Innovation and the Medieval Church

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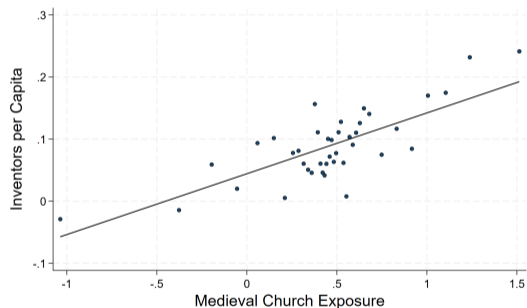
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Does Religion Affect Innovation?

- **Negative effects** due to religious dogma or legal institutions

  - Benabou Ticchi Vindigni 2015, 2022; Kuran 2013, Squicciarini 2020, Andersen Bentzen 2024

- **Positive effects** due to growth, cooperation, or human capital promoting attitudes and institutions

  - Weber 1905, Barro McCleary 2003, Guiso Sapienza Zingales 2003, Becker Woessmann 2009, Levy Razin 2012, Botticini Eckstein 2012, Squicciarini Voigtländer 2015, Henrich 2020
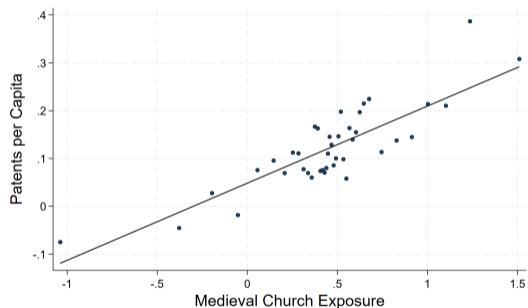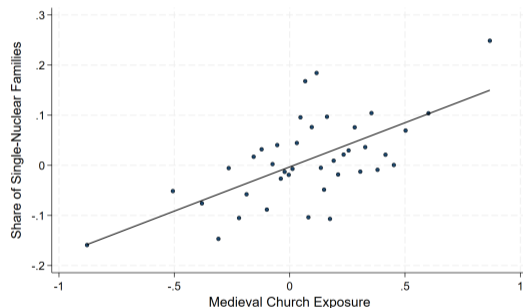
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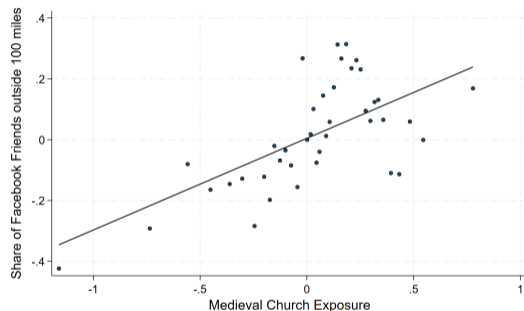
This Paper: the Church-Innovation Hypothesis

- **Hypothesis:** Greater exposure to the medieval Catholic Church **positively** affected innovation historically, and this effect persists today

- **Mechanism:** the Church's culture and institutions **expanded people's social networks**:
  - It supplied common culture (e.g., unified moral beliefs, Latin language), organizational infrastructure, funding and occupational opportunities (e.g., monks)
  - Its family and marriage legislation weakened kinship ties, increasing individuals' residential mobility and changing their psychologies (e.g., individualism, non-conformity, trust in strangers) (**??**);
  - Both factors promoted **social interactions among diverse people**: innovation through **recombination of ideas** (**????**).

Outline

1. **Historical Analyses**: Causality and Mechanisms

   1.1 Medieval Church and Historical Innovation: **Famous Creatives**
     - Event study;
     - Triple-difference.

   1.2 Historical Mechanism:
     - Expansion of **Social Networks** (event study);
     - Effect of Church's **Kinship**-related practices (repeated cross-section and event study).

2. **Contemporary Analyses**: Persistence and Mechanisms

   2.1 Medieval Church Exposure and Modern Innovation: **Patents** and **Inventors** (OLS)

   2.2 Contemporary Mechanism: **Social Structure** and **Psychology.** (OLS)

Data: Medieval Church Exposure

Independent Variable: Medieval Church Exposure

- Data from **?**, Schulz (2022)

- Based on the locations and histories of the Western Christian Church's bishoprics (administrative centers)

- For our goals: interpret as a proxy measure for the Church's influence at the local level.

- Empirically, we use bishoprics in two ways:
  - **Historical Panel**: documenting the geographic spread of Church across $1.5° \times 1.5°$ grid cells and every 50 years (500) (1000) (1500) (Grids 500) (Grids 1000) (Grids 1500)
  - **Cross-Section**: aggregating the number of centuries at least one bishopric existed within 100km from the centroids of the $0.125° \times 0.125°$ grid cells (Map)

1. Historical Analysis

1.1 Historical Analysis: Medieval Church and Famous Creatives

Historical Proxy for Innovation: Famous Creatives

- We proxy historical innovation with the number of **Famous Creatives** (i.e., individuals notable for the contribution to **science** and **culture** – historical **Inventors**) Validation

    - Data constructed using **?**, (e.g., used by **?**)

    - More than 800K famous people from 0 to 2018 in Europe, based on Wikipedia

    - Includes data on birth/death dates and locations

    - Aggregated to panel across $1.5° \times 1.5°$ grid cells and 50-year periods Examples Map 1500

    - **Famous Creatives**: science, culture Grids 500 Grids 1000 Grids 1500

    - Famous Non-Creatives: politics, military, religion, business, sport

Event Study: Famous Creatives and Church Exposure

- Examine the effect of the establishment of the first bishopric on the number of famous creatives in the grid cell

- Event study with staggered treatment: estimate **?**

- Identification assumption: parallel trend across grid cells
    - Absent the establishment of the bishopric, the number of famous people would have evolved in the same way;
    - We later turn to a triple-diff specification to relax this assumption.

- SE clustered at grid cell level

Event Study Results: Famous Creatives

Number of years before/after the First Church Exposure

Estimated according to ? methodology and inference

Panel Structure , Secular Creatives Science Culture 500 − 1500
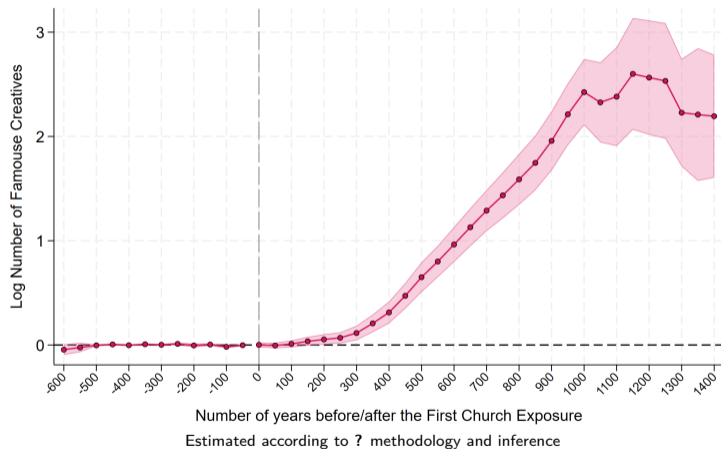
Event Study Results: Famous Non-Creatives
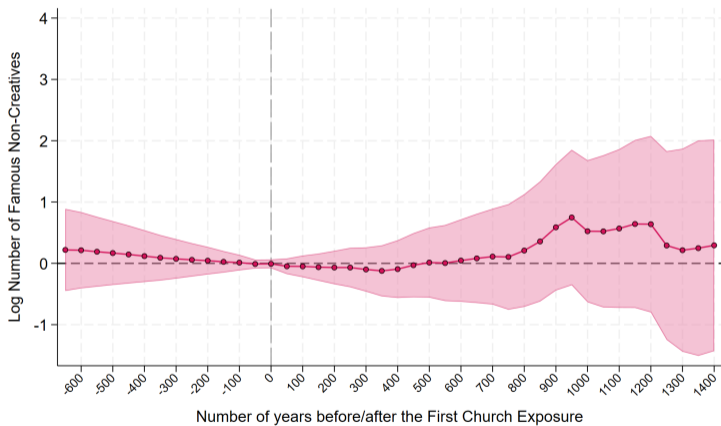
Estimated according to ? methodology and inference

Share of Creatives

Famous People Analysis, Triple Difference

- Previous analysis suggests that **Famous Creatives** are affected to a greater extent

- A setting for a **Triple Difference** analysis: identifying the effect in treated cells, post-exposure w.r.t. **Famous Creatives**

- Identification Assumption: within-cell parallel trends across famous people

- Allows accounting for all unobserved, time-varying confounding effects on a cell level (Period $\times$ Cell Fixed Effects)

Triple Difference Event Study Results: Famous People
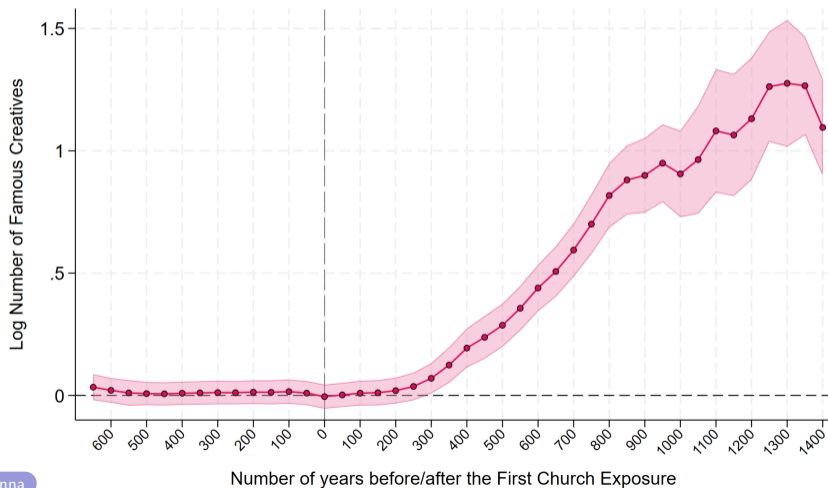
1.2 Historical Mechanisms: Expansion of Social Networks

Church and Social Networks

- **Hypothesis:** the Church interconnected individuals beyond the local level, contributing to a pan-European **social network**
    - the Church supplied common culture to communities in Medieval Europe
    - its family and marriage policies undermined intensive **kin**-based networks (more on that later)

- **Test the Mechanism**: We explore the Church's effect on the evolution of aspects of social networks as revealed from the migration patterns of famous creatives

Constructing Measures of Aspects of Networks

- Some famous creatives migrated: born in one place and died in another

- We connect grid cells linked by famous migrants in the dataset for each 50-year period

- We end up with a series of snapshots of connected grid cells over time: social networks

- We calculate **Degree Centrality** for each grid cell and use it as a dependent variable in our event study
  - Degree centrality measures the importance of a grid cell based on the number of direct connections it has to other grid cells

Evolution of Degree Centrality of Social Networks in Europe (I-NET)
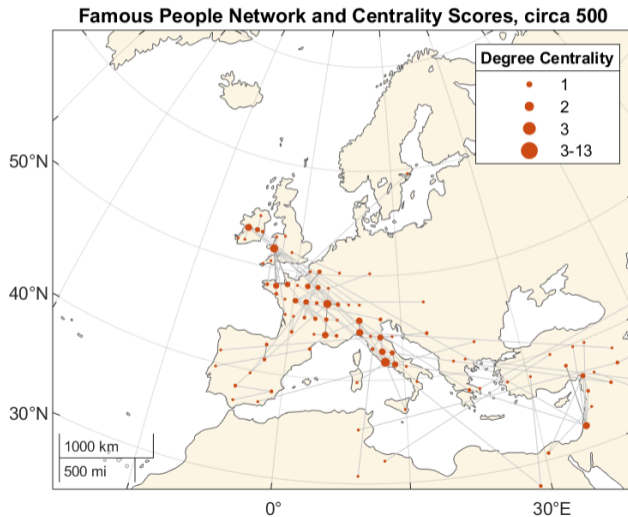
Famous People Network and Centrality Scores, circa 500

Evolution of Degree Centrality of Social Networks in Europe (I-NET)

Famous People Network and Centrality Scores, circa 1000

Evolution of Degree Centrality of Social Networks in Europe (I-NET)

Famous People Network and Centrality Scores, circa 1500
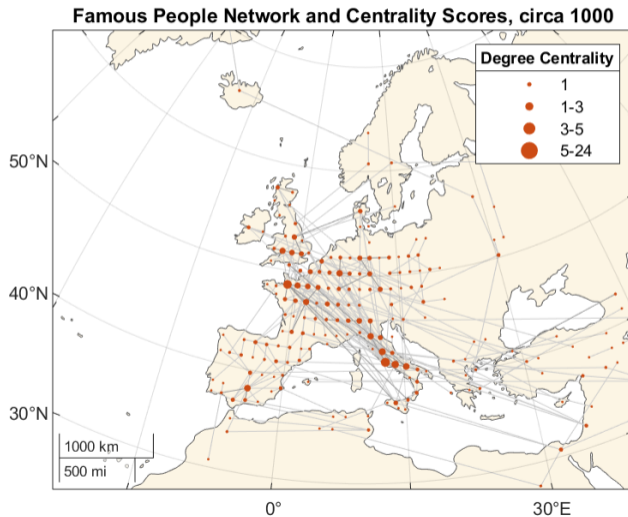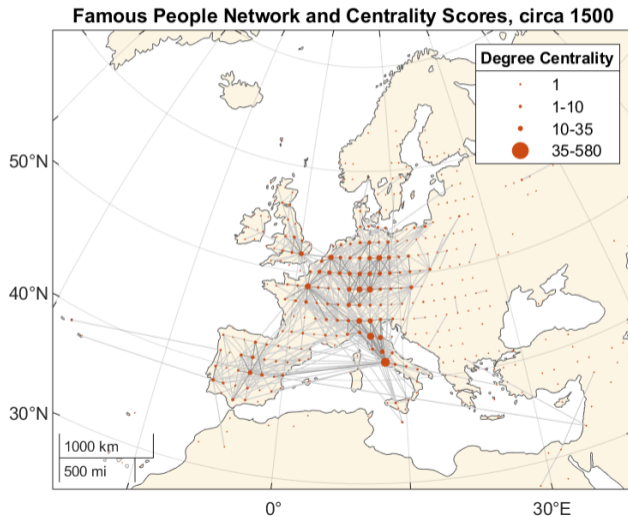
Event Study: Degree Centrality of Social Networks (I-NET)
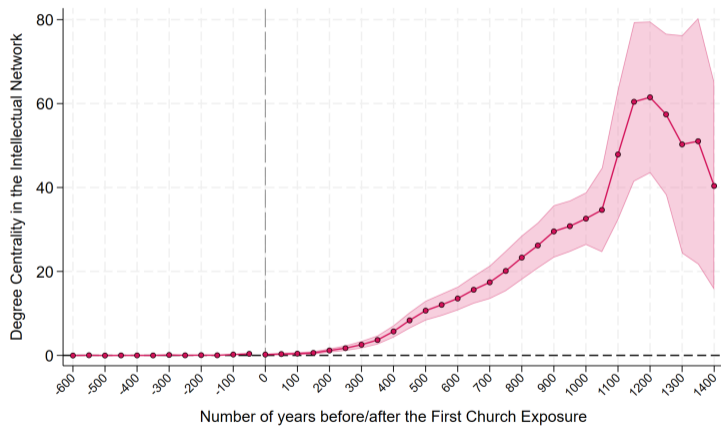
Estimated according to ? methodology and inference

Dyadic Analysis

1.2 Historical Mechanisms: Church and Kinship

The Church's Marriage and Family Legislation (MFL)

- **Hypothesis:** the Church standardized the kinship practices related to marriage and family affairs, undermining 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)

- **Test the Mechanism**: we identify the intensity of local exposure to the marriage and family legislation using data on **bishops' attendance to Synods** dealing with MFL

Marriage and Family Legislation Synods

- We use data on **synods** held within the Carolingian Empire between 500 – 800 (**?**):
  - Agenda (e.g., related to marriage and family legislation);
  - Attendance (i.e., which bishops were present).

- For each grid cell, we count the number of Synods dealing with MFL attended by the local bishop (i.e., local intensity of exposure to the Church's MFL) Map

- We estimate the association between MFL exposure and innovation, social networks (repeated cross-sections)

- Placebo: exposure to all other Synods (i.e., NOT dealing with MFL) Map

Social Network Centrality and Exposure to MFL Synods

	Social Network Degree Centrality, circa:								
	700	800	900	1000	1100	1200	1300	1400	1500
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A:									
MFL Synods Attended by the Bishop	0.03	0.18***	0.14***	0.44***	0.84***	0.54**	0.86**	0.53	1.25*
	(0.05)	(0.05)	(0.04)	(0.13)	(0.19)	(0.26)	(0.37)	(0.35)	(0.74)
Adjusted-R^2	0.01	0.13	0.07	0.11	0.23	0.05	0.09	0.00	0.04
Observations	103	103	103	103	103	103	103	103	103
Panel B:									
Other Synods Attended by the Bishop	-0.06	0.06	0.12**	-0.03	0.28	0.20	0.90***	0.04	-0.16
	(0.06)	(0.05)	(0.05)	(0.13)	(0.17)	(0.22)	(0.26)	(0.35)	(0.64)
Adjusted-R^2	0.01	-0.00	0.04	-0.01	0.02	-0.00	0.10	-0.02	-0.01
Observations	103	103	103	103	103	103	103	103	103
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Urban Population	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Church Exposure	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: MFL Synods Attended by the Bishop defined as the number of synods dealing with marriage and family legislation attended by at least one of the bishops from the 1.5 by 1.5-degree greed cell.

Event Study

Famous Creatives and Exposure to MFL Synods

	Log Number of Famous Creatives circa:								
	700	800	900	1000	1100	1200	1300	1400	1500
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A:									
MFL Synods Attended by the Bishop	0.06	0.06*	0.07**	0.06**	0.08***	0.10***	0.09***	0.08*	0.08*
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
Adjusted-R^2	0.01	0.01	0.02	0.01	0.03	0.07	0.04	0.05	0.10
Observations	103	103	103	103	103	103	103	103	103
Panel B:									
Other Synods Attended by the Bishop	-0.01	-0.01	-0.01	-0.01	-0.01	0.01	0.00	-0.03	-0.09**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Adjusted-R^2	-0.01	-0.01	-0.01	-0.02	-0.02	-0.01	-0.00	0.07	0.19
Observations	103	103	103	103	103	103	103	103	103
Geographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Urban Population	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Church Exposure	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: MFL Synods Attended by the Bishop defined as the number of Synods dealing with marriage and family legislation attended by at least one of the bishops from the 1.5 by 1.5-degree greed cell.

Event Study

2. Contemporary Analysis

2.1 Contemporary Analysis: Church Exposure and Patents

Contemporary Innovation and Medieval Church Exposure

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:			Patents per capita			
Medieval Church Exposure	0.15***	0.19***	0.18***	0.17***	0.16**	0.10***
	(0.04)	(0.05)	(0.05)	(0.05)	(0.06)	(0.03)
	[0.06]	[0.05]	[0.03]	[0.05]	[0.02]	[0.02]
Adjusted-R^2	0.02	0.09	0.09	0.09	0.09	0.12
Observations	78315	78315	78315	78315	78315	78308
Panel B:			Inventors per capita			
Medieval Church Exposure	0.08**	0.13***	0.13***	0.11***	0.10**	0.07***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.02)
	[0.04]	[0.04]	[0.03]	[0.03]	[0.01]	[0.01]
Adjusted-R^2	0.01	0.06	0.06	0.06	0.06	0.07
Observations	78315	78315	78315	78315	78315	78308
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

Notes: P-values in square brackets are calculated using the spatial correlation robust inference of ?.

Conley SE   Suppressed Bishoprics   Patents Data and Map

2.2 Contemporary Mechanisms

Church and Innovation: Mechanisms of Persistence

- Social connections partially established by the Church associated with social interactions among inventors today Table ;

- Exposure to MFL Synods during Middle Ages associated with patents today Table ;

- Evidence suggesting that the link between church and innovation may persist through:

    - Broader **social networks** (i.e., on Facebook) Table , Map ;

    - More atomized **social structure** (i.e., nuclear families) Table , Map ;

    - **Psychological traits** associated with weaker kinship and higher impersonal prosociality (i.e., individualism, non-conformism, universal trust and fairness) Table , Map ;

Data Description

Church Exposure and Persistence of Social Networks

	(1)	1200 (2)	1300 (3)	1400 (4)	1500 (5)	1600 (6)	1700 (7)	1800 (8)	1900 (9)	2000 (10)
					Number of Joint Patents (1980-2010)					
Famous People Migration Volume (circa)		0.05	0.00	0.06**	0.30***	0.20**	0.12**	0.25*	0.40***	0.32***
		(0.04)	(0.01)	(0.02)	(0.10)	(0.09)	(0.06)	(0.13)	(0.13)	(0.12)
Joint Number of Years under the Church	0.12***	0.11***	0.12***	0.11***	0.09***	0.10***	0.11***	0.10***	0.09***	0.11***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)
Grid Cells FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dyadic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.13	0.13	0.13	0.13	0.21	0.16	0.14	0.18	0.26	0.22
Observations	15891	15891	15891	15891	15891	15891	15891	15891	15891	15891

Notes: Dyadic OLS regression. Observation is a unique pair of $1.5° \times 1.5°$ grid cells. Dyadic controls include: distance and binary indicators of being in the same country and being connected via roman roads.

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Contemporary Patenting and MFL Synods

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

Notes: Anti-Incest Councils Attended by the Bishop defined as the number of synods dealing with incest bans attended by the local bishop

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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 effect on social networks and through its marriage and family legislation

  - Broader social networks and social structures are facilitated the flow of knowledge and innovation through recombination