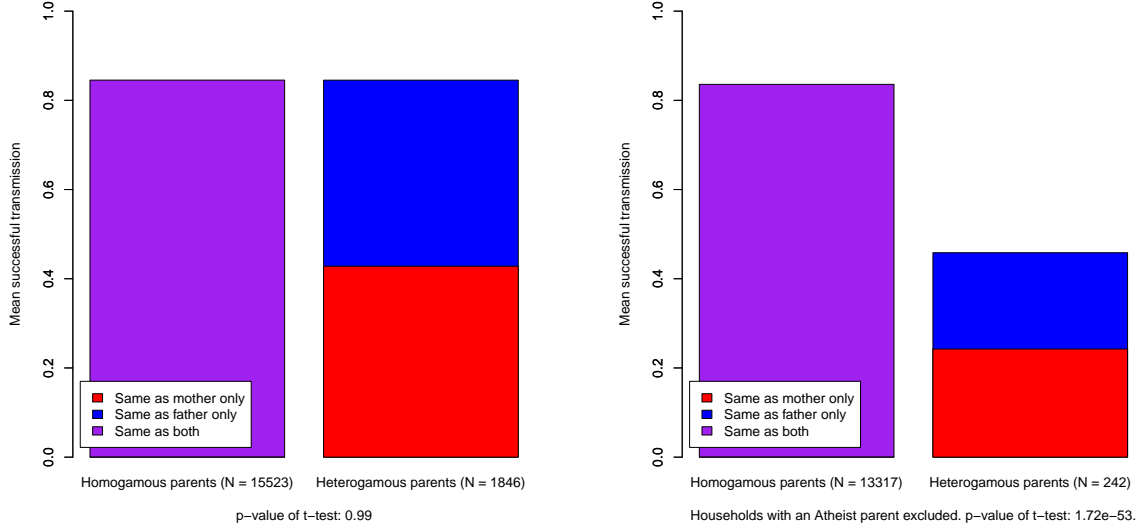


Figure A10: Transmission rates for homogamous and heterogamous households. The right-hand graph omits the respondents who declared having a ‘No religion’ parent.

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 A11, 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 A12, 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

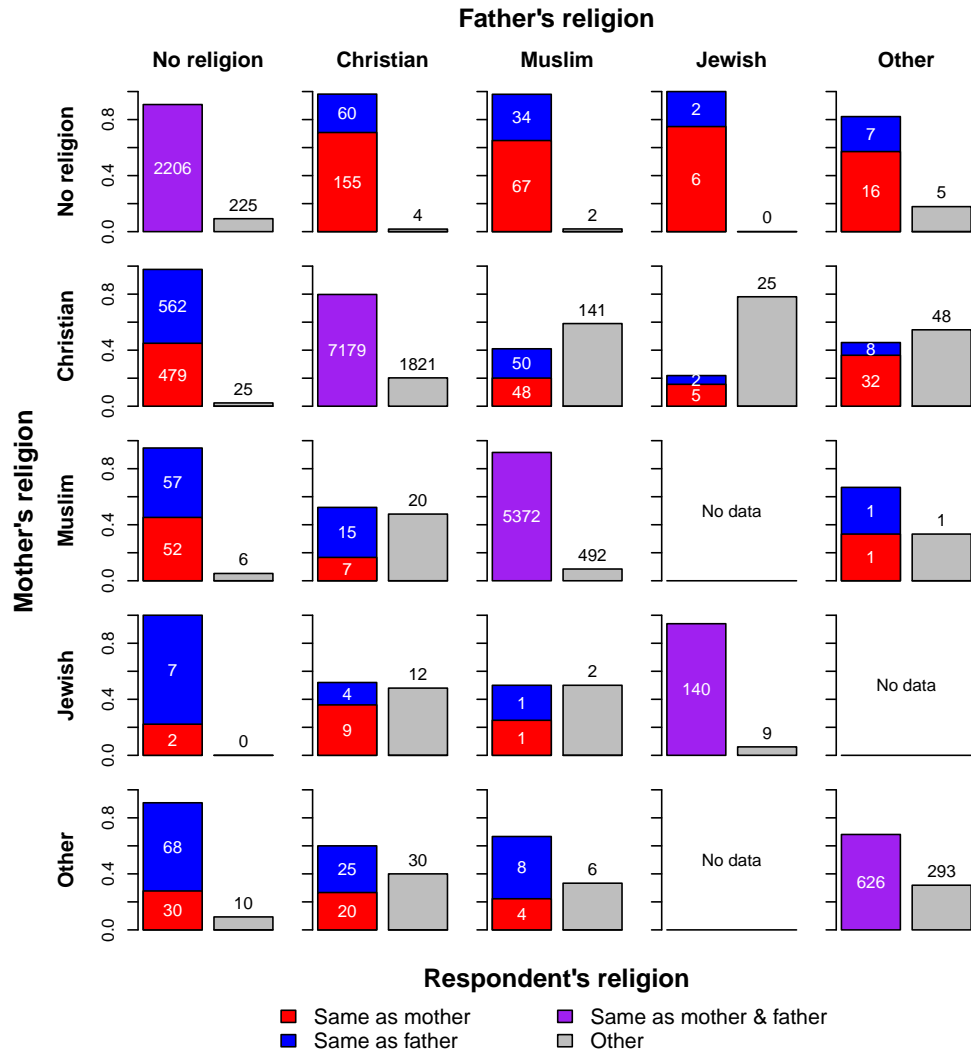


Figure A11: Transmission rates for all combinations of the parents' religions (number of observations reported for each bar).

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).

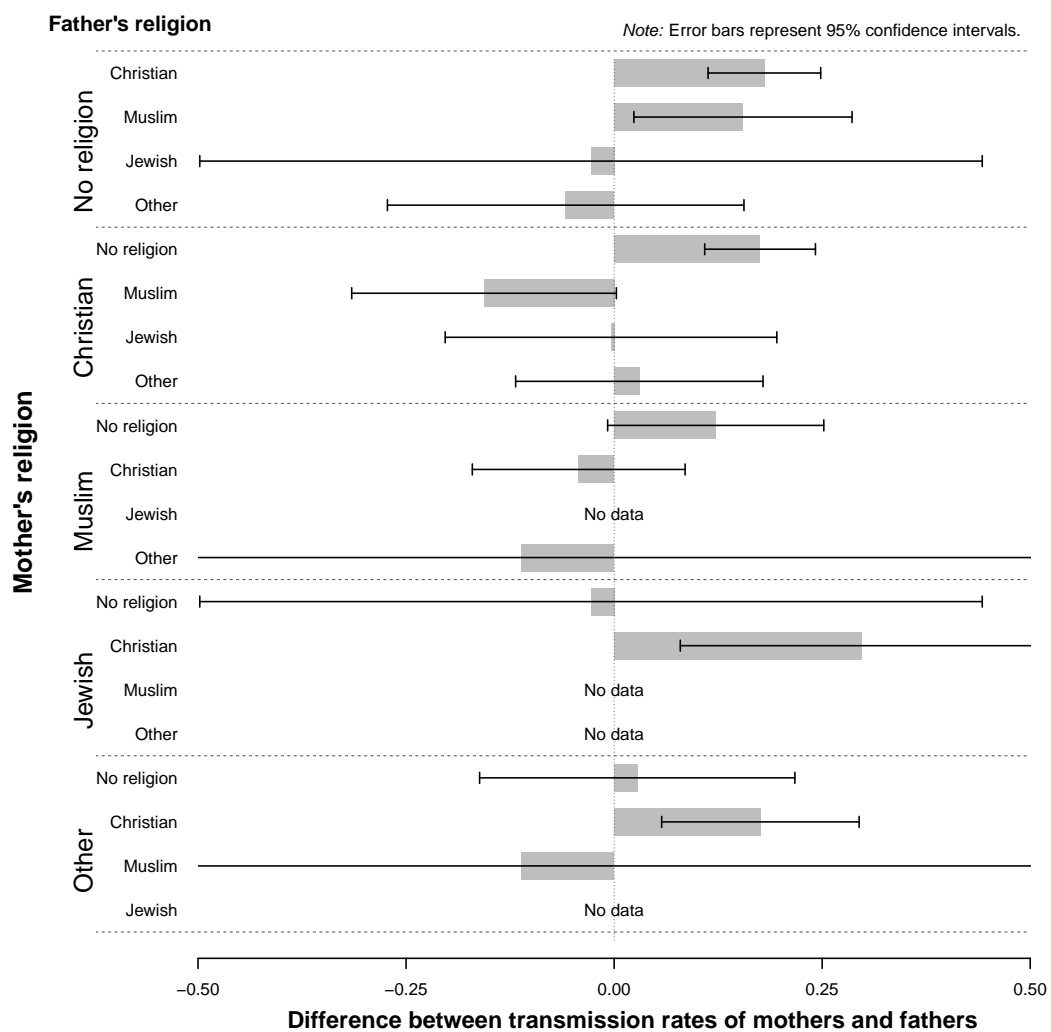


Figure A12: Mothers' advantage in religious transmission. Plotted are the differences between the transmission rate of mothers in households ab and the transmission rate of fathers in households ba for any religions $a \neq b$.

B Reduced-form models of transmission

B.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 15. 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.

B.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 B1, 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

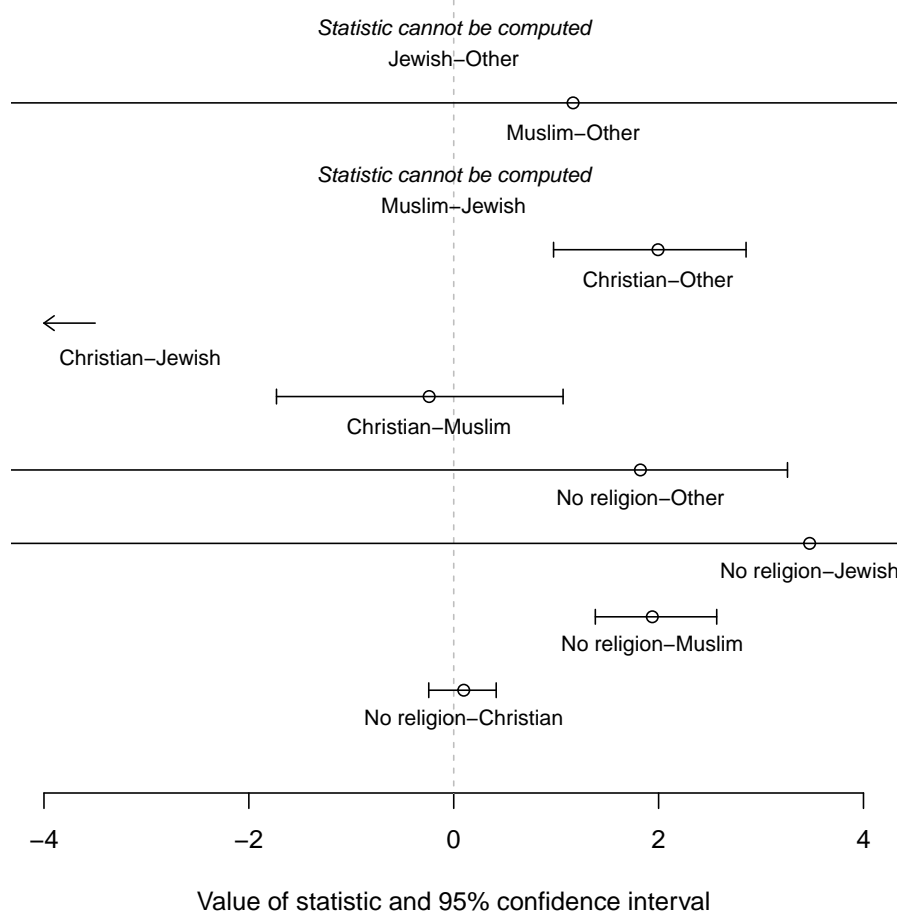


Figure B1: Statistical tests of equation (34) for all trait combinations ab .

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 B2 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.

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

See Figure B3.

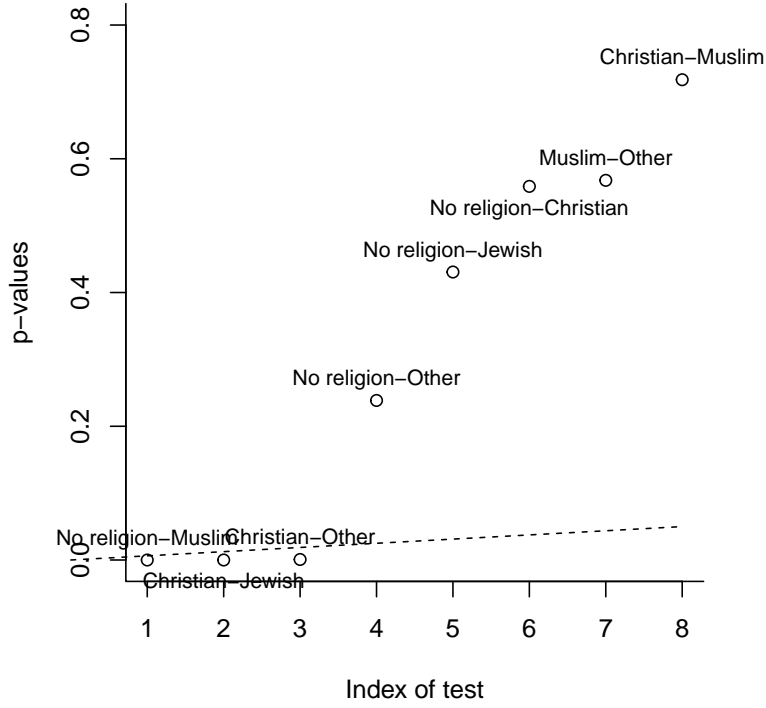


Figure B2: Benjamini–Hochberg procedure for multiple testing. p -values under the dashed line imply rejection of the corresponding test.

B.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 η_{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

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

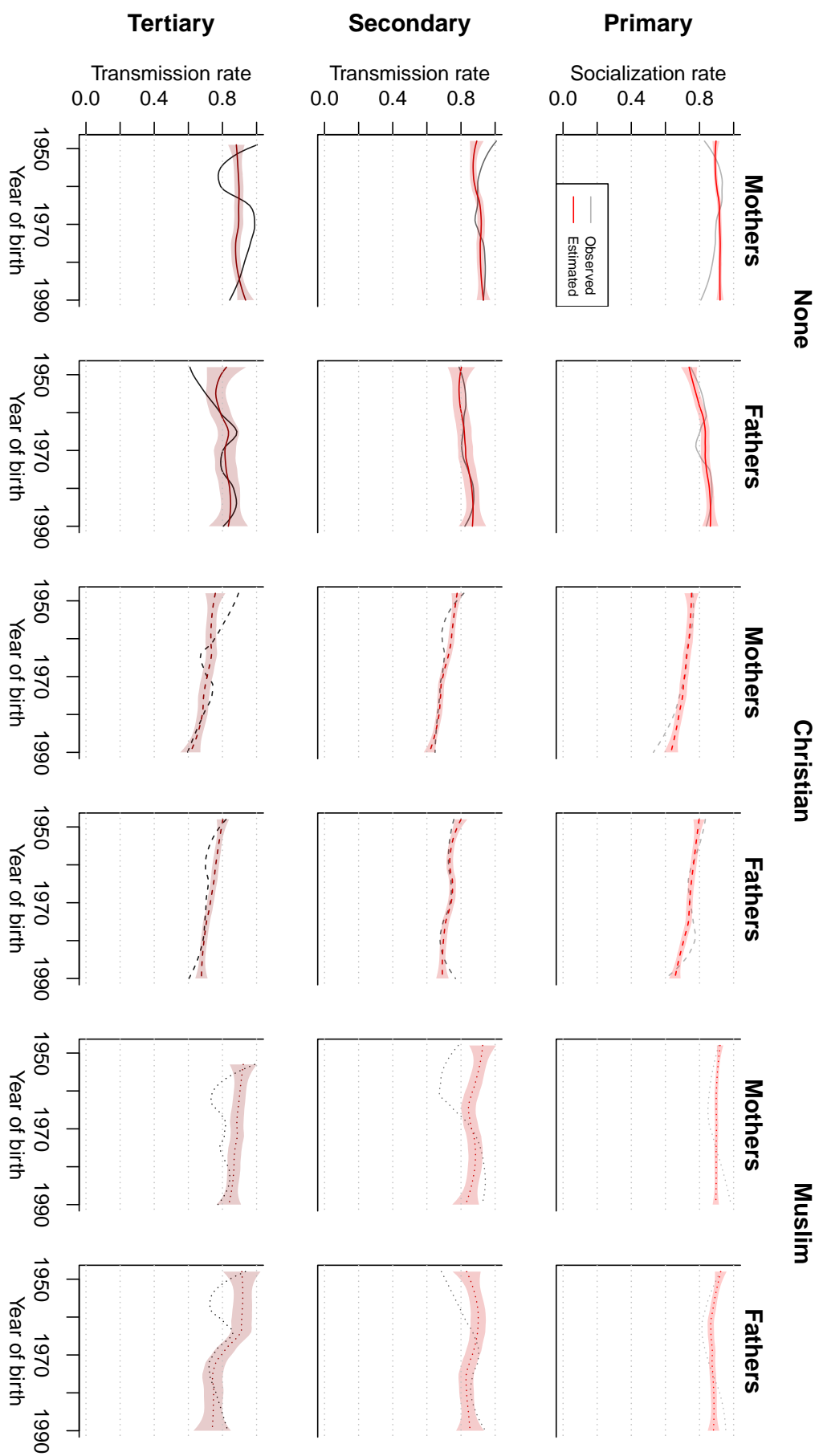


Figure B3: Conditional logit transmission, smoothed Observed vs. simulated transmission rates (by Religion & Education).

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 α to 1, and the vector of parameters to estimate is just $\beta = (m_1, \dots, m_N, f_1, \dots, f_N)$. Estimation of β 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 B1. 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 B4), by education (Figure B5), and by religion and education (Figure B6). 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 B1 for the estimation results.

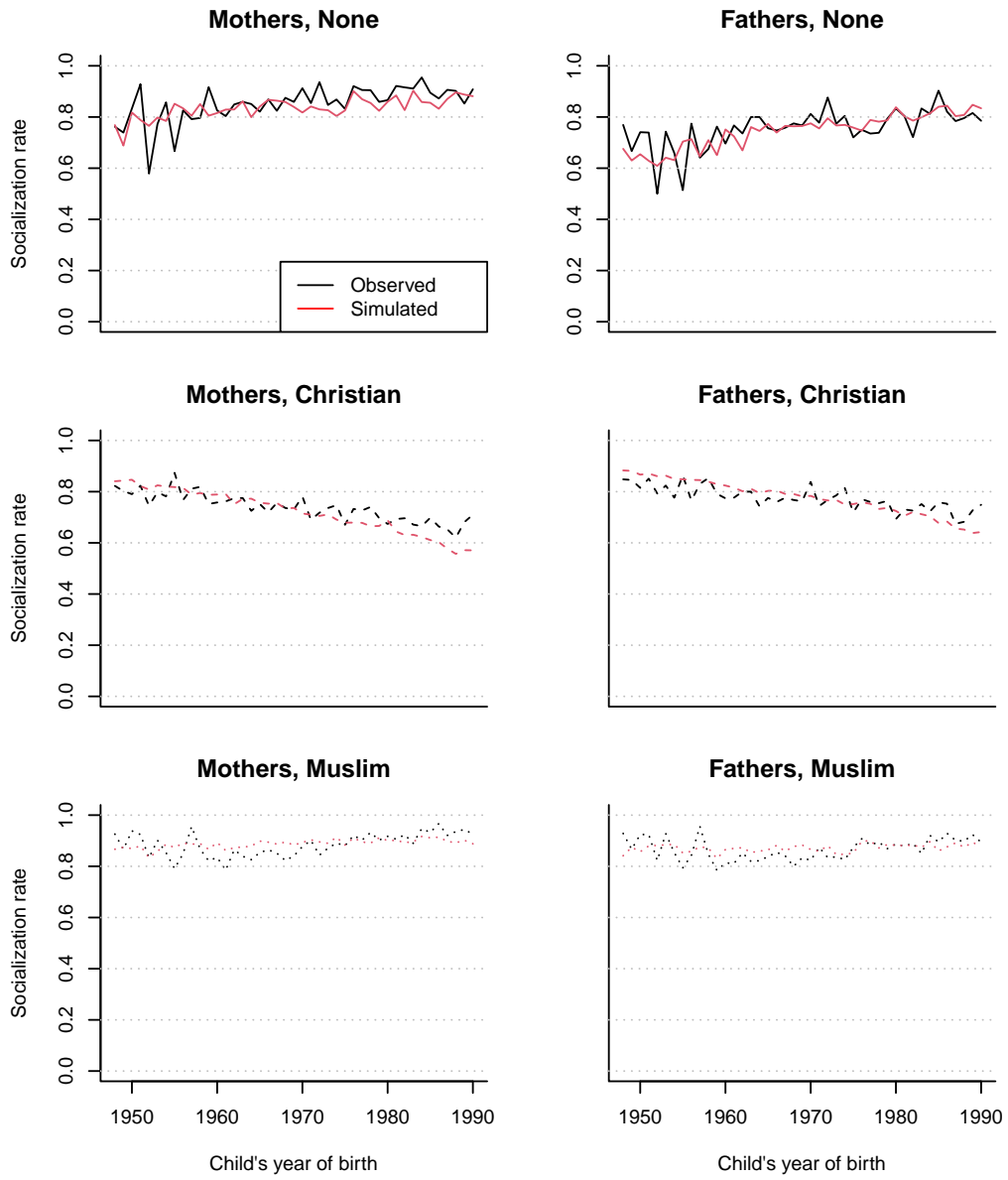


Figure B4: Nonlinear conditional logit transmission, Observed vs. simulated transmission rates (by Religion).

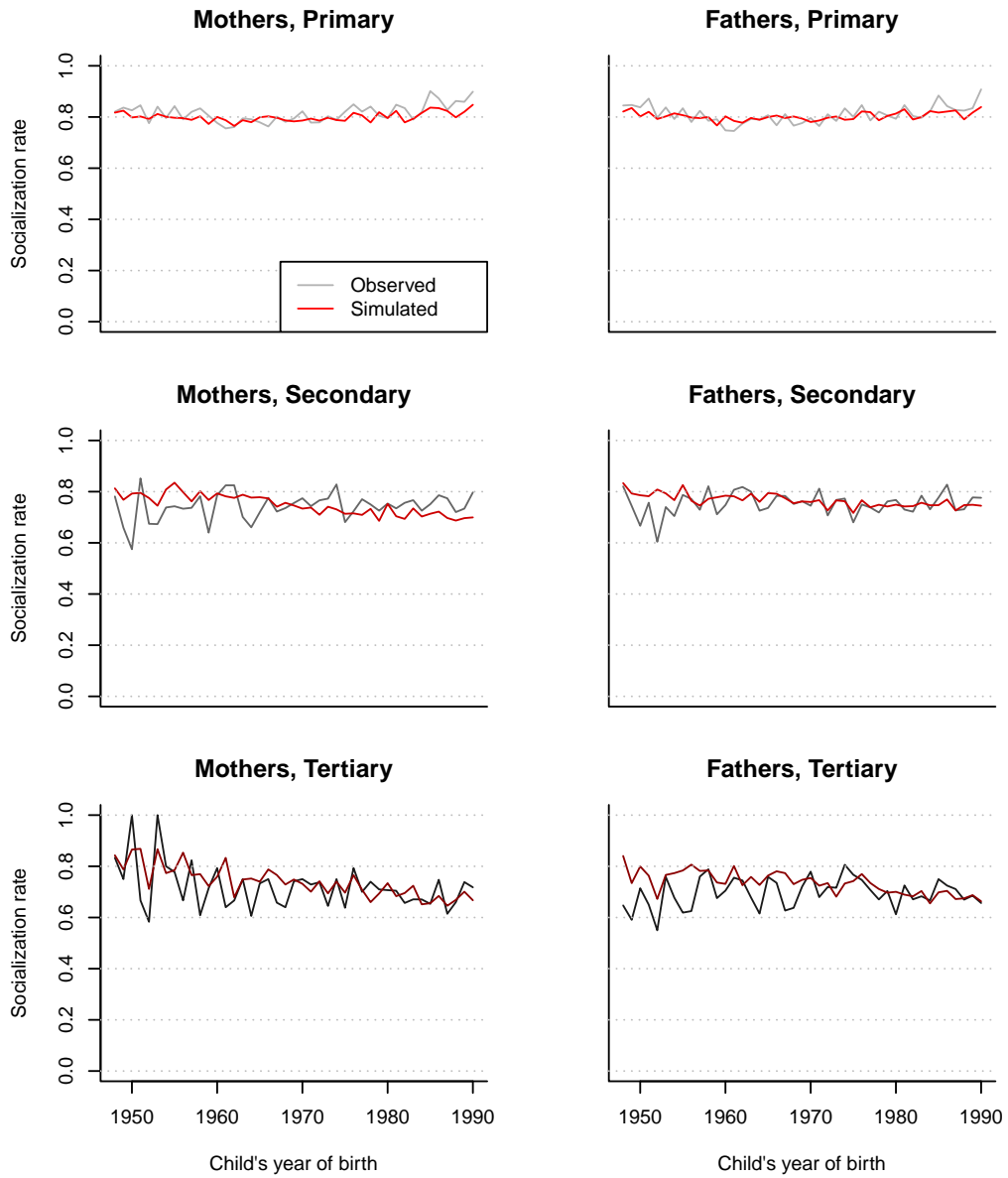


Figure B5: Nonlinear conditional logit transmission, Observed vs. simulated transmission rates (by Education).

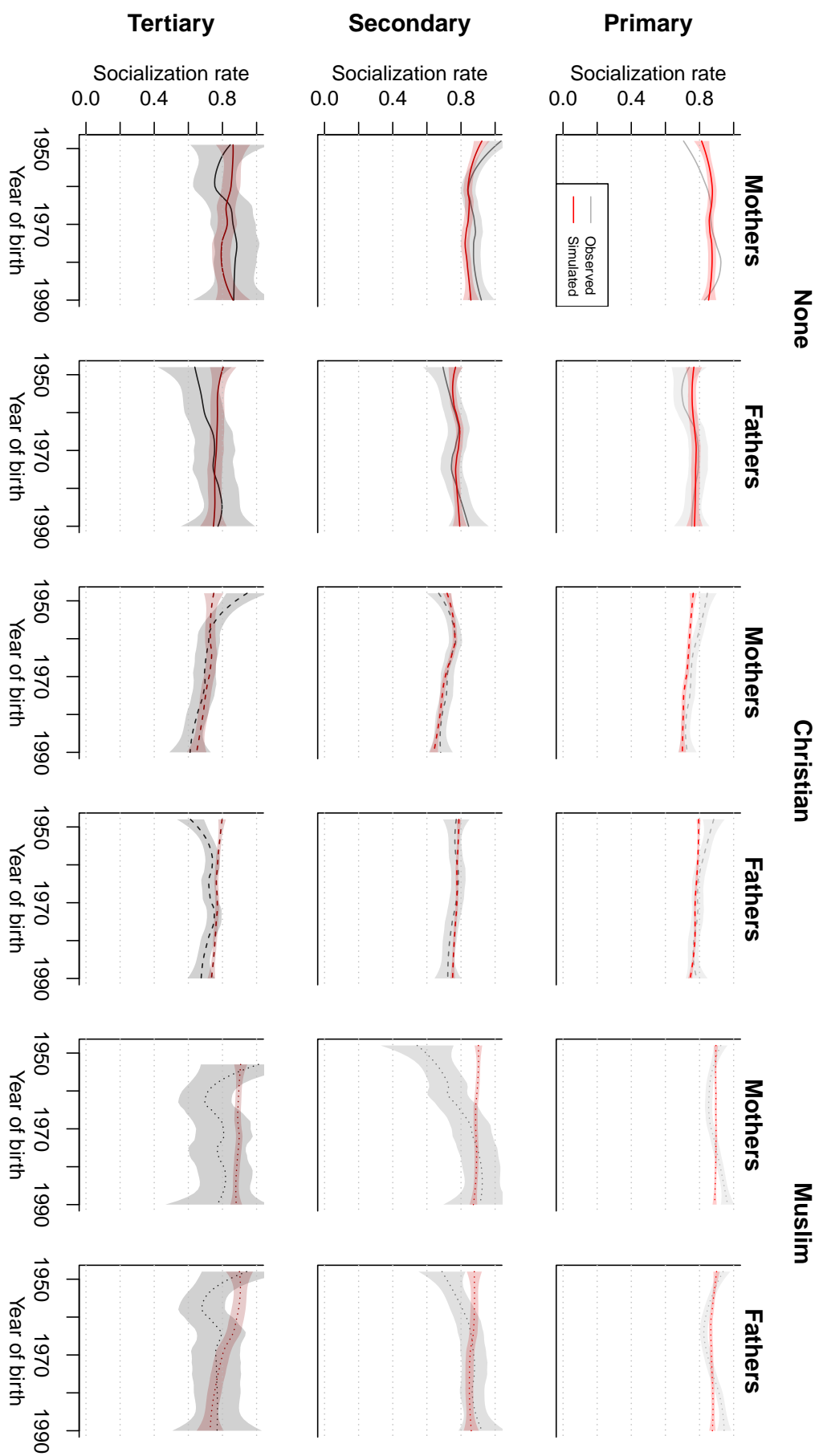


Figure B6: Nonlinear conditional logit transmission, smoothed Observed vs. simulated transmission rates (by Religion and Education).

Table B1: 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. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C 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 Φ is decreasing in u_2 . A match is then characterized by a measure ψ over Θ^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 Φ exists, I cannot find a closed-form expression for it. Instead, I can parametrize the Pareto frontier by the power μ ,

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

where Φ_1 is increasing and Φ_2 is decreasing in μ . A match must then be characterized by a measure ψ over Θ^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 μ .

The following issues arise compared to the usual framework:

- There is no explicit form for the function Φ 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 μ , thus introducing a new function into the equilibrium. A consequence is that μ 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 μ^{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

$$u_i = \max_j \{ \Phi_1(I, J, \mu^{IJ}) + \alpha_i^J \}$$

$$u_j = \max_i \{ \Phi_2(I, J, \mu^{IJ}) + \beta_j^I \}$$

where α_i^J and β_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 μ^{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.

D Analysis of deviance residuals

In order to examine the validity of the hypothesis of independent errors in section 5.1, here I analyze the residuals of the estimated structural model. In qualitative response models such as multinomial logit or ordered logit (which are the two models that I use), there are several options for computing residuals. Notable examples include response residuals, Pearson residuals, generalized residuals, or deviance residuals. Deviance residuals, in particular, are obtained by measuring the contribution of each individual observation to the total deviance of the estimated model. In models with multiple choice they are the easiest to handle because they are one-dimensional – whereas in the case of Pearson or generalized residuals, there are as many residuals as there are possible responses. For this reason, I choose deviance residuals for this analysis.

From equation (26), we can rewrite the deviance of the model as

$$-2 \ln L = \sum_i w_i (d_i^{\text{rel}} + d_i^{\text{edu}}) \quad (39)$$

where

$$d_i^{\text{rel}} = -2 \sum_{n=1}^N \mathbf{1}_{\{i \text{ is } n\}} \ln(\pi_{in}) \quad \text{and} \quad d_i^{\text{edu}} = -2 \sum_{e=1}^E \mathbf{1}_{\{i \text{ is } e\}} \ln(\phi_{ie}) \quad (40)$$

are the contributions of the individual observation i to the deviance, in terms of religious affiliation (d_i^{rel}) and educational attainment (d_i^{edu}) respectively. Deviance residuals r_i^{rel} and r_i^{edu} are then defined as

$$r_i^{\text{rel}} = (-1)^{\mathbf{1}_{\{n_i \neq \arg \max_n K_{in}\}}} \sqrt{d_i^{\text{rel}}} \quad (41)$$

$$r_i^{\text{edu}} = (-1)^{\mathbf{1}_{\{\ln H_i > \bar{h}_{e_i}\}}} \sqrt{d_i^{\text{edu}}}. \quad (42)$$

To understand the signs, recall that n_i is the observed religion of i and K_{in} her predicted level of religious capital in religion n . The condition $n_i \neq \arg \max_n K_{in}$ is then satisfied when the religious affiliation predicted by the model for i is different than the actual one. Thus, r_i^{rel} is positive if the model correctly predicted the religious affiliation of individual i , and negative otherwise. This sign is consistent with the definition of response residuals for binomial logit models, for instance.

For the education residuals, recall that e_i is the observed education level of i , and \bar{h}_{e_i} is the ordered logit threshold between having education level e_i and $e_i + 1$. Furthermore, $\ln H_i$ is the predicted level of (log-)human capital for i . Thus, r_i^{edu} is positive if the model predicted an education level identical or below the observed one, and negative otherwise. This is consistent with the common understanding of residuals (e.g. in traditional linear models), in which residuals are negative if the model “overshoots,” and positive if it “undershoots.”

I compute these deviance residuals, and present them in Figure D1. The plot represents the education residuals r_i^{edu} as a function of the religion residuals r_i^{rel} , as well as the best linear prediction. Note that there are no residuals r_i^{rel} between -1 and 0 (roughly). This is a mechanical consequence of the multinomial logit model: if an affiliation n is not predicted by the model (negative residuals), it means that its associated choice probability must be below $1/2$ (otherwise it would be the most likely outcome, i.e. the predicted outcome). As a consequence, in this case

Analysis of Deviance residuals

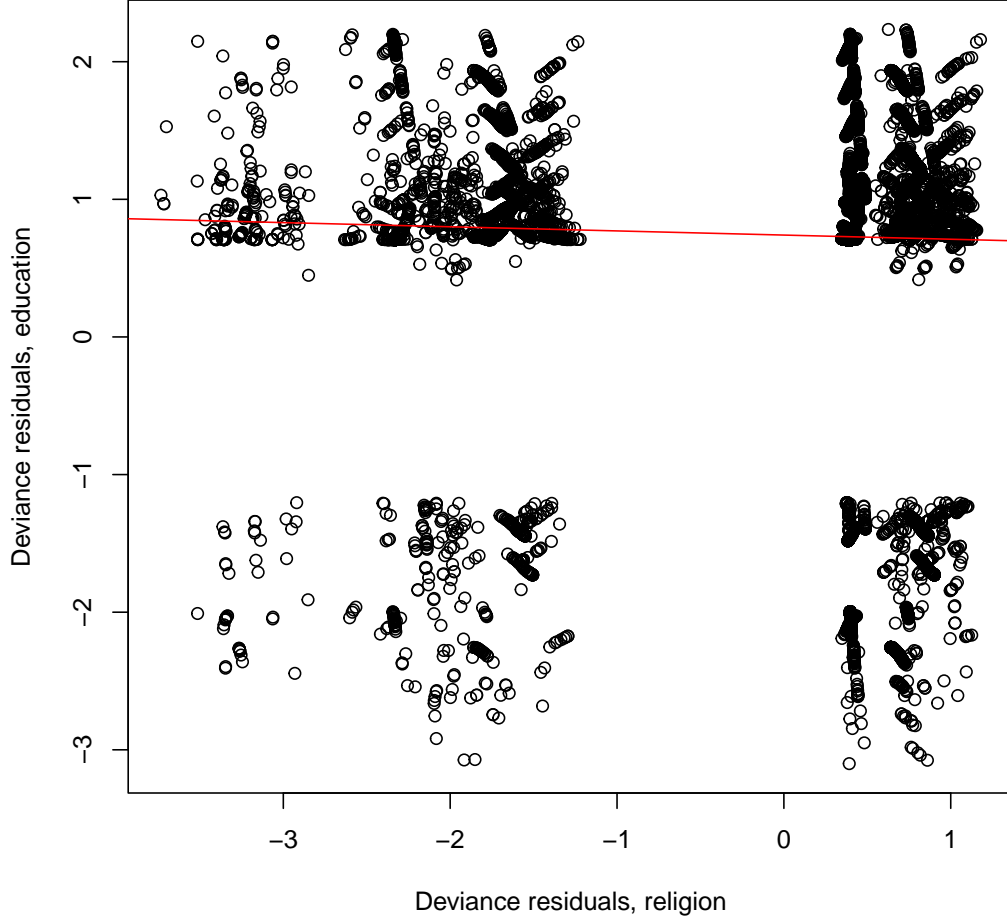


Figure D1: Deviance residuals on religion r_i^{rel} and education r_i^{edu} , along with linear prediction (in red).

the deviance contribution d_i^{rel} must be more than $-2 \ln(1/2) = 2 \ln 2$. Finally, the residual must be less than $-\sqrt{2 \ln 2} \simeq 1.18$; this is consistent with the observed values for r_i^{rel} . For a similar reason, there are no residuals r_i^{edu} between -1 and 0 (again, roughly), leading to an “empty cross” pattern.

The linear fit suggests a very weak negative correlation between the religious affiliation residuals r_i^{rel} and the educational attainment residuals r_i^{edu} . This suggests that the assumption on the independence of errors is reasonable.

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 E1 provides the sample distribution of marriages according to the spouses' education levels. The repartition of marriages is thus represented by a 3×3 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

$$\ln \left(\frac{n_{ij} n_{i+1, j+1}}{n_{i, j+1} n_{i+1, j}} \right) \quad (43)$$

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,

$$L_1 = \max_{\nu_{ij}} \sum_{ij} n_{ij} \ln(\nu_{ij}) \quad (44)$$

subject to the constraints

$$\ln \left(\frac{\nu_{ij} \nu_{i+1, j+1}}{\nu_{i, j+1} \nu_{i+1, j}} \right) \geq 0 \quad (\forall i, j \leq 2) \quad (45)$$

and

$$\sum_{ij} \nu_{ij} = N. \quad (46)$$

The likelihood L_0 is obtained by using an equality constraint in (45), 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 E1: 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 ₀₁ 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 E2: Estimated probabilities and local log odds ratios – full sample.

constraint (45) entirely. The statistics of interest are log-likelihood ratio (LR) test statistics,

$$\text{LR}_{01} = 2(L_1 - L_0) \quad \text{and} \quad \text{LR}_{12} = 2(L_2 - L_1). \quad (47)$$

The statistic LR₁₂ indicates to what extent TP2 fits the data, and LR₀₁ 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 E2 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 LR₀₁.

The value of the LR₀₁ 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.

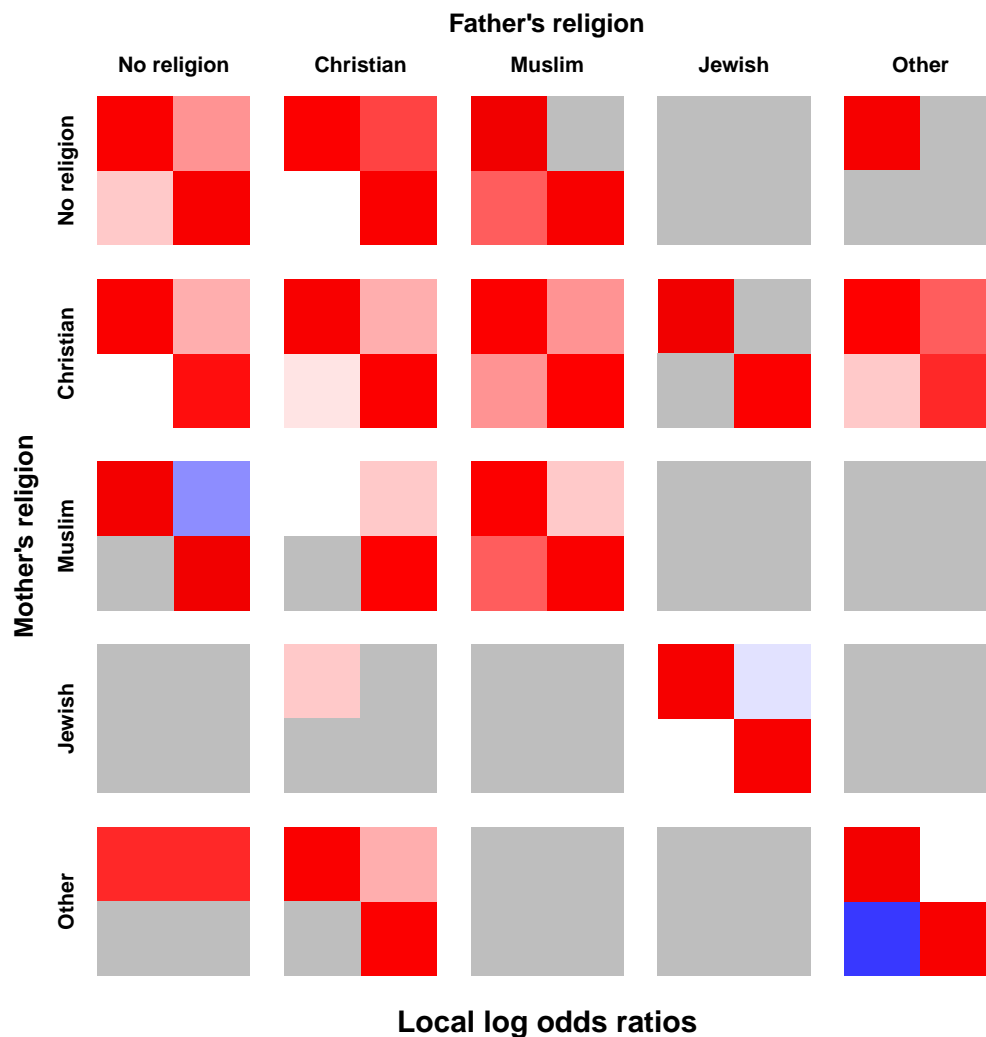


Figure E1: Local log odds ratios conditional on spouses' religious affiliation. Red indicates positive values, and blue negative ones. Lighter shades indicate values closer to 0. Gray indicates missing values.

Analysis conditional on spouses' religious affiliations. Figure E1 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 ₁₂ statistic: 0 p -value: 1		
Sec	0.176 (0.005)	0.160 (0.005)	0.071 (0.004)	LR ₀₁ 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 E3: 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 ₁₂ statistic: 0 p -value: 1		
Sec	0.112 (0.015)	0.188 (0.022)	0.133 (0.017)	LR ₀₁ 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 E4: 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 ₁₂ statistic: 0 p -value: 1		
Sec	0.221 (0.042)	0.095 (0.023)	0.081 (0.019)	LR ₀₁ 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 E5: 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 ₁₂ statistic: 0 p -value: 0.750		
Sec	0.312 (0.139)	0.000 (0.000)	0.187 (0.103)	LR ₀₁ 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 E6: 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 ₁₂ statistic: 0 p -value: 1		
Sec	0.312 (0.139)	0.000 (0.000)	0.187 (0.103)	LR ₀₁ 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 E7: Estimated probabilities and local log odds ratios – No religion, Other.