Forbidden Fruits:

The Political Economy of

Science, Religion and Growth

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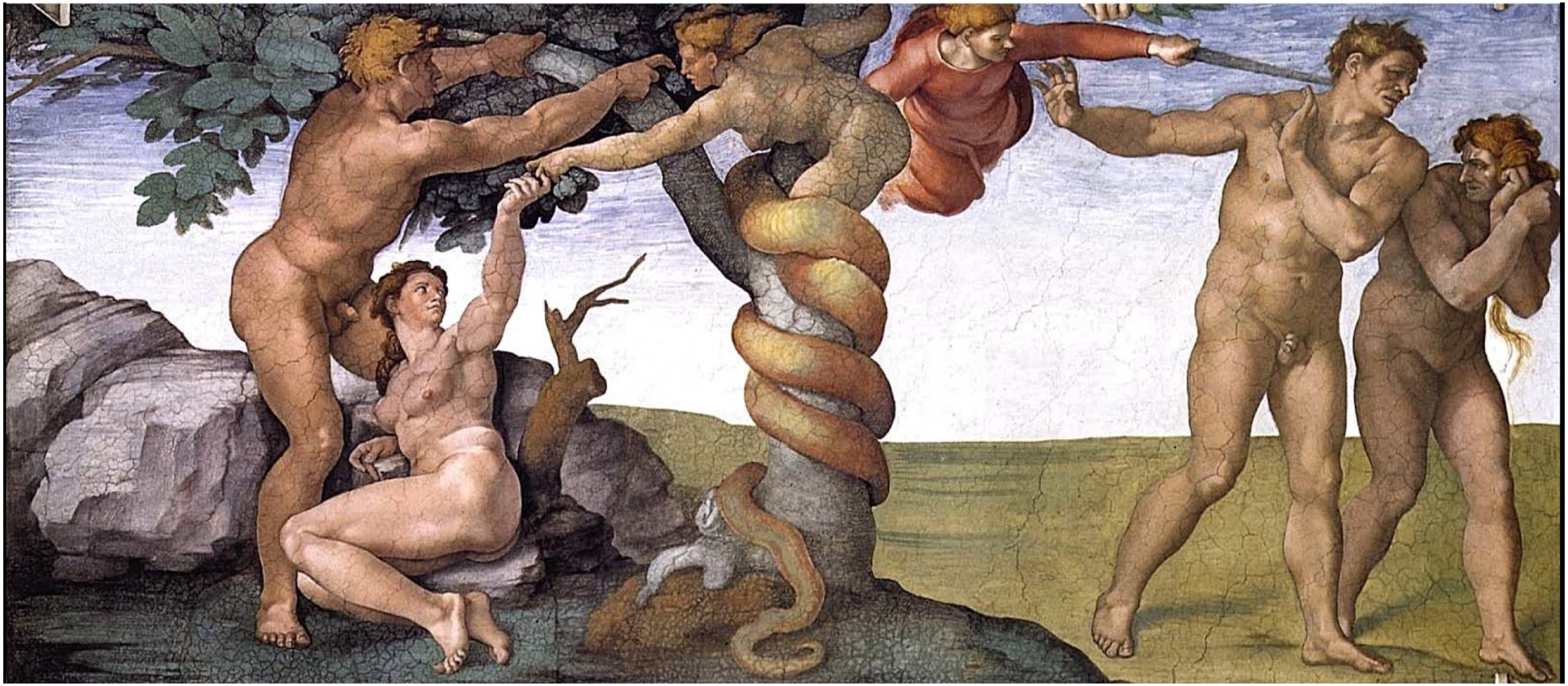


Introduction

- Aim: study interplay of religion, innovation [growth] and politics
- Throughout history and to this day, periodic clashes between science and organized religion. Political power arbitrates
  - Sacred texts, doctrines, tied to fixed "world view". Scientific discoveries recurrently contradict, falsify important aspects

1. Aristotle's lost treatises: Physics, On the Soul, On Generation & Corruption, Metaphysics, Meteorology, On the Heavens...

- Rediscovered in 12th century $\Rightarrow$ declared heretical, banned under penalty of excommunication from 1210 to 1325

2. Thomas Aquinas (1225–1274): new intellectual construction, making Christian doctrine and Aristotelian natural philosophy compatible

- "Medieval synthesis" of reason and faith, became official doctrine

Introduction

3. Scientific revolution: heliocentrism, atomism, infinitesimals, empiricism. Completely upended Aquinian synthesis ⇒ banned, severely repressed by Roman Church (Jesuits, Inquisition)

- Copernicus (1453), Bruno (1600), Galileo (1610), Cavalieri (1598-1647), Toricelli (1608-1647), Newton (1687)
- Darwinian evolution

4. Islamic world: following "golden age", deep and prolonged decline of science and knowledge-seeking, from 11^{th} century until present

- Printing press (1436): Ottoman Empire forbade it in 1483, under penalty of death, until 1727; de facto no printing until 19th century
- In 2007: top 46 Muslim countries produced 1.17% of world scientific literature, vs. .48% for Spain. Books translated into Arabic: 330 / year

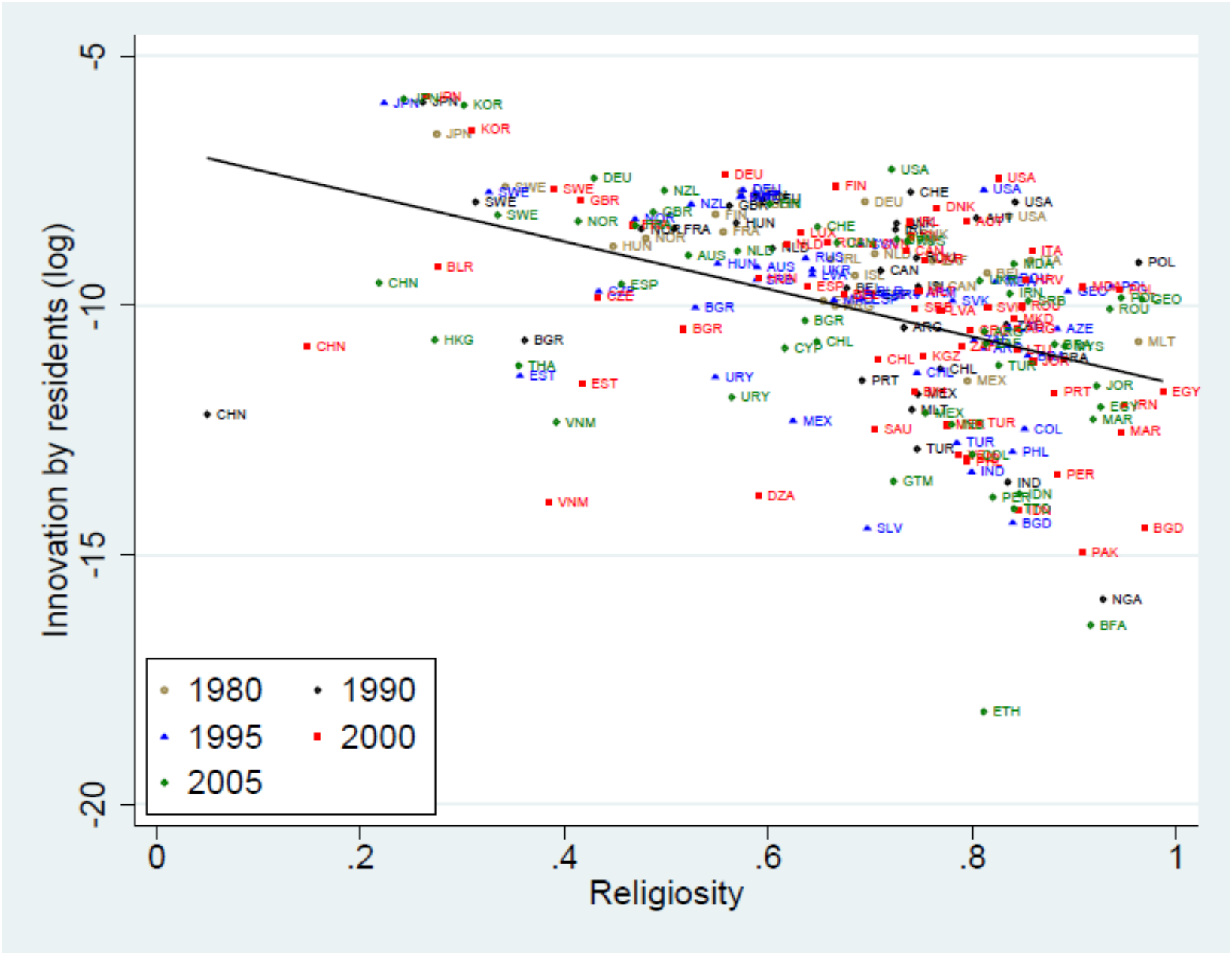
5 United States: origins of Earth, evolution, stem cell research ban, climate change... in constant flux. Rise of Religious Right, inequality

Outline

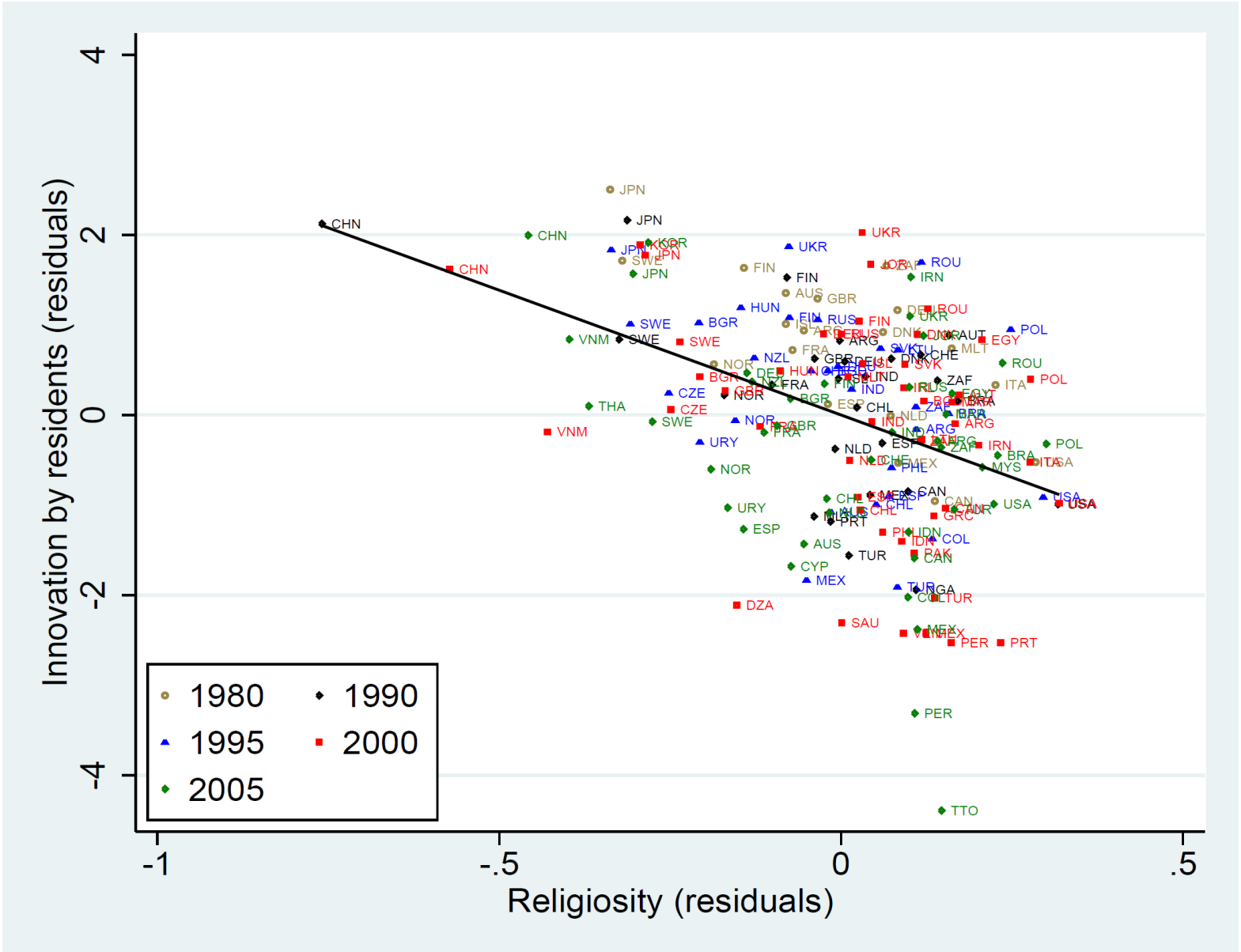
1. Historical and contemporary examples
2. New empirical facts
3. Model
    1. Scientific discoveries: if widely diffused and implemented, yield productivity gains but sometimes also erode religious beliefs
    2. Government in power can allow these ideas to spread, or spend resources to prevent and impede their diffusion
        - Subsequently, chooses taxes + mix of secular / religious public goods: spending, exemptions, laws
    3. Religious sector (e.g., Church) may undertake adaptation of doctrine, making it more compatible with new knowledge

- Remarks:
    - State variables: stocks of knowledge and religious capital
    - Scientific progress $\rightarrowtail$ religious beliefs $\rightarrowtail$ coalition gaining power (religious or secular led) $\rightarrowtail$ pace of scientific progress

Innovation and Religiosity Across Countries



Controls: GDP per capita, Population, Religious Freedom, Intellectual Property Right Protection, Foreign Direct Investment, Years of Tertiary Schooling



Innovation and Religiosity Across Countries

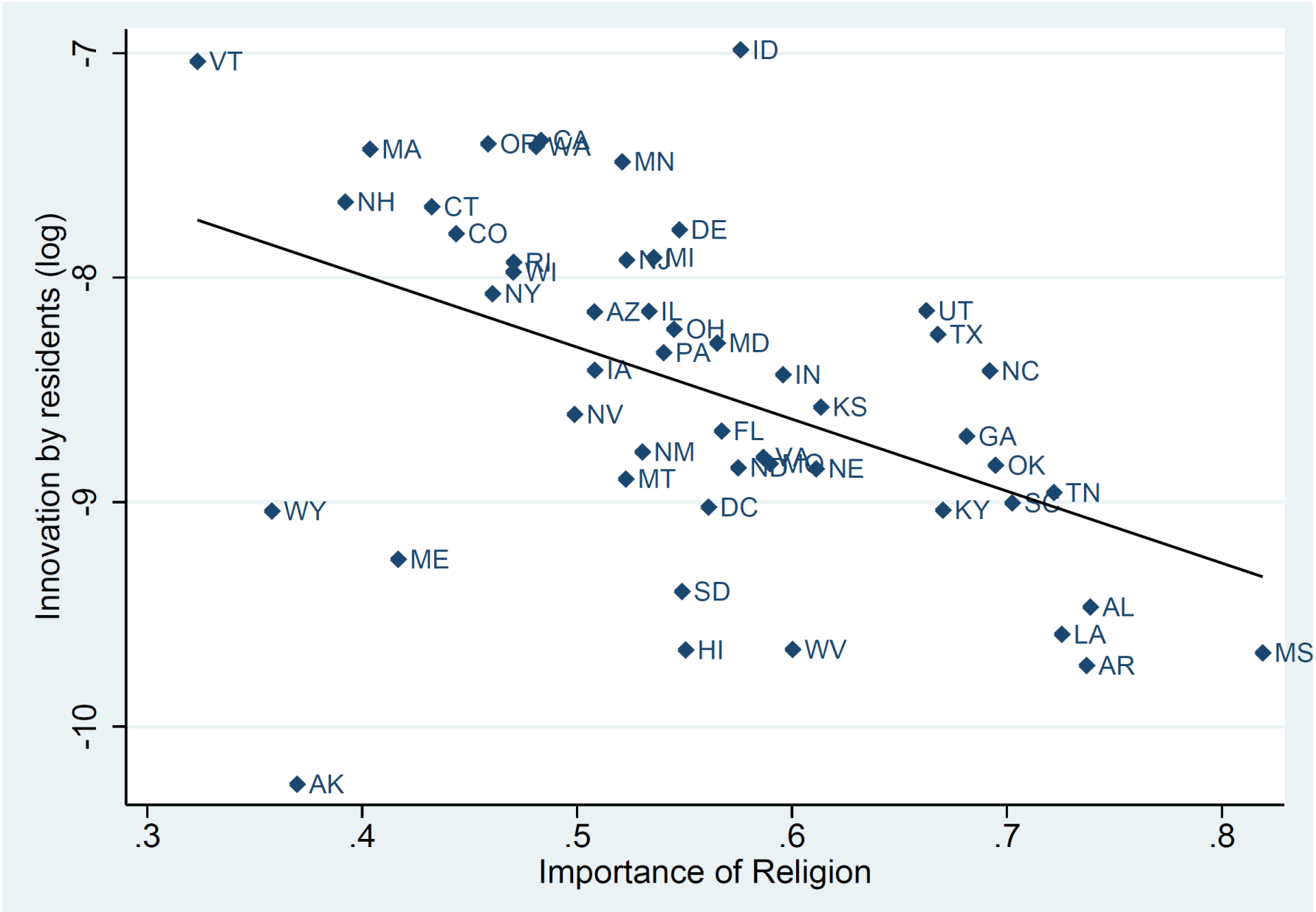
- Get very similar results with other measures of religiosity:
  - *Religious Person*
  - *Belief in God,*
  - *Importance of Religion in your life*
  - *Importance of God in your life*
  - *Religious Attendance*

Table 1: Religiosity and Innovation: Cross–Country Estimates

Dep. var.: *Residents' patents per capita (log)*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Religiosity	–4.776***		–2.771***		–2.614***		–2.048***	
	(1.318)		(0.573)		(0.614)		(0.699)	
Belief in God		–5.565***		–3.026***		–2.769***		–2.121**
		(1.822)		(0.991)		(1.001)		(0.891)
Religious freedom			0.009	0.016*	–0.003	0.007	–0.000	0.012
			(0.009)	(0.009)	(0.010)	(0.009)	(0.012)	(0.012)
GDP per capita (log)			1.393***	1.491***	1.102***	1.266***	1.300***	1.491***
			(0.222)	(0.215)	(0.254)	(0.251)	(0.263)	(0.265)
Population (log)			0.075	0.032	0.069	0.023	0.086	0.037
			(0.085)	(0.075)	(0.087)	(0.082)	(0.088)	(0.067)
Protection intellectual property			0.209	0.200	0.542***	0.407**	0.425**	0.284*
			(0.126)	(0.143)	(0.182)	(0.188)	(0.174)	(0.168)
Tertiary education (years)			0.860	0.964*	1.255**	1.138**	0.775	0.419
			(0.562)	(0.496)	(0.561)	(0.522)	(0.561)	(0.431)
Foreign direct investment			–0.027	–0.048**	0.006	–0.013	0.011	–0.004
			(0.021)	(0.023)	(0.021)	(0.024)	(0.021)	(0.026)
Protestant (pred.)							–0.227	–0.247
							(0.375)	(0.377)
Catholic (pred.)							–0.773**	–0.822**
							(0.369)	(0.315)
Muslism (pred.)							–0.543	–0.547
							(0.615)	(0.674)
Orthodox (pred.)							0.247	0.617
							(0.530)	(0.515)
Years fixed effects					YES	YES	YES	YES
Constant	–6.802***	–5.355***	–24.235***	–24.207***	–20.850***	–21.524***	–22.767***	–23.943***
	(0.942)	(1.546)	(2.846)	(2.845)	(3.224)	(3.230)	(3.426)	(3.474)
Observations	205	155	164	121	164	121	164	121
R–squared	0.187	0.203	0.719	0.780	0.758	0.797	0.775	0.821

Notes: OLS estimates. Standard errors (in parentheses) are clustered by country. *Significant at 10%; **significant at 5%; ***significant at 1%.

II - Innovation and Religiosity Across U.S. States



Controls: GSP per capita, Population, Fraction with at least Bachelor's Degree, Foreign Direct Investment,

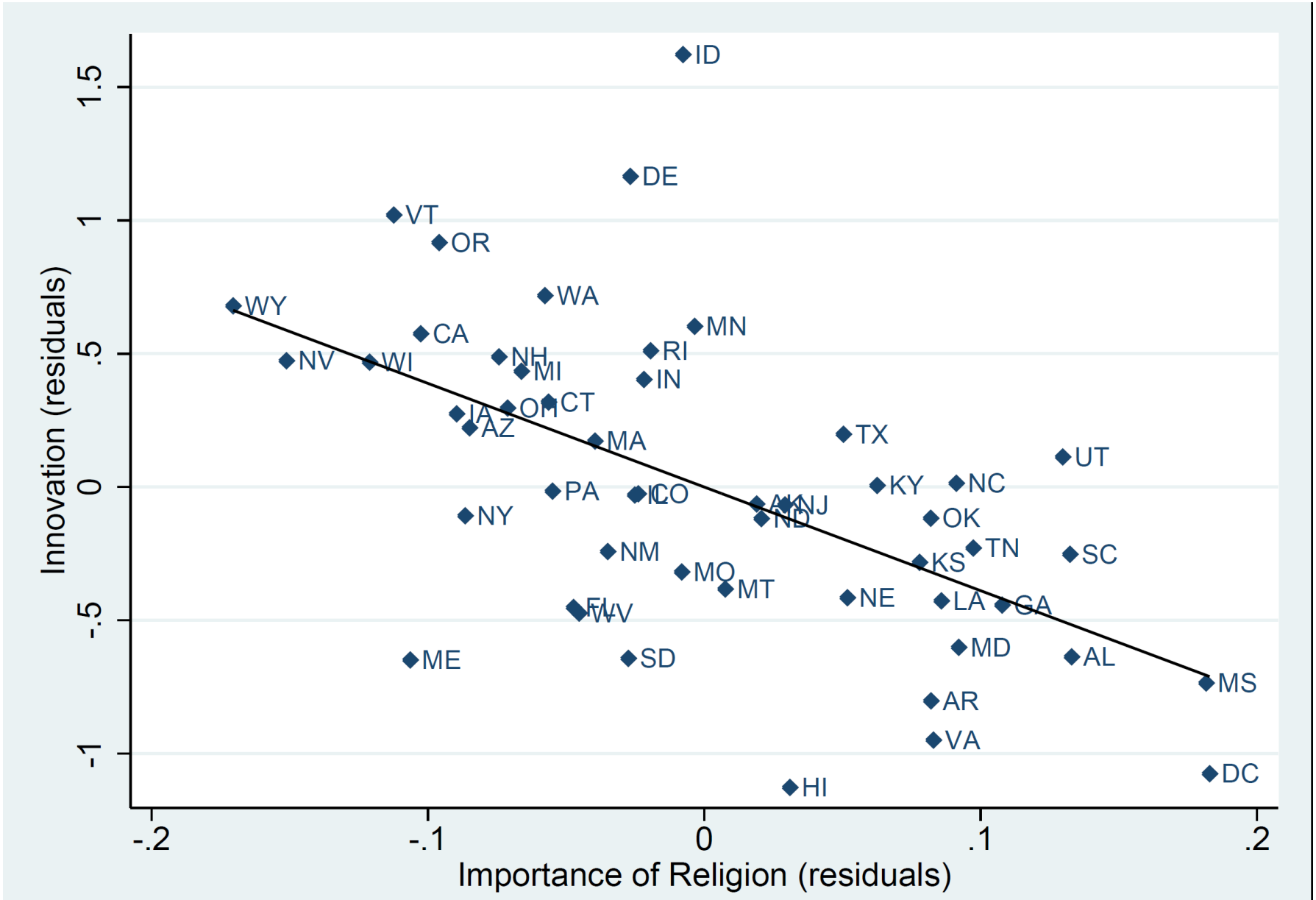
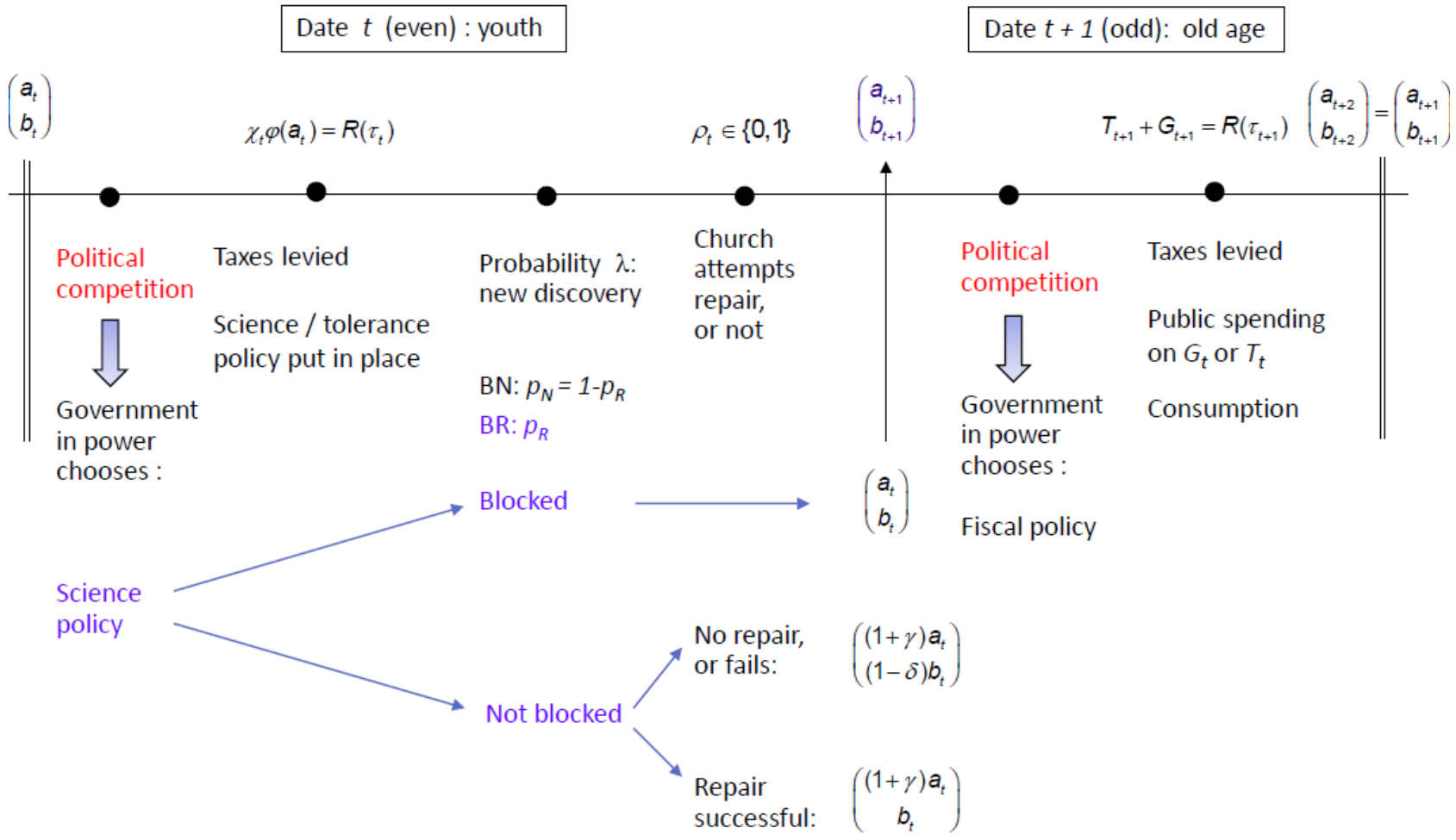


Table 2: Religiosity and Innovation in the US: Cross-State Estimates

Dep. var.: *Patents per capita (log)*	(1)	(2)	(3)	(4)	(5)	(6)
Importance of religion	−3.207***		−2.874***		−3.889***	
	(1.062)		(0.831)		(0.626)	
Belief in God		−10.167***		−7.119**		−9.210***
		(2.999)		(3.407)		(3.076)
GSP per capita (log)			−1.023*	−1.058	−0.386	−0.570
			(0.601)	(0.659)	(0.486)	(0.666)
Population (log)			0.250***	0.210**	0.211**	0.169*
			(0.078)	(0.084)	(0.079)	(0.089)
Tertiary education			0.073***	0.076**	0.032	0.044
			(0.026)	(0.031)	(0.020)	(0.030)
Foreign direct investment					−29.614***	−23.143***
					(5.552)	(7.067)
Constant	−6.706***	0.897	−1.632	4.237	−5.914	2.628
	(0.645)	(2.810)	(5.947)	(7.582)	(5.189)	(8.085)
Observations	51	51	51	51	51	51
R-squared	0.197	0.174	0.444	0.375	0.567	0.449

Notes: OLS estimates. Robust standard errors in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

Model



a_t : knowlege, productivity; b_t: religiosity; τ_t: tax rate

T_t : standard, secular public goods; G_t: religious public goods / exemptions / laws

III - The Model: Agents

- Non-overlapping generations: youth (t even), old age ($t+1$ odd):

$$U_t^i = \mathbb{E}_t[c_t^i + (c_{t+1}^i + \nu T_{t+1} + \beta^i b_{t+1} G_{t+1})(a_{t+1}/a_t)]$$

  - All magnitudes measured relative to current TFP (a_t, a_{t+1})
  - νT_{t+1}: utility from standard (secular) public goods, transfers
  - $\beta^i b_{t+1} G_{t+1}$: utility from (organized) religion

- Beliefs b_{t+1} complementary to "religious public goods" G_{t+1} : sanctuaries (churches, temples, mosques), priests, rituals
- Majority $r > 1/2$ of religious agents, $\beta^i = 1$, rest secular, $\beta^i = 0$
  - Types fixed, but intensity of religious beliefs (b_t, b_{t+1}) endogenous
- Income θ^i in both periods $\Rightarrow c_s^i = (1-\tau_s)\theta^i$, $\forall s$
  - Part I: no income differences, $\theta^i \equiv 1, \forall i \Rightarrow$ religious majority rules
  - Part II: rich and poor, $\theta_L < 1 < \theta_H \Rightarrow$ coalitions among four groups

Public Policies in Second Subperiod (t+1)

- Linear income tax $\tau \Rightarrow$ revenue $R(\tau)$, per unit of TFP
  - $R(\cdot) \curvearrowright$, revenue-maximizing tax rate $\hat{\tau}$
- Standard public goods and services T_{t+1} : infrastructure, safety, education. Valued equally at νT_{t+1} by those with $\beta^i = 0, 1$
  - Can also correspond to pure transfers
- Religious public goods G_{t+1} : provided directly (state religion) or via tax exemptions, subsidies, advantages conceded to religious sector

  $\Rightarrow$ Gvt's budget constraint at $t+1$:

$$T_{t+1} + G_{t+1} \leq R(\tau_{t+1}).$$

- Alternative G : legislation on school prayer, abortion, women's role...
  - Key is that provides different (dis)utility to different groups

Public Policies in First Subperiod (t)

- Policy decision is whether to invest resources in a control and repression apparatus designed to block diffusion of ideas deemed heretical, dangerous to the faith.
  - Religious police, Inquisition tribunals, censorship of school lessons, textbooks. Banning printing press. Subsidizing official or parallel doctrine-friendly "science" (creationism, climate change denial, etc.)
- Set-up cost, normalized by TFP, is $\varphi(a_t) \nearrow$ with society's level of knowledge and technology $\Rightarrow$ Gvt's budget constraint at t :

$$\chi_t \varphi(a_t) \leq R(\tau_t), \quad \chi_t = 0, 1.$$

- Censoring "dangerous ideas" emanating from scientific inquiry, methodology entail:
  - Ex ante: cost $\varphi(a_t)$ of setting up repressive apparatus
  - Ex-post: foregone TFP gains that could be reaped from applications

Discoveries: Productivity, Beliefs, and Blocking

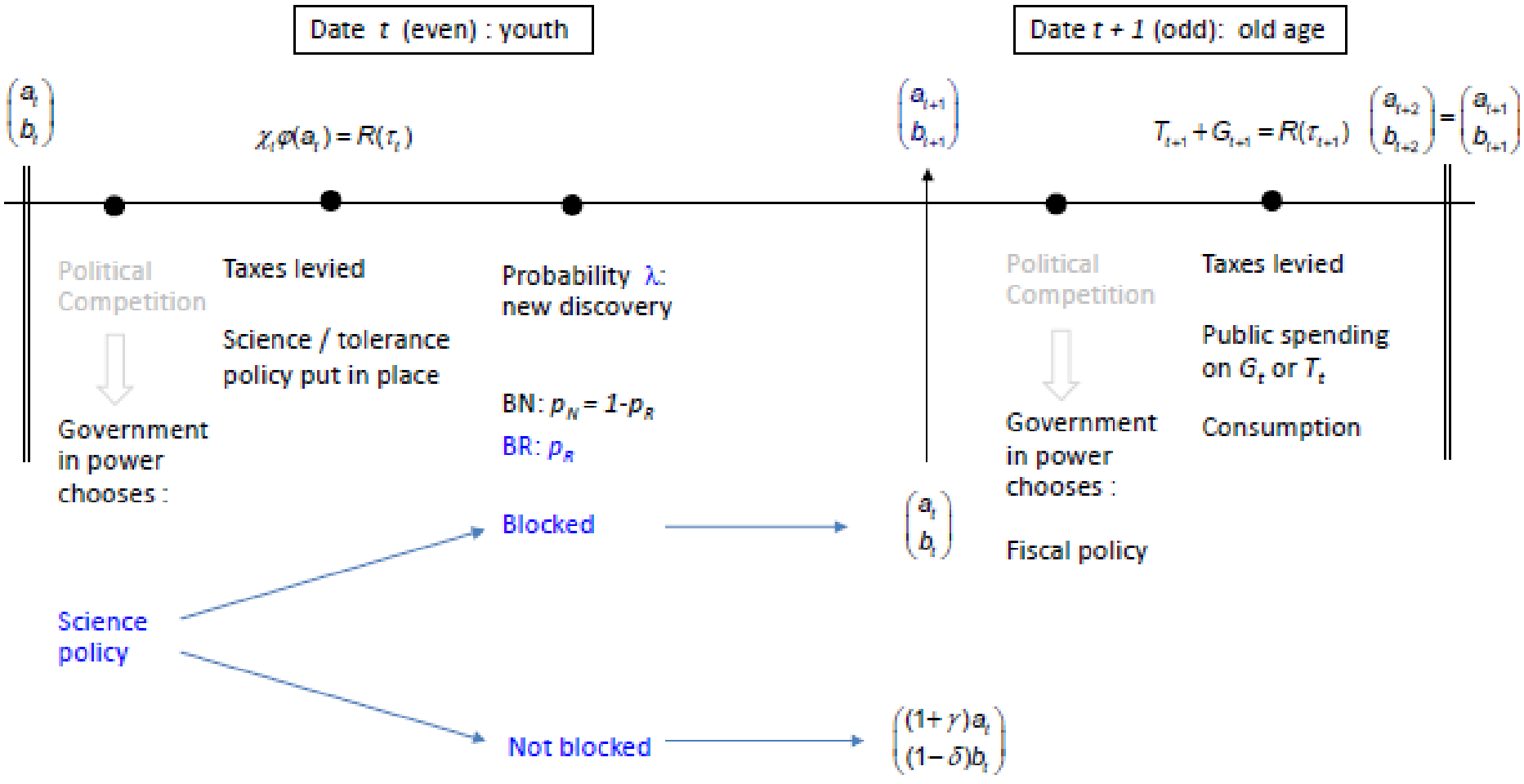
- Scientific discoveries: Poisson arrival rate λ, during the youth of each generation. Exogenous (domestic or from abroad), could endogenize
- If allowed to diffuse $\Rightarrow$ advances in practical knowledge & technology

$$\Rightarrow a_{t+1} = (1+\gamma)a_t$$

- May also contradict doctrine, sacred texts' statements about natural or social world $\Rightarrow$ shake and weaken the faith:
  - Fraction $p_R = 1 - p_N$ are belief-eroding (BR): if diffuse in population, erode religious capital $\Rightarrow b_{t+1} = (1-\delta)b_t$
  - Fraction p_N are belief-neutral (BN): no impact on b_t
  - Later on, allow for (exogenous) belief-enhancing (BE) shocks
- Blocking: religious majority or coalition may want to censor, deny, restrict access to, the new knowledge
  - Blocking can be targeted at BR innovations, is fully effective

$$\Rightarrow b_{t+1} = b_t, \text{ but also } a_{t+1} = a_t$$

Timeline


Date t (even) : youth
Date t + 1 (odd): old age
$\begin{pmatrix} a_t \\ b_t \end{pmatrix}$
$\chi_t \varphi(a_t) = R(\tau_t)$
$\begin{pmatrix} a_{t+1} \\ b_{t+1} \end{pmatrix}$
$T_{t+1} + G_{t+1} = R(\tau_{t+1})$
$\begin{pmatrix} a_{t+2} \\ b_{t+2} \end{pmatrix} = \begin{pmatrix} a_{t+1} \\ b_{t+1} \end{pmatrix}$
Political Competition
Taxes levied
Science / tolerance policy put in place
Probability λ: new discovery
BN: $p_N = 1\text{-}p_R$
BR: p_R
Government in power chooses :
Science policy
Blocked
Not blocked
$\begin{pmatrix} a_t \\ b_t \end{pmatrix}$
$\begin{pmatrix} (1+\gamma)a_t \\ (1-\delta)b_t \end{pmatrix}$
Political Competition
Taxes levied
Public spending on G_t or T_t
Consumption
Government in power chooses :
Fiscal policy

The Church / Religious Sector

- Small set of agents, drawn among the religious
- Whenever a *BR* scientific discovery occurs and diffuses through society, can attempt to "repair" the damage done to the faith:
  - Doctrinal adaptation through internal reform, e.g. working out reinterpretation of sacred texts, more compatible with scientific facts.
  - Can also take form of conflictual Reformation, schism or creation of new sects by competing faith entrepreneurs
- Treat here organized religion as a single actor, with preferences

$$\Gamma_t^i = \mathbb{E}_t \left[b_{t+1} G_{t+1} - \rho_t \eta b_t \right], \quad \rho_t \in \{0, 1\},$$

- Internalizes the religious utility $b_{t+1} G_{t+1}$ of the faithful.
  - Partially benevolent, or just capturing rents

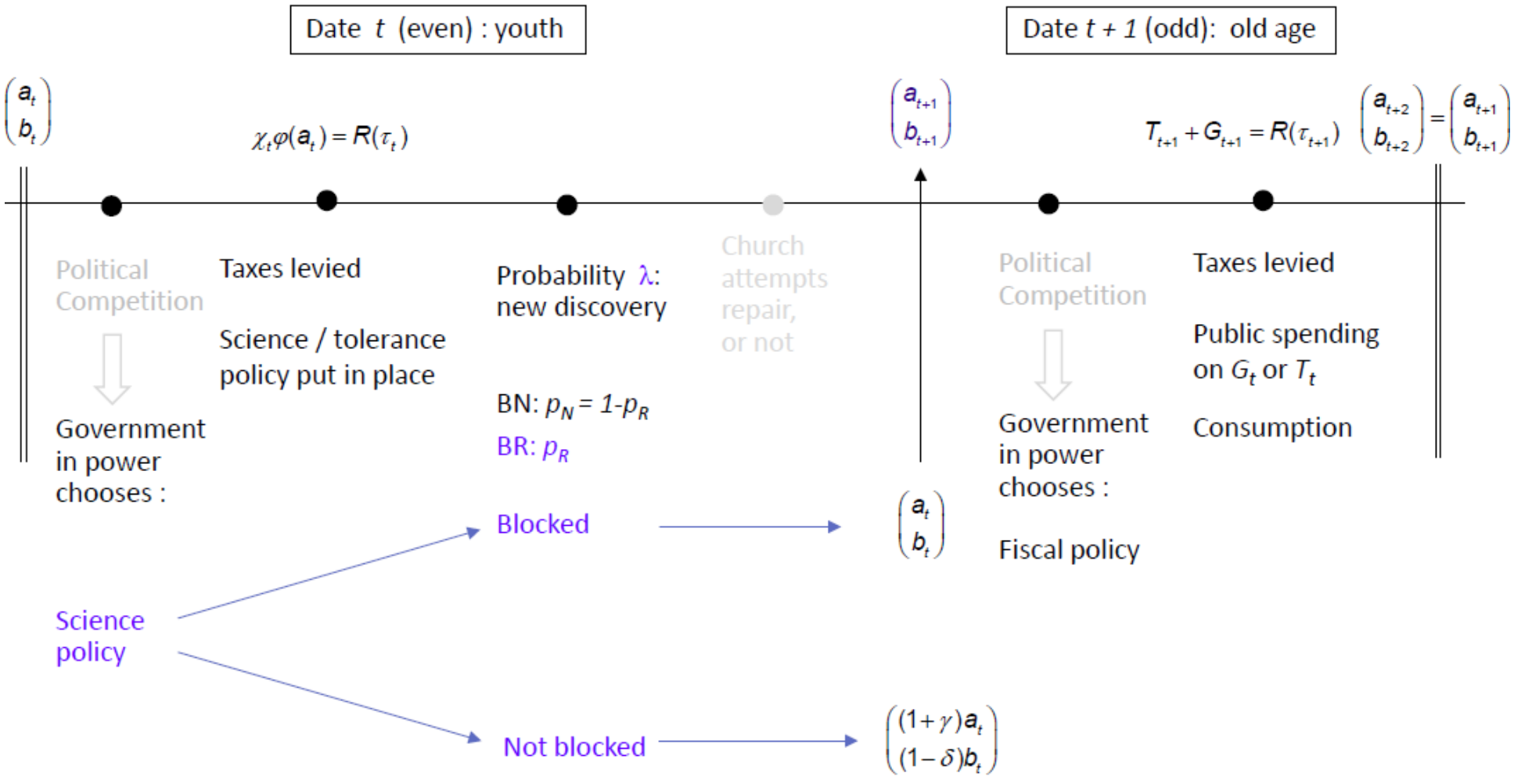
Doctrinal Adaptation - Repairing Beliefs

$$\Gamma_t^i = \mathbb{E}_t \left[b_{t+1} G_{t+1} - \rho_t \eta b_t \right], \quad \rho_t \in \{0, 1\},$$

- Incurs effort costs ηb_t if, following the diffusion of a *BR* innovation, it undertakes the work required to prevent b_t from eroding
- Succeeds with probability $q \Rightarrow b_{t+1} = b_t$

  Fails with probability $1 - q \Rightarrow b_{t+1} = (1 - \delta) b_t$
  - In either case: $a_{t+1} = (1 + \gamma) a_t$, as idea has diffused
- Empirical counterparts of η: key determinant is religious freedom:
  - Ease with which heterodox interpretations, new sects or cults are allowed to develop, and people to switch affiliation
  - State religion vs. competitive sector
  - Also: doctrine-specific features making adaptation easy/hard

Timeline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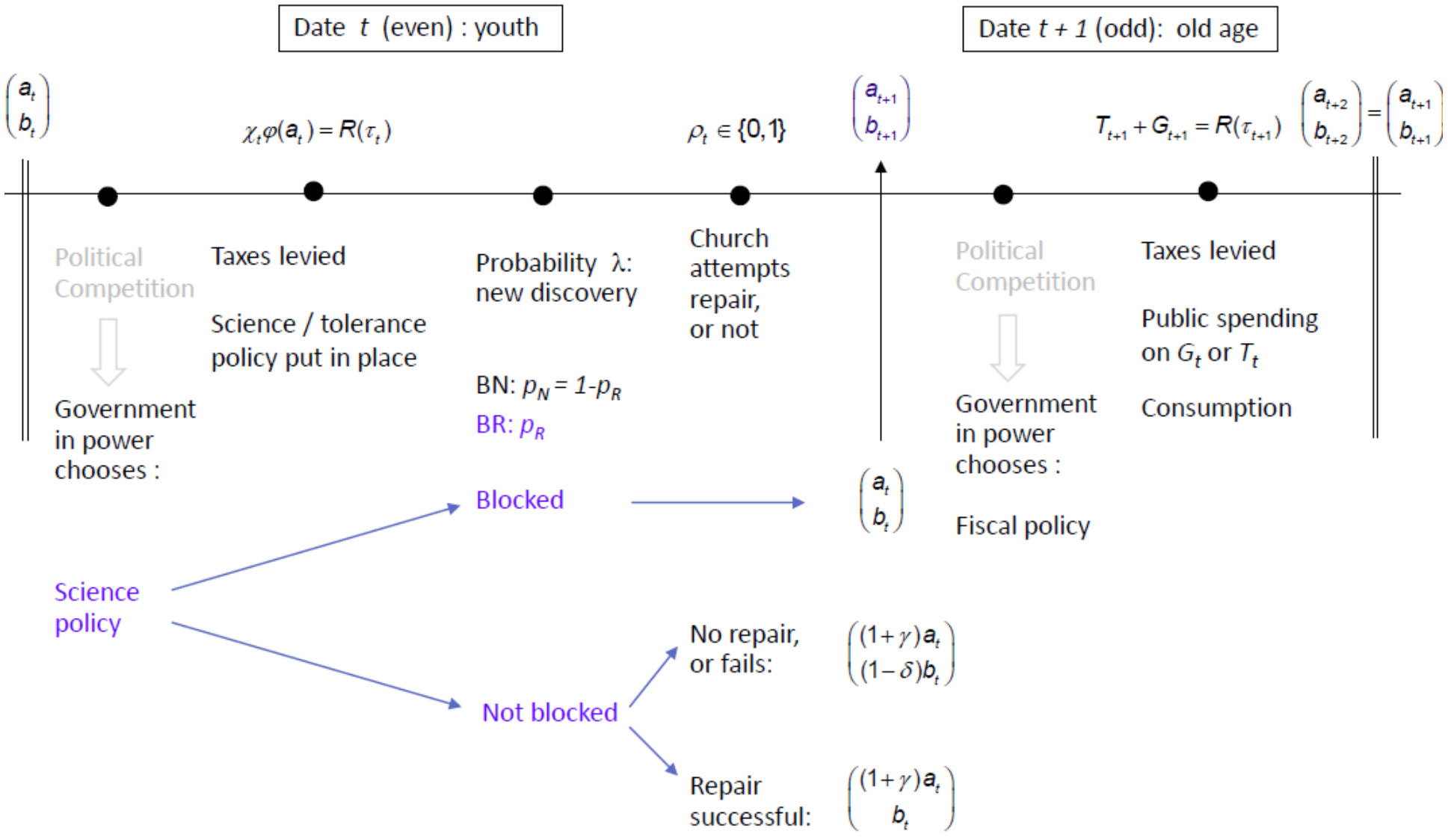
$T_{t+1} + G_{t+1} = R(\tau_{t+1})$
$\begin{pmatrix} a_{t+2} \\ b_{t+2} \end{pmatrix} = \begin{pmatrix} a_{t+1} \\ b_{t+1} \end{pmatrix}$
Political Competition
Government in power chooses :
Taxes levied
Science / tolerance policy put in place
Probability λ: new discovery
BN: $p_N = 1-p_R$
BR: p_R
Church attempts repair, or not
Blocked
$\begin{pmatrix} a_t \\ b_t \end{pmatrix}$
Science policy
Not blocked
$\begin{pmatrix} (1+\gamma)a_t \\ (1-\delta)b_t \end{pmatrix}$
Political Competition
Government in power chooses :
Fiscal policy
Taxes levied
Public spending on G_t or T_t
Consumption

Timeline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Science policy
Blocked
$\begin{pmatrix} a_t \\ b_t \end{pmatrix}$
Not blocked
No repair, or fails:
$\begin{pmatrix} (1+\gamma)a_t \\ (1-\delta)b_t \end{pmatrix}$
Repair successful:
$\begin{pmatrix} (1+\gamma)a_t \\ b_t \end{pmatrix}$

Equilibrium Fiscal Policy (date t+1)

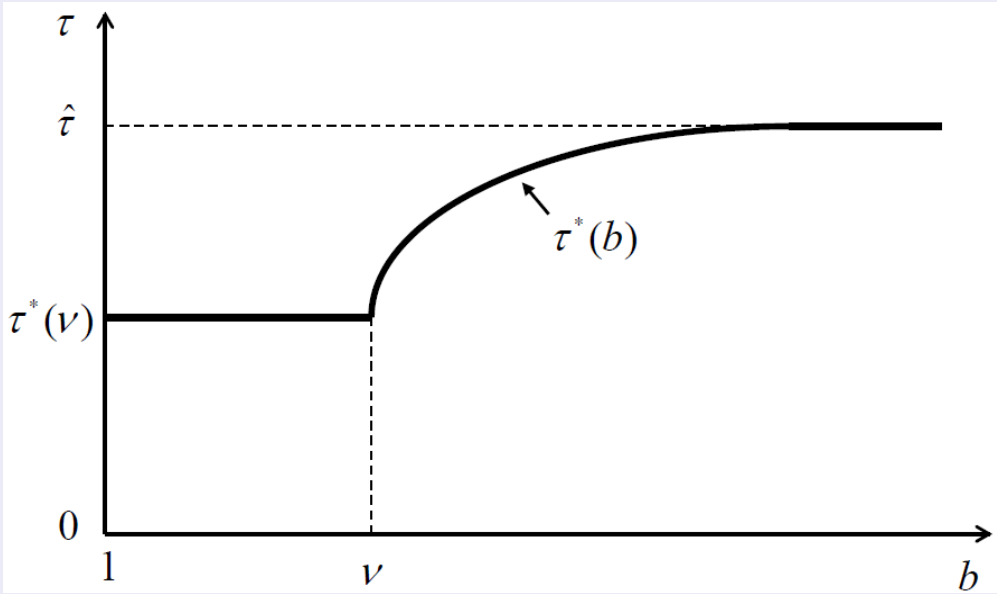
- No income differences $\Rightarrow$ religious majority rules

$$\max_{\tau,G} \{1-\tau+\nu\left[R(\tau)-G\right]+bG \mid 0 \leq G \leq R(\tau)\] \Rightarrow$$

$$\forall x, \text{ let } \tau^*(x) \text{ solve FOC} : xR'(\tau^*)=1$$

Proposition

(1) With religiosity b, tax rate in old age is:



(2) Spending on G is then $G(b;\nu)=0$ *if* $b<\nu$, $=R(\tau^*(b))$ *if* $b\geq\nu$

Church's Doctrinal Adaptation - Belief-Repairing

- Church cares about $bG(b;\nu) \Rightarrow$ beliefs worth more when strongly affect choice of $G \Rightarrow \pi \curvearrowright$ in b
- Working to repair the damage done to b by a BR innovation costs ηb, succeeds with probability $q \Rightarrow$ Church attempts iff

$$\pi(b,\nu) \equiv G(b;\nu) - (1-\delta)\, G((1-\delta)\, b;\nu) \geq \eta / q.$$

Proposition (repairing range)

(1) There exist unique $\underline{b}$ *and* $\bar{b}$, *such that the Church attempts repair after a belief-eroding innovation (not blocked by the state) iff b lies in* $[\underline{b}, \bar{b}]$.

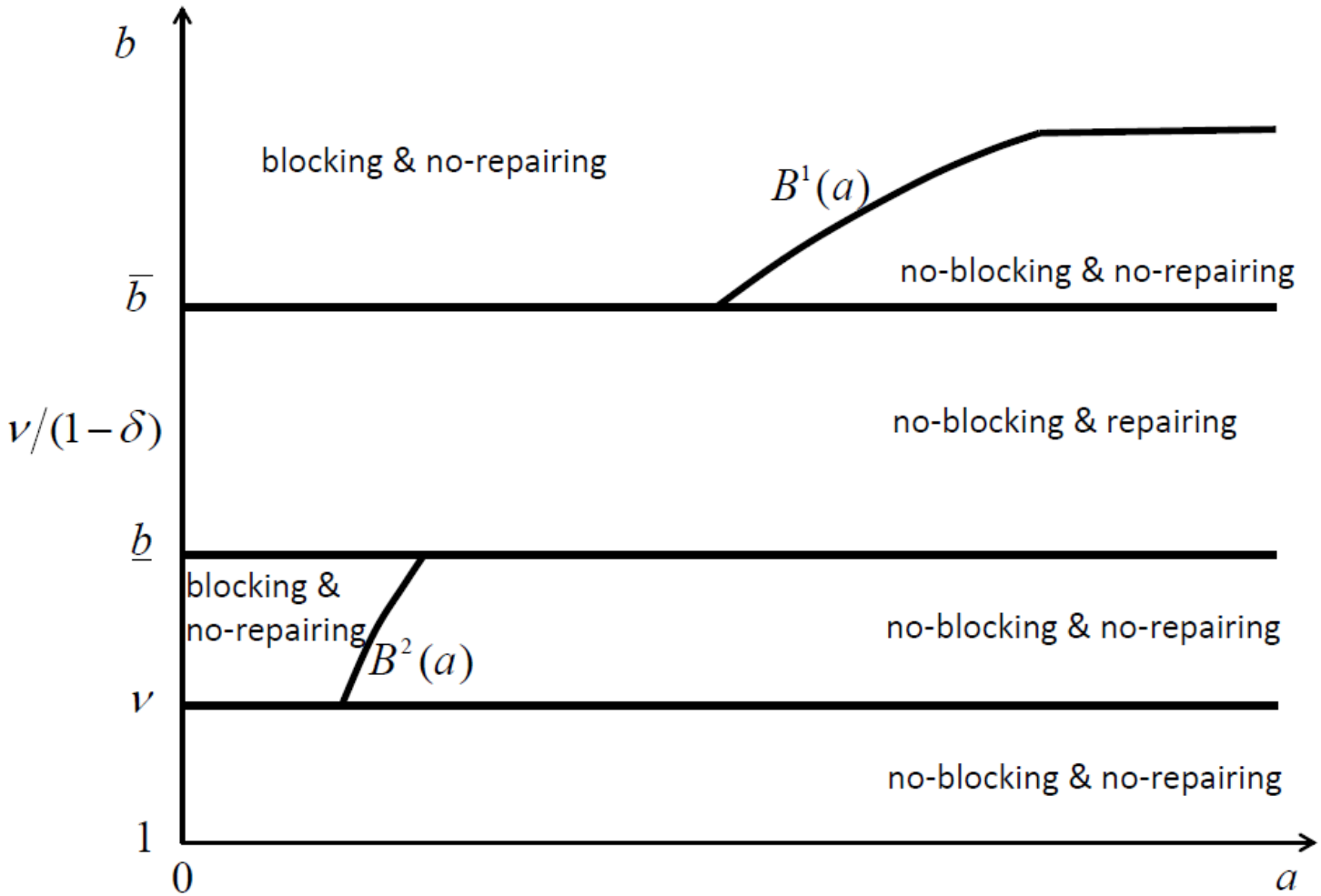
(2) $\nu \leq \underline{b} < \nu/(1-\delta) < \bar{b}$

State Policy Toward Science (date t)

- Decision at t : whether to invest in blocking potential BR discoveries. Tradeoff: option value of preserving religious capital vs. foregone TFP gains + setup cost of repressive apparatus
- Two clear cases in which clearly no point in blocking:
  - When $b < \nu$: religious agents themselves prefer secular public goods to religious ones, $\Rightarrow$ set $G(b, \nu) = 0$, derive no utility from organized religion. If b falls to $(1 - \delta)b$, no change
  - When $b \in [\underline{b}, \bar{b}]$: Church will attempt repair of unblocked BR innovations $\Rightarrow$ if sufficient likelihood $q \geq 1/(1 + \gamma)$ that will succeed, government prefers to "take a pass", let Church do the work
- Outside these two regions:
  - Net expected value of blocking $V^B - V^{NB} \nearrow$ in b Details
  - Cost of blocking $\varphi(a) \nearrow$ in $a \Rightarrow$

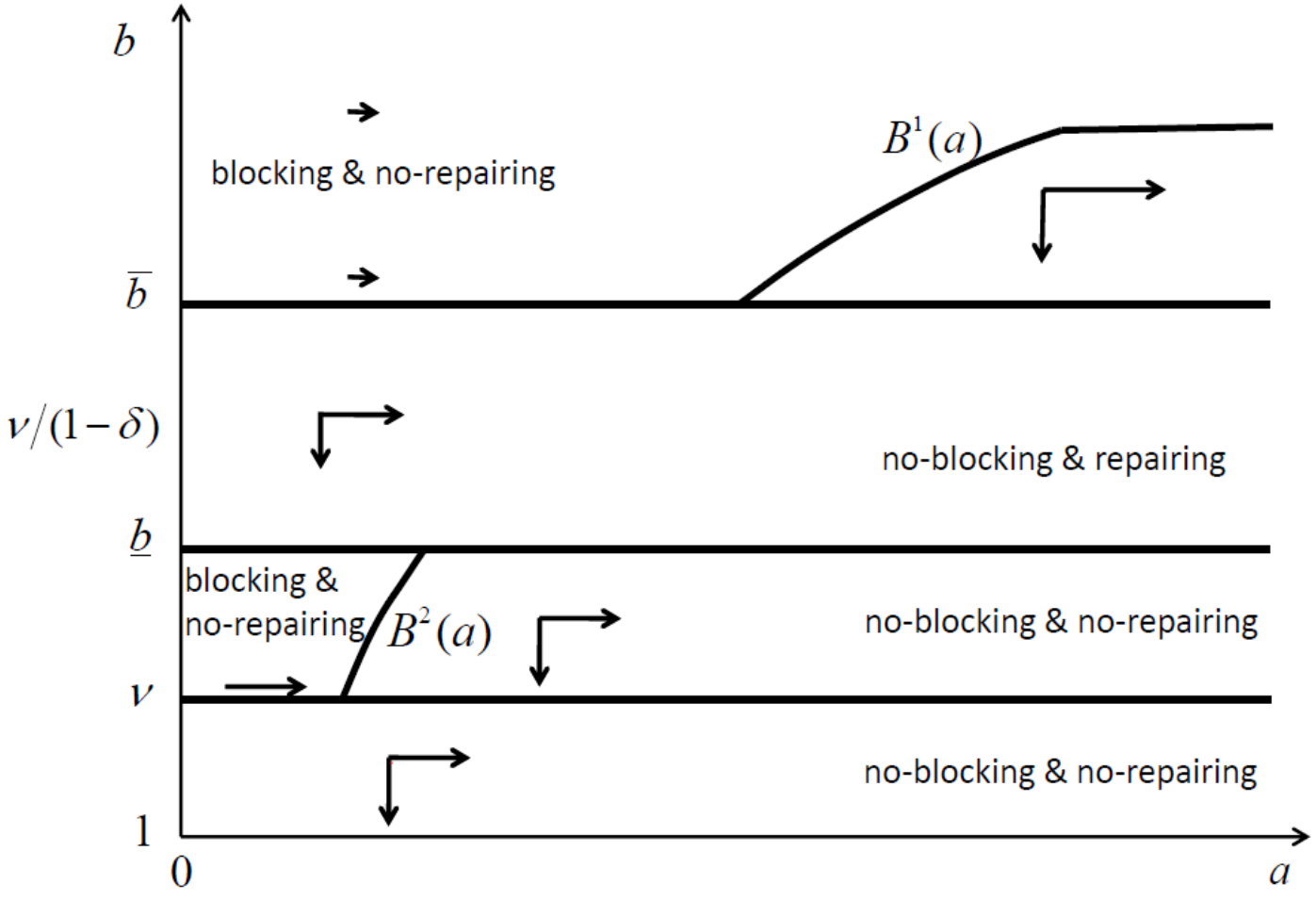
Proposition (state policy toward science)

Let $b \notin [0, \nu] \cup [\underline{b}, \bar{b}]$ *. Blocking occurs when* $b \geq B(a)$*, with* $B' > 0$*, i.e. when society is sufficiently religious, relative to its state of scientific and technical development*



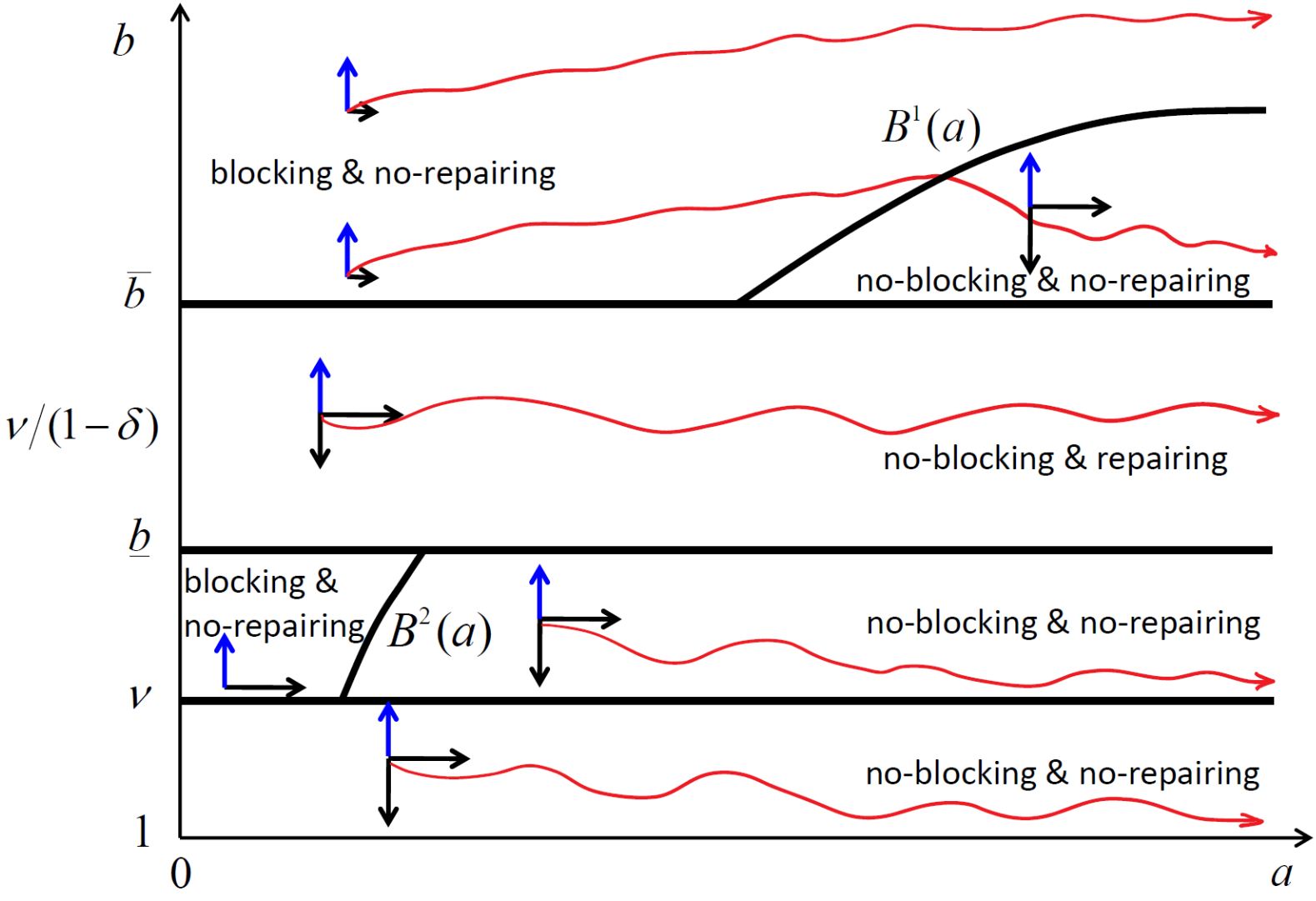
Dynamics of Scientific Progress and Religiosity

- Within-generation: done. Between, simplest case is where young inherit final stocks of knowledge and religiosity of the old: $(a_{t+2}, b_{t+2}) = (a_{t+1}, b_{t+1})$



Dynamics of Scientific Progress and Religiosity

- Religiosity-enhancing shocks: plague, earthquake, flood, war; cultural change, immigration. No link to science: $a_{t+2} = a_{t+1}$, $b_{t+2} = (1+\mu)b_{t+1}$ [prob. p_E] or $= b_{t+1}$



Average Trajectories in Each Regime

1. Non-blocking, non-repair "secularization" region: Western Europe, United States when b_t / a_t is low:

$$\begin{aligned} \mathbb{E}_t \left(a_{t+1} \right) / a_t &= 1 + \lambda \gamma, \\ \mathbb{E}_t \left(b_{t+1} \right) / b_t &= (1 - \lambda p_R \delta)(1 + p_E \mu) \end{aligned}$$

2. Non-blocking with repair region: United States for b_t / a_t moderately high, Singapore

$$\begin{aligned} \mathbb{E}_t \left(a_{t+1} \right) / a_t &= 1 + \lambda \gamma, \\ \mathbb{E}_t \left(b_{t+1} \right) / b_t &= \left[1 - \lambda p_R \left(1 - q \right) \delta \right] (1 + p_E \mu) \end{aligned}$$

3. Blocking region: theocratic regimes (Medieval Europe, Ottoman Empire, Ancient China, Pakistan), United States for b_t / a_t high:

$$\begin{aligned} \mathbb{E}_t \left(a_{t+1} \right) / a_t &= 1 + \lambda \left(1 - p_R \right) \gamma, \\ \mathbb{E}_t \left(b_{t+1} \right) / b_t &= 1 + p_E \mu \end{aligned}$$

Implications: Growth With and Without Secularization

- "Western Europe" and "United States" grow at the same rate $1 + \lambda\gamma$ (neither blocks), but
  - In WE, there is a downward trend in religiosity (with periodic upward shocks preventing degenerate long-distribution)
  - In US, can be mostly offset by adaptive response of the religious sector $\Rightarrow$ trendless fluctuations or slow-moving shifts in religiosity
- Provided a society is not excessively religious $(b < \bar{b})$, economic growth can thus occur both with and without secularization, as a result of endogenously different responses of religious sector $(\text{also } \eta)$
- In the "theocratic" region $b > \bar{b}$, religiosity trends up while knowledge and TFP stagnate, particularly if $\lambda_R \approx 1$.

IV - Inequality, Religion and the Politics of Science

- In each generation, $n < 1/2$ of rich agents, majority of poor.

  Pretax incomes θ_H or θ_L in both youth and old age,

$$\theta_L < \nu < \theta_H \quad \text{and} \quad \theta_H + (1-n)\,\theta_L \equiv 1$$

  - T never worth it for the rich $\Rightarrow$ can also interpret as pure transfers

- Income and religiosity distributed independently $\Rightarrow$ four groups:

  - Secular Poor, $SP = (1-n)(1-r)$, Secular Rich, $SR = n(1-r)$,

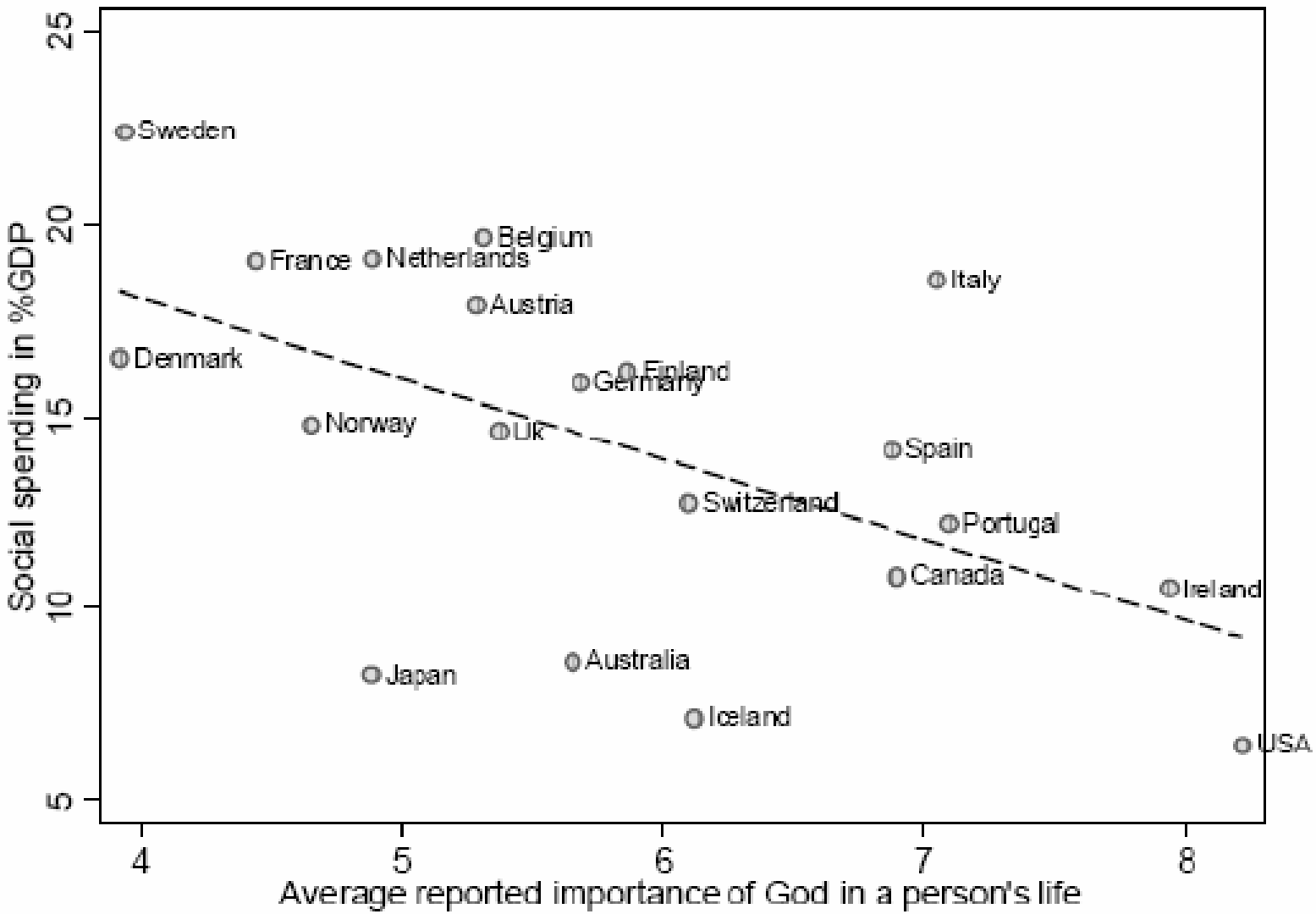
    Religious Poor, $RP = (1-n)r$, Religious Rich, $RR = nr$

- Assumption: Group's sizes (or power) ranked as:

$$SR < SP < SR + SP < RR < RP < 1/2 < 1 - n < r$$

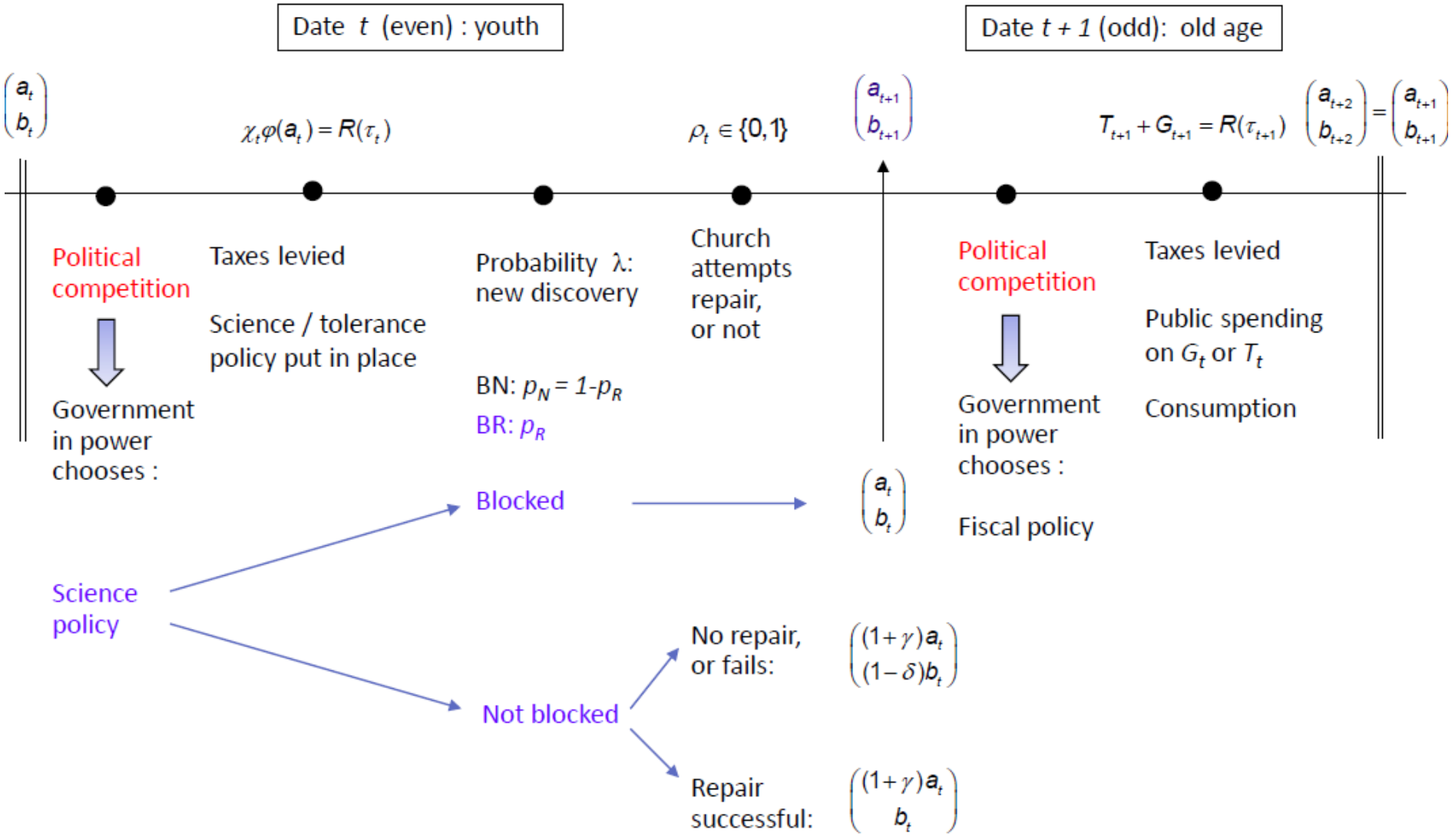
- Thus no group constitutes a majority on its own, but religious agents together, as well as poor agents together, do

Religion and Redistribution



Source: Scheve and Stasavage (2005)

Timeline


Date t (even) : youth
Date $t+1$ (odd): old age
$\begin{pmatrix} a_t \\ b_t \end{pmatrix}$
$\chi_t \varphi(a_t) = R(\tau_t)$
$\rho_t \in \{0,1\}$
$\begin{pmatrix} a_{t+1} \\ b_{t+1} \end{pmatrix}$
$T_{t+1} + G_{t+1} = R(\tau_{t+1})$
$\begin{pmatrix} a_{t+2} \\ b_{t+2} \end{pmatrix} = \begin{pmatrix} a_{t+1} \\ b_{t+1} \end{pmatrix}$
Political competition
Government in power chooses :
Taxes levied
Science / tolerance policy put in place
Probability λ: new discovery
BN: $p_N = 1\text{-}p_R$
BR: p_R
Church attempts repair, or not
Political competition
Government in power chooses :
Fiscal policy
Taxes levied
Public spending on G_t or T_t
Consumption
Science policy
Blocked
$\begin{pmatrix} a_t \\ b_t \end{pmatrix}$
Not blocked
No repair, or fails:
$\begin{pmatrix} (1+\gamma)a_t \\ (1-\delta)b_t \end{pmatrix}$
Repair successful:
$\begin{pmatrix} (1+\gamma)a_t \\ b_t \end{pmatrix}$

The Political Process

- Four groups $\Rightarrow$ forming coalitions required to gain power. Also, policy at $t+1$ is two-dimensional: level and mix of public spending
- Political competition –voting or open conflict– unfolds at t and $t+1$ according to variant of "citizen-candidate" model + PCPNE

  (Osborne-Slivinsky 1996, Besley-Coate 1997 + Bernheim et al. 1987)

1. In each social group, a randomly chosen member is selected as leader. Each then decides whether to make a bid for power or stay out
   - Fully strategic and forward-looking
2. Citizens (small) sincerely choose which active contender to support
3. If a leader gains support from 50%, he wins.
   - If not, runoff round or battle between the two with most support
4. Victorious leader implements his preferred policy.
   - No credible commitment to do otherwise.

Equilibrium Concept

- Citizen-candidate-type models typically feature many Nash equilibria, with different coalitions supporting different entry profiles

  $\Rightarrow$ Impose stronger requirement:

- Perfectly Coalition-Proof Nash Equilibrium (Bernheim et al. 1987) of the two-period (t and $t+1$) stage game played by each generation.

  Robust to joint deviations by any coalition that is itself

  - Self-enforcing
  - Dynamically consistent

- Prove unique PCPNE, solve as function of state variables (a, b)

- Here: show only main features & implications ⏩ Details

Whom Do the Religious Poor Side With ?

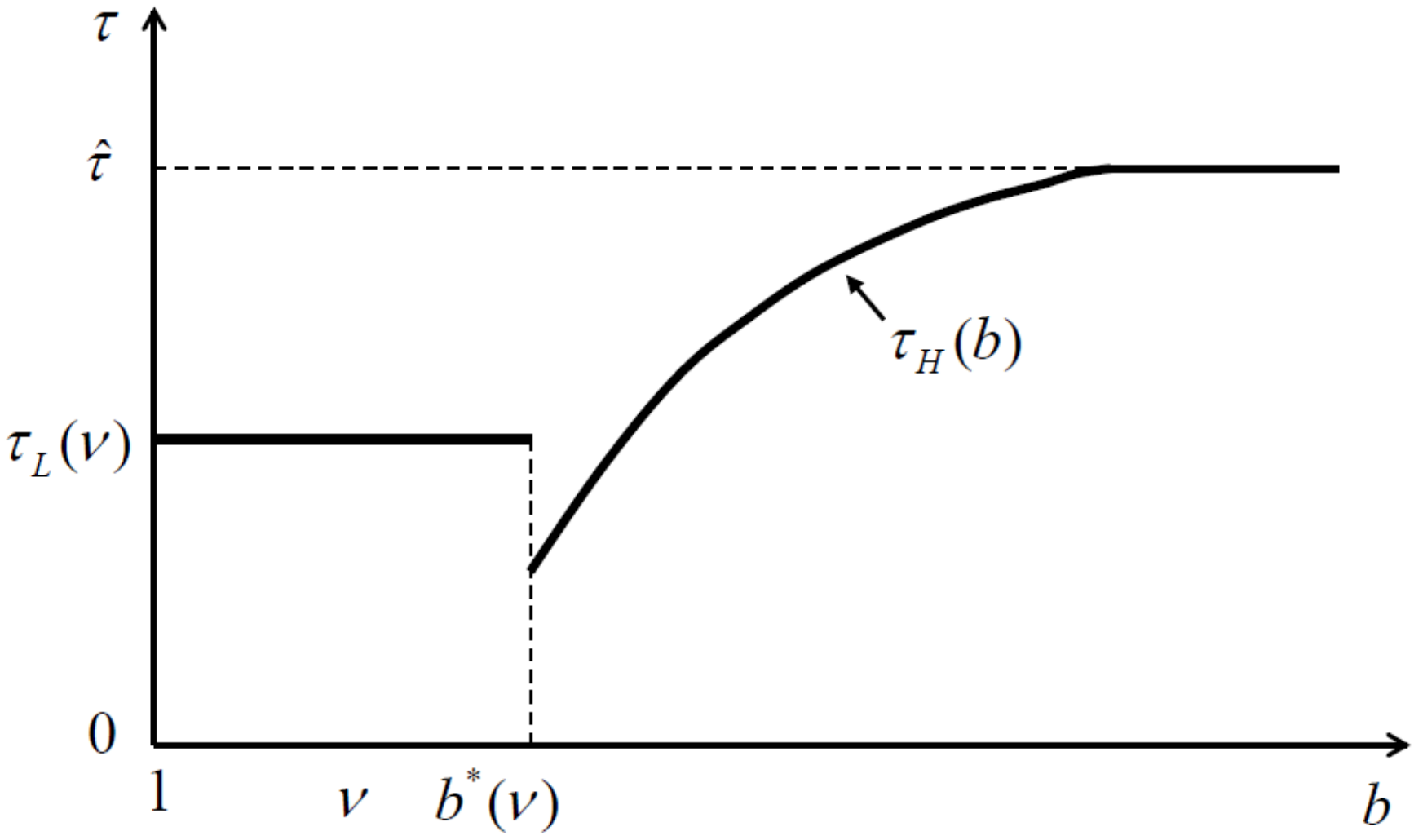
- When / if in power at $t+1$, the secular poor provide a lot of T and no G, the religious rich no T and a positive G, but (due to their distaste for taxes) at a level less than what the religious poor desire
  - T has value ν per unit, whereas G is complement to beliefs $b \Rightarrow$

Proposition (winning coalition at $t+1$)

The unique equilibrium outcome is characterized by belief threshold $b^*(\nu)$:

1. *If $b < b^*(\nu)$, the RP back the SP, who thus come to power and implement their ideal policy $\tau^*(\nu/\theta_L)$, with all revenue spent on T.*
2. *If $b \geq b^*(\nu)$, the RP back the RR, who thus come to power and implement their ideal policy $\tau^*(b/\theta_H)$, with all revenue spent on G.*
3. *$b^*(\nu)$ is increasing in ν, as well as in $\theta_H - \theta_L$,*

Whom Do the Religious Poor Side With?



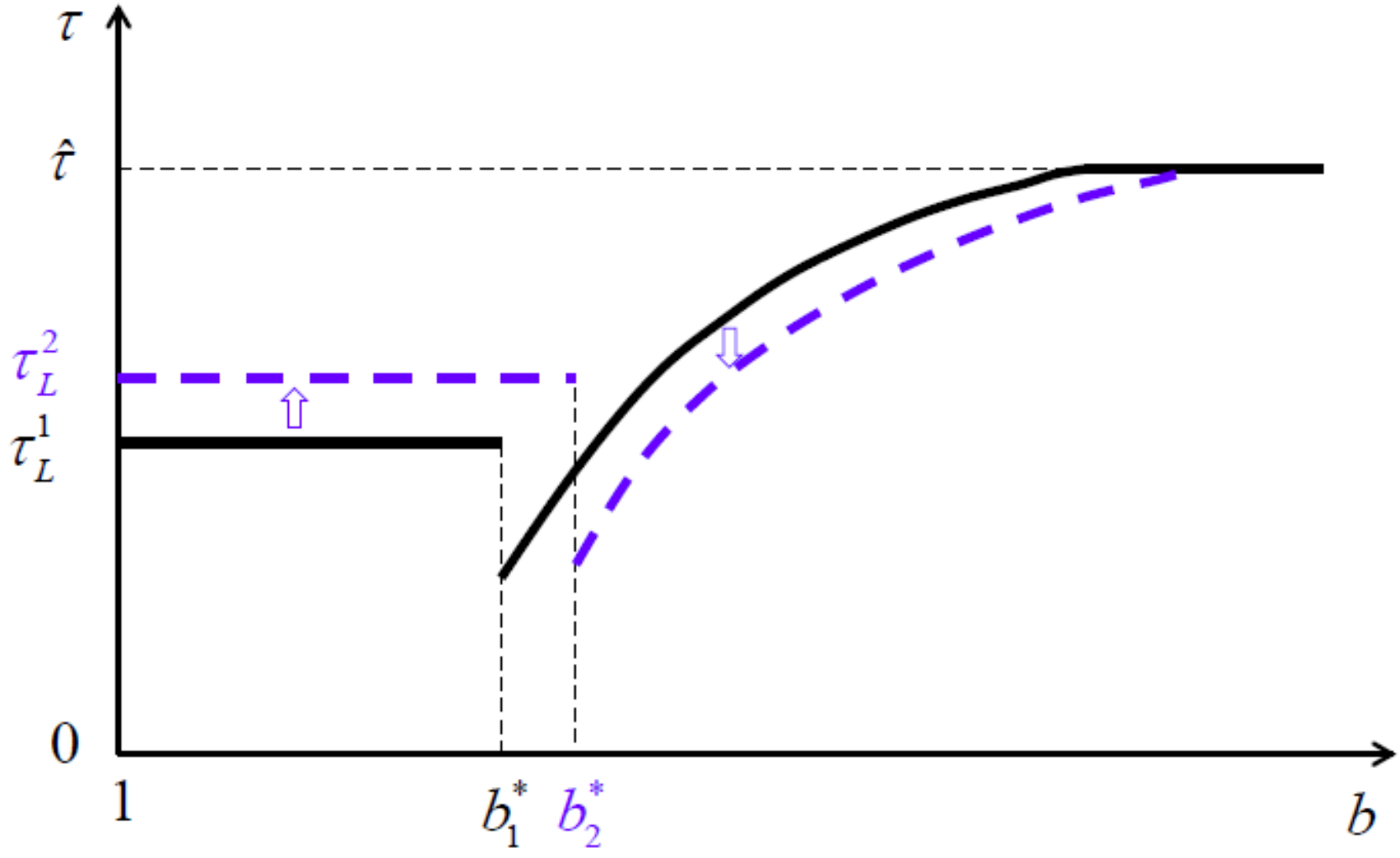
Religiosity and equilibrium tax rate

Key Implications

1. Religion as a "wedge" issue
   - In countries with low religiosity, secular governments come to power, implement welfare-state policies that (mostly) benefit the poor
   - Such countries tax more and have a larger public sector than somewhat more religious ones, such as the US, which provide not only a different set of public goods but also at a lower level
   - In latter countries, religion splits the usual pro-redistribution coalition of the poor. Decisive class is then not only more religious, but also richer

2. Fiscal effects of greater income inequality:
   - Higher taxes and government spending in low-religiosity countries (WE)
   - Lower levels of both (and different mix) in more religious ones (US)

Effect of Increased Inequality Depends on Religiosity



Mean-preserving spread in incomes: $nd\theta_H + (1-n)d\theta_L = 0$

- Church: Doctrinal Adaptation
  - Same basic intuition as before: expected return highest when $b \searrow$ would have large effect on $G \Rightarrow \pi(b)$ is single-peaked
  - Even sharper now: at $b^*(\nu)$, power switches from *RR* to *SP* $\Rightarrow G \downdownarrows 0$

Proposition (Church policy and income inequality)

(1) There exist a unique $\underline{b}$ *and* $\bar{b}$*, such that the Church attempts repair of a belief-eroding innovation (not blocked by the state) iff* $b \in [\underline{b}, \bar{b}]$ *.*

(2) Both $\underline{b}$ *and* $\bar{b}$ *rise with income inequality (m.p.s. in* θ*)*

- State: Blocking Ideas
  - Costs same as before (taxes at t to finance repressive apparatus, foregone TFP at $t+1$), but incidence is different for rich and poor
  - Benefits now differ not only between secular and religious but also by income, as erosion of beliefs can trigger reallocation of power from (religious) rich to (secular) poor at $t+1$

Equilibrium Blocking Policy (date t)

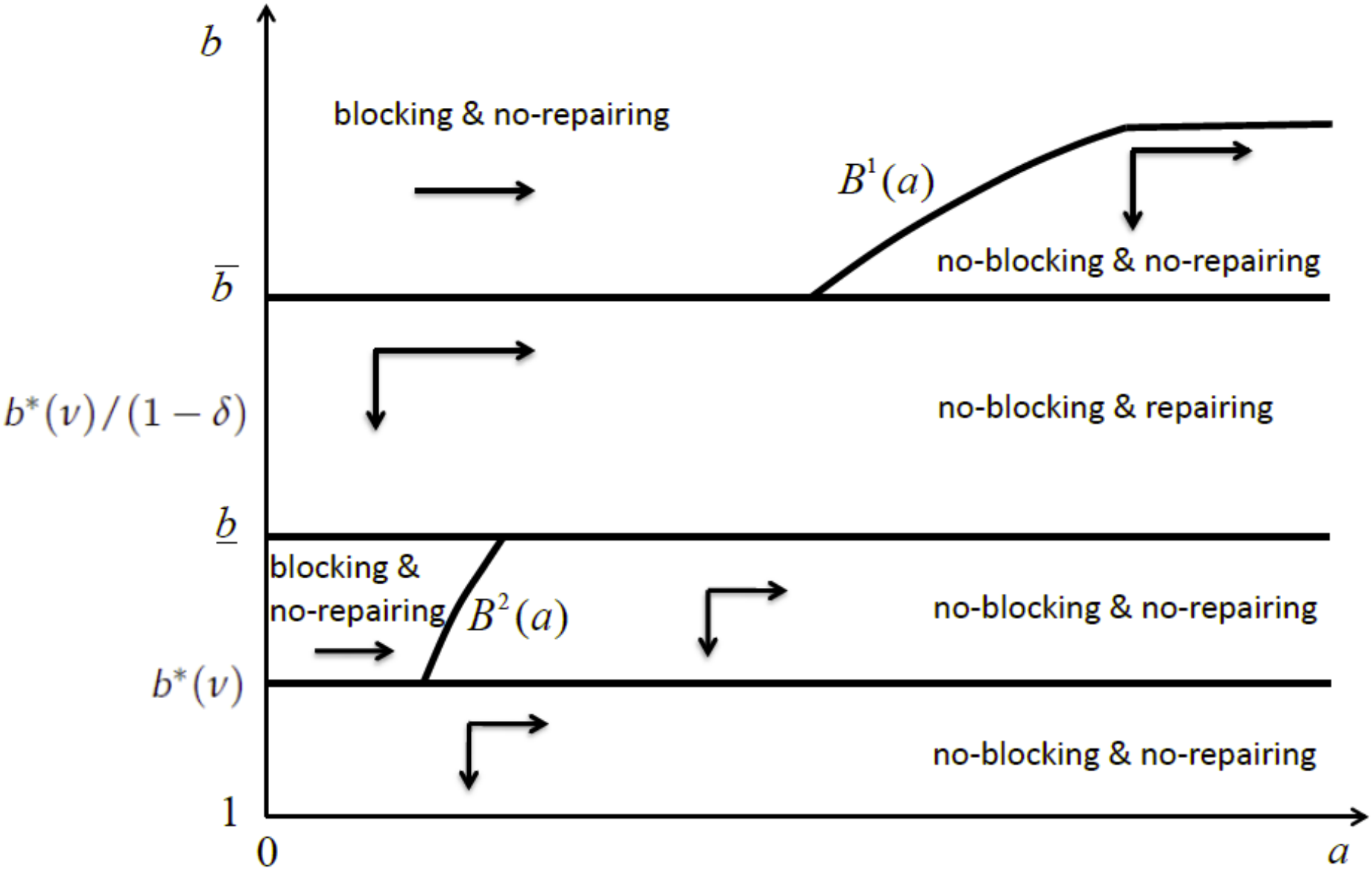
- Study, compare the four groups' blocking prefs. $\Rightarrow$ show that:
  1. The *SP* never want to block; nor do the *SR*, if γ is large enough
  2. No point in blocking when expect no fiscal policy conflict, $b < b^*(\nu)$, or that Church will repair, $b \in [\underline{b}, \bar{b}]$
  3. Whenever the *RR* want to block, then so do the *RP*

$\Rightarrow$The *RR* are always pivotal in the date-t political competition

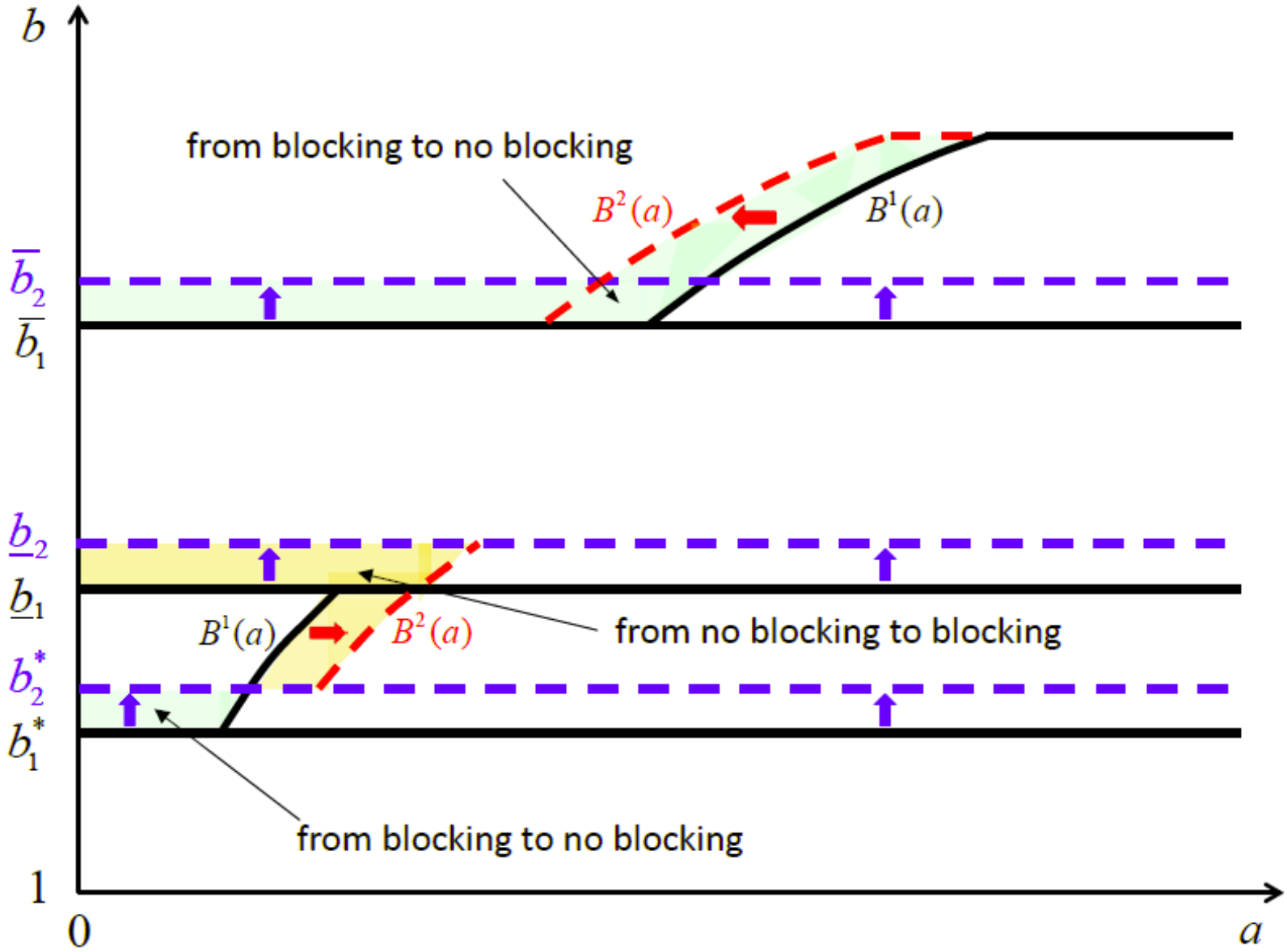
Proposition (winning coalition at t)

1. *The unique Perfectly Coalition-Proof Nash Equilibrium of the two-period game always implements the preferred science and knowledge policy of the religious rich.*
2. *The corresponding blocking boundary is an upward-sloping line $b = B(a)$ in the state space*

Phase Diagram with Inequality



Income Inequality and Science Policy



Mean-preserving spread in incomes: $nd\theta_H + (1-n)d\theta_L = 0$

Proposition (Inequality and the politics of science)

(1) In the "American" regime (intermediate b/a), greater income inequality $\Rightarrow$ more blocking of "threatening" scientific findings, and to (weakly) greater doctrinal rigidity (less adaptation) of the religious sector.

(2) At high enough levels of religiosity, corresponding to "theocratic" regimes, it has the opposite ("Arab Spring") effects.

- Inequality $\rightsquigarrow$ emergence of Religious-Right alliance
  1. At $t+1$, *RP* will support *RR* and their low-tax policy against own class interest (represented by *SP*) only if sufficiently religious$\Rightarrow$
  2. At t, *RP* have forward-looking incentive to "keep them religious" $\Rightarrow$ may want to block belief-eroding ideas, even though doing so is more costly to the rich (tax burden & foregone TFP)
  3. This incentive is stronger, the more redistribution would occur at $t+1$ if the *RP* (lacking faith) allied themselves with the *SP* instead –hence, the greater is income inequality $\theta_H - \theta_L$

Summary of Main Results

1. "Secularization" (Western Europe): declining religiosity, no repairing of beliefs, unimpeded knowledge, TFP
   - High taxes, public spending / policies tilted to secular, redistribution
2. "Theocracy" (Iran, Pakistan): very high religiosity, doctrinal rigidity, blocking of knowledge, TFP stagnation.
   - High taxes, public spending / policies tilted to religious
3. "Coexistence" (US): medium-high religiosity, adaptation of beliefs, usually unimpeded knowledge, TFP
   - Low taxes, fiscal or other policies tilted to religious
4. Inequality & Religious Right: rising inequality can lead to strategic coalition between (religious) rich and religious poor:
   - Former block science that would erode the beliefs of the latter
   - Latter then prefer low taxes + religion-tilted policies to high redistribution, favored by secular poor

Remarks

- Leading examples of "forbidden fruits" discussed involved the hard sciences on the one hand, religion stricto sensu on the other
- Clear from the model that both concepts should be taken in a much more general sense:
  1. Lysenkoism (official science in Soviet Union, 1935 to1964)
  2. Modern contraception (religions & states proscribed, then "adapted")
  3. Other examples, e.g. from social sciences, economics (China)
- It is largely the scientific method itself, with its emphasis on systematic doubt, contradictory debate and empirical falsifiability, that inevitably runs afoul of preestablished dogmas
- Could use model to study interactions between
  - Other types of radically new ideas: (social, political)
  - Threatened beliefs & interests (cultural, ideological, corporate)

Directions for Further Research

- Besides being source of utility for some, religiosity may also
  - Promote certain forms of human capital accumulation
  - Induce greater trust and trustworthiness among individuals
  - Legitimize authority of ruler or state $\Rightarrow$ reduce agency problems

  Tradeoff with allowing belief-eroding ideas to diffuse would remain $\Rightarrow$ likely hill-shaped relationship between religiosity and growth

- Interstate conflict: strong religiosity, state-church links, can be
  - Valuable assets in short to medium run: increase people's willingness to fight and die for the cause
  - In long run, a drag on scientific knowledge and technological innovation, leads to military backwardness (Ottoman Empire)

- Empirics: inverse relationship between religiosity and innovation, found across countries & US states, deserves further investigation.

Education vs. Innovation: the Jesuits

- *To keep ourselves right in all things, we ought to hold fast to this principle: What I see as white I will believe to be black if the hierarchical church thus determines it."*

  (Ignatius de Loyola, founder of Jesuit order – Spiritual Exercises (1522-1524), 13th Rule).

- *One should not be drawn to new opinions, that is, those that one has discovered,... [but instead] adhere to the old and generally accepted opinions... and follow the true and sound doctrine".*

  (Benito Pereira, Jesuit theologian and member of the Collegio Romano, 1564)

- *"We consider this proposition [that a line is composed of indivisible, infinitesimal points] to be not only repugnant to the common doctrine of Aristotle, but that it is by itself improbable, and... is disapproved and forbidden in our Society"*

  (Revisors General of the Collegio Romano, in numerous rulings)

Source: A. Alexander "Infinitesimal: How a Dangerous Mathematical Theory Shaped the Modern World" (2014)

Education vs. Innovation: the Jesuits

Claudio Aquaviva, fifth general of the Jesuits (1580-1615) and promulgator of the Ratio Studiorum (1586):

- *One should have as the primary goal in teaching to strengthen the faith and to develop piety. Therefore, no one shall teach anything not in conformity with the Church and received traditions, or that can diminish the vigor of the faith or the ardor of a solid piety."*

  "Let us try, even when there is nothing to fear for faith and piety, to avoid having anyone suspect us of wanting to create something new or teaching a new doctrine.

  Therefore no one shall defend any opinion that goes against the axioms received in philosophy or in theology, or against that which the majority of competent men would judge is the common sentiment of the theological schools.

Science and Islam Today

- Top 46 Muslim countries produced 1.17% of world scientific literature, vs. .48% for Spain
- Top 20 Arab countries produced 0.55%, vs. 0.89% for Israel
- Among 28 lowest producers of scientific articles in 2008, half were members of Organization of Islamic Cooperation
- Pakistan's one Nobel prize (physicist) is member of sect declared heretical in 1974. Banned from setting foot on any university campus
- Major University in Islamabad: 3 mosques + 1 planned, no bookstore
- Books translated per year into Arabic: 330
- Patents by Pakistan over 43 years: 8

Source: Pervez Hoodbhoy (2007)

Equilibrium Fiscal Policy (date t+1)

- Religious majority sets taxes and spending:

$$\max_{\tau,G} \ \{1-\tau+\nu\left[R(\tau)-G\right]+bG \mid 0\leq\tau\leq\hat{\tau},\ G\leq R(\tau)\}$$

- Define, $\forall x$, solution in τ to FOC $xR'(\tau)=1$ as

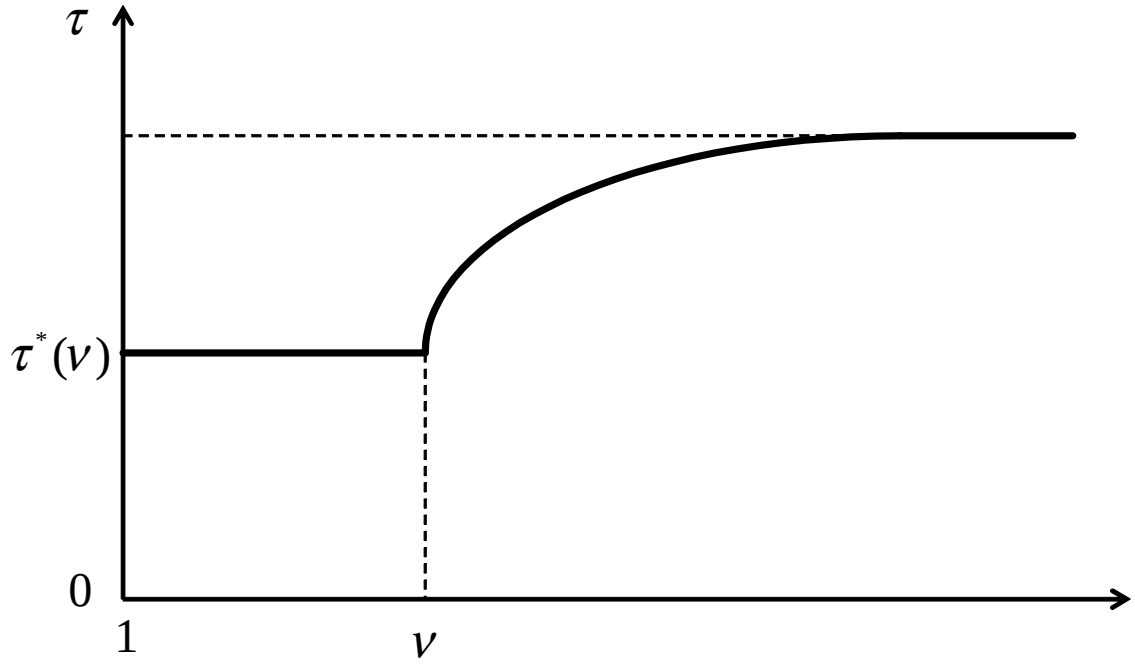
$$\tau^*(x)\equiv(R')^{-1}(1/x), \quad \text{strictly } \nearrow \text{ in } x$$

Proposition (fiscal outcome)

The fiscal policy implemented in the second period is:

(1) If $b<\nu$, then $(\tau,T,G)=(\tau^*(\nu),R(\tau^*(\nu)),0)$, with $\tau^*(\nu)$ and $R(\tau^*(\nu))$ increasing in ν.

(2) If $b\geq\nu$, then $(\tau,T,G)=(\tau^*(b),0,R(\tau^*(b)))$, with $\tau^*(b)$ and $R(\tau^*(b))$ increasing in b until $\tau^*(b)$ reaches $\hat{\tau}$ and constant afterwards



equilibrium tax rate as a function of religiosity

- Denote second-period equilibrium spending on G as

$$G(b,\nu) \equiv \begin{cases} 0 & \text{if } b < \nu \\ R(\tau^*(b)) & \text{if } b \geq \nu \end{cases}$$

Value of Successful Adaptation

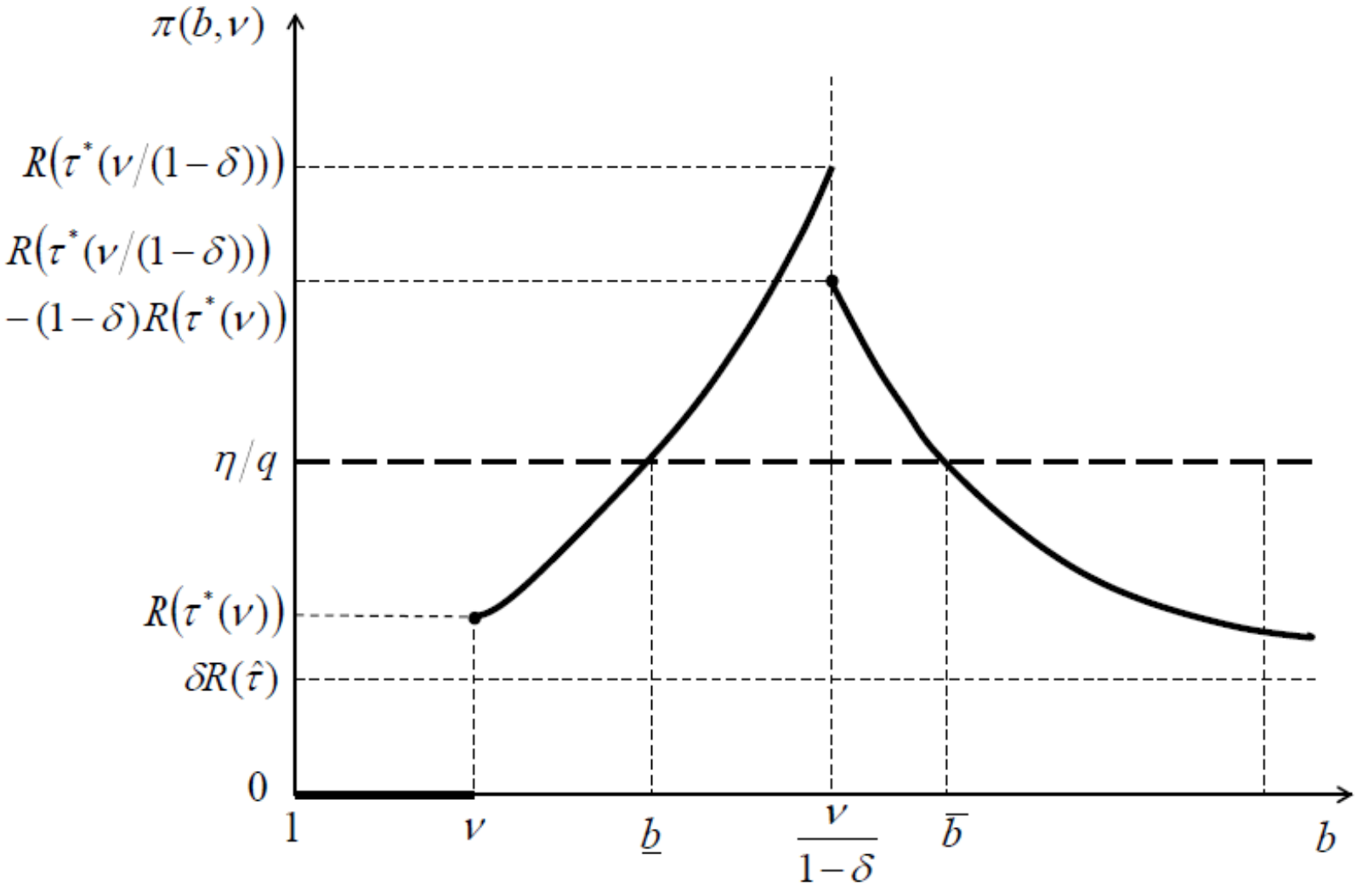


Figure: Church's expected value of repairing beliefs

Blocking Decision

- Religious agents' old-age utility when gvt. finances a public good which they value at u per unit, relative to the numeraire:

$$V(u) \equiv 1 - \tau^*(u) + uR(\tau^*(u)),$$

  setting tax rate at optimal $\tau^*(u)$.
- In equilibrium, u will equal $\max\{(1-\delta)b, \nu\}$. Thus, block when

$$\begin{aligned} R^{-1}(\varphi(a)) &\leq \Delta(b) \equiv \lambda p_R \left[V(b) - (1+\gamma) V\left(u'\right)\right] \\ &= \lambda p_R \{1 - \tau^*(b) + bR(\tau^*(b)) \\ &\quad - (1+\gamma)\left[1 - \tau^*(u') + \nu R\left(\tau^*(u')\right)\right]\} \end{aligned}$$

- Show that wherever $\Delta(b) > 0$, it is strictly increasing

Equilibrium Fiscal Policy (date t+1)

1. Preferred policies of each of the four groups
2. Outcome that emerges from political competition

Lemma (fiscal preferences of the poor)

(1) The ideal policy of the secular poor is $\tau_L(\nu) = \tau^*(\nu/\theta_L)$, *with all revenue spent on* T.

(2) The ideal policy of the religious poor is the same if $b < \nu$.
If $b \geq \nu$ *it is* $\tau_L(b) = \tau^*(b/\theta_L)$, *with all revenue spent on* G.

Lemma (fiscal preferences of the rich)

(1) The ideal policy of the secular rich is $\tau = T = G = 0$.

(2) The ideal policy of the religious rich is the same if $b < \theta_H$.
If $b \geq \theta_H$, *it is* $\tau_H(b) = \tau^*(b/\theta_H)$, *with all revenue spent on* G.