Catholic Censorship and the Demise of Knowledge Production in Early Modern Italy – Online Appendix

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A Additional Data

A.1 How representative are university professors and academicians?

The paper is based on publications by university professors and members of academies. One may wonder how well those publications represent the total production of knowledge in early modern times. To answer that question, one needs to define a new universe of persons from which we can extract the sample of university professors and compute their share. Looking at scientific domains, let us consider the scientists who have given their name to a crater on the moon. Those names were given by the Commission on Lunar Nomenclature of the International Astronomical Union from 1935 onward (Richardson 1945). Among these persons there are 54 Italians born before 1770. Figure 1 represents their occupation breakdown. A large majority of them were either a university professor or a member of an academy or both. This supports the idea that our sample of scholars is a good representation of people working in sciences.

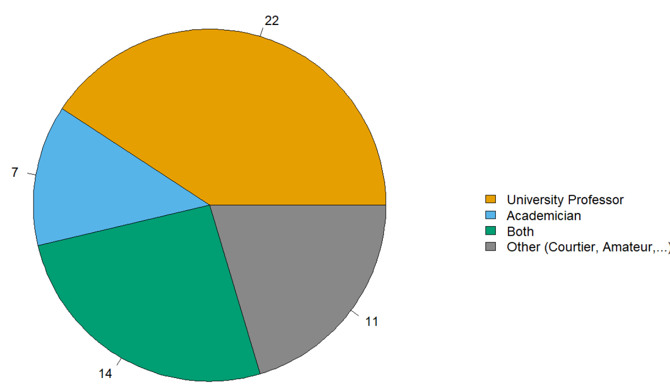

Figure 1: Occupations of Italians having given their name to a crater on the moon

A.2 How much of the Italian University/Academy population is covered?

Another question is how much of the Italian University/Academy population is covered. For universities, we can provide a precise answer. We believe we have a comprehensive coverage for the following universities: Ubologna-1088, Umacerata-1540, Umodena-1175, Upadua-1222, Upavia-1361, Upisa-1343, UromaGregoriana-1556. Thanks to very detailed secondary sources, we almost have all professors having taught there.

We have a broad coverage for the following universities StudFlorence-1321, Ucagliari-1606, Ucatania-1444, Umantua-1625, Umessina-1548, Unapoli-1224, Upalermo-1578, Uperugia-1308, Uroma-1303, Usalerno-1231, Usassari-1617. Thanks to detailed secondary sources, we have a large number of the professors having taught there, and we probably have all those who published something, which is the relevant dimension for this paper.

For the following list, we have only a partial coverage. Many of those universities are quite small, or specialized, or detached from bigger universities (Milano & Venice). We will be able to complete Ferrara and Parma soon. Ualtamura-1748, Uancona-1562, Ucamerino-1727, Ufermo-1585, Uferrara-1391, Ugenoa-1773, Ulucca-1369, Umilano-1556, Umondovi-1560, Uparma-1412, Upau-1722, Usiena-1246, Utorino-1404, Uurbino-1671, Uvenice-1470, Uvicenza-1204.

For academies, assessing our coverage is more complicated, as the number of academies is potentially very large. Each city had one or more small academies, sometimes very temporarily, gathering the curious minds of the moment. As we explained in the text, our more important source comes from the data compiled by the British library based on all the books in their possession related in one way or in another to an Italian academy. To this list, we added important academies for which there is a complete coverage based on a biographical dictionary of their members: the Crusca, the Ricovrati, and the Gelati.

A.3 How is the distribution of the scholars' fields changing over time?

Europe overtook Italy in terms of scholars quality. In principle, this could be driven by the mere fact that a field with low average publications became relatively more common in Italy than in Europe. To answer this question, in Table 1 we show the dynamics of scholars quality in Italy and Europe by field.[1] We observe that in each field the quality of scholars is initially lower in Europe than in Italy, and that at the time censorship was introduced Italy loses (or starts losing) its advantage. Figure 2 shows that censorship affects all fields.

	Distribution (%) of the scholars' fields for each period					Median publications per person				
Period	1	2	3	4	5	1	2	3	4	5
					Italy					
Theology	6	6	12	12	12	49	88	73	56	16
Law	39	27	20	13	14	68	81	22	6	15
Humanities	35	41	45	49	37	132	131	97	49	39
Medicine	13	16	13	13	15	58	66	73	65	24
Sciences	7	9	9	12	20	31	63	165	70	44
Others		1	<1	1	2		747	52	16	13
					Europe (excluding Italy)					
Theology	32	22	26	27	19	11	75	98	85	59
Law	24	18	18	14	12	6	23	46	59	72
Humanities	35	44	36	35	35	14	46	63	69	65
Medicine	5	10	12	13	17	29	52	71	52	59
Sciences	4	6	7	11	14	19	120	90	86	76
Others		1	<1	1	3		12	378	125	74

Note: periods: 1:1400-69, 2:1470-1539, 3:1540-1609, 4:1610-79, 5:1680-1749.
Theology: Theology, scriptures
Law: Canon law, Roman law, French law
Humanities: History, Literature, Philosophy, Ethics, Rhetoric, Greek, Poetry
Medicine: Medicine, Anatomy, Surgery, Veterinary, Pharmacy, Botany
Sciences: Mathematics, Logic, Physics, Chemistry, Biology, Astronomy, Geography
Others: Applied Sciences (Engineering, Architecture, Agronomy),Social Sciences

Table 1: Distribution & publications by period and field

[1] In case the scholar is associated with more than one field, we expand the observation according to the number of her/his fields. Details about each discipline can be found below Table 1.

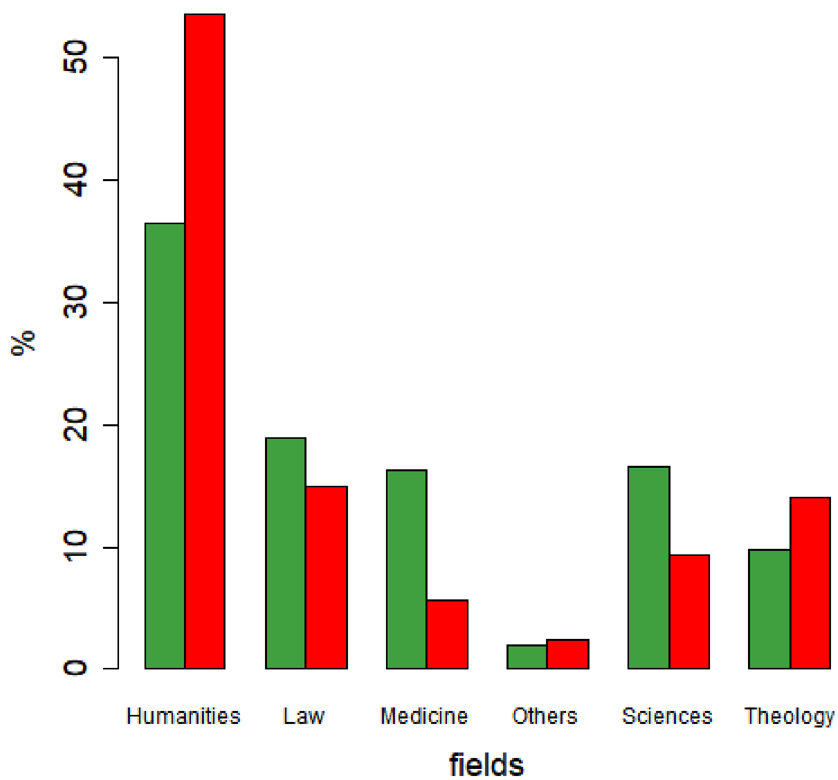

Figure 2: Distribution of the fields of scholars. Red: censored. Green: non-censored.

A.4 Famous Scholars

	Total number of published scholars					Median number of publications per person				
Period	1	2	3	4	5	1	2	3	4	5
Europe	84	243	396	448	579	132	361	374	335	184
Italy	41	71	137	111	120	351	299	309	176	132
France	12	48	76	129	177	95	550	566	277	168
Germany & Austria	15	82	80	44	189	83	276	299	779	259
Great Britain & Ireland	3	19	48	118	226	14	772	391	525	273
Denmark & Sweden		6	10	22	60		295	306	269	111
Spain & Portugal	8	27	37	16	18	84	334	161	119	148
Ubologna-1088	6	19	15	11	8	241	155	184	145	28
Unapoli-1224	3	3	2	2	3	539	64	136	436	1512
Upadua-1222	12	23	23	10	9	105	185	419	264	92
Upavia-1361	6	12	3		2	134	823	343		122
Uroma-1303	21	12	17	5	7	584	798	113	263	220
Upisa-1343		7	9	9	3		185	217	139	84
UromaGregoriana-1556			9	8	2			761	301	177
StudFlorence-1321	15	7	4	6	4	266	354	319	85	68
Utorino-1404	1	1	4		4	78	926	278		100
AcadRicovrati-1599			9	16	37			358	236	214
AcadCrusca-1583		1	10	25	28		587	241	125	163
AcadBologna-1714				1	65				82	131
AcadUmoristi-1600			6	23				592	306	
AcadGelati-1588			3	11	3			512	81	48
AcadIncogniti-1626			4	13				265	263	

Note: periods: 1:1400-69, 2:1470-1539, 3:1540-1609, 4:1610-79, 5:1680-1749

Note: Famous scholars: scholars having a Wikipedia page longer than 5000 characters

Table 2: Total number of famous scholars & publications by period

A.5 The gap in quality between censored and non-censored authors

Figure 3 below shows that before censorship was introduced in the second half of the sixteenth century, censored authors were of better quality than non-censored authors, but this gap shrank over time. Dots represent authors, which are ordered by their reference date, log publications, and by whether or not they were censored. The two solid lines are plotted using the *lowess* smoother.

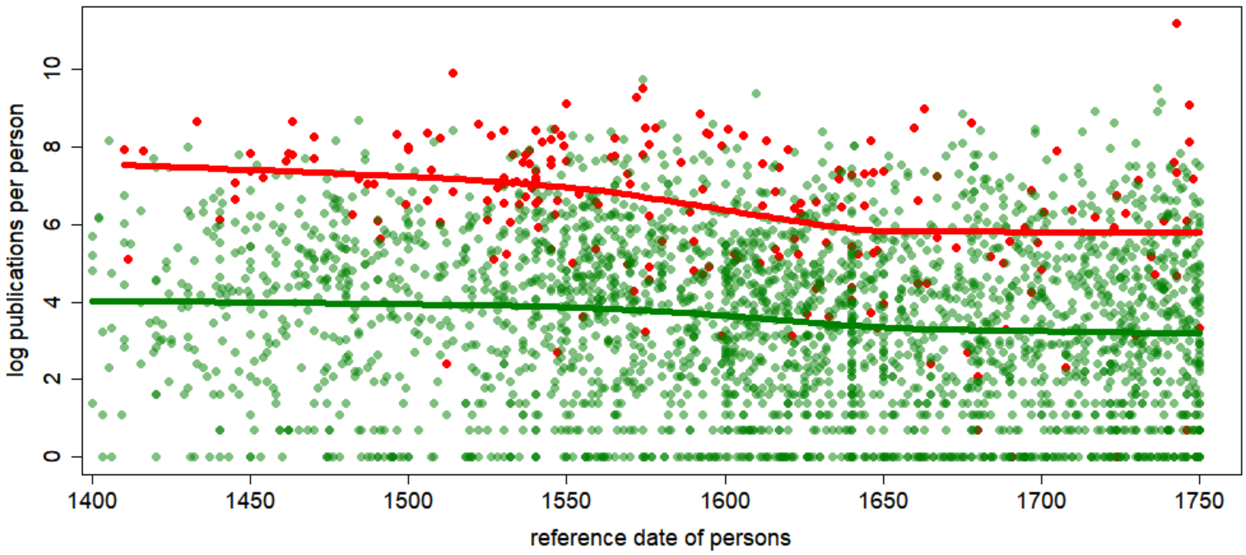

Figure 3: Log publications of published authors by reference date. Red: censored. Green: non-censored. Solid lines: *lowess* smoother.

A.6 Europe Map

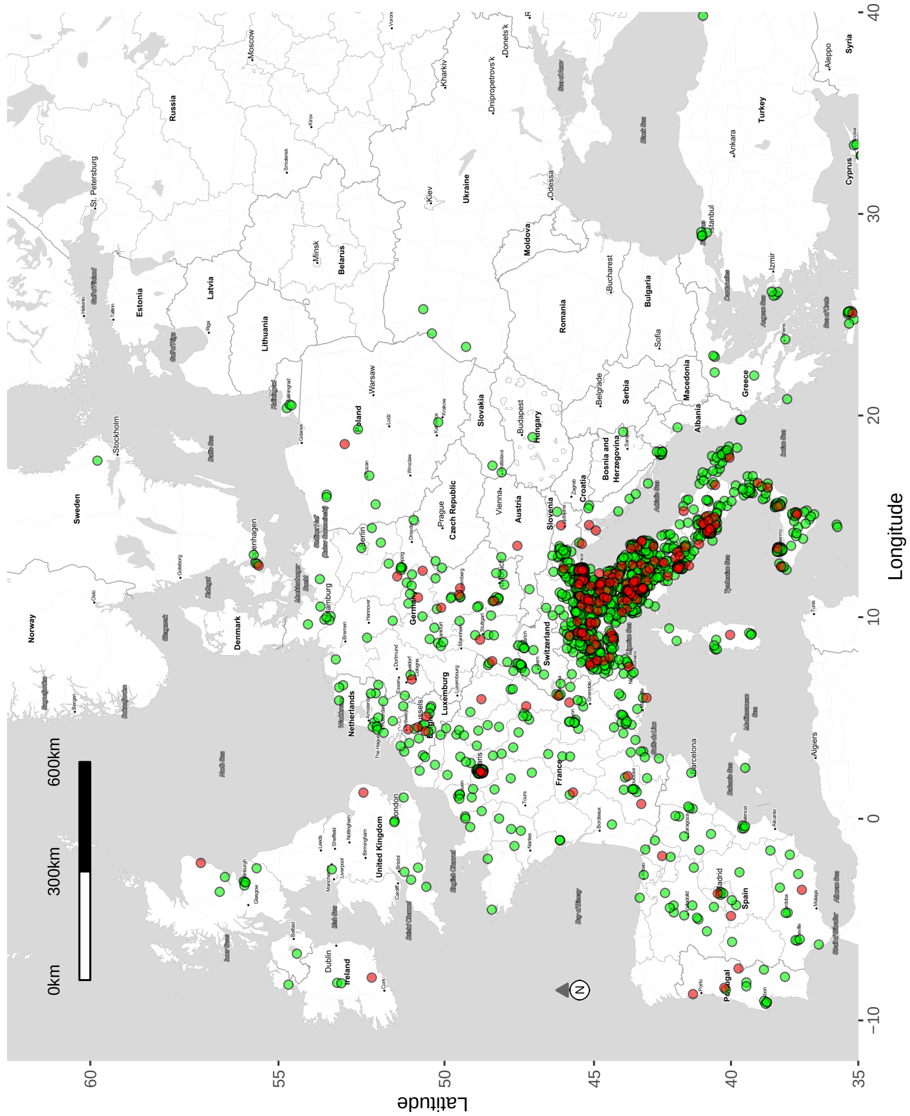

Figure 4: Place of birth of censored (red) and non censored (green) members of Italian universities & academies – Europe.

B Bibliographies

John Barclay (Pont-à-Mousson 1582 - Roma 1621, censored in 1608) was born to a Scottish-born father. In 1605 John Barclay presented the first part of his *Euphormionis Lusinini Satyricon*. This humanist novel is a very original piece of work (Correard 2017), including a satirical description of the Jesuit schools (he was raised in a Jesuit school). This book was put in the Index on 13 December 1608 (De Bujanda and Richter 2002). At the invitation of the Pope himself, he went to Rome in 1616 and resided there until he died in 1621. Moving to Rome was a way to signal that he was a good Catholic. John Barclay was a member of several Italian academies, including the Accademia degli Umoristi and the Accademia dei Lincei.

Giordano Bruno (Nola 1548 - Roma 1600, censored in 1600) was an Italian friar, a member of the Dominicans. His contributions span from philosophy to mathematics and cosmology. He is best known for being persecuted by the Catholic Church and was later regarded as a martyr for science. The Inquisition found him guilty of heresy for several of his views, among which his positions on cosmology: he theorized an infinite universe and a plurality of worlds. All of his works were entered the Index of forbidden books, and he was burned at stake in Rome's square, the Campo de' Fiori.

Bernardino Ciaffoni (Porto Sant'Elpidio 1615/1620 - Marches 1684, censored in 1701) was a theologian and belonged to the order of the Franciscans. He also used to be a rector of the well-known college San Bonaventura, located in Rome. His *Apologia*, published posthumously, defends the rigorist doctrine and fights the probabilism supported by Jesuits. This piece of work was introduced into the Index because of its 'insulting' claims against Jesuits.

Nicolaus Copernicus (Thorn 1474 - Frauenburg 1543, censored in 1616) was a Prussian mathematician and astronomer. In his book *De revolutionibus orbium coelestium*, he theorized the cosmos as having the Sun at the center of the solar system, where the Earth rotated around it. This theory is a deep contrast to the Ptolemaic model, where the Earth is stationary at the center of the universe. Several other scientists, including Galilei, contributed to his theory by bringing evidence to support it. While his theories were welcomed positively by the Church at first, his *De revolutionibus* was censored in 1616, after that the Church's conservative revolution.

Achille Gagliardi (Padova 1537 – Modena 1607, censored in 1703) was a Jesuit theologian and spiritual writer. He taught philosophy at the Roman College, then theology in Padua and Milan. He was a collaborator of the Archbishop of Milan Carlo Borromeo, who asked him to write a handbook of religion, the popular *Catechismo della fede cattolica*. His *Breve compendio* was censored because of his thoughts about the annihilation of the will during mystical states. These ideas are not compatible with free will, which is a cornerstone of catholic theology.

Galileo Galilei (Pisa 1564 - Arcetri 1642, censored in 1634) was an Italian astronomer and physicist. Also Professor in Padova and member of the prestigious Accademia dei Lincei, arguably he was the most notable and influential scientist of his times. He is also known as the father of modern science because of his work on the scientific method. His books were censored because of its support to atomism, heliocentrism, and Copernicanism. The Inquisition condemned him, and he was forced to abjure his thesis and spent the last part of his life under house arrest.

Serry Jacobus Hyacinthus (Toulon 1659 – Padua 1738, censored in 1722) was a theologian and belonged to the order of the Dominicans. Also consultor of the Congregation of the Index, he taught theology at the University of Padua from 1698. His *Historiae*, written under the pseudonym Augustinus Leblanc, deals with the Jesuit-Dominican controversy on grace and was prohibited by the Inquisition.

C Proofs of Propositions

C.1 The Fréchet Cheat Sheet

Since the irrelevance of books of type j is exponentially distributed with scale parameter k_t^j and given Equation (1), the distribution of book quality follows a Fréchet distribution with scale parameter ${k^j}^\theta$ and shape parameter $1/\theta$. This allows us to write the average book quality q^j by sector as:

$$E(q_i^j) = \int_0^\infty h_i^{-\theta}(k^j e^{-k^j h_i})dh_i \quad \text{with } j \in \{C, R\},$$

Now we can multiply the RHS by $(k^j)^{1+\theta}/(k^j)^{1+\theta}$ to obtain:

$$E(q_i^j) = (k^j)^{1+\theta} \int_0^\infty (k^j h_i)^{-\theta}(e^{-k^j h_i})dh_i.$$

Now, using a change of variable $y = k^j h_i$ we have that

$$E(q_i^j) = (k^j)^{1+\theta} \int_0^\infty (y)^{-\theta}(e^{-y})(1/k^j)dy.$$

We can finally show that

$$E(q_i^j) = \Gamma(1-\theta)\ (k^j)^\theta \qquad \text{with } \ j \in \{C, R\},$$

where

$$\Gamma(x) = \int_0^\infty s^{x-1}e^{-s}ds$$

is the Euler gamma function.

C.2 Occupational Choice

In general, if $X \sim \exp(\lambda_X)$ and $Y \sim \exp(\lambda_Y)$, $\alpha > 0$ is a real number

$$
\begin{aligned}
P(\alpha X < Y) &= \int_0^\infty P(X < \frac{Y}{\alpha} \mid Y = y) f_Y(y) dy \\
&= \int_0^\infty \int_0^{\frac{y}{\alpha}} f_X(x) f_Y(y) dx dy \\
&= \int_0^\infty \lambda_Y \exp(-\lambda_Y y) \left(1 - \exp\left(-\lambda_X \frac{y}{\alpha}\right)\right) dy \\
&= \int_0^\infty \lambda_Y \exp(-\lambda_Y y)\, dy - \left(\frac{\lambda_Y}{\frac{\lambda_X}{\alpha} + \lambda_Y}\right) \int_0^\infty \left(\frac{\lambda_X}{\alpha} + \lambda_Y\right) \exp\left(-\left(\frac{\lambda_X}{\alpha} + \lambda_Y\right) y\right) dy \\
&= 1 - \frac{\lambda_Y}{\frac{\lambda_X}{\alpha} + \lambda_Y} \\
&= \frac{\frac{\lambda_X}{\alpha}}{\frac{\lambda_X}{\alpha} + \lambda_Y} \\
&= \frac{\lambda_X}{\lambda_X + \alpha \lambda_Y}
\end{aligned}
\tag{C.1}
$$

Since $\tilde{h}_s^C \sim \exp(b_{t+1}^C)$, $\tilde{h}_s^R \sim \exp(b_{t+1}^R)$, and $\hat{p} > 0$, from Equation (C.1) it follows that

$$
\text{Prob}\{\tilde{h}_s^C > p^{-1/\theta} \tilde{h}_s^R\} = \frac{b_{t+1}^R}{b_{t+1}^R + b_{t+1}^C p^{-1/\theta}}
$$

C.3 Proof of Proposition 1

Using the variable z_t, Equation (12) can be rewritten as

$$
z_{t+1} = \frac{1-\beta}{\hat{p}} (z_t)^2.
$$

This recurrence Equation admits an explicit solution:

$$
z_t = \frac{\hat{p}}{1-\beta} \left(\frac{z_1(1-\beta)}{\hat{p}}\right)^{2^{t-1}}. \tag{C.2}
$$

Equation (11) implies that once we know the dynamics of z_t, we also know the dynamics of m_t. Given this change of variable, we use Equation (C.2) to study the limit of z_t and obtain

a) $z_1 < \hat{p}/(1-\beta) \Rightarrow \lim_{t\to\infty} z_t = 0$. Note also that $m_1 < 1/(2-\beta) \Leftrightarrow z_1 < \hat{p}/(1-\beta)$.

b) $z_1 > \hat{p}/(1-\beta) \implies \lim_{t\to\infty} m_t = 1$. Note also that $m_1 < 1/(2-\beta) \Leftrightarrow z_1 < \hat{p}/(1-\beta)$.

c) $z_1 = \hat{p}/(1-\beta) \implies z_t = \hat{p}/(1-\beta)\forall t$. Note $m_t = 1/(2-\beta)\forall t \Leftrightarrow z_t = \hat{p}/(1-\beta)\forall t$

From *a)* and Equation (11), *i)* follows. From *b)* and Equation (11), *ii)* follows. From *c)* and Equation Equation (11), *iii)* follows.

Note that we excluded $m_1 = 1$ from the proposition. In that case, no compliant books are left in the economy and imposing $\beta = 1$ would shut down the whole production of knowledge.

C.4 The Dynamics when the Church's Behavior follows a Rule of Thumb

In Section 3.4 we described the dynamics under a constant rate of censorship β_t. Here we endogenize the introduction of censorship by assuming that the Church chooses the lowest censorship rate that allows to converge to a world with no revolutionary ideas. This is equivalent to assume that the Church has lexicographic preferences, caring firstly to have $\lim_{t\to\infty} m_t = 0$, and secondly to minimize β_t. Given our assumptions, we can describe the dynamics of the share of revolutionary ideas in Proposition 1.

Proposition 1 *For a given share of revolutionary ideas $m_t \in [0,1)$, the Church will choose a level of censorship β_t such that $\beta_t = \max\{2 - 1/m_t + \epsilon, 0\}$, where ϵ is arbitrarily small.*

Proof. Notice that Proposition 1 states that $\lim_{t\to\infty} m_t = 0$ when $m_t < 1/(2-\beta_t)$, from which it trivially follows that $\beta_t = \max\{2 - 1/m_t + \epsilon, 0\}$. ■

Note that for any initial $m_1 \in [0,1)$, we will have $\lim_{t\to\infty} m_t = 0$, but the convergence will be slow due to the fact that in any period m_t would be set very close to the unstable steady state $1/(2-\beta_t)$. It is worth noting that Proposition 1 implies that the Church will impose no censorship if $m_t < 1/2$.

C.5 Proof of Proposition 2

Note that imposing censorship when $m = 0$ is not convenient:

$$\frac{u(0)}{1-\delta} = V^N(0) > V^C(0) - \psi = \frac{u(0)}{1-\delta} - \psi.$$

Note also that imposing censorship when $m = 1$ is not convenient.

$$\frac{u(1)}{1-\delta} = V^N(1) > V^C(1) - \psi = \frac{u(1)}{1-\delta} - \psi.$$

Note also that $V^M(m)$ and $V^C(m)$ are continuous functions in $m \in [0, 1]$: see Norets (2010) for a formal proof of continuity of discrete choice dynamic value functions under a set of assumptions that are satisfied in our case.

Then, it follows that there exists $\tilde{m}$ and $\breve{m}$, respectively in a neighborhood of 0 and 1, such that for each $m \in [0, \tilde{m}]$ and also for each $m \in [\breve{m}, 1]$, $V^N(m) > V^C(m) - \psi$ holds. According to proposition 1, if censorship is not imposed, $\tilde{m}$ converges to 0, while $\breve{m}$ will coverge to 1. Since censorship does not happen for each $m \in [0, \tilde{m}]$ and for each $m \in [\breve{m}, 1]$, proposition 2 is proved.

C.6 Proof of Proposition 3

We take $\overline{\psi}$ such that for some m^* we have $V^C(m^*) - \overline{\psi} > V^N(m^*)$, then for each $\psi < \overline{\psi}$ it holds $V^C(m^*) - \psi > V^N(m^*)$. Now define $\mathcal{D}(m) = V^C(m) - \psi - V^N(m)$: since this function is continuous, for an arbitrarily small ϵ we have that $\mathcal{D}(m^* - \epsilon) > 0$ and $\mathcal{D}(m^* + \epsilon) > 0$. Using again continuity we can claim that $\mathcal{D}(m) > 0$ for each $m \in [m^* - \epsilon, m^* + \epsilon]$, which implies that the Church will immediately impose censorship if m_0 belongs to this set.

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