Online Appendix C: Religious Conformity of Societal Laws

We extend here our framework to the case where the policies that religious agents value are not fiscal ones (subsidies, tax exemptions) but the conformity of society’s laws to religious precepts and proscriptions. Let $\tilde{\tau} \leq 1$ measure how strictly these are enforced, resulting in an income loss of $\tilde{\tau}\theta$ for any individual with productivity $\theta$ (per unit of contemporary TFP). These losses may reflect the reduced time and talent available for production, the costs of unplanned pregnancies, the resources consumed by rituals or spent on circumventing the restrictions (black market, bribes, trips abroad, etc.), or all of the above. For religious agents and the Church, these societal strictures also represent a public good which they value at $bG$, where $G$ is now equal to $G = \tilde{R}(\tilde{\tau})$ and the technology $\tilde{R}$ for producing it has the following properties.

**Assumption 9** The function $\tilde{R}$ is $C^3$, strictly increasing and strictly concave, with $\tilde{R}(0) = 0$, $\tilde{R}'(0) = 1$ and $\tilde{R}'(1) > 0$. Furthermore, $\tilde{R}'''(\tilde{\tau}) \leq 0$ for all $\tilde{\tau} \in [0, 1]$.

These properties are very similar to those of the tax revenue function $R(\tau)$, except that the latter is maximized at $\tau < 1$ whereas $\tilde{R}(\tilde{\tau})$ is maximized above 1. The only fiscal public good provided by the government during agents’ old age is now $T$, and the budget constraint (2) is replaced by $T = (1 - \tilde{\tau})R(\tau)$. The preferred policy of an agent with relative productivity $\theta$ and religious type $\beta \in \{0, 1\}$ is consequently given by

$$\max_{\tau, \tilde{\tau}} \left\{ (1 - \tilde{\tau}) [(1 - \tau)\theta + \nu R(\tau)] + \beta b\tilde{R}(\tilde{\tau}) \right\}.$$  \hfill (C.1)

Clearly, secular agents always want $\tilde{\tau} = 0$ and their fiscal preferences are unchanged. Religious agents are examined below.

**C.1 Economy without income differences**

- **Second-period policy outcome.** The unique distinction is between secular and religious agents so the latter, being in the majority, maximize (C.1) with $\theta = \beta = 1$, leading to:

$$\tau^*(\nu) = (R')^{-1}(1/\nu),$$  \hfill (C.2)

$$\tilde{\tau}^*(b) = \begin{cases} 0 & \text{for } b < \tilde{\nu} \\ (R')^{-1}(\tilde{\nu}/b) & \text{for } \tilde{\nu} \leq b \leq 1/R'(1) \\ 1 & \text{for } 1/R'(1) < b, \end{cases}$$  \hfill (C.3)

where we define

$$\tilde{\nu} \equiv 1 - \tau^*(\nu) + \nu R(\tau^*(\nu)).$$  \hfill (C.4)
There are three differences with respect to the baseline model. First, $G$ is now provided for all $b \geq \tilde{\nu}$ rather than for $b \geq \nu$. Second, $T$ is always provided (funded by the same tax rate $\tau^*(\nu)$ as before), whereas before it was equal to zero for $b < \nu$. Third, agents’ lower incomes due to the religious restrictions $\tilde{\tau} > 0$ imposed when $b \geq \tilde{\nu}$ reduce the tax base, so that for any given value of $\tau$, $T$ is also lower. Proposition 1 thus becomes:

**Proposition 10** The fiscal and legal policies implemented in the second period are:

1. If $b < \tilde{\nu}$, then $(\tau, \tilde{\tau}, T, G) = (\tau^*(\nu), 0, R(\tau^*(\nu)), 0); \tau^*(\nu))$, so that $\tau$ and $T$ increase in $\nu$.
2. If $b \geq \tilde{\nu}$, then $(\tau, \tilde{\tau}, T, G) = (\tau^*(\nu), \tilde{\tau}^*(b), (1 - \tilde{\tau}^*(b))R(\tau^*(\nu)), \tilde{R}(\tilde{\tau}^*(b)))$, so that so that $\tilde{\tau}$ and $G$ increase in $b$.

For any $b$ and $\nu$, we denote again the second-period equilibrium level of $G$ as

$$G(b, \nu) = \begin{cases} 0 & \text{if } b < \tilde{\nu} \\ \tilde{R}(\tilde{\tau}^*(b)) & \text{if } b \geq \tilde{\nu}. \end{cases} \quad (C.5)$$

- *Doctrinal repair.* With similar substitutions, the analysis is unchanged from that of Section 5.2. Indeed, the value of repairing, $\tilde{\pi}(b, \nu)$, has the same single-peaked shape as $\pi(b, \nu)$, due to the fact that $\tilde{R}$ has similar properties to those of $R$ (see Lemma 10 in Online Appendix D). The analogue to Assumption 2 is obtained similarly:

**Assumption 10** $\delta \tilde{R}(1) < \eta/q < \tilde{R}(\tilde{\tau}^*(\tilde{\nu}/(1 - \delta)) - (1 - \delta) \tilde{R}(\tilde{\tau}^*(\tilde{\nu}))$.

We thus obtain a parallel to Proposition 2 with $\nu$ simply replaced by $\tilde{\nu}$.

- *Science policy.* The analysis in Section 5.3 is also essentially unchanged: the blocking loci remain $R^{-1}(\varphi(a)) \leq \Delta^1(b)$ in region 1 ($b > \tilde{b} > \tilde{\nu}/(1 - \delta)$), and $R^{-1}(\varphi(a)) \leq \Delta^2(b)$ in Region 2 ($\tilde{\nu} \leq b < \tilde{b}$), but now with

$$\Delta^1(b) = \lambda p R \left\{ \left[ 1 - \tilde{\tau}^*(b) \right] \tilde{\nu} + b \tilde{R}(\tilde{\tau}^*(b)) - (1 + \gamma) \left[ (1 - \tilde{\tau}^*(b')) \tilde{\nu} + b' \tilde{R}(\tilde{\tau}^*(b')) \right] \right\} \quad (C.6)$$

$$\Delta^2(b) = \lambda p R \left\{ \left[ 1 - \tilde{\tau}^*(b) \right] \tilde{\nu} + b \tilde{R}(\tilde{\tau}^*(b)) - (1 + \gamma) \tilde{\nu} \right\}. \quad (C.7)$$

Both functions are again increasing wherever they are non-negative (see Online Appendix D.2.3), therefore Proposition 3 still applies.

**C.2 Economy with unequal incomes**

**C.2.1 Preferred societal and fiscal policies**

As observed earlier, the fiscal preferences of secular agents remain unchanged. For the religious poor, maximizing (C.1) yields $\tau = \tau_L(\nu/\theta_L)$ as in the original specification, while $\tilde{\tau} = \tilde{\tau}_L(b) \equiv$
The ideal policy of the religious rich is similar, except that \( \tau_H(\nu) \equiv 0 \), hence \( \tilde{\theta}_H \equiv \theta_H \) and \( \tilde{\tau}_H(b) = \tilde{\tau}^*(b/\theta_H) \). The reason why \( \tilde{\theta}_L \) exceeds \( \theta_L \), and increases in \( \nu \), is that the RP face an additional tradeoff: the tax-base losses generated by religious restrictions imply that the same optimal tax rate \( \tau_L(\nu) \) yields a lower level of \( T \), leading them to choose positive levels of \( G \) and \( \tilde{\tau} \) only when \( b \geq \tilde{\theta}_L > \theta_L \). For further reference, let us also define

\[
\tilde{b}_j \equiv \tilde{\theta}_j/\tilde{R}'(1), \text{ for } j = L, H. \tag{C.9}
\]

Thus \( \tilde{\tau}_j(b) = 0 \) for \( b \leq \tilde{b}_j \), solves \( b\tilde{R}'(\tilde{\tau}) = \tilde{\theta}_j < b \leq \tilde{b}_j \), and \( \tilde{\tau}_j(b) = 1 \) for \( b > \tilde{b}_j \).

**Lemma 9**

1. The ideal policies of the SP and the SR are the same as in Proposition 1.
2. The ideal policy of the RR coincides with that of the SR (i.e., \( T = G = 0 \)) for \( b < \theta_H \), while for \( b \geq \theta_H \) it is \( (\tau, \tilde{\tau}, T, G) = (0, \tilde{\tau}_H(b), 0, \tilde{R}(\tilde{\tau}_H(b))) \), where \( \tilde{\tau}_H(b) \equiv \tilde{\tau}^*(b/\theta_H) > 0 \).
3. The ideal policy of the RP is \( (\tau, \tilde{\tau}, T, G) = (\tau_L(\nu), \tilde{\tau}_L(b), (1 - \tilde{\tau}_L(b))R(\tau_L(\nu)), \tilde{R}(\tilde{\tau}_L(b))) \).

They always tax income at the same rate \( \tau_L(\nu) \) as the SP, but legislate the religious public good \( G \) only when \( b \geq \tilde{\theta}_L \), setting \( \tilde{\tau}_L(b) \equiv \tilde{\tau}^*(b/\tilde{\theta}_L) > 0 \).

**C.2.2 Political coalitions at \( t + 1 \)**

In the benchmark model, Lemma 1 showed the existence of a belief threshold \( b^* \) above which the religious poor abandoned their “class interests”, siding with the religious rich rather than the secular poor. It also showed \( b^*(\nu; \theta_H, \theta_L) \) to be increasing in \( \nu \) and \( \theta_H \), and decreasing in \( \theta_L \). The very same intuition and results obtain here provided that \( \tilde{R} \) is everywhere less concave than \( R' \), or more generally has the following property.

**Assumption 11** For any \( s \leq 1 \), \( \tilde{R}'(s) \leq R'(s) \). Consequently, \( \tau^*(x) \leq \tilde{\tau}^*(x) \), for all \( x \).

The (redefined) \( b^*(\nu) \) tells us how the RP rank the RR versus the SP, but a CPNE at date \( t + 1 \) involves more than that: all possible coalitions, deviating subcoalitions, etc., must be checked for deviation-proofness. In particular, since the RP now implement redistribution \( T > 0 \) even when they impose \( G > 0 \), the SP might prefer such a policy to that of the RR (who set a lower \( G \), but \( T = 0 \)). This, in turn, could lead to winning coalitions different from those of the baseline model, with the RP emerging as victor. To rule out this case and ensure that the political outcome remains unchanged, additional assumptions are required.
Assumption 12

\[ \frac{-\tilde{R}''(1)}{\tilde{R}'(1)} \leq \min \left\{ \frac{(1 - \tilde{\tau})(\theta_H - \theta_L)}{\theta_L + \nu R(\tilde{\tau})}, \frac{\tilde{\theta}_L}{\theta_L} \left[ -\tilde{R}''(0) \right] \right\}. \]

This is of the same nature as Assumption 6, in that it requires the presence of enough income inequality in society, as both terms on the right-hand side are easily seen to increase with \( \theta_H \) and decrease with \( \theta_L \).

Assumption 13

\[ \frac{\tilde{R}(1)}{\tilde{R}'(1)} < (1 - \tau_L(\nu)) + \frac{\nu R(\tau_L(\nu))}{\theta_H}. \]

A smaller value of \( \tilde{R}(1)/\tilde{R}'(1) \) makes Assumptions 12 and 13 both more likely to hold.\(^{47}\)

The unique CPNE outcome at date \( t + 1 \), paralleling that in Proposition 5, is then characterized below (see Online Appendix D for proofs).

**Proposition 11** Under Assumptions 11-12, and if \( \tilde{\tau}_L(b^*(\nu)) \) is relatively high, the equilibrium societal and fiscal policy in the second period is unique and characterized by a religiosity threshold \( b^*(\nu; \theta_H, \theta_L) > \theta_H > \nu \), or \( b^*(\nu) \) for short, such that:

1. If \( b < b^*(\nu) \), the religious poor back the secular poor, who thus come to power and implement their preferred policy, \( (\tau, \tilde{\tau}, T, G) = (\tau_L(\nu), 0, \tilde{R}(\tau_L(\nu)), 0) \).
2. If \( b \geq b^*(\nu) \), the religious poor back the religious rich, who thus come to power and implement their preferred policy, \( (\tau, \tilde{\tau}, T, G) = (0, \tilde{\tau}_H^*(b), 0, \tilde{R}(\tilde{\tau}_H^*(b))) \).
3. The threshold \( b^* \) is strictly increasing in \( \nu \) and \( \theta_H \), and strictly decreasing in \( \theta_L \).

**C.2.3 Church’s Behavior, Blocking Equilibrium, and Comparative Statics**

The remaining analysis is essentially unchanged from that of the benchmark model, since:

(i) The policy outcome at \( t + 1 \) hinges in the same manner on whether the \( SP \) or the \( RR \) are in power, namely on \( b \) being below or above (the redefined) \( b^*(\nu; \theta_H, \theta_L) \).

(ii) The \( SP \) and the \( RR \)'s policies are the same as in the baseline, except that for the latter \( \tau_H(b) \) and \( R(\tau_H(b)) \) are replaced by the similarly-behaved \( \tilde{\tau}_H^*(b) \) and \( \tilde{R}(\tilde{\tau}_H^*(b)) \).

(iii) The same is therefore true for the Church’s repairing decision, with Assumption 8 becoming:

\[ \begin{align*}
\tilde{R}(1) &\leq \min \left\{ \frac{\theta_H - \theta_L}{\theta_L + \nu R(\tilde{\tau})}, \frac{\tilde{\theta}_L}{\theta_L} \left[ -\tilde{R}''(0) \right] \right\}.
\end{align*} \]

\(^{47}\) Since the right-hand side of Assumption 13 is bounded below by \( 1 - \tilde{\tau} \), sufficient (and simpler) conditions for both assumptions to hold are that \( \frac{\tilde{R}(1)}{\tilde{R}'(1)} \leq 1 - \tilde{\tau} \) and \( \frac{-\tilde{R}''(1)}{\tilde{R}'(1)} \leq \min \left\{ \frac{\theta_H - \theta_L}{\theta_L + \nu R(\tilde{\tau})}, \frac{\tilde{\theta}_L}{\theta_L} \left[ -\tilde{R}''(0) \right] \right\} \).
Assumption 14: \( \delta \tilde{R}(1) < \eta/q < \tilde{R}(\tau_H(b^*(\nu)/(1 - \delta))) - (1 - \delta)\tilde{R}(\tau_H(b^*(\nu))). \)

(iv) Continuing the backward induction, the four groups’ preferences with respect to blocking (value functions and resulting coalition formation) are also unchanged, up to the same substitutions, resulting in the same monotonicities and comparative statics. ■

Online Appendix D: Proofs for Appendix C

D.1 Economy without Income Differences

The only result not proved in Appendix C concerns the behavior of the religious sector.

Lemma 10 The function \( \pi(b, \nu) \) equals 0 for \( b < \tilde{\nu} \), then jumps up to \( \pi(\tilde{\nu}, \nu) = \tilde{R}(\tau^*(\tilde{\nu})). \) It is continuous and increasing on \( [\tilde{\nu}, \tilde{\nu}/(1 - \delta)] \), then jumps down to \( \pi(\tilde{\nu}/(1 - \delta), \nu) = \tilde{R}(\tau^*(\tilde{\nu}/(1 - \delta))) - (1 - \delta)\tilde{R}(\tau^*(\tilde{\nu})). \) Finally, it is continuous and strictly decreasing on \( [\tilde{\nu}/(1 - \delta), +\infty) \), with \( \lim_{b \to +\infty} \pi(b, \nu) = \delta \tilde{R}(1) > 0. \)

Proof. The proof is identical to that of Lemma 2 as \( \tilde{R} \) has similar properties to those of \( R. \) Together with Assumption \[10\] this yields the optimal-repairing interval. ■

Let us now turn to the State’s blocking loci. In Region 1, differentiating (C.6) and using the envelope theorem gives

\[
\frac{\partial \Delta^1(b)}{\partial b} = \lambda p_R \left[ \tilde{R}(\tau^*(b)) - (1 + \gamma) (1 - \delta) \tilde{R}(\tau^*(b')) \right].
\] (D.1)

Blocking \( BR \) innovations requires that \( \Delta^1(b) \geq 0 \), which by (C.6) takes the form

\[
\tilde{R}(\tau^*(b)) - (1 + \gamma) (1 - \delta) \tilde{R}(\tau^*(b')) \geq (\tilde{\nu}/b) \left[ (1 + \gamma) (1 - \tilde{\tau}^*(b')) - (1 - \tilde{\tau}^*(b)) \right].
\] (D.2)

Since \( \tilde{\tau}^*(b) \) is nondecreasing and \( b' \equiv (1 - \delta)b \), the right-hand side of (D.2) is strictly positive. Therefore, \( \Delta^1(b) \geq 0 \) implies that \( \partial \Delta^1(b)/\partial b > 0 \) in (D.1). Similarly, from (C.7) we obtain \( \partial \Delta^2(b)/\partial b = \lambda p_R \tilde{R}(\tau^*(b)) \), which is always positive. Finally, we omit the proof that there is no blocking when \( b \in [b, \tilde{b}] \) as it closely follows the one in Appendix B.2.

D.2 Economy with Unequal Incomes

To prove Proposition \[11\] we again solve the game backwards from \( t + 1. \)

D.2.1 Political preferences at \( t + 1 \)

Recall the definitions of \( \tilde{\tau}_L(b) \) and \( \tilde{\tau}_H(b) \) from Appendix \[2.1\]. The proofs establishing the existence and uniqueness of \( b^*(\nu) \) in Lemma \[4\] of Appendix B go through unchanged, by simply
replacing everywhere $\tau_H(b)$ and $R(\tau_H(b))$ with $\tilde{\tau}_H(b)$ and $\tilde{R}(\tilde{\tau}_H(b))$. In particular, the RP’s indifference condition (between SP and RR) defining $b^*(\nu)$ is now

$$[1 - \tilde{\tau}_H(b^*(\nu))]\theta_L + b^*(\nu)\tilde{R}(\tilde{\tau}_H(b^*(\nu))) = [1 - \tau_L(\nu)]\theta_L + \nu R(\tau_L(\nu)).$$

(D.3)

For any $b \geq \bar{b}_H > \bar{b}_L$ defined by $[\bar{b}_H, \bar{b}_L]$, we have $\tilde{\tau}_H(b) = \tilde{\tau}_L(b) = 1$: the RR and RP’s ideal policies coincide ($\tilde{\tau} = 1$, making $\tau$ irrelevant), so the RP must prefer the RR to the SP. By definition of $b^*$ this means that $b^*(\nu) < \bar{b}_H$, therefore

$$\forall \ b \leq b^*(\nu), \ \tilde{\tau}_H(b) < 1 \text{ and } b\tilde{R}'(\tilde{\tau}_H(b)) = \theta_H. \quad (D.4)$$

The proofs for the comparative statics of $b^*(\nu)$ with respect to $\nu$ and $\theta_H$ also remain unchanged. For monotonicity in $\theta_L$, however, under the benchmark specification we made use of the fact that $\tau_L(\nu) > \tau_H(b^*(\nu))$; see Lemma 5 in Appendix B. In the present case, we show a similar inequality, which in turns makes the same proof of monotonicity go through.

**Lemma 11** Under Assumption [1D], $\tau_L(\nu) > \tilde{\tau}_H(b^*(\nu))$.

**Proof.** Suppose, by contradiction, that $\tau_L(\nu) \leq \tilde{\tau}_H(b^*(\nu))$. Let us rewrite (D.3) as

$$\tilde{\tau}_H(b^*(\nu)) - \tau_L(\nu) = \frac{b^*(\nu)\tilde{R}(\tilde{\tau}_H(b^*(\nu)))}{\theta_L} - \frac{\nu R(\tau_L(\nu))}{\theta_L}$$

$$= \frac{b^*(\nu)}{\theta_L} \left[ \tilde{R}(\tilde{\tau}_H(b^*(\nu))) - \tilde{R}(\tau_L(\nu)) \right] + \frac{b^*(\nu)}{\theta_L} \left[ \tilde{R}(\tau_L(\nu)) - R(\tau_L(\nu)) \right] + \frac{b^*(\nu) - \nu}{\theta_L} R(\tau_L(\nu)). \quad (D.5)$$

Since $R(0) = \tilde{R}(0) = 0$ and $\tilde{R}'(x) \geq R'(x)$ for all $x$, $\tilde{R}$ lies everywhere above $R$. Together with $b^*(\nu) > \nu$, this implies that the last line in (D.5) is strictly positive. Turning to the second line, the Mean-Value Theorem implies that

$$\tilde{R}(\tilde{\tau}_H(b^*(\nu))) - \tilde{R}(\tau_L(\nu)) = \left[ \tilde{\tau}_H(b^*(\nu)) - \tau_L(\nu) \right] \cdot \tilde{R}'(c),$$

for some $c \in [\tau_L(\nu), \ \tilde{\tau}_H(b^*(\nu))]$. We can then rewrite (D.5) as

$$\frac{b^*(\nu) - \nu}{\theta_L} R(\tau_L(\nu)) > 0. \quad (D.6)$$

This clearly rules out $\tilde{\tau}_H(b^*(\nu)) = \tau_L(\nu)$, but also $\tilde{\tau}_H(b^*(\nu)) > \tau_L(\nu)$, which would imply $b^*(\nu)\tilde{R}'(c) < \theta_L$, hence $b^*(\nu)\tilde{R}'(\tilde{\tau}_H(b^*(\nu))) < \theta_L$, by concavity of $\tilde{R}$. Recall, however, that by
we have $bR(\tau_H(b)) = \theta_L$, implying a contradiction for $b = b^*(\nu)$. ■

D.2.2 Coalition formation and CPNE at $t + 1$

A - Region $b < b^*(\nu)$

Case 1: $b < \tilde{\theta}_L \equiv (1 - \tau_L(\nu))\theta_L + \nu R(\tau_L(\nu))$. The RP’s ideal policy coincides with that of the SP, which is therefore always implemented.

Case 2: $\tilde{\theta}_L \leq b < \theta_H$. In this case the RP desire $G > 0$, but the RR do not. Table D.1 reports the corresponding preference structure.

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<td>SR</td>
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where $(x, y) = (2, 3)$ [subcase (a)], or $(3, 2)$ [subcase (b)].

Table D.1. Fiscal preferences of each group when $(1 - \tau_L(\nu))\theta_L + \nu R(\tau_L(\nu)) \leq b < \theta_H$.

The RR have the same ideal policy as the SR ($G = T = 0$), so the SP and RP are indifferent between them (as in Region A, Case 2 of the baseline model, where $\nu < b < \theta_H$; see Table B.2). The RR and SR prefer the SP to the RP, because both these groups redistribute income at the rate $\tau_L(\nu)$ but latter also impose positive levels of $G$.

The RP rank the SP in 2nd place, by Lemma 4 (1) and the fact that $b < b^*(\nu)$. The SP, in turn, rank the RP as 2nd for values of $b$ close to $\theta_L$, as the latter then impose only a low level of $G$ (subcase (b)). As $b$ increases (and eventually approaches $\theta_H$), it is possible that the SP switch to preferring the ideal policy of the SR (and RR) to that the RP, because the losses generated by $\tilde{\tau}_L(b)$ more than compensate their gains from redistribution. The RP will then be ranked last (subcase (a)).

In either subcase, the SP winning is the unique CPNE, as they are preferred to the RR by both the SP and the RP. Formally, subcase (a) in Table D.1 is identical to that in Table B.2; that the equilibrium is also unchanged in subcase (b) is immediate to verify.

Case 3: $\theta_H \leq b < b^*(\nu)$. Table D.2 reports the preference structure for this case.

48 First note that the RP winning is not a CPNE. Indeed, assume that RP = E is a NE. A profitable deviation is (RR = N, SP = E) since it brings the SP to power and (3, 1) < (4, z) as $z \in \{2, 3\}$. The deviation is also self-enforcing: if the RR deviate and enter, they go to round 2 with the RP and lose. Similarly, it is immediate to show that the SP winning is a CPNE.
where \((x, y, z) = (3, 4, 2)\) or \((4, 3, 2)\) [subcase (a)], or \((4, 2, 3)\) [subcase (b)]; \((x', y') = (2, 3)\) or \((3, 2)\).

Table D.2. Fiscal preferences of each group when \(\theta_H \leq b < b^*(\nu)\).

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<td>SR</td>
<td>x'</td>
<td>4</td>
<td>y'</td>
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</table>

This case differs from the previous one, since the RR now choose \(G > 0\). The SP, however, may still prefer the RP to the SR because of the income redistribution which the former provide, but not the latter. In this case the SP rank the RR last, as they are a just as source of losses, by imposing \(G > 0\) (subcase (b)). Alternatively, the SP may rank the SR as 2nd; they could then prefer the RR to the RP, or vice versa (subcase (a)).

By definition of \(b^*(\nu)\), the RP still continue to prefer the SP to the RR, and always rank the SR last. The preferences of the SR are the same as in Region A, Case 1 of the baseline framework (see Table B.1).

Consider, finally, the RR. A priori, they could now prefer (when \(b\) is high relative to \(\theta_H\)) the RP’s policy to that of the SP, and this in turn may prevent the SP from winning. The reason is that, in this case, the SP may rank 2nd the RP’s ideal policy (this was not the case in the baseline framework). And if both the SP and the RR rank the SP in second place, they will be the winner. The first part of Assumption 12 serves to rule out this scenario and ensure that the preferences of the RR remain the same as in subcase (a) of Table B.1. Indeed, the RR prefer the SP to the RP if:

\[
[1 - \tau_L(\nu)] \theta_H + \nu R(\tau_L(\nu)) > [1 - \bar{\tau}_L(b)] [(1 - \tau_L(\nu)) \theta_H + \nu R(\tau_L(\nu))] + b \bar{R}(\bar{\tau}_L(b)).
\]

This expression simplifies to

\[
\Gamma(b) \equiv -\bar{\tau}_L(b) [(1 - \tau_L(\nu)) \theta_H + \nu R(\tau_L(\nu))] + b \bar{R}(\bar{\tau}_L(b)) < 0. \tag{D.7}
\]

This condition always holds for \(b\) equal or close to \(\theta_H\), since in this case the RR’s preferred societal policy is \(\bar{\tau}_H(\theta_H) \approx 0\), whereas the RP impose on them not only the same redistribution \(\tau_L(\nu)\) as the SP, but also a strictly positive \(\bar{\tau}_L(B)\). Hence, (D.7) is always satisfied if \(\partial \Gamma / \partial b \leq 0\) for all \(\theta_H \leq b < b^*(\nu)\). Differentiating (D.7), we obtain

49 The religious component of the RR’s policy package imposes lower losses (a lower \(\bar{\tau}\)) on the SP than that of the RP. However, the RP provide some income redistribution that may compensate for such losses.

50 Both SP and RP tax and redistribute income at the same rate \(\tau_L(\nu)\), but transfers \(T\) under the SP are higher, as there are no income losses from a positive \(\bar{\tau}\).
\[
\frac{\partial \Gamma}{\partial b} = -\frac{\partial \bar{\tau}_L(b)}{\partial b} \left[ (1 - \tau_L(\nu))\theta_H + \nu R(\tau_L(\nu)) \right] + b \tilde{R}'(\bar{\tau}_L(b)) \frac{\partial \bar{\tau}_L(b)}{\partial b} + \tilde{R}(\bar{\tau}_L(b)). \quad (D.8)
\]

- **Interior solution for \( \bar{\tau}_L(b) \).** Suppose first that \( b^*(\nu) \leq \bar{b}_L \), so that for all \( b \leq b^*(\nu) \), \( \bar{\tau}_L(b) \) is defined by the first-order condition \( b \tilde{R}'(\bar{\tau}_L(b)) = \tilde{\theta}_L \). This also implies that \( \partial \bar{\tau}_L(b)/\partial b = \tilde{\theta}_L / [-b^2 \tilde{R}''(\bar{\tau}_L(b))] > 0 \), therefore \( \partial \Gamma / \partial b \leq 0 \) if and only if

\[
\frac{(\tilde{\theta}_L)^2}{-b^2 \tilde{R}''(\bar{\tau}_L(b))} + \tilde{R}(\bar{\tau}_L(b)) \leq \frac{\tilde{\theta}_L}{-b^2 \tilde{R}''(\bar{\tau}_L(b))} [\tilde{\theta}_L + (1 - \tau_L(\nu)) (\theta_H - \theta_L)] \iff \frac{-\tilde{R}''(\bar{\tau}_L(b))}{[\tilde{R}'(\bar{\tau}_L(b))]^2} \tilde{R}(\bar{\tau}_L(b)) \leq \frac{(1 - \tau_L(\nu)) (\theta_H - \theta_L)}{(1 - \tau_L(\nu)) \theta_L + \nu R(\tilde{\tau})}. \quad (D.9)
\]

The left-hand-side is increasing in \( \bar{\tau}_L(b) \), and therefore reaches its maximum at \( -\tilde{R}''(1) \tilde{R}(1)/[\tilde{R}'(1)]^2 \).

On the right-hand side, the numerator is minimized when \( \tau_L(\nu) = \tilde{\tau} \), while the denominator is always less than \( \theta_L + \nu R(\tilde{\tau}) \). Therefore, \( (D.9) \) will hold provided that

\[
\frac{-\tilde{R}''(1) \tilde{R}(1)}{[\tilde{R}'(1)]^2} \leq \frac{(1 - \tilde{\tau}) (\theta_H - \theta_L)}{\theta_L + \nu R(\tilde{\tau})}.
\]

Rearranging terms, this is exactly the first part of Assumption \[12\]. Thus \( \Gamma(b) < 0 \), meaning that the RR prefer the SP to the RP, holds for all \( b \leq \bar{b}_L \).

- **Corner solution for \( \bar{\tau}_L(b) \).** Suppose now that \( b^*(\nu) > \bar{b}_L \) meaning that \( \bar{\tau}_L(b) = 1 \) for all \( b \in [\bar{b}_L, b^*(\nu)] \); for \( \tilde{\theta}_H(b) \), in contrast, we have \( (D.4) \). Over that range, \( (D.8) \) now yields \( \partial \Gamma / \partial b = \tilde{R}(1) > 0 \), so \( (D.7) \) will hold if it is satisfied at \( b = b^*(\nu) \), i.e.

\[
b^*(\nu) \tilde{R}(1) < (1 - \tau_L(\nu)) \theta_H + \nu R(\tau_L(\nu)). \quad (D.10)
\]

Since \( \bar{\tau}_L(b) = 1 \), it follows from \( b^*(\nu) < \bar{b}_H \) and the definition of \( \bar{b}_H \equiv \theta_H / \tilde{R}'(1) \) in \( (C.9) \) that \( b^*(\nu) < \theta_H / \tilde{R}'(1) \). Therefore, a sufficient condition is

\[
\frac{\tilde{R}(1)}{\tilde{R}'(1)} \leq \frac{(1 - \tau_L(\nu)) \theta_H + \nu R(\tau_L(\nu))}{\theta_H}, \quad (D.11)
\]

which is Assumption \[13\]. Thus \( \Gamma(b) < 0 \) for \( b \in [\bar{b}_L, b^*(\nu)] \) as well, and again the RR prefer the SP to the RP.

Clearly, the RR also always prefer the SR to the SP (who tax). The rest of the proof that the SP winning is the unique CPNE is then similar to that of the baseline model.

---

\[51\] Indeed, \( S(x) \equiv -\tilde{R}''(x) \tilde{R}(x)/[\tilde{R}'(x)]^2 \) is increasing in \( x \) (hence maximized at \( x = 1 \)), since \( S'(x) \left[ \tilde{R}'(x) \right]^2 = - \tilde{R}''(x) \tilde{R}(x) + \tilde{R}''(x) \tilde{R}'(x) \tilde{R}'(x) - \tilde{R}'(x)^2 \tilde{R}(x) > 0 \).
**B - Region** \( b^*(\nu) < b \).

The RP now prefer the RR to the SP. If the SP prefer the RR to the RP, the entire structure of preferences is the same as in the baseline’s Table B.3, leading to the RR winning as the unique CPNE. The SP indeed prefer the RR’s policy package to that of the RP if

\[
[1 - \bar{\tau}_H(b)]\theta_L > [1 - \bar{\tau}_L(b)] \left[ (1 - \tau_L(\nu))\theta_L + \nu R(\tau_L(\nu)) \right] \equiv [1 - \bar{\tau}_L(b)]\bar{\theta}_L. \tag{D.12}
\]

As \( b \) increases, \( \bar{\tau}_L(b) \) and \( \bar{\tau}_H(b) \) reach 1 at finite levels \( \tilde{b}_L \) and \( \tilde{b}_H \) defined in \( \text{C.9} \); since there is no income to left redistribute, the fiscal component of the RP’s policy becomes irrelevant. When \( b \in [\tilde{b}_L, \tilde{b}_H) \), the SP prefer the RR to the RP, and when \( b \geq \tilde{b}_H \) they are indifferent between them. We now need to check that \( \text{D.12} \) is satisfied for all \( b \in [b^*(\nu), \tilde{b}_L) \), when this interval is nonempty. At \( b = b^*(\nu) \), by definition,

\[
[1 - \tau_L(\nu)]\theta_L + \nu R(\tau_L(\nu)) = [1 - \bar{\tau}_H(b^*(\nu))]\theta_L + b^*(\nu)\bar{R}(\bar{\tau}_H(b^*(\nu))). \tag{D.13}
\]

Substituting \( \text{D.13} \) into \( \text{D.12} \) evaluated at \( b^*(\nu) \), the latter can be rewritten as

\[
\bar{\tau}_L(b^*(\nu))[1 - \bar{\tau}_H(b^*(\nu))]\theta_L - [1 - \bar{\tau}_L(b^*(\nu))]b^*(\nu)\bar{R}(\bar{\tau}_H(b^*(\nu))) > 0. \tag{D.14}
\]

**Lemma 12** Condition \( \text{D.14} \) is satisfied when \( \bar{\tau}_L(b^*(\nu)) \) is high enough, namely

\[
\bar{\tau}_L(b^*(\nu)) > \frac{\Phi \theta_L + \nu R(\tau_L(\nu))}{[1 - \tau_L(\nu)]\theta_L + \nu R(\tau_L(\nu))}, \tag{D.15}
\]

where \( \Phi \equiv (\theta_H - \theta_L)^{-1}\left\{ \theta_H \left[ \bar{R}(\tau_L(\nu)) - R(\tau_L(\nu)) \right] + (\theta_H - \nu) R(\tau_L(\nu)) \right\} \).

**Proof.** The proof proceeds in three steps.

**Step 1.** From the definition of \( b^*(\nu) \) in \( \text{D.13} \), we obtain

\[
b^*(\nu) \bar{R}(\bar{\tau}_H(b^*(\nu))) = [\bar{\tau}_H(b^*(\nu)) - \tau_L(\nu)]\theta_L + \nu R(\tau_L(\nu)). \tag{D.16}
\]

Substituting \( \text{D.16} \) into equation \( \text{D.14} \) yields

\[
0 < \bar{\tau}_L(b^*(\nu)) \left[ 1 - \bar{\tau}_H(b^*(\nu)) \right] \theta_L - [1 - \bar{\tau}_L(b^*(\nu))] \left\{ [\bar{\tau}_H(b^*(\nu)) - \tau_L(\nu)]\theta_L + \nu R(\tau_L(\nu)) \right\}
\]

or, after some simple manipulations,

\[
\bar{\tau}_L(b^*(\nu))\theta_L - \left\{ [\bar{\tau}_H(b^*(\nu)) - \tau_L(\nu)]\theta_L + \nu R(\tau_L(\nu)) \right\} + \bar{\tau}_L(b^*(\nu)) \left[ -\tau_L(\nu)\theta_L + \nu R(\tau_L(\nu)) \right] > 0.
\]

Isolating the terms in \( \bar{\tau}_L(b^*(\nu)) \), this is equivalent to
\[ \tilde{\tau}_L(b^*(\nu)) \{[1 - \tau_L(\nu)] \theta_L + \nu R(\tau_L(\nu)) \} > [\tilde{\tau}_H(b^*(\nu)) - \tau_L(\nu)] \theta_L + \nu R(\tau_L(\nu)). \]

Since the term in curly brackets is strictly positive, (D.14) becomes
\[ \frac{\tilde{\tau}_L(b^*(\nu))}{\tau_L(\nu)} > \frac{[\tilde{\tau}_H(b^*(\nu)) - \tau_L(\nu)] \theta_L + \nu R(\tau_L(\nu))}{1 - \tau_L(\nu)} \theta_L + \nu R(\tau_L(\nu)). \]

**Step 2.** In the remaining part of the proof, we look for a lower bound on \( \tilde{\tau}_H(b^*(\nu)) - \tau_L(\nu) \) that does not depend on \( b^*(\nu) \). Recalling the definition of \( b^*(\nu) \) as rewritten in (D.6), we have
\[ \tilde{\tau}_H(b^*(\nu)) - \tau_L(\nu) = \frac{b^*(\nu)}{\theta_L} \left[ \tilde{R}(\tau_L(\nu)) - R(\tau_L(\nu)) \right] + \frac{b^*(\nu) - \nu}{\theta_L} R(\tau_L(\nu)), \]
for some \( c \in (\tilde{\tau}_H(b^*(\nu)), \tau_L(\nu)) \). Since \( R' \) is decreasing, this implies
\[ \tilde{\tau}_H(b^*(\nu)) - \tau_L(\nu) < \frac{b^*(\nu)}{\theta_L} \left[ \tilde{R}(\tau_L(\nu)) - R(\tau_L(\nu)) \right] + \frac{b^*(\nu) - \nu}{\theta_L} R(\tau_L(\nu)) \]
\[ \text{subject to } \frac{b^*(\nu)}{\theta_L} \tilde{R}'(c) - 1 \]
\[ \Phi. \]

**Step 3.** Condition (D.17) provides an upper bound, \( \Phi \), which does not depend on \( b^*(\nu) \), for the term \( \tilde{\tau}_H(b^*(\nu)) - \tau_L(\nu) \). Together with (D.17), this implies a fortiori:
\[ \tilde{\tau}_L(b^*(\nu)) > \frac{\Phi \theta_L + \nu R(\tau_L(\nu))}{1 - \tau_L(\nu)} \theta_L + \nu R(\tau_L(\nu)), \]
which is exactly (D.15). Finally, since the right-hand-side does not depend on \( b^*(\nu) \), it provides a lower bound for \( \tilde{\tau}_L(b^*(\nu)) \) above which (D.14) holds.

From here on we shall assume that \( \tilde{\tau}_L(b^*(\nu)) \) satisfies (D.15), so that (D.12) holds at \( b = b^*(\nu) \). To show that it also holds for \( b > b^*(\nu) \), we rewrite it as
\[ [1 - \tilde{\tau}_H(b)] \theta_L - [1 - \tilde{\tau}_L(b)] \theta_L > 0. \]

Under (D.14), a sufficient condition for (D.12) to hold for \( b > b^*(\nu) \) is that the left-hand side of (D.20) be nondecreasing in \( b \). From the first order conditions of the RR’s and RP’s, we have
\[ \frac{\partial \tilde{\tau}_H(b)}{\partial b} = -\frac{\tilde{R}'(\tilde{\tau}_H(b))}{bR''(\tilde{\tau}_H(b))}, \quad \frac{\partial \tilde{\tau}_L(b)}{\partial b} = -\frac{\tilde{R}'(\tilde{\tau}_L(b))}{bR''(\tilde{\tau}_L(b))}. \]
Using these expressions, \([1 - \tau_H(b)] \theta_L - [1 - \tau_L(b)] \tilde{\theta}_L\) weakly increases in \(b\) if

\[
\frac{\tilde{\theta}_L}{\theta_L} \geq \frac{\tilde{R}'(\tau_H(b))}{-\tilde{R}''(\tau_L(b))} \cdot \frac{-\tilde{R}''(\tau_L(b))}{\tilde{R}'(\tau_L(b))},
\]

(D.21)

By Assumption 9 we have: (i) \(\tilde{R}'(\tau_H) < 1\), since \(\tilde{R}'(0) = 1 \geq \tilde{R}'(x)\) for any \(x\) as \(\tilde{R}''(x) < 0\); (ii) \(-\tilde{R}''(\tau_L(b)) / \tilde{R}'(\tau_L(b)) \leq -\tilde{R}''(1) / \tilde{R}'(1)\), since \(-\tilde{R}''(x) / \tilde{R}'(x)\) is increasing in \(x\) and \(\tilde{R}'(1) > 0\); (iii) \(-\tilde{R}''(\tau_H(b)) \geq -\tilde{R}''(0)\), since \(\tilde{R}''(x) \leq 0\) and \(\tilde{R}''(x) < 0\). These three facts imply that

\[
\frac{1}{-\tilde{R}''(0)} \geq \frac{\tilde{R}'(\tau_H(b))}{-\tilde{R}''(\tau_L(b))} \cdot \frac{-\tilde{R}''(\tau_L(b))}{\tilde{R}'(\tau_L(b))},
\]

so that (D.21) is always satisfied under Assumption 12, the second part of which is \(\tilde{\theta}_L/\theta_L \geq \tilde{R}''(1) / (\tilde{R}''(0) \tilde{R}'(1))\). This completes the proof that (D.12) is satisfied for all \(b \in [b^*(\nu), \tilde{b}_L)\) and, therefore, that the \(SP\) prefer the ideal policy of the \(RR\) to that of the \(RP\) in this range.

Table D.3 reports the preference structure for this case.

<table>
<thead>
<tr>
<th></th>
<th>(SP)</th>
<th>(RP)</th>
<th>(RR)</th>
<th>(SR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SP)</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>(RP)</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>(RR)</td>
<td>(x)</td>
<td>(y)</td>
<td>1</td>
<td>(z)</td>
</tr>
<tr>
<td>(SR)</td>
<td>(x')</td>
<td>4</td>
<td>(y')</td>
<td>1</td>
</tr>
</tbody>
</table>

where \((x, y, z) = (3, 4, 2)\) [subcase(a)], or \((4, 2, 3)\) or \((4, 3, 2)\) [subcase b]; \((x, y') = (2, 3)\) or \((3, 2)\).

Table D.3. Fiscal preferences of each group when \(b^*(\nu) < \tilde{b}\).

It is the same as in the baseline’s Table B.3, so the \(RR\) winning is the unique CPNE.

D.2.3 Behavior of the Religious Sector and Science Policy

Replacing \(\tau_H(b)\) and \(R(\tau_H(b))\) by \(\tilde{\tau}_H^*(b)\) and \(\tilde{R}(\tilde{\tau}_H^*(b))\) in Lemma 6 and Assumption 8 (which then becomes Assumption 14), the same proofs lead to the same characterization and comparative statics of the Church’s repairing policy.

As stated at the end of Appendix C, with these same substitutions the four groups’ blocking preferences (value functions at \(t\)) inherit, from the later stages of the game, the same properties as in the core model, and therefore does the equilibrium coalition formation (PCPNE) and its comparative statics.
Online Appendix E: Integration of State and Church

We analyze here the case where there is no State-Church separation. Clearly, this requires that religious agents be in power. We therefore take this as given, or more simply focus on the case of homogenous incomes, which delivers this outcome. In the baseline model, religious citizens and the Church had the same value $bG$ for religious public goods (or laws); their payoffs differed because citizens also have an income endowment from which they consume and pay taxes, while only the Church paid the cost $\eta b$ for doctrinal repairing. A natural unitary objective function merges (1) and (3), so that the unified State-Church body now maximizes

$$U_t^i = \mathbb{E}_t[c_t^i - \rho_t \eta b_t + c_{t+1}^i + b_{t+1}G_{t+1}].$$  \hfill (E.1)

Up to a renormalization, this is equivalent to summing the original (1) and (3), which corresponds to the case where Church and State are nominally distinct but can make compensating lump-sum transfers to each other. The political game is the same as before, except that now the unified State-Church player decides sequentially: (i) whether to block belief-eroding innovations ex ante; (ii) if it hasn’t, whether to repair the doctrine ex post when one occurs, or do nothing; (iii) its preferred provision of both secular and religious public good; this last aspect is unchanged, and still described by Proposition 1.

Naturally, when Church-State is an integrated actor it will choose, between blocking and repair, the one instrument that is the most efficient, weighing all the (direct and opportunity) costs and benefits of each option according to (E.1). Intuition suggests, and we shall verify, that the outcome will depend in the same straightforward way as before on the cost $\eta$ and effectiveness $q$ of repair, and on the setup cost for blocking, $\varphi(a)$. How the decision varies with the level of religiosity $b$, on the other hand, now leads to a richer set of possibilities. We shall both: (i) provide intuitive conditions for the blocking locus to remain upward-sloping everywhere, demonstrating the robustness to State-Church merging of the whole dynamical system, and in particular of the feature that increased religiosity makes blocking more likely, generating an absorbing basin of attraction; (b) show that, absent such conditions, parts of the blocking locus may now be downward-sloping, reversing this last feature; a sufficiently strong and coordinated religious state will then find reform more efficient than blocking.

### E.1 State-Church’s Belief-Repairing Strategy

The State-Church entity will now invest in doctrinal adaptation if

$$q \left[ 1 - \tau^* (b) + bR(\tau^* (b)) \right] + (1 - q) \left[ 1 - \tau^* (b') + b'R(\tau^* (b')) \right] - \eta b \geq 1 - \tau^* (b') + b'R(\tau^* (b')) \hfill (E.2)$$
with \( b' = (1 - \delta) b \) when \( b \geq \nu / (1 - \delta) \). When \( b \in (\nu, \nu/(1 - \delta)) \) the condition is unchanged except that \( b' \) is replaced by \( \nu \).

1. For \( b \geq \nu / (1 - \delta) \), we can rewrite (E.2) as:

\[
\pi (b, \nu) \equiv -\tau^* (b) + bR(\tau^* (b)) + \tau^* (b') - b' R(\tau^* (b')) \geq \eta/q. \tag{E.3}
\]

Using the first-order conditions (5) defining \( \tau^* (b) \) and \( \tau^* (b') \), we have

\[
\frac{\partial \pi (b, \nu)}{\partial b} \equiv \frac{\tau^* (b) - \tau^* (b')}{b^2} > 0,
\]

since \( b' < b \) and \( \tau^* (b) \) is increasing in \( b \).

2. For \( b \in (\nu, \nu/(1 - \delta)) \), the repairing condition can be rewritten as

\[
\pi (b, \nu) \equiv -\tau^* (b) + bR(\tau^* (b)) + \tau^* (\nu) - \nu R(\tau^* (\nu)) \geq \eta/q. \tag{E.4}
\]

Using again the first order condition for \( \tau^* (b) \), we have in this range

\[
\frac{\partial \pi (b, \nu)}{\partial b} \equiv \frac{\tau^* (b) - \tau^* (\nu) + \nu R(\tau^* (\nu))}{b^2} \geq 0,
\]

since the optimality of fiscal decisions requires that \( \tau^* (\nu) \leq \nu R(\tau^* (\nu)) \). Thus, \( \pi (b, \nu) \) is increasing in \( b \) over \( \mathbb{R}_+ \) (whereas in the baseline case it was hill-shaped), up to the point where it reaches its maximal value of \( \delta R(\hat{\tau}) \); \( \pi (b, \nu) \) is also continuous everywhere, and it is equal zero to for \( b \leq \nu \); see Figure E.1.

![Figure E.1: Return to Doctrinal Repair for Integrated State-Church entity](image)

**Proposition 12** When \( \eta/q < \delta R(\hat{\tau}) \), there exists a unique threshold \( \hat{b} > \nu \), defined as \( \pi(\hat{b}, \nu) = \eta/q \), such that the State-Church entity attempts doctrinal repair following unblocked belief-eroding innovations if and only if \( b \geq \hat{b} \). If \( \eta/q > \delta R(\hat{\tau}) \), repairing is never optimal.
E.2 State-Church Policy Toward Science

The analysis of blocking when there is no repairing (i.e., \( b < \hat{b} \)) is exactly the same as in the baseline framework. In particular, there is no blocking when \( b < \nu \), and for \( \nu \leq b < \hat{b} \) Proposition 3 applies. The State-Church entity thus blocks \( BR \) discoveries if and only if \( (a, b) \) lies above the upward-sloping locus \( b = B^1(a) \) in the first case, or \( b = B^2(a) \) in the second.

- **Characterization of the blocking region for \( b \geq \hat{b} \)**: It remains to examine the choice of the State-Church entity between blocking and repairing when \( b \geq \hat{b} \). Its value from blocking \( BR \) discoveries is the same as in (9), i.e.

\[
V^B(a, b) = 1 - R^{-1}(\varphi(a)) + [1 - \lambda + \lambda p_R + \lambda (1 - p_R)(1 + \gamma)] V(b), \tag{E.5}
\]

where \( V(b) = 1 - \tau^*(b) + bR(\tau^*(b)) \) is its second-period utility, defined by (8) in Section 5.3. As to the value of repairing, it is

\[
V^R(a, b) = 1 + [1 - \lambda + \lambda (1 - p_R)(1 + \gamma) + \lambda p_R q (1 + \gamma)] V(b)
+ \lambda p_R (1 - q)(1 + \gamma) V(b') - \lambda p_R \eta b, \tag{E.6}
\]

where \( V(b') \) is defined as follows:

1. **High religiosity**: when \( b \geq \max\{\hat{b}, \nu/(1 - \delta)\} \), we have \( V(b') = 1 - \tau^*(b') + b'R(\tau^*(b')) \), with \( b' \equiv (1 - \delta)b \).

2. **Intermediate religiosity**: when \( \hat{b} \leq b < \nu/(1 - \delta) \), we have \( V(b') = V(\nu) = 1 - \tau^*(\nu) + \nu R(\tau^*(\nu)) \).

Using (9) and (E.6) and rearranging terms, it follows that blocking is preferred to repairing, \( V^B(a, b) \geq V^R(a, b) \), when

\[
R^{-1}(\varphi(a)) \leq \lambda p_R \{ \eta b - [q(1 + \gamma) - 1] V(b) - (1 - q)(1 + \gamma) V(b') \} \equiv \Delta^1(b). \tag{E.7}
\]

As the term on the left is positive (and increasing in TFP \( a \)), the occurrence of blocking requires that \( \Delta^1(b) > 0 \). From (E.7), note that Assumption 7, which in the baseline framework ensures that there is never blocking (\( \Delta^1(b) \leq 0 \)) when the Church is willing to attempt repair, no longer guarantees this recursivity. This is because the single State-Church entity now making both choices internalizes the cost of repairing \( \eta b \), which, other things equal, makes blocking relatively more attractive than under State-Church separation.

We also observe, intuitively, that the possibility of blocking (\( \Delta^1(b) > 0 \)) is greater, the higher is the cost of repairing \( \eta \), and the lower its probability of success \( q \) or/and the TFP gains \( \gamma \) forsaken by blocking.
We next provide explicit conditions for blocking to occur over a nonempty region, while Assumption 7 continues to hold. If \( \eta / q < \delta R(\hat{\tau}) \), then by Proposition 12, \( \hat{b} < +\infty \) and for all \( b \geq \hat{b} \), repairing is preferred to doing nothing. Since blocking is preferred to repairing for some positive range of \( a \)'s if and only if \( \Delta^1(b) > 0 \), it will actually occur for all \( (a,b) \) with \( a \) in that range and \( b \geq \hat{b} \) if and only if

\[
[q (1 + \gamma) - 1] V(b) + (1 - q) (1 + \gamma) V(b') < \eta b \leq \eta \delta b R(\hat{\tau}).
\]  

(E.8)

As the leftmost term is increasing in \( b \), this condition becomes, for \( b \) large enough (so that \( \tau^*(b) = \hat{\tau} \) and hence \( V(b) = 1 - \hat{\tau} + b R(\hat{\tau}) \) and \( V(b') = 1 - \hat{\tau} + (1 - \delta) b R(\hat{\tau}) \)):

\[
[\gamma - \delta (1 - q) (1 + \gamma)] R(\hat{\tau}) < \eta < q \delta R(\hat{\tau}),
\]

which defines a non-empty interval for \( \eta \) if and only if \( \gamma - \delta (1 - q) (1 + \gamma) < q \delta \), or equivalently:

\[
\delta > \frac{\gamma}{1 + \gamma (1 - q)}.
\]  

(E.9)

This requires that \( q\gamma < 1 \), but the latter is compatible with \( q (1 + \gamma) \geq 1 \). Suppose, finally, that \( \eta / q \geq \delta R(\hat{\tau}) \), so that \( \hat{b} = +\infty \), i.e. repairing is never optimal. Blocking will occur when \( V^B(a,b) > 0 \), which by (E.5) defines for any \( b \) a nonempty interval for \( a \), and conversely for any \( a \) will hold for all \( b \) large enough, as \( V(b) \approx b R(\hat{\tau}) \) also becomes arbitrarily large.

- **Shape of the blocking locus** \( B^1(a) \). If this boundary is increasing, as in the benchmark model, then once again as a country becomes more religious, blocking becomes more likely (in particular, relative to repairing). If it is decreasing, or non-monotonic, on the other hand, the reverse may happen. In what follows, we provide conditions, and intuitions, for both cases.

Since the left-hand side of (E.7) is increasing in \( a \) (a more scientifically advanced country is still always less likely to block), the blocking boundary will be upward-sloping if and only if \( \Delta^1(b) \) is increasing in \( b \). The same two cases as in (E.6) must be distinguished.

1. **High religiosity:** \( b \geq \max\{\hat{b}, \nu/(1 - \delta)\} \). We have

\[
\frac{\partial \Delta^1(b)}{\partial b} = \lambda p_R \left\{ \eta - [q (1 + \gamma) - 1] R(\tau^*(b)) - (1 - q) (1 + \gamma) (1 - \delta) R(\tau^*(b')) \right\},
\]  

(E.10)

as the first order conditions for \( \tau^*(b) \) and \( \tau^*(b') \) imply respectively that \( \partial V(b) / \partial b = R(\tau^*(b)) \) and \( \partial V(b') / \partial b = (1 - \delta) R(\tau^*(b')) \). From (E.10) it is immediate that \( \partial^2 \Delta^1(b) / \partial b^2 \leq 0 \) for all \( b \), so \( \partial \Delta^1(b) / \partial b \) is monotonically decreasing in \( b \). Its minimum value is thus achieved at all \( b \)
above the threshold \( \bar{b} \) defined by \( \tau^*(\bar{b}/(1-\delta)) = \hat{\tau} \), and equal to

\[
\min_{\bar{b}} \left\{ \frac{\partial \Delta^1(b)}{\partial b} \right\} = \left. \frac{\partial \Delta^1(b)}{\partial b} \right|_{b \geq \bar{b}} = \lambda p_R \{ \eta - [q (1 + \gamma) - 1] R(\hat{\tau}) - (1-q) (1+\gamma) (1-\delta) R(\hat{\tau}) \},
\]

(E.11)

which is positive when\(^{32}\)

\[
\eta > [\gamma - \delta (1-q) (1+\gamma)] R(\hat{\tau}).
\]

(E.12)

In particular, if

\[
\delta (1-q) > \frac{\gamma}{1+\gamma},
\]

(E.13)

condition (E.12) is automatically satisfied, and it is easy to see that (E.9) is also implied.

When (E.12) holds, so that the minimum value of \( \partial \Delta^1(b)/\partial b \) in (E.11) is positive, equation (E.7) with the equality sign defines an upward-sloping blocking locus, \( b = B^1(a) \); see Figure E.2a. Blocking will take place when \((a,b)\) is above (equivalently, to the left of) this schedule, and repairing (or, for \( b \) low enough, neither) when it is below. Moreover, as \( a \) becomes large, \( \varphi(a) \) tends to \( \overline{\varphi} < R(\hat{\tau}) \), implying that \( B^1(a) \) tends to the horizontal asymptote \( \Delta^1(b) = R(\overline{\varphi}) \), as illustrated in Figure E.2a.

Note, finally, that the condition (E.11) for an upward-sloping locus (or the stronger E.13) is quite intuitive: as \( b \) rises, the cost of repairing \( \eta b \) must increase faster than the opportunity cost of blocking (i.e., leaving aside the fixed cost \( \varphi(a) \)), which is the difference between religious consumption \( bG \lesssim bR(\hat{\tau}) \) lost due to foregone TFP growth \( \gamma \) and that lost due to eroded faith following a failed repair attempt.

\(^{32}\)Recall also that the maximal value of \( \pi(b,\nu) \) is \( \delta R(\hat{\tau}) \), so the only restriction on \( \eta \) follows from \( \delta R(\hat{\tau}) \geq \eta/q \). Therefore, substituting \( \eta = q \delta R(\hat{\tau}) \) into (E.12), the parameter space satisfying (E.12) is non-empty as long as \( \delta > \gamma/[1+\gamma (1-q)] \), which is again condition (E.9).
When (E.11) is reversed, conversely, the blocking locus $B^1(a)$ will not be positively sloped everywhere: since $\partial \Delta^1(b)/\partial b$ is monotonically decreasing in $b$, its sign may become negative when religiosity exceeds a certain threshold; formally, if $\partial \Delta^1(b)/\partial b\big|_{b=b_0} > 0$ but $\partial \Delta^1(b)/\partial b\big|_{b=b_0} < 0$, the blocking locus $B^1(a)$ has first a positive and then a negative slope as $b$ rises, as illustrated in Figure E.2b. If instead $\Delta^1(b) > 0$ but $\partial \Delta^1(b)/\partial b\big|_{b=b_0} < 0$ for all $b \geq \hat{b}$, so the blocking locus $B^1(a)$ will be decreasing everywhere, as in Figure E.2c. In particular, we can provide a sufficient condition for $B^1(a)$ to be negatively sloped (at least over some range): combining equation (E.9), which ensures a non-empty blocking region above $\hat{b}$, with the opposite of (E.13), which ensures that, for some nonempty range of $\eta$, (E.12) is reversed, so that $\min_b\{\partial \Delta^1/b\} < 0$, yields:

$$\frac{\gamma}{1 + (1-q)\gamma} < \delta < \frac{\gamma}{(1-q)(1+\gamma)}.$$  

(E.14)

(2) Intermediate religiosity: $\hat{b} \leq b < \nu/(1 - \delta)$. In this range, the blocking locus is defined by equation (E.7) with the equality sign and $V(b') \equiv V(\nu)$\(^5\) Its slope, (E.10) now becomes

$$\frac{\partial \Delta^1(b)}{\partial b} = \lambda p_R \{\eta - [q(1+\gamma) - 1] R(\tau^*(b))\}.$$  

(E.15)

From Assumption\(^\footnote{The earlier analysis on the non-emptiness of the parameter space for blocking remains unchanged in this region, now simply setting $V(b') = V(\nu)$.} i.e. $q(1+\gamma) > 1$, and $R(\tau^*(b)) \leq R(\hat{\tau})$, it follows that

$$\eta > [q(1+\gamma) - 1] R(\hat{\tau}) = [\gamma - (1-q)(1+\gamma)] R(\hat{\tau})$$  

(E.16)
ensures that $\partial \Delta^1(b)/\partial b$ is always positive, and therefore the $b = B^1(a)$ locus is upward-slopping in this range; see again Figure E.2a. The interpretation is similar to the previous case, except that now if repair fails the entire value of religious consumption is lost, as the secular public good will be preferred.

As before, absent (E.16) $B^1(a)$ could be nonmonotonic (first increasing, then decreasing), or monotonically decreasing in $b$, in this region as well. This occurs, for some nonempty range of $\eta$, when the right-hand-side of (E.16) is positive (which, in turn, ensures that (E.9) holds), that is:

$$\delta > \frac{\gamma}{(1-q)(1+\gamma)}.$$  \hfill (E.17)

Finally, comparing (E.10) and (E.15) shows that $\partial \Delta^1(b)/\partial b$ is larger in absolute value in case (1) than in case (2), which implies that the blocking locus is steeper when $\hat{b} \leq b < \nu/(1-\delta)$ than when $\nu/(1-\delta) \leq \hat{b} \leq b$; see again Figure E.2c.

E.3 Dynamics of Scientific Progress and Religiosity: Summary

As established above and illustrated by Figures E.2a and E.2c, we see that, in countries where there is no separation between State and Church (presumably requiring a relatively high level of religiosity to start with):

(a) As before, it remains the case that belief-eroding innovations are likely to be blocked when the economy is not well developed in terms of scientific and technical knowledge, whereas religious doctrines becomes more likely to adapt as the economy grows.

(b) It also remains the case that, when religiosity is higher than a certain threshold $\hat{b}$, there is always either blocking of BR innovations or repairing of beliefs – both ways of preserving valuable religious capital.

(c) Under a simple and intuitive condition, it remains the case that higher religiosity makes blocking relatively more likely than repairing, leading again to stagnating theocracies, and more generally leaving all results from the benchmark model qualitatively unchanged. Under alternative parameter configurations, which we also provide, this particular ranking of policies can be reversed in part of the phase diagram, making it easier for even slow knowledge growth (e.g., due only to neutral innovations) to ultimately move the economy outside of the stagnation region.
APPENDIX F: Innovation and Religiosity Across Countries and States – Robustness Checks

Section F.1 presents the robustness checks for the cross-country analysis, and Section F.2 those for the analysis across U.S. states.

F.1 Cross-Country Patterns: Robustness Checks

Subsection F.1.1 contains the estimates and scatterplots for the relationship between religiosity and innovation with all five measures of religiosity not shown in the main text (Table F.1, Figures F.1-F.4).

Subsection F.1.2 reports the material for the robustness checks when:
- using total patents per capita, namely those filed in a country by both residents and foreigners, in place of patents per capita by residents (Table F.2);
- the control set includes dummies for current and formerly Communist countries, as well their interactions with religiosity measures (Table F.3, Figures F.5a-5b);
- using controls for the population shares of major religions, rather than which one is dominant (Table F.4).

F.1.1 Robustness checks with other measures of religiosity

We first reproduce Table 2 (also in the main text), which contains the estimates for the three main measures of religiosity—Religious person, Belief in God, Church Attendance. Table F.1 next provides the estimates for all specifications using the other two indexes—Importance of religion, God is very important. We then show the scatterplots displaying the unconditional and conditional relationship between all five measures of religiosity and the level of innovation (Figures 1a-1b, contained also in the main text, followed by Figures F.1-F.4).

For each of the five religiosity variables, we list below the corresponding figures showing the unconditional and the conditional relationships (baseline specification), as well the table and column containing the corresponding estimate:
(i) Religious person: Figures 1a, 1b (Table 2: Columns 1, 4).
(ii) Belief in God: Figures F.1a, F.1b (Table 2: Columns 2, 5).
(iii) Church attendance: Figures F.2a, F.2b (Table 2: Columns 3, 6).
(iv) Importance of religion: Figures F.3a, F.3b (Table F.1: Columns 1, 3).
(v) God is very important: Figures F.4a, F.4b (Table F.1: Columns 2, 4).
TABLE 2: Religiosity and Innovation: Cross-Country Estimates

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<th>Dep. var.: Residents’ patents per capita (log)</th>
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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
<th>(12)</th>
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<td>Religiosity</td>
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<td>-2.280***</td>
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<td></td>
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<td>Belief in God</td>
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<td>-1.826***</td>
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<tr>
<td>Church attendance</td>
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<td>-1.917***</td>
<td>-1.917***</td>
<td>-1.129***</td>
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<td>(0.009)</td>
<td>(0.009)</td>
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<tr>
<td>GDP per capita (log)</td>
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<td>1.143***</td>
<td>1.056***</td>
<td>0.754***</td>
<td>0.853***</td>
<td>0.771***</td>
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<td>0.986***</td>
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<td>(0.180)</td>
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<td>0.581</td>
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<td>(0.457)</td>
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<td>Foreign direct investment</td>
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<td>Protestant (pred.)</td>
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<td>(0.286)</td>
<td>(0.322)</td>
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<td>Catholic (pred.)</td>
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<td>-0.689*</td>
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<td>(0.282)</td>
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<tr>
<td>Muslim (pred.)</td>
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<td>-0.642</td>
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<td>Orthodox (pred.)</td>
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<td>Year fixed effects</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
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<td>172</td>
<td>224</td>
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<td>222</td>
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<td>Adjusted R-squared</td>
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<td>0.728</td>
<td>0.756</td>
<td>0.777</td>
<td>0.739</td>
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</table>

Notes: OLS estimates. Standard errors (in parentheses) are clustered by country. *Significant at 10%; **significant at 5%; ***significant at 1%.
TABLE F.1
Religiosity and Innovation: Cross–Country Estimates. Robustness with other measures of religiosity

<table>
<thead>
<tr>
<th>Dep. var.: Residents’ patents per capita (log)</th>
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<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
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<tr>
<td>Importance of religion</td>
<td>-5.154***</td>
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<td>-2.018***</td>
<td>-1.833***</td>
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<td>(0.518)</td>
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<tr>
<td>God is very important</td>
<td>-5.020***</td>
<td>-2.517***</td>
<td>-2.198***</td>
<td>-2.236***</td>
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<td></td>
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<tr>
<td></td>
<td>(0.513)</td>
<td>(0.432)</td>
<td>(0.427)</td>
<td>(0.544)</td>
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</tr>
<tr>
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<td></td>
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<td>(0.009)</td>
<td>(0.010)</td>
<td>(0.009)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>GDP per capita (log)</td>
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<td>0.952***</td>
<td>0.732***</td>
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<td>(0.151)</td>
<td>(0.164)</td>
<td>(0.163)</td>
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<td>Population (log)</td>
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<td>0.154**</td>
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<td>(0.072)</td>
<td>(0.079)</td>
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<tr>
<td>Protection intellectual property</td>
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<tr>
<td>Tertiary education (years)</td>
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<td>1.185***</td>
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Notes: OLS estimates. Standard errors (in parentheses) are clustered by country. *Significant at 10%; **significant at 5%; ***significant at 1%.
(i) **Religious person**: Figures 1a, b (Table 2: Columns 1, 4).

**FIGURE 1a: Unconditional relationship**

**FIGURE 1b: Conditional relationship**
(ii) **Belief in God**: Figures F.1a, F.1b (Table 2: Columns 2, 5).

**FIGURE F.1a**: Unconditional relationship

**FIGURE F.1b**: Conditional relationship
(iii) **Church attendance**: Figures F.2a, F.2b (Table 2: Columns 3, 6).

**FIGURE F.2a**: Unconditional relationship

**FIGURE F.2b**: Conditional relationship
(iv) Importance of religion: Figures F.3a, F.3b (Table F.1: Columns 1, 3).

**FIGURE F.3a:** Unconditional relationship

**FIGURE F.3b:** Conditional relationship
(v) *God is very important*: Figures F.4a, F.4b (Table F.1: Columns 2, 4).

**FIGURE F.4a:** Unconditional relationship

**FIGURE F.4b:** Conditional relationship
F.1.2 Robustness checks with total patents per capita, controlling for Communist countries, and for the population shares of major religions

In this subsection, we report the robustness checks for the international cross-country analysis when:

− using total patents per capita, namely those filed in a country by both residents and foreigners (Table F.2);
− using dummies for current and formerly Communist countries, as well their interactions with religiosity measures (Table F.3 and Figures F.5a-5b);
− controlling for the population shares of major religions, rather than which one is dominant (Table F.4).
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<tr>
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Notes: OLS estimates. Standard errors (in parentheses) are clustered by country. *Significant at 10%; **significant at 5%; ***significant at 1%
Table F.3 reports the estimates of the relationship between religiosity and innovation for all five measures of religiosity when we include a dummy for current and former Communist countries and its interaction term with the religiosity variable. This allows us to estimate the impact of religiosity on innovation in communist and non-communist countries.

The unconditional estimated marginal effects of religiosity on innovation in Communist and non-Communist countries are shown in Figure F.5a; they are obtained from the estimates reported in Columns 1-5 of Table F.3. The figure shows that the estimated effect of religiosity on innovation is always significantly negative in never-Communist countries, while it is always insignificant in countries that are or that experienced a Communist regime.

Figure F.5b reports the estimated marginal effects of religiosity on innovation when we include the full set of controls, corresponding to the estimates in Columns 6-10 of Table F.3. The results of the unconditional estimates are confirmed; the only exception is the estimated coefficient of Church attendance in never-Communist countries that is still negative, but no longer statistically significant at standard levels.
TABLE F.3: Religiosity and Innovation: Cross-Country Estimates. Robustness with current and former Communist countries

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<th>Dep. var.: Residents’ patents per capita (log)</th>
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<td><strong>-7.772</strong></td>
<td><strong>-2.324</strong></td>
<td>(1.081)</td>
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<tr>
<td>Belief in God</td>
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<td><strong>-2.069</strong></td>
<td>(1.402)</td>
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<tr>
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<td>Importance of religion</td>
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<td><strong>-1.734</strong></td>
<td>(0.650)</td>
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<tr>
<td>God is very important</td>
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<td><strong>-0.705</strong></td>
<td>(0.535)</td>
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<tr>
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<td>Religiosity x Communist</td>
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<td><strong>3.016</strong></td>
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<td>Belief in God x Communist</td>
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<td><strong>3.348</strong></td>
<td>(1.936)</td>
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<td>Importance of religion x Communist</td>
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<td>Religious freedom</td>
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<td>0.818</td>
<td>0.774</td>
<td>0.796</td>
<td>0.807</td>
<td></td>
</tr>
</tbody>
</table>

Notes: OLS estimates. Standard errors (in parentheses) are clustered by country. *Significant at 10%; **significant at 5%; ***significant at 1%.
Estimated marginal effects of religiosity on innovation in Communist and non-Communist countries:

**FIGURE F.5a: Unconditional estimates**

**FIGURE F.5b: Conditional estimates**
Table F.4 reports the estimates of the relationship between the level of innovation and all five measures of religiosity, when controlling for the population shares of major religions, rather than which one is dominant (as reported in Columns 10-12 of Table 2 and Columns 7-8 of Table F.1).

**TABLE F.4: Religiosity and Innovation: Cross-Country Estimates. Robustness with the shares of religions**

<table>
<thead>
<tr>
<th>Dep. var.: Residents' patents per capita (log)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
</table>
| Religiosity                                   | –1.713***  
                                                   (0.627) |
| Belief in God                                 | –1.689**  
                                                   (0.652) |
| Church attendance                             | –0.864  
                                                   (0.725) |
| Importance of religion                        | –1.718***  
                                                   (0.482) |
| God is very important                         | –2.094***  
                                                   (0.534) |
| Religious freedom                            | –0.003  
                                                   (0.012) |
| GDP per capita (log)                          | 0.906***  
                                                   (0.194) |
| Population (log)                              | 0.086  
                                                   (0.084) |
| Protection intellectual property              | 0.548***  
                                                   (0.177) |
| Tertiary education (years)                    | 0.869*  
                                                   (0.455) |
| Foreign direct investment                     | –0.009  
                                                   (0.010) |
| Protestant (share)                            | –0.389  
                                                   (0.614) |
| Catholic (share)                              | –0.754  
                                                   (0.546) |
| Muslim (share)                                | –0.648  
                                                   (0.649) |
| Orthodox (share)                              | 0.598  
                                                   (0.708) |
| Year fixed effects                            | YES   |
| Constant                                     | –19.321***  
                                                   (2.670) |
| Observations                                  | 220   |
| Adjusted $R^2$                                 | 0.755  
                                                   0.781  
                                                   0.745  
                                                   0.766  
                                                   0.788 |

Notes: OLS estimates. Standard errors (in parentheses) are clustered by country. *Significant at 10%; **significant at 5%; ***significant at 1%.
F.2. The United States: Robustness checks

We first reproduce Table 3 and Figures 2a-2b, which are also in the main text. We next include the corresponding scatterplots when religiosity is measured by the variables Belief in God and Church attendance respectively.

For each of the three religiosity variables used in the U.S. cross-state analysis, we list below the scatterplots for the unconditional and conditional (baseline) relationships, as well as the table and column containing the corresponding estimate:
(i) Importance of religion: Figures 2a, 2b (Table 3: Columns 1, 7).
(ii) Belief in God: Figures F.6a, F.6b (Table 3: Columns 2, 8).
(iii) Church attendance: Figures F.7a, F.7b (Table 3: Columns 3, 9).

| TABLE 3: Religiosity and Innovation in the US: Cross-State Estimates |
|-------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Dep. var.: Patents per capita (log)             | (1)      | (2)      | (3)      | (4)      | (5)      | (6)      | (7)      | (8)      | (9)      |
| Importance of religion                         | −3.226*** (1.057) | −3.015*** (0.787) | −3.913*** (0.625) |
| Belief in God                                  | −12.977*** (3.287) | −8.688** (3.536) | −10.290*** (3.385) |
| Church attendance                              |          |          |          | −2.737** (1.289) |
| GSP per capita (log)                           | −1.125* (0.588) | −1.061 (0.663) | −1.222* (0.617) | −0.477 (0.489) | −0.569 (0.673) | −0.709 (0.618) |
| Population (log)                               | 0.260*** (0.078) | 0.199** (0.090) | 0.237*** (0.085) | 0.218*** (0.079) | 0.154 (0.094) | 0.200** (0.089) |
| Tertiary education                             | 0.074*** (0.025) | 0.078** (0.032) | 0.086*** (0.026) | 0.035* (0.021) | 0.050 (0.032) | 0.054** (0.024) |
| Foreign direct investment                      | −6.681*** (0.647) | 3.718 (3.128) | −7.422*** (0.550) | −0.551 (5.907) | 6.065 (7.258) | −0.227 (6.420) | −5.075 (5.267) | 3.886 (7.887) | −3.803 (6.559) |
| Constant                                       | −6.681*** (0.647) | 3.718 (3.128) | −7.422*** (0.550) | −0.551 (5.907) | 6.065 (7.258) | −0.227 (6.420) | −5.075 (5.267) | 3.886 (7.887) | −3.803 (6.559) |
| Observations                                   | 51       | 51       | 51       | 51       | 51       | 51       | 51       | 51       | 51       |
| Adjusted R-squared                             | 0.198    | 0.206    | 0.101    | 0.463    | 0.396    | 0.386    | 0.567    | 0.451    | 0.456    |

Notes: OLS estimates. Robust standard errors in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.
(i) *Importance of religion*: Figures 2a, 2b (Table 3: Columns 1, 7).

**FIGURE 2a: Unconditional relationship**

**FIGURE 2b: Conditional relationship**
(ii) **Belief in God**: Figures F.6a, F.6b (Table 3: Columns 2, 8).

**FIGURE F.6a**: Unconditional relationship

**FIGURE F.6b**: Conditional relationship
(iii) Church attendance: Figures F.7a, F.7b (Table 3: Columns 3, 9).

FIGURE F.7a: Unconditional relationship

FIGURE F.7b: Conditional relationship
APPENDIX G: Data Appendix


The (five) measures of religiosity and the (four) variables for predominant religions (as well as the shares of religions) all come from the World Values Survey (WVS) and the European Values Study (EVS), i.e., respectively:


The six waves (1980–2010) of the World Values Survey are the following:
- Wave 5: 2005-2009 – denoted as year 2005
- Wave 6: 2010-2014 – denoted as year 2010

The four waves (1981-2008) of the European Values Study are the following:
- Wave 3: 1999 – integrated with WVS Wave 4 – 2000
- Wave 3: 2008 – integrated with WVS Wave 6 – 2010

Note: In computing the aggregate (five) variables of religiosity as well as the (four) variables of predominant religions (listed below) from the WVS/EVS datasets, individual data have been weighted with the variable Weight – S017 (Question text: Weight by gender and age). At the same time, in computing such aggregate variables, the denominator of each variable (i.e. the total number of respondents) does not include the individuals whose answer to the question considered is one of the following categories: –5 Missing; Unknown; –4 Not asked in survey; –3 Not applicable; –2 No answer; –1 Don’t know

Year
Variable name in our dataset: year

Religiosity
Variable name in our dataset: relig
Variable name in the WVS/EVS: F034 Religious person

Our variable Religiosity is the share of the individuals in each country that have replied they are “A religious person” to the following question:
F034 – Independently of whether you go to church or not, would you say you are?
1 A religious person
2 Not a religious person
3 A convinced atheist
Other answer: –5 Missing; Unknown; –4 Not asked in survey; –3 Not applicable; –2 No answer; –1 Don’t know

The total number of respondents is the sum of those that responded 1, 2, or 3. Hence, the variable Religiosity is the ratio between the number of those that responded they are “A religious person” and the total number of respondents:

\[ \text{relig} = \frac{\#(1)}{\#(1, 2, 3)} \]

Belief in God
Variable name in our dataset: god
Variable name in the WVS/EVS: F050 Believe in: God

Our variable Belief in God is the share of the individuals in each country that believe in God, i.e. that have replied “Yes” to the following question:

F050 – Which, if any, of the following do you believe in? God:
0 No
1 Yes
Other answer: –5 Missing; Unknown; –4 Not asked in survey; –3 Not applicable; –2 No answer; –1 Don’t know

The total number of respondents is the sum of those that responded 0 or 1. Hence, the variable Belief in God is the ratio between the number of those that responded “Yes” and the total number of respondents:

\[ \text{god} = \frac{\#(1)}{\#(0, 1)} \]

Church attendance
Variable name in our dataset: atleastweek
Variable name in the WVS/EVS: F028 How often do you attend religious services

Our variable Church attendance is the share of the individuals in each country that attend religious services at least once a week, i.e. that have replied they attend religious services “More than once a week” or “Once a week” to the following question:

F028 – Apart from weddings, funerals and christenings, about how often do you attend religious services these days?
1 More than once a week
2 Once a week
3 Once a month
4 Only on special holy days/Christmas/Easter days
5 Other specific holy days
6 Once a year
7 Less often
8 Never practically never
Other answer: –5 Missing; Unknown; –4 Not asked in survey; –3 Not applicable; –2 No answer; –1 Don’t know

The total number of respondents is the sum of those that responded 1, 2, 3, 4, 5, 6, 7, or 8. Hence, the variable Church attendance is the ratio between the number of those that responded they attend religious services “More than once a week” or “Once a week” and the total number of respondents:

\[ \text{atleastweek} = \frac{\#(1, 2)}{\#(1, 2, 3, 4, 5, 6, 7, 8)} \]

Importance of religion
Variable name in our dataset: imp_religion
Variable name in the WVS/EVS: A006 Important in life: Religion
Our variable *Importance of religion* is the share of the individuals in each country that have replied that religion is important in their life, i.e. that have replied “Very important” or “Rather important” to the following question:

A006 – For each of the following aspects, indicate how important it is in your life. Would you say it is: Religion

1 Very important
2 Rather important
3 Not very important
4 Not at all important

Other answer: 5 Missing; Unknown; 4 Not asked in survey; 3 Not applicable; 2 No answer; 1 Don’t know

The **total number of respondents** is the sum of those that responded 1, 2, 3, or 4. Hence, the variable *Importance of religion* is the ratio between the number of those that responded that religion is “Very important” or “Rather important” and the total number of respondents:

\[ \text{imp_religion} = \frac{\#(1, 2)}{\#(1, 2, 3, 4)} \]

God is very important
Variable name in our dataset: imp_god10
Variable name in the WVS/EVS: F063 How important is God in your life

Our variable *God is very important* is the share of the individuals in each country that have replied that God is very important in their life, i.e. that have replied “10 Very important” to the following question:

F063 – How important is God in your life? Please use this scale to indicate—10 means very important and 1 means not at all important.

1 Not at all important
2 2
3 3
4 4
5 5
6 6
7 7
8 8
9 9
10 Very important

Other answer: 5 Missing; Unknown; 4 Not asked in survey; 3 Not applicable; 2 No answer; 1 Don’t know

The **total number of respondents** is the sum of those that responded one of the categories between 1 and 10. Hence, the variable *God is very important* is the ratio between the number of those that responded that God is “Very important” and the total number of respondents:

\[ \text{imp_god10} = \frac{\#(1)}{\#(1, 2, 3, 4, 5, 6, 7, 8, 9, 10)} \]

Religion Shares of:

Protestant
Variable name in our dataset: prot

Catholic
Variable name in our dataset: cath

Muslim
Variable name in our dataset: musl

Orthodox
Variable name in our dataset: orth

These variables are obtained from the variable in the WVS/EVS named:
F025 Religious denomination – “Do you belong to a religious denomination? In case you do, answer which one.”

Categories
0 No religious denomination
1 – 91, 12001, 360001, 528001, 528002, 710001, 710002 – “Various denominations”
Other answer: –5 Missing; Unknown; –4 Not asked in survey; –3 Not applicable; –2 No answer; –1 Don’t know

The share of each religion i is the ratio between the number of individuals belonging to the denominations that refer to that religion and the number of individuals that answered the question F025 on religious denomination, i.e. individuals in categories “Other answer” are not included (as explained above). Hence:
Share of religion i = #i / #(0 – 91, 12001, 360001, 528001, 528002, 710001, 710002)
The details for each of the four religions considered are reported below.

**Religion Shares of Protestant**
Variable name in our dataset: prot
It is the share of the individuals in each country that have replied to question F025 by stating that they belong to one of the following categories:
5 Anglican
17 Christian
18 Christian Fellowship
19 Christian Reform
20 Church of Christ / Church of Christ / Church of Christ of Latter-day Saints
25 Evangelical
44 Lutheran
46 Methodists
61 Presbyterian
62 Protestant
78 The Church of Sweden

prot = #(5, 17, 18, 19, 20, 25, 44, 46, 61, 62, 78) / #(0 – 91, 12001, 360001, 528001, 528002, 710001, 710002)

**Religion Shares of Catholic**
Variable name in our dataset: cath
It is the share of the individuals in each country that have replied to question F025 by stating that they belong to one of the following categories:
15 Catholic: doesn’t follow rules
29 Greek Catholic
64 Roman Catholic

cath = #(15, 29, 64) / #(0 – 91, 12001, 360001, 528001, 528002, 710001, 710002)

**Religion Shares of Muslim**
Variable name in our dataset: musl
It is the share of the individuals in each country that have replied to question F025 by stating that they belong to one of the following categories:
2 Al-Hadis
22 Druse
49 Muslim
63 Qadiani
70 Shia
75 Sunni

musl = #(2, 22, 49, 63, 70, 75) / #(0 – 91, 12001, 360001, 528001, 528002, 710001, 710002)

**Religion Shares of Orthodox**
Variable name in our dataset: orth
It is the share of the individuals in each country that have replied to question F025 by stating that they belong to one of the following categories:
6 Armenian Apostolic Church
30 Gregorian
52 Orthodox

\[
\text{orth} = \frac{#(6, 30, 52)}{#(0–91, 12001, 360001, 528001, 528002, 710001, 710002)}
\]

**Predominant religion:**
Predominant religion in each country is a dummy variable denoting which religious group represents the absolute majority. Specifically, the dummy variable is equal to 1 if the fraction of members of religious group i is greater than 0.5 and it is 0 otherwise.
The details for each of the four religions considered are reported below.

**Protestant (predominant)**
Variable name in our dataset: pred_prot
\[
\text{pred_prot} = 1 \text{ if prot} > 0.5 \\
\text{pred_prot} = 0 \text{ if prot} \leq 0.5 \\
\text{pred_prot} = \text{missing if prot is missing}
\]

**Catholic (predominant)**
Variable name in our dataset: pred_cath
\[
\text{pred_cath} = 1 \text{ if cath} > 0.5 \\
\text{pred_cath} = 0 \text{ if cath} \leq 0.5 \\
\text{pred_cath} = \text{missing if cath is missing}
\]

**Muslim (predominant)**
Variable name in our dataset: pred_musl
\[
\text{pred_musl} = 1 \text{ if musl} > 0.5 \\
\text{pred_musl} = 0 \text{ if musl} \leq 0.5 \\
\text{pred_musl} = \text{missing if musl is missing}
\]

**Orthodox (predominant)**
Variable name in our dataset: pred_orth
\[
\text{pred_orth} = 1 \text{ if orth} > 0.5 \\
\text{pred_orth} = 0 \text{ if orth} \leq 0.5 \\
\text{pred_orth} = \text{missing if orth is missing}
\]

**Religious freedom**
Variable name in our dataset: Relfree


The index is based on twenty criteria. Countries were coded from information contained in the U.S. State Department report on International Religious Freedom, 2002. Each criterion was coded 0/1 and the total scale was standardized to 100 points, ranging from low to high religious freedom. See for more details the technical note “Freedom of Religion State” at pp. 293–294 of Norris and Inglehart (2011).

Data are available at [http://www.pippanorris.com/](http://www.pippanorris.com/)

The Religion Freedom index is the same for all of the six years of our sample.
Population
Variable name in our dataset: pop
Total population of the country correspondent to the year considered. The variable is taken for the year considered and, if this is missing, we use the closest data within four years starting with the subsequent year first.
Source: World Development Indicators
Variable: Population, total. Series code: SP.POP.TOTL

Population (log)
Variable name in our dataset: lpop
lpop = ln(pop)

Gross Domestic Product per capita
Variable name in our dataset: gdp
GDP per capita in constant 2010 U.S. dollars. The variable is taken for the year considered and, if this is missing, we use the closest data within four years starting with the subsequent year first.
Source: World Development Indicators
Variable: GDP per capita (constant 2010 US$). Series code: NY.GDP.PCAP.KD

Gross Domestic Product per capita (log)
Variable name in our dataset: lgdp
lgdp = ln(gdp)

Foreign direct investment
Variable name in our dataset: fdi
Foreign direct investment, net inflows (% of GDP). The variable is taken for the correspondent year considered and, if this is missing, we use the closest data within four years starting with the subsequent year first.
Source: World Development Indicators
Variable: Foreign direct investment, net inflows (% of GDP). Series code: BX.KLT.DINV.WD.GD.ZS

Patents by residents and nonresidents
Patents are taken from the World Intellectual Policy Organization (WIPO).
Data available at https://www3.wipo.int/ipstats/index.htm?tab=patent

Our dataset contains the following three variables.

Total number of patents submitted by residents’ applicants.
Variable name in our dataset: pat_wipores

Total number of patents submitted by non-residents’ applicants.
Variable name in our dataset: pat_wipononres

The total number of patents submitted by all, residents and non-residents, applicants.
Variable name in our dataset: pat_wipo_tot = pat_wipores + pat_wipononres
**Patents per capita by residents**
Variable name in our dataset: innov_res
Patents per capita by residents is the ratio between the total number of patents filed by residents’ applicants and total population, i.e.
innov_res = pat_wipores / pop

**Innovation by residents (log)**
Variable name in our dataset: linnov_res
This is the variable used as a main proxy of innovation and it is the logarithm of the patents per capita by residents, i.e.:
linnov_res = log(innov_res)

**Total patents per capita**
Variable name in our dataset: innov_tot
Total patents per capita is the ratio between total number of patents filed by all, residents and nonresidents, applicants and total population, i.e.
innov_tot = pat_wipo_tot / pop

**Total patents per capita (log)**
Variable name in our dataset: linnov_tot
This variable is the logarithm of total patents per capita.
linnov_tot = log(innov_tot)

**Protection intellectual property**
Variable name in our dataset: ipr
This variable is an index of patent protection between 0 and 5 that has been initially proposed by Ginarte, J.C., Park, W.G. (1997). “Determinants of patent rights: a crossnational study.” Research Policy, 26, 283–301.
We have used the latest version of the index that has been recently revised by Park who has posted the data in his webpage at [http://fs2.american.edu/wgp/www/?_ga=2.150063158.1045324815.1586191710-954683830.1586191710](http://fs2.american.edu/wgp/www/?_ga=2.150063158.1045324815.1586191710-954683830.1586191710)

**Tertiary education (years)**
Variable name in our dataset: yr_sch_ter
File name: BL2013_MF1599_v2.0.dta

**Communist**
Variable name in our dataset: communist
Dummy variable equal to 1 if the country is a communist state or was a communist state, and 0 otherwise.
We report below the list of countries from Wikipedia. The countries that are not in our dataset are reported in brackets.

**Current communist states:** China, (Cuba), (Korea – DPRK), (Laos), Vietnam.

**Current non-communist states with communist majority:** (Nepal).

**Previous communist states:** (Afghanistan), (Albania), (Angola), (Benin), Bulgaria, (Congo), Czechoslovakia (see below), Ethiopia, (Germany, GDR), (Grenada), Hungary, (Kampuchea), (Mongolia), (Mozambique), Poland, Romania, (Somalia), Soviet Union (see below), (Tuva), Yemen – PDRY, Yugoslavia (see below).

Countries in our sample from:

- **Ex-Czechoslovakia:** Czezh Republic, Slovakia.
- **Ex-Yugoslavia:** Bosnia Herzegovina, Croatia, Macedonia, (Montenegro), Serbia, Slovenia.
- **Ex-Soviet Union:** (Abkhazia), Armenia, (Artsakh), Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, (South Ossetia), (Tajikistan), (Transnistria), (Turkmenistan), Ukraine, Uzbekistan.
G.2. Data Appendix: *Religiosity and Innovation in the US – Cross-State Estimates*

**State**
Name of the State  
Variable name in our dataset: state1

**Code**
Code of the State  
Variable name in our dataset: code

**Importance of religion**
Share of individuals (in a 0-1 scale) that have responded “Very important” to question Q.21 – How important is religion in your life – very important, somewhat important, not too important, or not at all important?
1 Very important  
2 Somewhat important  
3 Not too important  
4 Not at all important  
9 Don’t know/refused
Data taken from the Pew Research Center’s Religion & Public Life Project, Religion Landscape Survey, and refer to year 2007.  
The dataset is available at [http://religions.pewforum.org/](http://religions.pewforum.org/).  
File downloaded: 2013-07-03.  
Variable name in our dataset: very_imp

Note: In computing the aggregate variable Importance of religion respondents have been weighted using the variable “Weight”, that is the sample weight for all landline respondents, as this is “Recommended for use in all analyses” by PEW. Moreover, the denominator (i.e. the total number of respondents) does not include those individuals whose answer is:  
9 Don’t know/refused  
The total number of respondents is the sum of those individuals that responded 1, 2, 3, or 4. Hence, the variable Importance of religion is “1 Very important” and the total number of respondents as follows:  
very_imp = #(1) / #(1, 2, 3, 4)

**Belief in God**
Share of individuals (in a 0-1 scale) that believe in God or a universal spirit, i.e. that have responded “Yes” to question Q.30 – Do you believe in God or a universal spirit?
1 Yes  
2 No  
3 Other  
9 Don’t know/refused
Data taken from the Pew Research Center’s Religion & Public Life Project, Religion Landscape Survey, and refer to year 2007.  
The dataset is available at [http://religions.pewforum.org/](http://religions.pewforum.org/).  
File downloaded: 2013-07-03.  
Variable name in our dataset: belief_god

Note: In computing the aggregate variable Belief in God respondents have been weighted using the variable “Weight”, that is the sample weight for all landline respondents, as this is “Recommended for use in all analyses” by PEW. Moreover, the denominator (i.e. the total number of respondents) does not include those individuals whose answer is:
9 Don’t know/refused
The total number of respondents is the sum of those individuals that responded 1, 2, or 3. Hence, the variable Belief in God is the ratio between the number of those that have responded that “1 Yes” and the total number of respondents as follows:
\[
\text{belief_god} = \frac{\#(1)}{\#(1, 2, 3)}
\]

Church attendance
Share of individuals (in a 0-1 scale) that declare to attend church at least once a week, i.e. the share of individuals that have responded “1 More than once a week” or “2 Once a week” to question Q.20 – Aside from weddings and funerals, how often do you attend religious services... more than once a week, once a week, once or twice a month, a few times a year, seldom, or never?
1 More than once a week
2 Once a week
3 Once or twice a month
4 A few times a year
5 Seldom
6 Never
9 Don’t know/Refused
Data taken from the Pew Research Center’s Religion & Public Life Project, Religion Landscape Survey, and refer to year 2007.
The dataset is available at http://religions.pewforum.org/
File downloaded: 2013-07-03.
Variable name in our dataset: atleastweek

Note: In computing the aggregate variable Church attendance respondents have been weighted using the variable “Weight”, that is the sample weight for all landline respondents, as this is “Recommended for use in all analyses” by PEW. Moreover, the denominator (i.e. the total number of respondents) does not include those individuals whose answer is:
9 Don’t know/refused
The total number of respondents is the sum of those individuals that responded 1, 2, 3, 4, 5, or 6. Hence, the variable Church attendance is the ratio between the number of those that responded to attend religious services “1 More than once a week” or “2 Once a week” and the total number of respondents as follows:
\[
\text{atleastweek} = \frac{\#(1, 2)}{\#(1, 2, 3, 4, 5, 6)}
\]

GSP per capita (log)
Data taken from the Bureau of Economic Analysis, State or DC.
The dataset is available at https://www.bea.gov/data/gdp/gdp-state
Variable name in our dataset: l_gsp_cap

Population
Data taken from the United States Census Bureau, Table 1. Intercensal Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2010.
The dataset is available at https://www.census.gov/data/tables/time-series/demo/popest/intercensal-2000-2010-state.html
Variable name in our dataset: pop2007

Population (log)
Log of the population of the State in 2007.
Variable name in our dataset: l_pop
\[
l_{\text{pop}} = \log(\text{pop2007})
\]
**Tertiary education**
Share (in percentage term) of the State population with bachelor’s degree or more.
Data take from the United States Census Bureau, Educational Attainment in the United States: 2007. Issued
January 2009, P20-560. Page 8, Table 2. Educational Attainment for the Population Aged 25 and Over by
The data is available at
File downloaded: 2020-02-12.
Variable name in our dataset: at_least_ba

**Gross domestic product (GDP) by State in 2006**
Gross domestic product (GDP) by State (SAGDP2N) in 2006 (All industry total). In millions of current dollars.
Data taken from the Bureau of Economic Analysis, State or DC.
The dataset is available at https://www.bea.gov/data/gdp/gdp-state
Variable name in our dataset: gsp2006
Note: the variable Gross domestic product by State in 2006 is used to compute the Foreign direct investment
as a share of GSP (see next).

**Foreign direct investment**
It is the Foreign Direct Investment as a share of GSP, i.e. it is the ratio between Foreign Direct Investment by
State in the United States (FDIUS) in 2006 (variable name in the dataset = FDI) and the Gross domestic product
(GDP) by State (SAGDP2N) in 2006 (variable name in the dataset = gsp2006).
Variable name in our dataset: fdi_st
fdi_st = FDI / gsp2006

FDI = Foreign Direct Investment in the United States (FDIUS) in 2006. Table III.D11. Gross Property, Plant,
and Equipment of Affiliates, State by Use. In millions of dollars.
Data taken from the Bureau of Economic Analysis, State or DC.
The dataset is available at

Note: we have used the Foreign Direct Investment for the year 2006 because the corresponding data for 2007
was missing for some States.

**Patents**
Total number of patents submitted by residents of the State in 2007.
The total number of patents submitted by residents of the State are taken from the U.S. PATENT AND
TRADEMARK OFFICE, Electronic Information Products Division, Patent Technology Monitoring Team
(PTMT), available at http://www.uspto.gov/web/offices/ac/ido/ocep/taf/st_co_07.htm
Variable name in our dataset: patents

**Patents per capita (log)**
Logarithm of the ratio between the total number of patents submitted by residents of the State and the
population of the State in 2007.
Variable name in our dataset: l_innov
l_innov = log(patents / pop2007)