Innovation, the Church, and WEIRD Psychology

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Does Religion Affect Innovation?

- **Negative effects** due to religious dogma or legal institutions
  - Benabou Ticchi Vindigni 2022, Kuran 2011, Squicciarini 2020
- **Positive effects** due to growth, cooperation, or human capital promoting attitudes
  - Weber 1905, Barro McCleary 2003, Guiso Sapienza Zingales 2003, Becker Woessmann 2009, Levy Razin 2012, Botticini Eckstein 2012, Henrich 2020

This Paper: Main Findings

- **Setting:** the medieval Catholic Church and innovation in Europe
- **Data:** spread of medieval Western Church's bishoprics (Schulz 2022, Schulz + 2019)
- Two complementary analyses:
  - **OLS analysis** of contemporary patenting across fine-grained grid cells ($\approx$ 12km$\times$12km)
  - **Event-study analysis** of historical innovation and growth outcomes (e.g, notable people)
- **Main findings: exposure to the medieval Catholic Church spurs innovation**
  - 0.15 s.d. more patents per capita today if 1 s.d. greater exposure to the medieval Church
  - More notable people in science and arts in centuries after a bishopric was established

This Paper: Mechanism

- **Hypothesis:** Church undermined intensive kinship, with conducive effects for innovation
  1. **Changes in social structure:** broader and more integrated social networks, facilitating transmission and recombination of existing knowledge (de la Croix Doepke Mokyr 2018)
  2. **Changes in psychology:** more individualistic, analytic and less obedient, conformist psychology, traits conducive for innovation (Schulz + 2019, Henrich 2020)

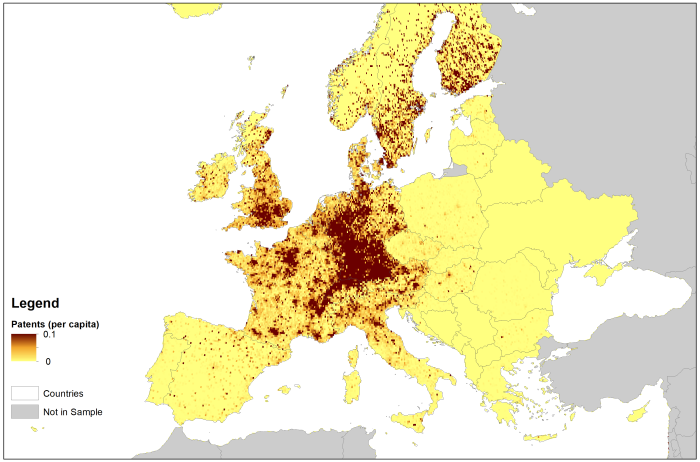
- Three additional analyses suggest this mechanism can partially explain the main finding:
  - Effect strongest where bishops attended councils dealing with **anti-incest legislation**
  - **RDD analysis** around the borders of the **Carolingian Empire**, where King Pepin and Emperor Charlemagne heavily enforced incest prohibitions
  - **Mediation analysis** suggest the effect is partially explained by more **extensive social networks** and greater prevalence of **WEIRD psychological traits**

OLS Estimates: Contemporary Innovation

Contemporary Innovation Outcome: Patents per Capita

- Geocoded worldwide patent data from **?**
  - 18.8 million patent filings from 1980s to present
- The dataset records the first filing of a patent only to avoid double counting of patents filed in several countries
- Location identified as coordinates through the address of the inventor
- We calculate absolute and per-capita number of patents across $0.125^\circ \times 0.125^\circ$ grid cells
  - If a patent as more than one inventor who live in different grid cells, we count the patent in each of these grid cells
- Gridded population data from CIESIN Columbia University (2018)

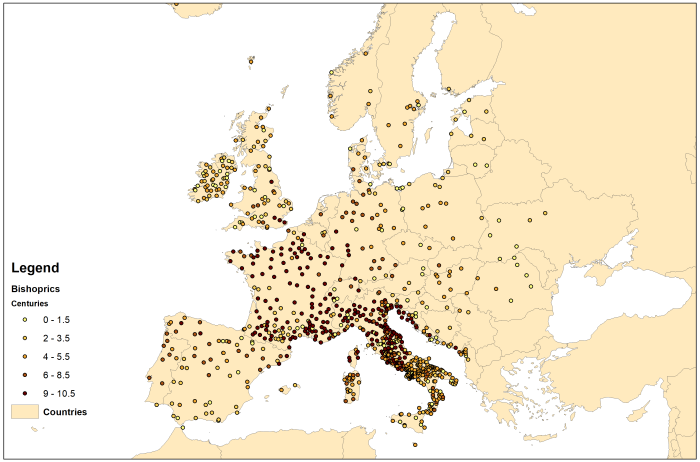
Geography of Contemporary Patenting across Grid Cells in Europe



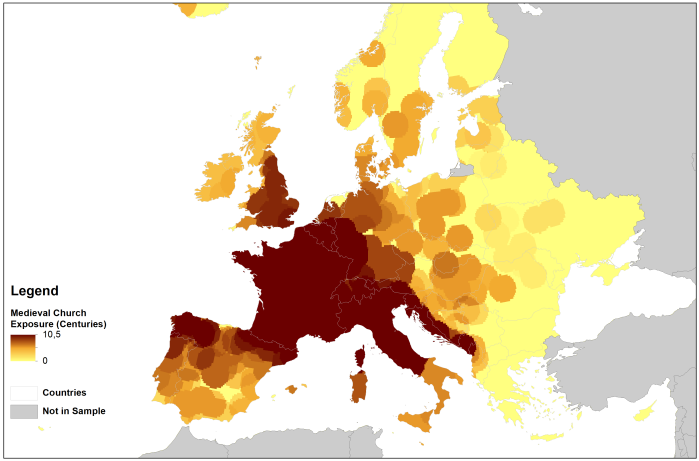
Independent Variable: Exposure to the Medieval Catholic Church

- The number of centuries at least one bishopric existed within a 100 km radius from the centroids of the $0.125^\circ \times 0.125^\circ$ grid cells
- Data and methodology from Schulz (2022) and **?**

Medieval Church Exposure: Bishoprics Locations



Geography of Medieval Church Exposure Across Grid Cells

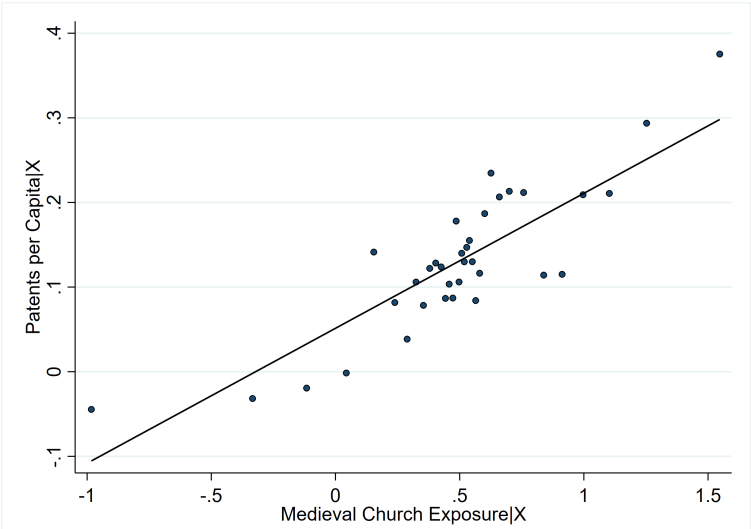


Contemporary Patenting and Medieval Church Exposure

	Patents per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
Medieval Church Exposure	0.15***	0.20***	0.16***	0.15***	0.16***	0.10***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.06)	(0.03)
Country FE	No	Yes	Yes	Yes	Yes	Yes
Latitude/Longitude	No	No	Yes	Yes	Yes	Yes
Geographic Controls	No	No	No	Yes	Yes	Yes
Additional Controls	No	No	No	No	Yes	Yes
Administrative Regions FE	No	No	No	No	No	Yes
Adjusted-R^2	0.02	0.09	0.09	0.09	0.10	0.12
Observations	75131	75131	75131	75131	75131	75131

Latitude and longitude polynomial is of a second order. Geographic controls are mean elevation, terrain ruggedness, caloric agricultural suitability, distance to coast or river, temperature and precipitation annual mean and standard variation. Additional controls include region area, population, distance to the closest roman road, distance from Wittenberg.

Contemporary Patenting and Church Exposure: Binned Scatter Plot



Contemporary Patenting and Suppressed Medieval Bishoprics

	Patents per capita					
	All Sample					UK and DEU
	(1)	(2)	(3)	(4)	(5)	(6)
Years since first Bishopric	0.16***	0.23***	0.20***	0.19***	0.20***	0.23***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.07)
Years Bishopric Suppressed	-0.04***	-0.03***	-0.03**	-0.03**	-0.03**	-0.03**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Country FE	No	Yes	Yes	Yes	Yes	Yes
Latitude/Longitude	No	No	Yes	Yes	Yes	Yes
Geographic Controls	No	No	No	Yes	Yes	Yes
Additional Controls	No	No	No	No	Yes	Yes
Adjusted-R^2	0.02	0.09	0.09	0.09	0.10	0.28
Observations	75131	75131	75131	75131	75131	5425

Years Bishopric Suppressed denotes the time a bishopric was destroyed mostly due to conflict or revolts.

Event-study Estimates: Historical Innovation

Event Study of Historical Innovation Outcomes and Church Exposure

- We proxy historical innovation with the **number of notable people** in science & culture
  - Data constructed by **?**
  - More than 2M famous people from 3500 BC to 2018 CE, based on Wikipedia and Wikidata
  - Aggregated to panel across $1.5^\circ \times 1.5^\circ$ grid cells and 50-year periods from 500 to 1500 CE
- We also draw on a novel dataset of historical **urban population** to measure econ. growth
  - Data constructed by **?**
  - Estimates of the urban population in 2,262 European settlements from 700 to 2000 CE
  - Aggregated to panel across $1.5^\circ \times 1.5^\circ$ grid cells and 50-year periods from 700 to 1500 CE

Event Study of Historical Innovation Outcomes and Church Exposure

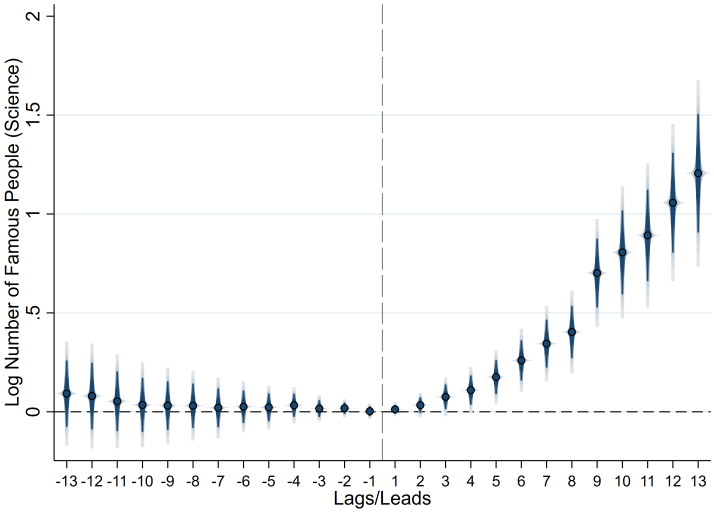
- We estimate a conventional two-way fixed effects event study equation:

$$y_{gt}^{k} = \beta_0 + \sum_{\tau=1}^{T} \beta_\tau (Lag_\tau)_{gt} + \sum_{\tau=1}^{T} \beta_{-\tau} (Lead_\tau)_{gt} + \mu_t + \lambda_g + \varepsilon_{gt}$$

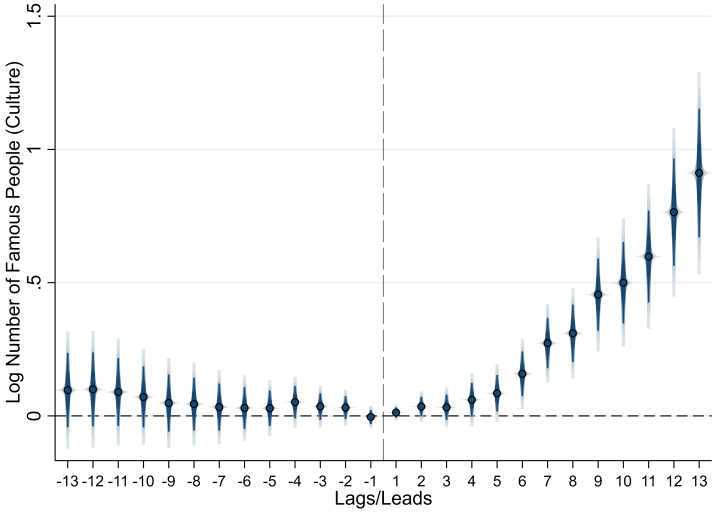
  - y_{gt}^{k} is the outcome k measured in the grid cell g in period t
  - μ_t and λ_g are period and location fixed effects
  - Lags and leads are indicate the periods before/after the establishment of the first bishopric in grid cell g at time $Event_g$:

$$(Lag_\tau)_{gt} = 1[t = Event_g - \tau]$$
$$(Lead_\tau)_{gt} = 1[t = Event_g + \tau]$$

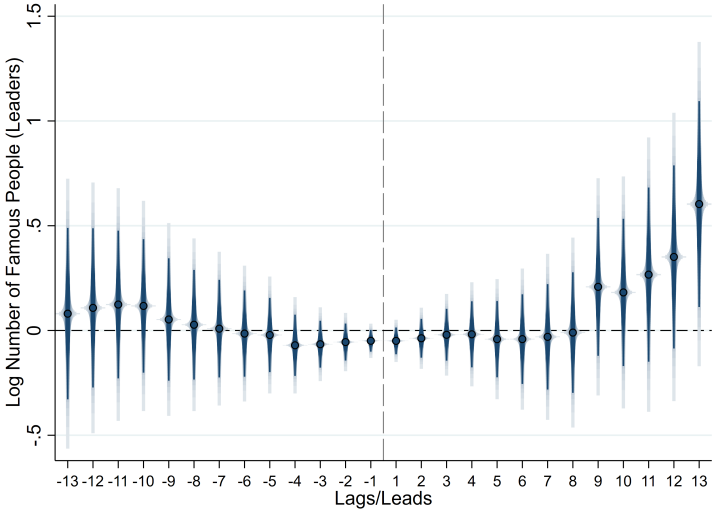
Event Study: Famous Scientists



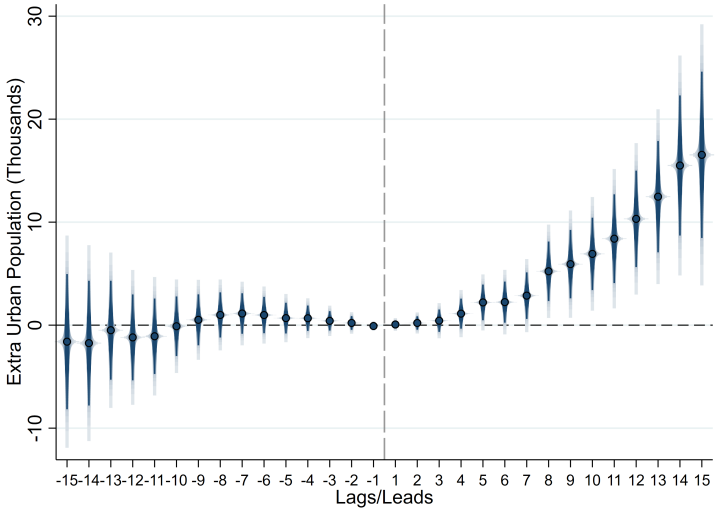
Event Study: Famous People in Culture



Event Study: Famous Political, Military, Noble, Religious, Business Leaders



Event Study: Historical Urban Population



Mechanisms

Western Church's Marriage Prohibitions

- **Hypothesis:** Church undermined intensive kinship, with conducive effects for innovation
  - Prescribed free consent of groom and bride
  - Forbade polygamy, divorce; discouraged adoption
  - Forbade consanguineous marriage (includes affinal and spiritual kin)

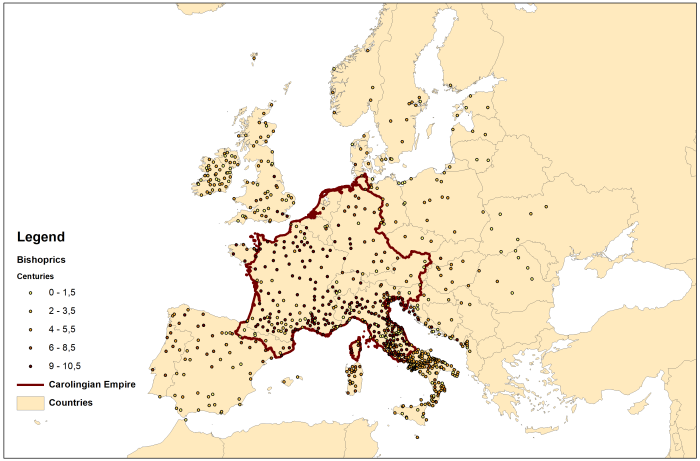
- **6th century:** Obsession in Merovingian Gaul: 13 out of 17 Synods dealt with incest
- **8th century:** Increased enforcement under Carolingian rulers Pepin and Charlemagne in conjunction with the pope
- **11th century:** Extension to 6th degree cousins until 1215; Gregorian reforms

Contemporary Patenting and Exposure to Incest Prohibition

	Patents per capita						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Anti-Incest Councils Attended by the Bishop	0.11**	0.05	0.13**	0.13**	0.13**	0.12**	0.09***
	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.03)
Medieval Church Exposure		0.11**	0.17***	0.14***	0.13***	0.14***	0.09***
		(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)
Country FE	No	No	Yes	Yes	Yes	Yes	Yes
Latitude/Longitude	No	No	No	Yes	Yes	Yes	Yes
Geographic Controls	No	No	No	No	Yes	Yes	Yes
Additional Controls	No	No	No	No	No	Yes	Yes
Administrative Regions FE	No	No	No	No	No	No	Yes
Adjusted-R^2	0.01	0.02	0.09	0.10	0.10	0.10	0.12
Observations	75131	75131	75131	75131	75131	75131	75131

Anti-Incest Councils Attended by the Bishop defined as the number of synods dealing with incest bans attended by a particular bishop.

Incest Prohibitions Were Heavily Enforced within the Carolingian Empire



Contemporary Patenting and Carolingian Empire (OLS and RDD)

	Patents per 10k people						
	All Sample					100 km	200 km
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Carolingian Empire	7.46***	6.77***	6.47***	6.77***	7.07***	2.15***	2.29***
	(1.75)	(2.41)	(2.46)	(2.42)	(2.46)	(0.34)	(0.67)
Country FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Latitude/Longitude	No	No	Yes	Yes	Yes	Yes	Yes
Geographic Controls	No	No	No	Yes	Yes	Yes	Yes
Additional Controls	No	No	No	No	Yes	Yes	Yes
Adjusted-R^2	0.03	0.09	0.09	0.10	0.10	0.25	0.21
Observations	75131	75131	75131	75131	75131	4291	8518
Number of Countries	68	68	68	68	68	14	20

Placebo Borders Roman Empire

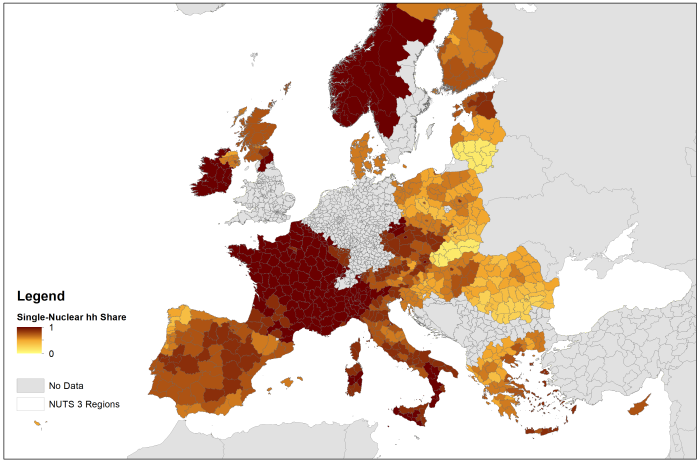
Contemporary Patenting and Carolingian Empire: Parts of the Border

	Patents per 10k people					
	All Sample	East	DEU	ITA	FRA	ESP
	(1)	(2)	(3)	(4)	(5)	(6)
Carolingian Empire	2.29***	2.41***	1.82**	1.22***	2.78**	0.39**
	(0.67)	(0.53)	(0.51)	(0.02)	(0.06)	(0.09)
Country FE	Yes	Yes	Yes	No	No	No
Latitude/Longitude	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.21	0.38	0.30	0.05	0.00	0.03
Observations	8518	4400	2107	514	775	1411

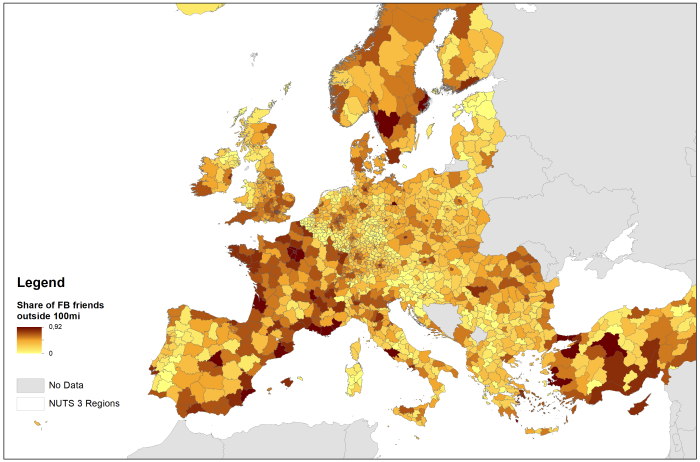
Contemporary Patenting, Social Structure, and Psychology: Data

- We draw on two proxy measures for **intensive kinship** and **expansive social networks**
  - Prevalence of **nuclear family** based on 2001 European Census
    - Share of single-nuclear family households (as opposed to multi-nucleus) at NUTS 3 level
  - Share of **Facebook friends outside a 100 mi radius** around an individual
    - Based on the Social Connectedness Index from **?**, available at NUTS 3 level
- We use four major psychological traits associated with **WEIRD psychology**
  - First principal component: universal trust, universal fairness, individualism, non-conformism
  - Taken from the European Social Survey, following **?**, at NUTS 2/3 level

Share of Single-Nuclear Households across NUTS 3 Regions



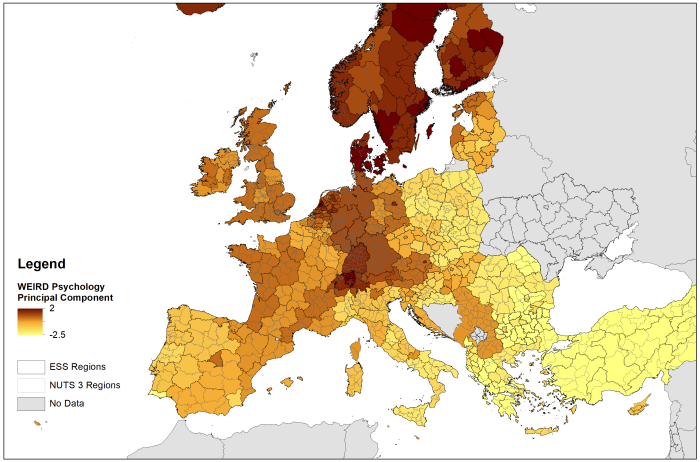
Share of Facebook Friends outside 100 mi Radius across NUTS 3 Regions



Contemporary Patenting and Social Structure

	Patents per capita					
	(1)	(2)	(3)	(4)	(5)	(6)
Share of Single-Nuclear Households	0.11**	0.15***	0.13***			
	(0.04)	(0.04)	(0.04)			
Share of FB friends outside 100 miles				0.17***	0.21***	0.27***
				(0.05)	(0.05)	(0.07)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Lon/Lat Polynomial	No	Yes	Yes	No	Yes	Yes
Geographic Controls	No	Yes	Yes	No	Yes	Yes
Additional Controls	No	No	Yes	No	No	Yes
Adjusted-R^2	0.63	0.66	0.67	0.39	0.47	0.48
Observations	759	759	759	1476	1476	1476

WEIRD Psychology Principal Component across NUTS 2/3 Regions



Contemporary Patenting and WEIRD Psychology

	Patents per capita				
	(1)	(2)	(3)	(4)	(5)
Universal Trust	0.43***				
	(0.16)				
Universal Fairness		0.33**			
		(0.13)			
Individualism			0.34**		
			(0.16)		
Non-Conformism				0.27***	
				(0.09)	
WEIRD Psychology					0.62***
					(0.20)
Country FE	Yes	Yes	Yes	Yes	Yes
Lon/Lat Polynomial	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes
Adjusted-R^2	0.47	0.45	0.46	0.46	0.47
Observations	1474	1474	1474	1474	1474

Horse Race

Contemporary Patenting and Church Exposure: Mediation

	Patents per capita						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Medieval Church Exposure	0.11***	0.08***	0.24***	0.17***	0.24***	0.15***	0.05*
	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)
Share of Multi-Nuclear Households		-0.13***					-0.05*
		(0.02)					(0.03)
Share of FB friends within 100 miles				-0.20***			-0.13***
				(0.03)			(0.02)
Psychological Principal Component						0.58***	0.18***
						(0.06)	(0.04)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lon/Lat Polynomial	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Share of of Total Effect Mediated		0.28		0.28		0.38	0.55
Adjusted-R^2	0.51	0.52	0.45	0.48	0.45	0.48	0.58
Observations	759	759	1476	1476	1474	1474	757

Conclusion

- Evidence that the medieval Catholic Church has benefited innovation up to today
  - Church exposure is positively associated with contemporary and historical innovation
- Evidence that the effect can be partially explained by the Church's incest regulations
  - These prohibitions led to social structures and a package of psychological traits that are more conducive to the transmission and recombination of knowledge into innovations