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Winners and Losers from the Protestant Reformation: An Analysis of the Network of European Universities

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Abstract

Using a new database of European academics, we provide a global view of the effect of the Protestant Reformation on the network of universities and on their individual importance within the network (centrality). A connection (edge) between two universities (nodes) is defined by the presence of the same scholar in both universities. Protestantism strongly impacted the structure of the network. Dyadic regressions confirm that geography was important as well, but does not substitute for the effect of religion. We isolate the effect of religion on each university centrality comparing simulated networks with and without religious identity. The reorganization of the network induced by the Reformation harmed Protestant universities less than Catholics. As the number of publications per university is strongly correlated with centrality, our simulations lend credence to the view that the loss of connectedness of the Southern European universities after the (Counter-)Reformation was important in triggering their scientific demise.

Keywords: Upper-Tail Human Capital, Universities, Network, Centrality, Publications, Fragmentation.
JEL Classification Numbers: N33, O15, I25.

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1 Introduction

Medieval universities, together with other bottom-up institutions such as monasteries, guilds, and communes, are considered to be central to the development of Europe (Greif 2006). Still, after having played a pivotal role in the Scientific Revolution of the 16th-17th centuries, many of these grand institutions seem to have plunged into an intellectual coma thereafter. This is particularly true for Southern European universities. One possible culprit for this decline is the loss of mobility of persons and ideas following the Protestant Reformation and the ensuing Catholic Counter Reformation. The literature has already stressed several important effects of the Protestant Reformation on the development of Europe (Cantoni, Dittmar, and Yuchtman 2018, Cantoni 2015, Becker and Woessmann 2009, Becker, Pfaff, and Rubin 2016). In addition to the mechanisms stressed in that literature, Ridder-Symoens (1996) argues that the Reformation led to clustering of universities, which shaped the mobility pattern of students in early modern times.[1] Beyond students' mobility, clustering might also affect the mobility pattern of teachers and scholars, which might be even more subject to restrictions than that of students.

In this paper, we analyse teachers' mobility across Europe and provide a global view of the effect of the Reformation on the network of universities and on their individual position within the network. The objects (*nodes*) in the network are universities active before 1793 in Europe. A connection (*edge* or *link*) between two universities is defined as the presence of the same scholar in both universities. To take a famous example, the English philosopher Roger Bacon (1219–1292) lectured in Oxford (c. 1233), then accepted an invitation to teach in Paris (c. 1237). This established (or rather reinforced, as Bacon was not alone in that case) a connection between those two universities, facilitating the flow of ideas, manuscripts, students between the two places. Connections between universities are built from the database of university scholars developed by De la Croix (2021e). The sources used to build this database are primary (published *cartularia* and *matricula*), secondary (books on history of universities and on biographies of professors in a specific university) and tertiary (biographical dictionaries by topic or regions, and encyclopedias).

Our main motivation for the study of the network of universities lies in the idea that the structure of a network plays a crucial role in the diffusion of information (Jackson, Rogers, and Zenou 2017). The way universities used to be connected with each other through the mobility of scholars might have affected the propagation speed of knowledge, ideas, and the intensity of academic production. Our paper aims at exploring to what extent the documented decline in scientific production of Catholic universities

[1] "There were henceforth three kinds of university: the Protestant universities, many of them proselytizing, active in training clergymen (Wittenberg, Heidelberg, Geneva and Strasburg for example); secondly, the Catholic universities of the Counter-Reformation, also proselytizing, and dedicated to educating competent clergy (in this the Jesuits played a leading part). The studia of Paris, Louvain, Ingolstadt, Vienna, Graz, Würzburg, Cologne, Pon-à-Mousson, Dole and others, as well as the Iberian universities, are of this kind. The third group comprises several universities that consciously adopted a tolerant attitude, and did not willingly refused students who were not of their religion: for instance, Padua and Siena, Orléans and Montpellier, all of them Catholic universities, or Leiden and the other Dutch universities, model Calvinist universities though they were."

during the 17th and 18th centuries can be explained by the reorganization of the network induced by the Reformation.

The decline in Catholic Universities echoes the debate on the little divergence occurring within Europe in the early modern period, and on its institutional and cultural determinants (Allen 2003; De Pleijt and Van Zanden 2016; Henriques and Palma 2019; Rota and Weisdorf 2020). Although universities themselves contributed little to the advancement of applied sciences in the early modern period, the quality of universities can still impact development through enhancing the quality of human capital in general, and of its upper tail in particular.

To study the effect of the Reformation on the network of European universities, we build seven successive networks over the period from 1000 (creation of the first associations of professors or students dedicated to education) until 1793 (French Revolution). Each network covers a period of about 100 years. The Reformation started around 1523 (creation of an higher-education college in Strasbourg, followed by the creation of the first full fledged Protestant university in Marburg, Germany). We thus obtain four networks before the Protestant Reformation and three networks after the emergence of Protestantism. We analyze the main characteristics of the network through time and find that Reformation does correlate with a lower density and to more division in the network. In fact, we observe a sharp clear-cut divide between Protestant and Catholic universities in the network after the Reformation, with only 5,05% of all links connecting them in 1598-1684. This is all the more striking as connections between universities that would convert into Protestantism and universities that would remain Catholic reaches 20.78% of all links on the brink of the Reformation. This proportion of interfaith links falls to 3.59% in 1685-1793, suggesting a long lasting impact of the Reformation on the mobility of scholars. Of course, we need to distinguish the effect of religion from a pure geographical effect. Using dyadic regressions, we show that religion is a strong determinant of network structure. Moreover, fragmentation increases not only between Protestant and Catholic universities, but also within those broad groups.

Looking at data through the lens of graph theory also endows us with powerful tools to study how well universities are connected in the network. In particular, we find that publications of the top five scholars in each university is strongly correlated with classical measures of centrality in the network over the period under study. In order to isolate the impact of the Reformation on each university centrality, we predict the network structure from dyadic regressions with and without religions. This allows us to compute universities' predicted centrality, along with the "natural" centrality of universities in an atheist world. We compare these two simulated centrality measures and find that the Reformation harmed less Protestants than Catholics on average. Finally, we find that the Reformation impacted positively the publications of top five scholars in Protestant Universities, partly by improving their relative position in the network. These trends seem particularly relevant to explain the scientific demise of the universities in the South of Europe (including France) in the modern period.

This paper speaks to the literature on the effect of Protestantism on the development of Europe. It offers a new angle based on unique data about the mobility of university professors. Compared to Cantoni, Dittmar, and Yuchtman (2018), Cantoni (2015), Becker and Woessmann (2009), and Becker, Pfaff, and Rubin (2016), we see the Reformation and the Counter-Reformation as affecting the relationships between people and universities, without necessarily affecting preferences or technology (which were the focus of the rest of the literature).

Our paper belongs to a tradition in economic history to use the conceptual framework offered by network theory to describe how relations between nodes shape some economic or social outcome.[2] The seminal paper using networks in economic history is probably Padgett and Ansell (1993). They construct a network of marriages in early Renaissance Florence and analyze its characteristics (centrality, etc.) to understand how the Medici gained political control. Another important paper is by Puga and Trefler (2014), who construct a similar network for Venice in the Middle Ages to study monopolization of the galley trade. Compared to these approaches, we introduce a methodological novelty. We use a dyadic regression to predict links, and, inspired by the quantitative macroeconomics literature, we run counterfactual simulations to show how the network would look if religion did not play a role. A counter-factual network is useful to illustrate the importance of religious affiliation compared to the importance of geographical proximity.[3]

To our knowledge, few other papers study phenomena related to the Protestant Reformation through a network angle. Kim and Pfaff (2012) document the key role of university students in diffusing Evangelical ideas or Catholic orthodox ideology in their places of origin. They explore city-to-university ties in the Holy Roman Empire between 1523 and 1545 and show that cities exposed to Evangelical activism through student enrollments in Wittenberg and Basel universities were more likely to institute reform. By contrast, reform was less likely in hometowns of students enrolled in the universities of Cologne and Louvain, the two leading bastions of Roman orthodoxy.

Our analysis is moreover related to the literature on mobility of researchers and scientific production,

[2] Beyond using network maps to describe relations, there is a rising number of papers using exogenous changes in network structure to build causal identification strategies, see for instance Telek (2018), Becker et al. (2018), Benzell and Cooke (2020).

[3] To our knowledge, only two papers in the economic and social networks literature use counterfactuals. Mayer and Puller (2008) explore how alternative university policies could reduce social segmentation among students, while Canen, Jackson, and Trebbi (2020) investigate how political polarization in the U.S. Congress affects legislative activity. Both papers build their counterfactual analysis on a model of network formation. We cannot use this approach as in our framework, nodes (universities) do not decide to create or sever connections. Dyadic regressions have been widely used to study the determinants of network formation, see for instance (De Weerdt 2004, Fafchamps and Gubert 2007, De Weerdt, Genicot, and Mesnard 2019). In the transport network literature, Swisher IV (2017) uses counterfactual networks to quantify the effect of the railroad on U.S. growth from its introduction in 1830 to 1861. He estimates the output loss in a counterfactual world without the technology to build railroads, but retaining the ability to construct canals. His counterfactual canal network is built through a decentralized network formation game played by profit-maximizing transport firms. In our paper, links between universities are created by mobile scholars. Although studying mobility decisions of scholars is beyond the scope of this paper, it can arguably be said that the Reformation increased the cost of moving from a Protestant to a Catholic university, or vice versa. In our atheist world, we would assume that such cost would not depend on religious considerations.

since the network position of a university reflects by construction the mobility of scholars. Ejermo, Fassio, and Källström (2020) show with contemporary Swedish data that mobility between universities increases significantly the scientific publications of researchers. The arrival of new scholars in a university department can also have positive spillover effects thanks to the diffusion of ideas (Moser, Voena, and Waldinger 2014). In this sense, Ductor et al. (2014) study how knowledge about the coauthor network of an individual researcher helps to develop a more accurate prediction of his or her future productivity. Goyal, van der Leij, and Moraga-González (2006) and Ductor, Goyal, and Prummer (2018) respectively study the broad structure of the coauthorship network among economists and gender differences within this network.

The paper is organized as follows. We first define our network of European universities and present the main mechanisms we have in mind (Section 2). We describe the data we built on professors and universities (Section 3), then and we describe the main features of the network before and after the Reformation (Section 4). Section 5 is devoted to separating the role of geography vs the role of religious affiliation. Section 6 looks at effects on academic production. Finally, Section 7 concludes.

2 Theory

A network of universities. Let $N = \{1, 2, \ldots, n\}$ be the set of universities in the network g. For two universities $i, j \in N$, we define $g_{ij} \in \{0, 1\}$ as the *link* or *edge* between them, with $g_{ij} = 1$ signifying that at least one individual scholar has taught in both universities and $g_{ij} = 0$ otherwise. We consider that the links are *undirected*: if a scholar has moved from university i to university j, this generates a link *between* i and j, and not a link *from* i to j only. Formally, $g_{ij} = g_{ji}$ for all universities i and j. The *strength of the link* s_{ij} is given by the number of scholars who have taught in both universities i and j. If all scholars of a given university stayed in this same university during their entire career, then this university is an *isolate* in the network. This means that it has no connection with other universities in the network. The network of universities, g, is thus the collection of universities (nodes) and the links between them. We define such a network of universities for each period of time that we study.

Diffusion and Learning through the network of universities. The idea behind our definition of the network is the following. When a given professor had appointments in two (or more) places over his life, it established a relationship enhancing the flow of ideas, manuscripts, and students between the two places, which might last well beyond the death of the professor. The network of universities can then reflect priviledged ways of diffusion and learning (Jackson 2008 chap. 7 & 8). Several mechanisms are at play.

First, during the pre-industrial era, knowledge was partly codified in books, but more importantly, was embodied in people. When a scholar moves, she brings knowledge from one place to another. This is why

competition to attract talents was fierce among universities, leading to permanent flows between them (Denley 2013). There are many examples of knowledge diffusion through physical moves. Let us mention the rediscovery of Roman law, which was superior to customary law at regulating complex transactions, spread from Italy to France in the Middle Ages either through the hiring by French universities of Italian professors, or by having some French professors be appointed to Italian universities (Arabeyre, Halpérin, and Krynen 2007). Second, codified knowledge in books can also travel physically with scholars. Even though books became more affordable after the invention of the movable type printing press, they were not as accessible as today. Biographical dictionaries contain many examples of professors donating their book collection to the university by testament. Probably the best example of the role of books carried by scholars in the diffusion of knowledge is when the Greek scholars fled the fall of the Byzantine Empire, bringing forgotten books by Greek philosophers to the many Italian universities in which they were hired (Harris 1995). Third, links are established by the presence of doctoral students. When a scholar moves to another university but maintains a connection with current or former students in her original university, a link is established. Students and professors cannot be systematically tracked with the available data, but some examples can be documented using the *Mathematics Genealogy Project*,[4] linking students to masters in the (broad) field of mathematics. Fourth, when a newly created university hires professors from an existing one, a long lasting relationship is established. For example, the University of Dublin, founded in 1592, was originally populated by scholars coming from Cambridge (Venn 1922). This established a long lasting, well documented, link between the two universities. This is also true for Louvain (founded 1425) which started with several professors hired from Cologne, itself founded in 1388 (Lamberts and Roegiers 1990a).

In some cases, links are established when a professor has to flee war or persecution. This happened in particular after the Reformation, when scholars reallocated according to their faith (or in some cases changed faith to keep their current location). Still, an intellectual link was created by this move. For example, the Calvinist reformation developed in Geneva in the 16th century owes much to lawyers active in Bourges during the preceding centuries. This rejoins the literature on how practical knowledge flowed from France to Prussia with the expulsion of the Huguenots (Hornung 2014).

Confessionalization. As soon as we classify universities as either Catholic or Protestant, we use the notion of Confessionalization. According to Lotz-Heumann (2016), Confessionalization refers to the process of "confession-building". This process occurred through "social-disciplining," as there was a stricter enforcement by the churches of their particular rules for all aspects of life in both Protestant and Catholic areas. This had the consequence of creating distinctive confessional identities. Every aspect of life was affected by the move initiated by Luther and Calvin. This paved the way to early modern state formation, increasing the segmentation of Europe (Schilling 1995). The extent and strength of Confessionalization

[4] `https://genealogy.math.ndsu.nodak.edu`

is hard to measure, particularly at the European level, and this is one contribution of our approach.

The science-religion nexus. When we raise the question of the relationship between scientific output and religious affiliation, we implicitly touch the delicate question of the attitude of religions with respect to science. Bénabou, Ticchi, and Vindigni (2015) propose a game-theoretic framework to think about this issue. There are two players in the game: a government which can prevent scientific innovations to avoid the erosion of religious beliefs, and a church which can adjust its doctrine to make it more complementary with scientific progress. The model leads to describe the joint dynamics of religious beliefs and productivity. Two of the possible stationary equilibria highlighted by the authors are of interest for us, and resembles the Catholic/Protestant divide. One is a regime with knowledge stagnation, extreme religiosity with no modernization effort. Another one (called "American") combines scientific progress and stable religiosity with religious institutions engaged in doctrinal adaptation. The theory remains however limited on the role of parameters delimiting the different regimes. Why did the Catholics engage in repressing new knowledge in the sixteenth century (for example through censoring publications, see Becker, Pino, and Vidal-Robert (2020)), while they were more open to science before the Reformation? Our analysis in terms of network of universities may highlight the different position of Catholic and Protestant universities within the network in terms of centrality vs. being marginalized within the network.

3 Professors and Universities

In this section we describe the data on scholars used to construct the network of universities and we report qualitative and quantitative evidence on the decline of Southern universities in the 17 and 18th centuries.

The data on professors we use are obtained from the sources listed in detail in Appendix B. More details can be obtained in the collection *Repertorium Eruditorum totius Europae* with a summary in De la Croix (2021e). We detail here the main sources for some important samples, to highlight to the reader the strengths and weaknesses of the individual data on which the network of universities will be built. With 3285 professors, the University of Bologna (founded 1088) provides the largest sample, thanks to its seven centuries of existence and to the excellent coverage found in the secondary literature. Almost all the data were encoded from the book of Mazzetti (1847) which provides short biographies for these professors, including whether they had appointments in other universities. The university of Heidelberg (founded 1386) is the Germanic university with the highest number of recorded scholars, 1210 professors, thanks to the list of professors published in Drüll (1991) and Drüll (2002). For the University of Louvain (founded 1425), an important university in the Renaissance and the university of one the authors of this paper, collecting data was more complicated, as there was no Mazetti or Drull to write a catalogue of professors for this once famous university. Data were collected from a variety of sources: Lamberts

and Roegiers (1990a), Ram (1861) (for the list of rectors), Nève (1856) (for the history of the Collegium trilingue), Schwinges and Hesse (2019) (for deans before 1550), and Brants (1906) (for the law faculty). Each person was searched for in biographical dictionaries such as Eloy (1755) (doctors), Sommervogel (1890) (Jesuits), and the national biography to find more information about careers. The combinations of these various sources unearth 1138 professors, hence a good coverage of this university. A similar strategy of combining several secondary sources was applied for the University of Paris. English universities, Oxford and Cambridge, are covered by the books on their alumni (Venn (1922) for Cambridge, and Foster (1891) and Emden (1959) for Oxford). Finally, we took the liberty to add some important higher education institutions to the list of "official universities" provided by Frijhoff (1996), such as Gresham College in London, and the Herborn Academy in the Holy Roman Empire (this is detailed in Appendix B.

Even if the coverage of the smaller universities is sometimes unequal, the coverage of the persons who matter for our study remains high: *mobile* scholars are indeed more likely to be identified as they would appear in multiple sources. *Productive* scholars are also more likely to be in the database, as they would be mentioned in books about each university, even if those books are very incomplete (such as books celebrating the xth anniversary of the university).

While searching for professors, we found many qualitative elements about the decline of universities in the 17th century. The view of the literature is that Catholic universities became unattractive during the 17th-18th centuries, partly because of religious views (the Counter Reformation, the Inquisition). Here are some compelling examples. (1) About the medical school at the University of Valencia during the 17th century: "the neoscholastic ideology of the Counter-Reformation converted the Faculty, for the most part of the century, into a nucleus of intransigent Galenism, opposed to the innovations of the Scientific Revolution." (López Piñero 2006) (2) The same view applies to Lleida where the advances of the sixteenth century were later reversed: "The rigid vigilance exercised by the Supreme Council of the Inquisition paralyzed the University and caused the decadence of the university body. In such cases, thought is threatened and all innovation seems dangerous. The teacher dictates the text, students copy it, and that is all. Medieval routines subsist and Aristotle, Galen, and Avicenna reemerge enslaved under the tyranny of obsequious teaching, ... This state of affairs lasted for two centuries. It could be said that throughout this long period, Spanish universities, which had been so prestigious until then, disconnected from the European cultural rhythm." (Esteve i Perendreu 2007) (3) On Salamanca, the most prestigious Spanish university, we read "In the early decades of the eighteenth century, Salamanca was simply treading water. Such a condition cannot be wholly ascribed to the often cited isolation of the Spanish university or to the impact of the Inquisition. These two factors had an undoubted effect in the seventeenth century, but by 1750 (...) faculty politics posed a serious handicap (...)" (Addy 1966) (4) Going now to Italy, a general viewpoint is that "Yet in the 17th century, Italy lost its earlier pre-eminence in literary and scientific culture, falling behind by at least 20-30 years compared to other European countries. The 17th century

universities in Italy ceased to attract illustrious teachers for lack of adequate salaries, while political and religious divisions considerably reduced the flow of foreign students." (Pepe 2006) (5) For the case of Pavia, we read that "In the last decades of '500 and until the mid '700, the decline of the University of Pavia is sharp; almost abandoned, at that point it conducted a miserable existence without any hint of the past splendour, when – crowded with students and masters of distinguished authority – it had consistently contributed to the progress and diffusion of culture." (De Caro 1961) (6) About the University of Cahors (France): "We enter the 18th century without any more highlight for her. There is no more star standing in the pulpit. (...) There is no longer this immense crowd coming from afar to follow her classes. There are not even any more grievances, abuses, and speculative turbulence to be charged to her; there is no more than an earthy routine, a discolored, anonymous, needy, and penniless company. The Age of Enlightenment is precisely for the University of Cahors as for most of her sisters the dark time of mediocrity." (Ferté 1975) (7) There is also the idea that they expended all of their energy in futile fights between religious factions: "Louvain was for a long time considered the center of Jansenism, as a champion of Catholic-heretical dogma. However, as the true faith continued to be disputed among the different orders and clerical teachers, the University was able (...) successfully to defend its status and privileges, even at a time when its attractiveness as a center of learning already belonged to the past." (Hammerstein 1996)

This qualitative evidence is confirmed by a more quantitative approach. We first classify universities according to their religious affiliation as reported in Frijhoff (1996). Four broad groups are defined as follows. The set $\mathbf{C}$ includes all universities which have never ceased to endorse the Catholic faith over the period considered. The set $\mathbf{P}$ includes the universities which either converted to Protestantism at some point, or which were created as such from the beginning. The set $\mathbf{M}$ gathers "mixed" universities which accommodated both Catholic and Protestant faiths, either moving back and forth between Protestantism and Catholicism, or teaching both theologies in parallel. It only includes three universities: Heidelberg, Erfurt, and Orange.[5] Within $\mathbf{C}$ it becomes useful to distinguish universities which were run by the Jesuits after the Counter-Reformation, belonging to $\mathbf{C^J}$, from the universities which remained "secular", belonging to $\mathbf{C^S}$, where secular here means not belonging to a monastic order. The Jesuits' congregation, the Society of Jesus, operated a large number of schools and universities throughout Europe (Grendler 2018), with the aim of educating virtuous leaders who would act for the common good (and fight the Reformation). The oldest and most prestigious Catholic universities fought the influence of this new congregation and kept the Jesuits out (Louvain, Paris, Bologna, Padua, Krakow). Within $\mathbf{P}$, we will distinguish the four brands of Protestantism: $\mathbf{P^P}$ for Presbyterian (only in Scotland), $\mathbf{P^L}$ for Lutheran (Germanic, Nordic), $\mathbf{P^C}$ for Calvinist (Dutch, French, Swiss, German), and $\mathbf{P^A}$ for Anglican (English, Irish), with $\mathbf{P^P} \cup \mathbf{P^L} \cup \mathbf{P^C} \cup \mathbf{P^A} = \mathbf{P}$.

[5] There are two Orthodox universities in our database, Saint-Petersburg, Moscow, that we do not include in the analysis.

The period under study goes from 1000 until 1793. We divide time into seven periods. Following a tradition in history, we use major events to define seven periods rather than centuries: 1) from the creation of the first associations of professors and students dedicated to education in 1000 until 1199; 2) from the creation of the university of Paris in 1200 until 1347; 3) from the Black Death in 1348 until 1449; 4) from the creation of the printing press in 1450 until 1522; 5) from the creation of the first Protestant university in 1523 until 1597; 6) from the Edict of Nantes in 1598 until 1684; 7) from the Revocation of the Edict of Nantes in 1685 until 1793, in the middle of the French Revolution.

Focusing on the two main types of universities, **C** and **P**, we compute the total number of scholars of universities and their publications over time. Results are shown in Table 1. Detailed data are reported in Appendix (Table C.2). These numbers are computed by summing all the publications recorded in Worldcat by members of universities. Worlcat provides a comprehensive contemporary measure of scientific output. One could argue that a measure of output should be based on the works published while the author was still alive. What was published after the death of the person might reflect how the author gained popularity *post-mortem*, which might not be relevant for determining his/her productivity. This, however, is not possible to implement, because many first editions of books are not available anymore. For example, there is no doubt that Pierre Abélard (1079-1142) was a philosopher of great renown during his life. All his written output available in the libraries today, from philosophical works to love letters, was published after 1600.

Another issue with measuring academic output from contemporaneous library catalogues arises from the possible loss of some publications over time. This does not seem to be of major importance, though. Chaney (2020) compares the books contained in the Universal Short Title Catalogue database of St. Andrews (2019) (`https://ustc.ac.uk/`) with those referenced in VIAF (Virtual International Authority File). The USTC aims to cover all books published in Europe between the invention of printing and 1650. Chaney successfully located 81% of these authors in the VIAF data. Such a high level of coverage is consistent with the claim that VIAF provides a reasonable approximation to the population of known European authors. As Worldcat relies on VIAF, this also holds for Worldcat.

The total publications of Catholic and Protestant universities founded before 1523 is reported in the first two rows in section A of Table 1. It is obtained by summing the publications of their members. When a person taught at several universities over her life, we divide her publications by the number of affiliations and allocate this amount to each university. The numbers show the rise of publications following the invention of the printing press. The printing press was adopted quickly throughout Europe, with no difference between countries (Timperley 1839). Later, there is growth in the last three periods among old Protestant universities: 326k publications in 1523-1597 to 339k and 427k publications in 1598-1684 and 1685-1793. There is a clear decline among Catholic universities, from 331k publications in 1523-1597 to 200k 1685-1793, despite a large number of scholars of the order of 4000 per period (section B of Table 1).

Table 1: Publications and Scholars over time

	1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793
A. Total number of publications per period (÷1000)							
Old universities (founded bef. 1523)							
C	23.0	132.5	81.7	204.8	331.1	178.4	200.9
P	0.9	8.8	3.1	73.2	326.3	339.0	427.2
New universities (founded aft. 1523)							
C					80.0	88.5	149.3
P					178.4	390.6	738.6
Ratios **C**/**P**							
old	24.31	15.13	26.24	2.80	1.01	0.53	0.47
new					0.45	0.23	0.20
B. Total number of scholars per period							
Old universities (founded bef. 1523)							
C	230	2012	3987	5133	5023	4739	6154
P	12	78	270	909	1061	1083	1461
New universities (founded aft. 1523)							
C				768	2452	3511	
P				551	1566	3024	
Ratios **C**/**P**							
old	19.2	25.8	14.8	5.6	4.7	4.4	4.2
new					1.4	1.6	1.2

P bef. 1523 covers universities which converted later to Protestantism.

Table 2: Publications per Publishing Scholar and of top Scholars over time

	1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793
C. Publications per publishing scholar per period (÷1000)							
Old universities (founded bef. 1523)							
C	0.24	0.32	0.17	0.25	0.23	0.14	0.10
P	0.16	0.17	0.11	0.48	0.56	0.44	0.37
New universities (founded aft. 1523)							
C					0.29	0.14	0.15
P					0.49	0.34	0.29
Ratios **C**/**P**							
old	1.52	1.90	1.55	0.52	0.41	0.31	0.28
new					0.59	0.41	0.51
D. Publications of top 5 scholars per period							
Old universities (founded bef. 1523)							
C	18.7	88.5	57.8	139.8	184.4	113.0	113.1
P	0.9	6.4	3.0	66.5	234.6	146.8	166.9
New universities (founded aft. 1523)							
C					54.2	60.5	105.0
P					126.4	183.5	289.0
Ratios **C**/**P**							
old	19.91	13.82	19.50	2.10	0.79	0.77	0.68
new					0.43	0.33	0.36

P bef. 1523 covers universities which converted later to Protestantism.

The overtaking by Protestant scholars is even more striking when we consider new universities. The total output of Protestant scholars is five times that one of Catholic scholars, despite some absolute growth in the Catholic world driven mostly by the elite institutions created by the kings of France (Collège Royal and Jardin des Plantes).

To account for heterogenous coverage of obscure scholars, we restrict the sample to publishing scholars in section C of Table 1. We observe that the productivity of publishing scholars in old Catholic universities systematically decreases over time relative to productivity in old Protestant universities. Within new institutions, publishing scholars are on average twice more productive in Protestant universities than in Catholic universities, from 1523 until 1793. Finally, to address heterogeneity in the coverage of publications by publishing scholars, we consider only publications by top 5 scholars, for which we have very good coverage. Section D of Table 1 confirms the decline of old Catholic universities relative to old Protestant universities over time. Moreover top 5 scholars in new Protestant universities publish almost three times more than their counterparts in the Catholic world from 1598 to 1793.

4 The Network of Universities

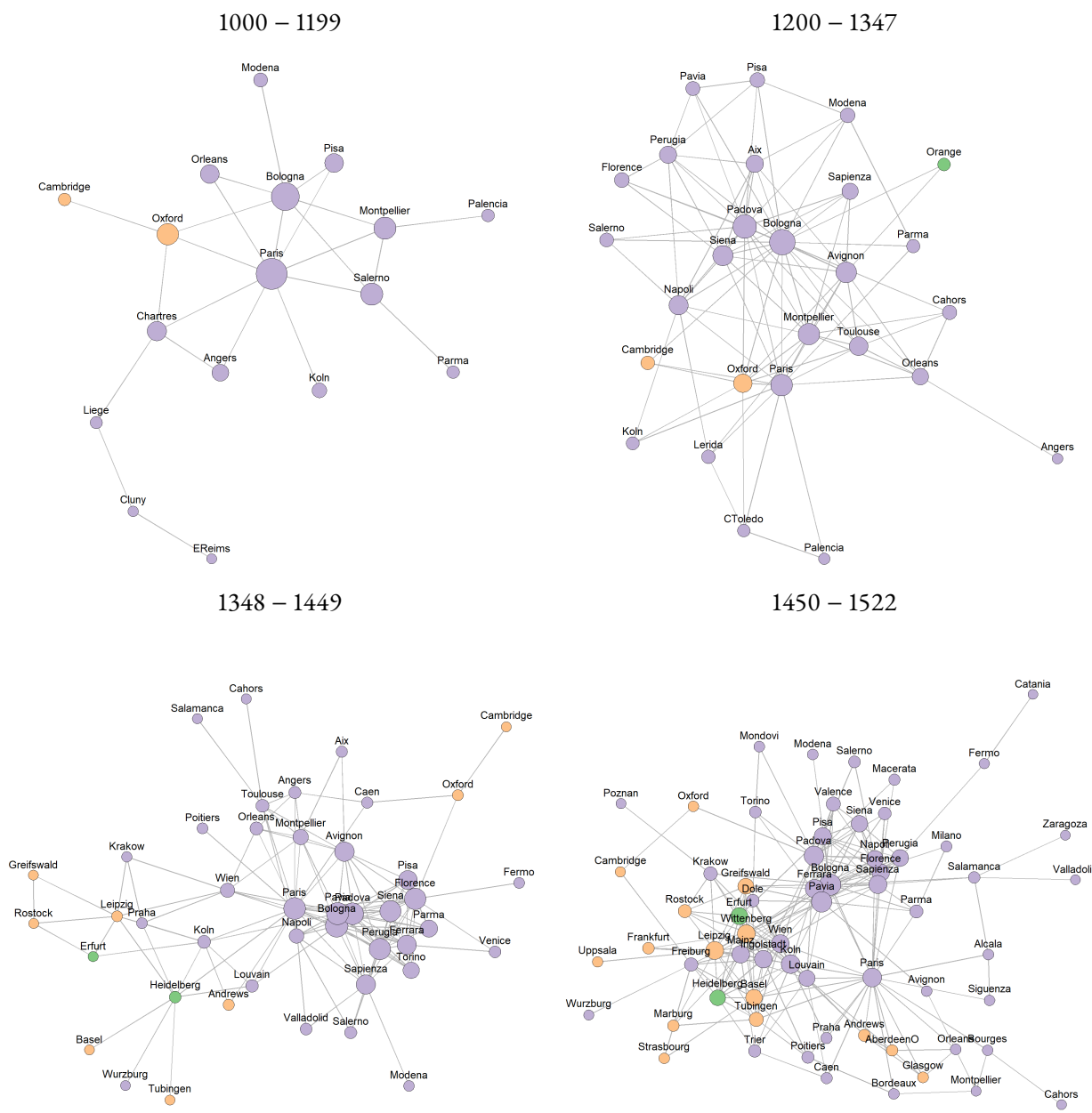
We build the network of European universities for each period, and thus obtain four networks before the Reformation, that started around 1523, and three networks after. In Figures 1 and 2, we map out these networks of universities before and after the Reformation.

A connection between two universities illustrates the transfer of one or several scholars between them, without taking into account the direction of transfer. More specifically, each network captures all the displacements of scholars that occurred by period. The 1523-1597 network in Figure 2 is particular, as it witnesses a reallocation of scholars to fit the new religious conditions: French and Belgian Protestants moving North, but also British Catholics moving to France (Rheims and Douai, see Bideaux and Fragonard 2003).[6] We consider that this reallocation of scholars ends in 1598, when the edict of Nantes is promulgated, granting rights to French Protestants, including the right to have their own universities. We code universities according to their religious affiliation. Before the Reformation, all universities were Catholic, but in the network we nonetheless distinguish between purple universities that remain Catholic after the Reformation and orange universities that convert to Protestantism. The only three green universities, Erfurt, Heidelberg and Orange, become mixed universities. After the Reformation, each different brand of Protestantism gets in own color: Anglican are pink, Calvinist yellow, Lutheran orange and Presbyterian maroon. The Jesuit universities that actively took part in the Counter-Reformation are blue, while "secular" Catholic universities are purple. Finally, mixed universities are green. Let us point out that the positioning of universities in these figures is determined by the standard Fruchterman-Reingold force-directed algorithm (Fruchterman and Reingold 1991) that groups universities more closely together when they are linked to each other. So the positioning of universities is not based on geography, religion, or other university attributes. Overall, we already observe a clear-cut divide between Protestant and Catholic universities in the two last networks after the Reformation, based on the mobility of scholars only.

Our figures also show the centrality of each university by changing the size of its circle. We are measuring here eigenvector centrality, which will be described in more details later. Our network maps can be used to give a crash course on the history of the academic landscape in Europe. It goes as follows. In the first period (1000-1999), the burgeoning Paris and Bologna are, as expected, the two most central universities. The medical centers of Montpellier and Salerno are also quite central, as is the cathedral school of Chartres. Oxford is the little sister of Paris. In the second period (1200-1348), the Bologna-Paris-Oxford-Montpellier group is rejoined by Padova, Avignon (which may have benefitted from the presence of the

[6] From 1529 to 1536, the English Parliament breaks with Rome and establishes the Church of England. In 1555, the Peace of Augsburg allows rulers within the Holy Roman Empire to choose either Lutheranism or Roman Catholicism as the official confession of their state. In 1560, the Scottish Parliament establishes the Kirk. In the Appendix, Table A.1 summarizes major Reformation events and Figure A.1 shows the religious situation in Europe around 1560.

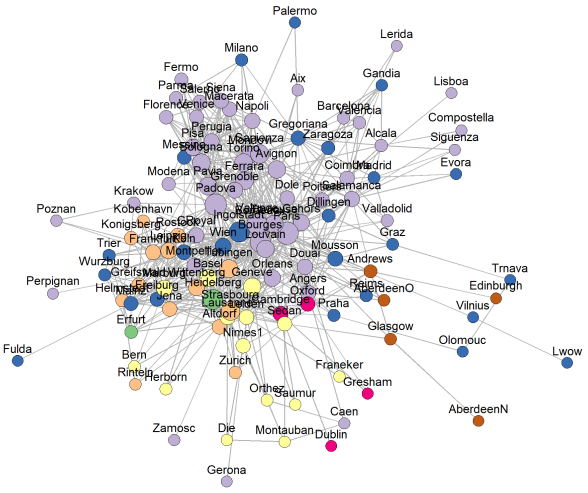
Figure 1: Networks before the Reformation



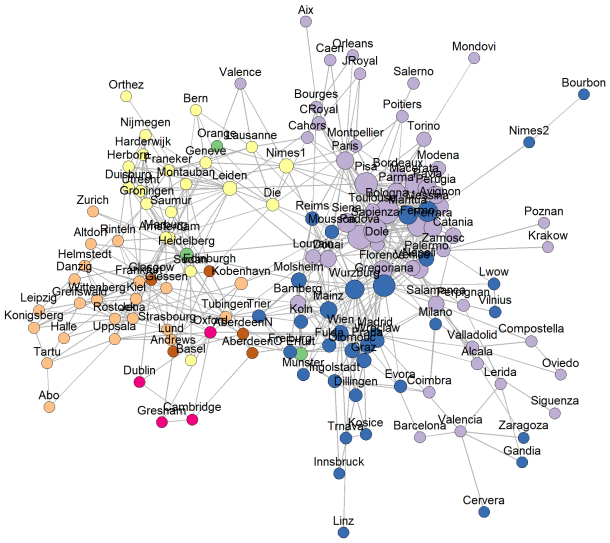
Note: Universities that would remain Catholic after the Reformation are purple, while universities that would convert to Protestantism are orange. Mixed universities are green.

Figure 2: Networks after the Reformation

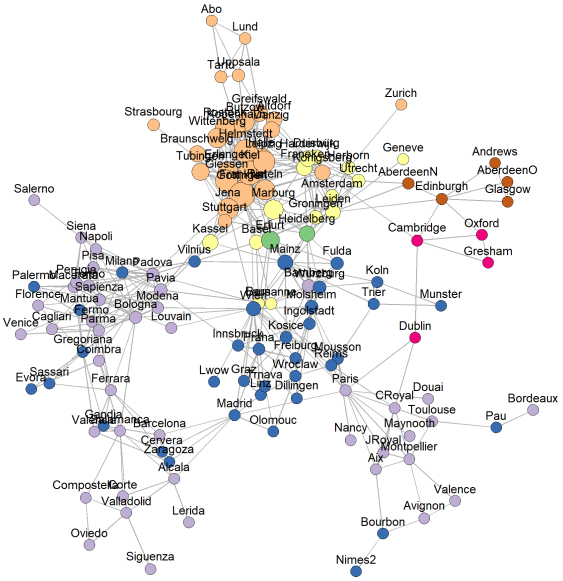
1523 – 1597



1598 – 1684



1685 – 1793



Note:"Secular" Catholic universities are purple, while Jesuit universities are blue-filled. Lutheran, Presbyterian, Calvinist and Anglican universities are respectively orange, brown, yellow and pink. Mixed universities are green.

Pope court), Toulouse, and Siena. Salerno is declining, and Chartres has disappeared from the map. After the black death (1349-1450), it is the Italian moment. The studium in Florence, the university of the Pope in Rome (Sapienza), and Parma rejoin the group of highly central universities. The newly founded universities of Vienna and Louvain start to appear on the map. During the last period before the Reformation (1451-1522), there are additional newcomers, some of whom will ultimately become protestants, such as the universities of Leipzig, Greifswald and Wittenberg. Paris is still there, Louvain centrality has grown, Oxford centrality has shrunk. The period of the Reformation (1523-1597) is one in which many universities display a high degree of centrality. The network is made of a core of universities having multiple links between each other, with a periphery of less connected places. We remark the emergence of a new type of universities in blue, those either founded by the Jesuits, or in which the Jesuits played a key role. In the period during which Protestantism was tolerated in France (1598-1685), the network is obviously split into two blocks, the Protestants and the Catholics. the Catholic universities are still the most central. But they are of two types. The secular Catholic, not run by any specific monastic order, and the Jesuit universities. We observe that the mothership of all Jesuit universities, the Gregoriana, is indeed the most central one in their network. It is surprising not to see the Dutch universities emerging at this stage. For the German universities, many were engulfed in the Thirty Year War. In the last period (1686-1793), there is a complete reversal of situation, at least seen from the point of view of centrality. The Lutheran universities, led by the newly founded Universities of Gottingen and Halle, are now the most central ones, followed by the Calvinist universities in Holland. The other nodes in the network have lost the centrality they had previously, including the Jesuit universities.

We now examine the main macro characteristics of the networks. Let us first define them. The *density of the network* is the ratio of observed links in a network to the maximum number of possible links. For an undirected network with N nodes, the maximum number of links is $N(N-1)/2$ so the density for an undirected network is: $2L/[N(N-1)]$, where L is the number of observed links in the network. The *degree of a university i*, d_i, is the number of distinct universities with which the university i is connected. Formally $d_i = \#|j : g_{ij} = 1|$. The *average degree* of a the network g, denoted $d(g)$, is the mean of the degrees of all connected universities in the network. The *distance* $l(i,j)$ between two universities i and j is the length of the shortest path between them. The *diameter* is the largest distance between any two universities in the network. The *average distance* of all pairs of universities in the network g is denoted $l(g)$. Note that we compute these statistics for each network without taking isolates into account. Statistics defined above are displayed in Table 3.

First, we observe a large increase in the number universities across time, going from 18 to 151. In contrast, the number of connected pairs of universities keeps increasing before the Reformation, until it reaches a peak during the 1523-1597 period. As we already discussed, this period is specific as it witnesses a constrained reallocation of scholars due to the emergence of Protestantism. Interestingly, the number of

Table 3: Descriptive Statistics of the Networks

	1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793
Universities	18	31	50	73	120	146	151
Connected universities	17	27	44	66	115	140	144
Connected pairs	24	93	136	231	692	535	473
Scholars in connected pairs	42	367	679	745	1555	1457	2146
Density	0.18	0.26	0.14	0.11	0.11	0.05	0.05
Average degree	2.82	6.89	6.18	7	12.03	7.64	6.57
Diameter	6	3	6	5	5	7	8
Average distance	2.62	1.88	2.54	2.54	2.46	3.1	3.47

connected pairs decreases during the two last periods after the Reformation. However, when we consider the total number of scholars connecting each pair of universities, it keeps increasing over the period. As a result, the average number of scholars connecting two universities increases from 3.22 just before the Reformation to 4.54 in the 1685-1793 period. So a professor in a given university was more likely to move to another university that already had a connection with his current university after the Reformation than just before, even though the number of universities more than doubled between these two periods. Then, the networks of universities are sparser after the Reformation: the density of the network more than halved. This is due to both the increase in the number of universities in the networks and the decrease of links after the peak mentioned in the 1523-1597 period. The average degree of universities in the networks is quite stable for the three periods just before the Reformation and the two last periods after: on average, universities are connected to about 7 other universities over the period. This number strikingly increases to slightly more than 12 during 1523-1597 period: again, this is due to the forced reallocation of scholars during this troubled period which increased mobility significantly. Finally, the average distance of the networks increases after the Reformation. For the five first periods, it requires on average 2.41 steps to connect any pair of universities in the networks and at most 5 steps. In contrast the average distance of the networks increases to 3.10 and 3.47, and the diameter reaches 7 and 8 in the two last periods.

We now explore to what extent the individual position of universities in the networks correlates with the publications of their top 5 scholars. As explained in Section 3, we focus on top 5 scholars for which we have a very good coverage. We consider five classic network measures of centrality. We already defined the first one, the *degree* of a university i, d_i, which measures the number of university i's neighbors. The four other centrality measures are as follows. The *strength* s_i captures the average strength of existing links of university i with its neighbors. The *closeness centrality* $\mathcal{C}_i$ describes how quickly university i is reachable from all other universities in the network. The *betweenness centrality* $\mathcal{B}_i$ measures the importance of university i in connecting other universities in the network. The *eigenvector centrality* $\mathcal{E}_i$ captures how "well-connected" university i's neighbors are. We provide detailed definitions of these four measures in

Appendix F. We regress academic output of top 5 scholars in each university on the different network measures described above, in a panel over our seven periods. Results are displayed in Table 4.

Table 4: Position in the network and Scientific Production

	Dependent variable: p_{it}				
degree	0.087***				
	(0.016)				
strength		0.029**			
		(0.013)			
closeness			10.241***		
			(1.510)		
betweenness				6.947***	
				(2.724)	
eigenvector					1.647***
					(0.374)
Observations	589	589	538	589	589
Adjusted R^2	0.639	0.618	0.629	0.619	0.630

*p<0.1; **p<0.05; ***p<0.01 Includes university and period fixed effects, controls for varying coverage & activity periods.

Every column of Table 4 presents a regression of the logarithm of publications of top 5 scholars plus 1 of each university, which we denote p_{it}, on our five measures of network position. It includes university and period fixed effects along with controls for coverage and activity period. The coverage of a university is the number of observed professors who taught there divided by its activity period length. The activity period length of a university is the number of years during which this university is active. We find that all these centrality measures correlate significantly with academic output of top 5 scholars. This indicates that the more central a university in the network along these different dimensions, the higher its academic output. Assuming that the flow of ideas follows the paths created by mobile scholars, we may understand that the more central a university, the more new and diversified ideas it can access, which would enhance its academic production. Of course, our regressions only allow us to establish correlation between position in the network and academic production, not to infer causality. Moreover it is also very plausible that causality goes the other way: more prestigious and productive universities likely attract more scholars, which improves their central position in the network. But still, the diffusion of ideas mechanism described above is also possibly at play.

We now examine more closely how religious affiliation interacts with network structure. Connections between Catholic and Protestant universities over time are shown in Table 5.

We first note that in 1450-1522, just before the Reformation, almost 21% of connections are between **C** universities and would-be **P** universities, while this share shrinks to 5.05% and 3.59% during the last two

Table 5: Connections between Catholic and Protestant Universities

	1450 -1522	1523 -1597	1598 -1684	1685 -1793
Proportion of **C**-**P** edges	20.78	21.1	5.05	3.59
IH index for **C** univ	0.57	0.54	0.87	0.92
IH index for **P** univ	0.33	0.29	0.64	0.69
Modularity religion	0.10	0.18	0.37	0.43

periods after the Reformation. During the first three periods under study, this proportion is low because there are few would-be **P** universities relative to **C** universities. Additionally, Catholic and Protestant universities tend to have more connections with universities of the same religion over and above the relative size of their religious group. We use the *inbreeding homophily index* developed by Coleman (1958) (see Appendix E for a definition) in order to compare the degree of homophily among Catholic and Protestant universities across time. The inbreeding homophily index is positive and increases significantly in the two last periods after the Reformation for **C** and **P** universities. While the IH index for **C** universities equals 0.57 from 1450 to 1522, it peaks to 0.87 and 0.92 in 1598-1684 and 1685-1793 respectively. We find a similar pattern for **P** universities: their IH index increases from 0.33 before the Reformation to 0.64 and 0.69 in the two last periods after the Reformation.

Finally, we use the modularity score to evaluate to what extent the partition of universities along their religious affiliation explains the structure of the network. We consider a community structure Π based on religions. We distinguish three communities in Π : Catholic, Protestant and Mixed. The partition of universities along religious affiliations exhibits positive modularity scores, indicating that there are more links in communities than we would expect in a randomly generated graph. But while the modularity score just before Reformation is 0.10, it reaches 0.37 and 0.43 in the two last periods under study, indicating that religion is a good predictor of the network structure after the Reformation. To make sure that the partition along religious affiliations is a significant community structure, we replicate 100 randomized networks that have the same degree distribution as the original data and evaluate their modularity scores for the two last periods after Reformation. We find that no randomized networks have a modularity score higher than 0.37 and 0.43 respectively in 1598-1684 and 1685-1793. In fact, the maximal modularity scores of these 100 networks for these two periods are respectively 0.06 and 0.04. Thus it can be said that division along religious affiliations significantly impacts the structure of the network of universities after the Reformation.

However, we should not omit the fact that religious affiliation is highly correlated with geography, as most Protestant universities are located in Northern Europe and most Catholic universities are to be found in

Southern European countries. To ensure that our previous analysis does not simply capture the impact of closer geographic distance rather than membership of the same religious group, we disentangle these two effects in the next Section.

5 Geography vs. Culture

In this Section we show that geography is also important, which is not surprising, but does not substitute for the effect of religion. To study the geographical and religious determinants of a connection between two universities, we use dyadic regressions.

Dyadic regressions in network analysis are regressions in which each observation expresses a relationship between each possible pair of nodes. In our setting, we successively investigate the following dependent variables for all pairs of universities i and j: (i) the presence or the absence of a link g_{ij}; (ii) the strength or intensity of the link s_{ij}; and (iii) the inverse of the length of the shortest path $1/l(i,j)$. Our aim is to estimate to what extent belonging to the same religious group determines the presence and the intensity of a connection between two universities, as well as the length of the shortest path connecting them in the network, controlling for geography. Since there may exist heterogeneous effects across subreligions, we decompose the effect of sharing the same religious affiliation by distinguishing the effect of both being Lutheran from the effect of both being Calvinist, and so on. Our main independent variables of interest are thus the geographic distance between any pair of universities and dummy functions indicating whether the two universities of the dyad are both Lutheran, Calvinist, etc. Our estimated model is

$$\begin{aligned} y_{ij} =& \beta_0 + \beta_1 d_{ij} + \beta_2 \, \mathbf{I}(i,j \in \mathbf{P}^L) + ... + \beta_8 \, \mathbf{I}(i,j \in \mathbf{M}) \\ &+ \beta_9 v_{ij} + \beta_{10} \underline{\nu}_{ij} + \gamma \, \mathbf{K}_{ij} + \alpha_i + \alpha_j + \epsilon_{ij} \end{aligned} \tag{1}$$

The dependent variable y_{ij} is a dyadic network measure as described above.

Distance is defined as $d_{ij} = \ln(\text{cost}^{\min} + \text{cost}_{ij})$, where cost_{ij} is the minimum cost it takes to travel from i to j computed using Özak's (2010, 2018) human mobility index. Parameter $\text{cost}^{\min}$ is the minimum cost incurred when travelling within the same city (say from Jardins des Plantes to Sorbonne). We assume it is equivalent to the cost of walking within the old city of Rome between the Vatican City and the Colosseum (3.5 km).

Dummy functions $\mathbf{I}(i,j \in \mathbf{P}^L)$, etc, indicate whether or not universities i and j are both Lutheran, Mixed, etc. We include such a dummy function for each subreligion, i.e. $\mathbf{P^L}$, $\mathbf{P^C}$, $\mathbf{P^P}$, $\mathbf{P^A}$, $\mathbf{C^S}$, $\mathbf{C^J}$ and $\mathbf{M}$. For each specification, we include cross effects to control for the differentiated impact of belonging to different subreligious groups. We introduce dummy functions, captured by the vector $\mathbf{K}_{ij}$, for each configuration

except the one which will be the reference category.[7]

We also add two other explanatory variables: the number of overlapping years during which both universities i and j are active, which is denoted v_{ij}, and the minimum coverage denoted $\underline{\nu}_{ij} = \min(\nu_i, \nu_j)$ where the coverage ν_i of university i is the number of observed professors who taught there divided by its activity period length. This is to control for the fact that two universities that are simultaneously active during a long time period are more likely to have a connection than two universities that only share a couple of active years. We add minimum coverage controls because we are more likely to observe a connection between two universities for which we have lots of information in our sample, as this is the case for Germany and Italy, than between universities for which we have poorer coverage.

To address the issue of spatial correlation, we use a two-way fixed effect model, which includes a fixed effect for universities i and j, α_i and α_j (see De Weerdt (2004) and De Weerdt, Genicot, and Mesnard (2019)). Autocorrelation is the possible correlation between the error term associated with the dyad formed by university i and university j, ϵ_{ij}, and all the error terms associated with other dyads in which i or j appear, $\epsilon_{.i}$, $\epsilon_{i.}$, $\epsilon_{.j}$ and $\epsilon_{j.}$. Concretely, we include one dummy for each university that indicates whether the specific university is part of the dyad or not. This means that there are two dummy variables equal to one for each observation. By including these university fixed effects we control for observable attribute variables, for instance the fact that big universities may have more connections than universities with small capacity. These university fixed effects also enable us to control for unobserved attribute variables: for instance, universities that encourage mobility are more likely to have more links than universities that do not. Including these dummies thus purges the effects of all attribute variables and therefore eliminates autocorrelation.

To run our dyadic regressions, we make a dataset of all possible unique combinations of two universities. We include in this dataset all universities where at least one scholar taught during the period under study.[8] For instance, in 1685-1879 we count 151 such universities, so the number of possible dyads is 11325.[9] We delete dyads for which the two universities were not active during a same period of time. This is to avoid two potential biases in our estimates. The first one is simply the fact that two universities that were not simultaneously active are less likely to share a connection. For instance, if university i was active until 1690, it is very unlikely that it shares a connection with university j that opened ten years later. Second, even for universities whose active periods are separated by less than 100 years, deleting such dyads mitigates the issue of the mobility of scholars triggered by the closing of their university. Assume that university i closes, forcing its scholars to find another teaching position at another university that is currently active. If university j opens only a few years after the closing of university i, we cannot know whether scholars

[7] For instance, $\mathbf{I}(i \in \mathbf{P}^L$ and $j \in \mathbf{P}^A$ or $i \in \mathbf{P}^A$ and $j \in \mathbf{P}^L) \in \mathbf{K}_{ij}$ is equal to 1 if there is one Lutheran university and one Anglican university in the dyad, and 0 otherwise.

[8] In other words, we include the universities that are connected and the ones that are isolated in the networks defined above.

[9] In a network with N nodes, t he number of possible dyads is $N(N-1)/2$.

would have chosen university j or not if it were active when their previous university i closed. Deleting such dyads removes these possible biases. Thus our final sample for 1685-1793 reduces to 11238 dyads. We show in Table 6 results when the dependent variable is the presence or the absence of a link. Results on intensity and on the inverse of the length of the shortest path are respectively displayed in Table D.9 and Table D.10 in the Appendix.

Table 6: Dyadic Regressions

	Dependent variable: presence or absence of a link						
	1000	1200	1348	1450	1523	1598	1685
	-1199	-1347	-1449	-1522	-1597	-1684	-1793
d_{ij}	-0.144^{***}	-0.214^{***}	-0.209^{***}	-0.173^{***}	-0.161^{***}	-0.116^{***}	-0.109^{***}
	(0.040)	(0.024)	(0.013)	(0.008)	(0.006)	(0.004)	(0.003)
$\mathbf{I}(i,j \in \mathbf{P}^J)$					-0.042	0.008	0.102^{***}
					(0.048)	(0.027)	(0.023)
$\mathbf{I}(i,j \in \mathbf{P}^C)$					0.205^{***}	0.233^{***}	0.304^{***}
					(0.063)	(0.055)	(0.039)
$\mathbf{I}(i,j \in \mathbf{P}^P)$					-0.018	0.445^{***}	0.367^{***}
					(0.101)	(0.072)	(0.065)
$\mathbf{I}(i,j \in \mathbf{P}^A)$					0.442^{***}	0.672^{***}	0.537^{***}
					(0.119)	(0.088)	(0.078)
$\mathbf{I}(i,j \in \mathbf{C}^S)$					0.278^{***}	0.163^{***}	0.148^{***}
					(0.041)	(0.024)	(0.021)
$\mathbf{I}(i,j \in \mathbf{C}^J)$					0.135^{**}	0.081^{**}	0.162^{***}
					(0.064)	(0.040)	(0.036)
Observations	153	437	1,225	2,623	7,091	10,565	11,238
Adjusted R^2	0.313	0.447	0.363	0.297	0.270	0.217	0.247
Notes:	*p<0.1; **p<0.05; ***p<0.01						
	Includes university fixed effects, controls for varying coverage & activity periods, interaction terms between all subreligion. Reference category: $\mathbf{C}^S$-$\mathbf{P}^L$ dyads.						

Our main result is that religion significantly explains the structure of the network of European universities after the Reformation, even when geography is controlled for. First, the impact of geographic distance is unsurprisingly significant and consistent across periods. Increasing traveling costs between two universities reduces their odds of being connected (first line of Table 6). Moreover, the higher the cost of travel between two universities, the less intense the connection between them and the farther they lie from each other in the network (see Tables D.9 and D.10). Second, we note that for all subgroups sharing the same religious affiliation is associated with a statistically higher probability of being connected in the network for almost all periods after the Reformation (three last columns of Table 6). For instance, in 1685-1793, for two universities, both being Calvinist raises their probability of having a connection by 0.304 on average relative to dyads containing one Lutheran university and one Secular university, all else being equal. The

pattern is less clear for the intensity of the connection, but we clearly observe that two universities sharing the same subreligion are more likely to lie closer to each other in the network in all periods after the Reformation (see Tables D.9 and D.10).

To better grasp the importance of religion we simulate the networks predicted by the dyadic regression, with and without religious variables. Using the estimates from our dyadic regressions, we simulate links to generate predicted networks and atheist (counterfactual) networks. To construct the predicted networks, we attribute to each dyad its predicted value of the probability of a connection between the two universities of the dyad. Then we define a threshold value for these predicted probabilities above which we assume that a link is created. We choose this threshold such that we keep the same number of connected universities as in the observed networks. We use the same methodology to construct the atheist network, except that we cancel the effect of religion variables. Figure 3 shows the simulated networks for the two last periods after the Reformation, and Table 7 displays the descriptive statics.

Table 7: Descriptive Statistics of Observed, Simulated, and Counterfactual Networks after Reformation

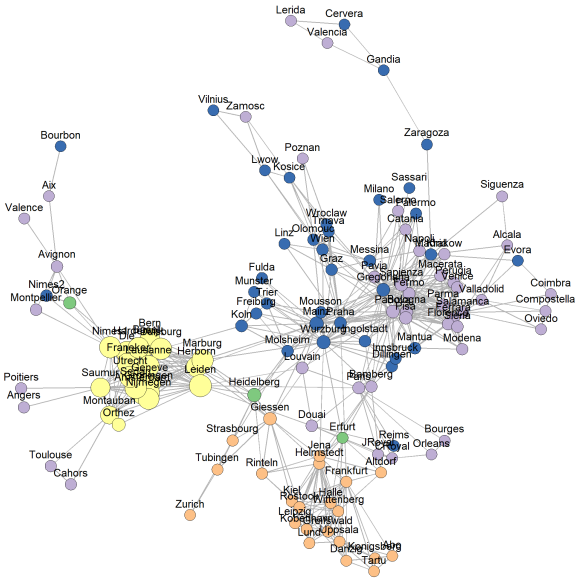
		Observed	Predicted	Atheist
1598-1684	Connected U.	140	140	140
	Connected pairs	535	622	1259
	Density	0.05	0.06	0.12
	Average distance	3.10	3.36	2.48
	Modularity ($\mathbf{P} - \mathbf{C}$)	0.37	0.44	0.09
	Interfaith Edges (%)	5.05	3.70	38.13
1685-1793	Connected U.	144	144	144
	Connected pairs	473	789	1440
	Density	0.05	0.07	0.13
	Average Distance	3.47	3.61	2.18
	Modularity ($\mathbf{P} - \mathbf{C}$)	0.43	0.38	0.02
	Interfaith edges (%)	3.59	4.82	38.19

Number of connected universities matched by construction

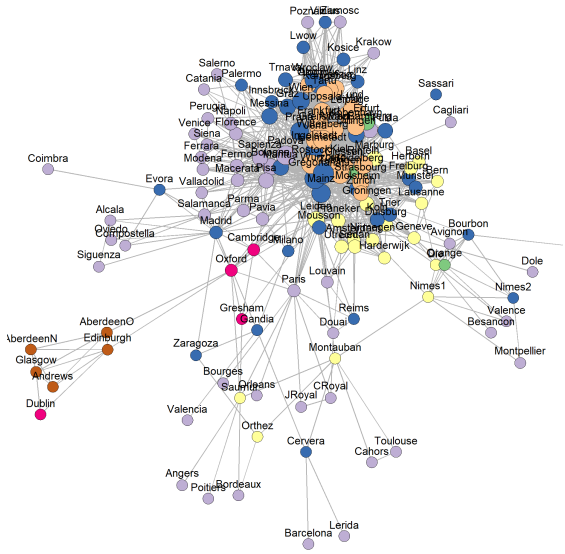
Our dyadic regression only explains about 23% of observed links, but when comparing the main descriptive statistics of the predicted networks with the ones of the observed networks, we find that our simulation performs well for average distance, modularity score and proportion of interfaith edges. However, it generates a larger number of links, which explains higher density. We then compare predicted networks with atheist networks. We find that if religion was not a determinant of network structure, the proportion of connections between Protestant and Catholic universities would have risen from about 4% to 38% on average. If religion had not been a criterion for mobility, we would have observed many more exchanges between scholars in the Protestant and Catholic worlds. The overall structure of the network would have been affected, as illustrated by the drop in modularity scores between the predicted and

Figure 3: Simulated Networks

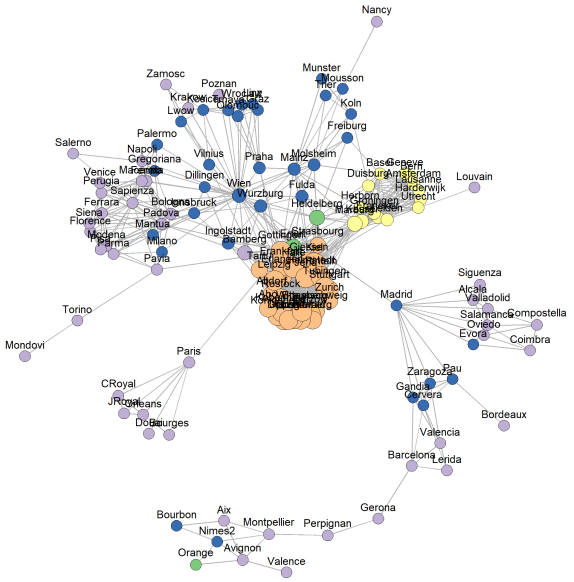
1598 – 1684: Predicted Network



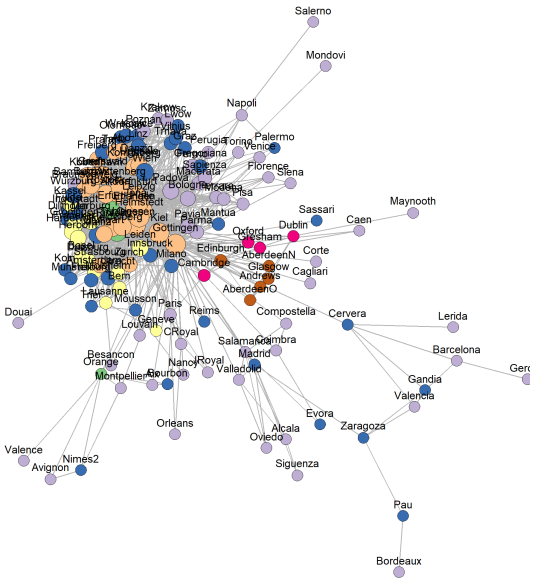
Atheist Network



1685 – 1793: Predicted Network



Atheist Network



Note:"Secular" Catholic universities are purple, while Jesuit universities are blue-filled. Lutheran, Presbyterian, Calvinist and Anglican universities are respectively orange, brown, yellow and pink. Mixed universities are green.

atheist networks. While the partition of universities across religions explains significantly the structure of predicted networks with modularity scores around 0.4, it is a poor predictor of the atheist networks, as their modularity scores do not exceed 0.09. Additionally, it is likely that if religion had not mattered the network of European universities would have been smaller, as illustrated by the decrease in average distance for atheist networks. It is not easy to discern to what extent this drop is due to the removal of the religion effect, or to the increase in links in atheist networks. However, increasing links while keeping the number of connected universities constant does not necessarily imply a drop in average distance, as we may notice when comparing these statistics for the observed and the predicted networks.

We thus confirm that, on top of geography, religion was a strong determinant of network structure. What could be the mechanisms behind this effect? Religious intolerance is an obvious candidate. But there can be more. Protestantism promoted the use of spoken tongues rather than Latin in written texts, a mechanism called "vernacularization". Binzel, Link, and Ramachandran (2020) claim that by the end of the 16th century, vernacular works became the majority, which led to more knowledge production in the early modern period. The use of spoken tongues in teaching may of course prevent a professor of medicine from Rome to teach in Jena, breaking down the homogeneity in the European university landscape. One should however not overestimate the importance of vernacularization. The work by Binzel, Link, and Ramachandran (2020) is based on all types of works published, and may not be an accurate description of scholarly work. To clarify this point, we looked at the languages used in the publications of the university professors of our database, and found that Latin resisted longer in academia. It started to decline for professors starting their career in 1700, implying that vernacularization is an eighteenth century phenomenon in academia.

6 Reformation, centrality and academic production

In this Section, we explore whether the Reformation have harmed differently Catholic and Protestant universities in terms of their individuals positions in the network. We saw in Section 4 that position of universities in the network was significantly correlated with publications of their top 5 scholars (see Table 4). Moreover, Section 5 showed that the Reformation deeply impacted the structure of the network of European universities. Thus we would like to investigate whether the Reformation can explain differences in publications' performances between Protestant and Catholic universities highlighted in Table 1, through the network structure.

To do so, we compute the eigenvector centrality score of each university in the predicted networks, $\hat{\lambda}_{it}$, as well as their eigenvector centrality score in the atheist networks, $\tilde{\lambda}_{it}$. We normalize centrality scores in the atheist networks according to the highest score of centrality score in the predicted networks. The eigenvector centrality score in the atheist networks can be interpreted as the "natural" centrality score of

universities: it tells us what would have been the centrality score of each university if the Reformation had never taken place. The difference between these two scores for university i, $\hat{\lambda}_{it} - \tilde{\lambda}_{it}$, thus measures the increase (or decrease) of its centrality score due to Reformation relative to its natural centrality score. If the difference is positive, then it can be said that Reformation had a positive impact on university i in terms of eigenvector centrality score. We average these differences in centrality scores for Catholic and Protestant universities after the Reformation, and then perform t-tests to determine whether there are significant differences in the means of the two groups. Results are shown in Table 8.

Table 8: Winners and Losers from the Reformation in terms of centrality

	1523-1597	1598-1684	1685-1793
$L^C = E_{i\in\mathbf{C}}[\hat{\lambda}_{it} - \tilde{\lambda}_{it}]$	+0.033	−0.118	−0.073
$L^P = E_{i\in\mathbf{P}}[\hat{\lambda}_{it} - \tilde{\lambda}_{it}]$	−0.133	+0.021	−0.066
$H_0 : L^C = L^P$, P-value	[0.000]	[0.038]	[0.784]

We observe that in 1523-1597, the network reorganization due to the forced mobility of scholars harms Protestants more than Catholics in terms of eigenvector centrality. However, in 1598-1684 and 1685-1793, it harms Catholics more.[10]

Thus, it can be said that after the troubled period of 1523-1597 during which Protestantism consolidated, the Reformation and Counter-Reformation harmed Catholic universities more than Protestant universities in terms of eigenvector centrality. We now want to measure the impact of the Reformation on publications through the network structure. We do so by explaining the publications of institutions in a panel of universities over the seven periods. The estimated model is:

$$p_{it} = \beta_0 + \beta_1 I(i \in \mathbf{P}) + \beta_2 I(i \in \mathbf{M}) + \beta_3 \tilde{\lambda}_{it} + \beta_4 (\hat{\lambda}_{it} - \tilde{\lambda}_{it}) + \alpha_i + \alpha_t + \epsilon_{it} \tag{2}$$

The dependent variable p_{it} is the logarithm of publications of top 5 scholars plus 1. We add religious dummies $I(i \in \mathbf{P})$, etc indicating whether the university is Protestant, etc. The reference category is Catholic universities. To assess the impact of the Reformation, we code all universities as Catholic before 1523. We also add eigenvector centrality in the atheist network $\tilde{\lambda}_{it}$ to capture changes in the non-religious features of the network affecting publications, as well as the difference in centrality between predicted and atheist networks $\hat{\lambda}_{it} - \tilde{\lambda}_{it}$ as a measure of the effect of religion through the network. Finally, we add university and period fixed effects α_i, α_t. Results are displayed in Table 9.

The first column of Table 9 shows that becoming Protestant increases undoubtedly publications of top 5 scholars, which is consistent with Table 1. The second column tells us that becoming more central in terms of eigenvector centrality "naturally" increases publications, which is consistent with Table 4. The

[10] The difference in means is significant at 1% in 1523-1597, 5% in 1598-1684 and not significant in 1685-1793.

Table 9: Religions, centrality and publications

	Dependent variable: p_{it}			
$i \in \mathbf{P}$	2.893***		1.604***	1.636***
	(0.466)		(0.459)	(0.457)
$\tilde{\lambda}_{it}$		4.448***	3.899***	4.033***
		(0.446)	(0.469)	(0.471)
$\hat{\lambda}_{it} - \tilde{\lambda}_{it}$				0.818**
				(0.368)
Univ FE	YES	YES	YES	YES
Period FE	YES	YES	YES	YES
Observations	589	589	589	589
Adjusted R^2	0.487	0.548	0.559	0.564

*p<0.1; **p<0.05; ***p<0.01
$i \in \mathbf{M}$ included in controls. Reference: $i \in \mathbf{C}$

third column shows that both effects are correlated through geography. Finally, the coefficient associated to the difference in centrality between predicted and atheist networks in the fourth column is an indication that becoming more central due to the Reformation increases publications. The fact that the coefficient associated to the Protestant dummy is still significant in column 4 suggests that part of publications is explained by the Protestant culture, which arguably relied more on writings than the Catholic one. But the fact that the two other coefficients of this specification are also positive and significant is an indication that position in the network mattered as well, especially reorganization of positions in the network due to the Reformation. Thus it can be said that part of the decline of Catholic universities in terms of publications in the modern period can be explained by the Reformation. Reformation and Counter-Reformation induced constrained mobility of scholars during the 17th-18th centuries, which harmed Catholics more than Protestants in the European network of universities.

Finally, we zoom in on the very low proportion of links between Catholic and Protestant universities in 1598-1684 and 1685-1793. In 1598-1684, twenty two professors link the Catholic and Protestant worlds, representing only a very small share of the total number of professors who taught in at least two universities in this period (22/871 = 2.5%). In 1685-1793, this proportion falls to 1.1%, with only fourteen scholars connecting Catholic and Protestant universities out of 1263 mobile scholars. A short biography of these bridge builders is provided in Appendix G. There is a majority of renowned scholars, who might be immune from petty religious fights. Who would dare to ask one of the Bernoulli to convert to Catholicism if Padova really wants to hire him ? We also note that these links involving superstars touch a small number of universities. Padova seems an example of openness. The Dutch universities too seem to have been quite open. We do not observe any connection involving a Spanish or a Polish university. Beyond the stars, we also have a few "obscure" scholars establishing links between the two worlds. This seems to

occur more often when they teach some very specialized topic (Hebrew, Arabic). Then, there are cases of conversion, for which we do not know what came first: a true conversion requiring a change of university, or a better job offer requiring a conversion.

Table 10 displays the results of a regression of the logarithm of the number of academic works on a dummy variable indicating if a professor connects a Protestant and a Catholic university and on another dummy indicating if a professor is a mobile scholars. We restrict our sample to publishing scholars.

Table 10: Publications of the Connecting Scholars

	Dependent variable: logarithm of number of works	
	1598 -1684	1685 -1793
constant	1.415***	1.687***
	(0.026)	(0.022)
mobile	0.825***	0.587***
	(0.083)	(0.069)
connecting **P** and **C**	1.739***	3.041***
	(0.490)	(0.622)
Observations	8,907	12,879
Adjusted R^2	0.012	0.007
Notes:	*p<0.1; **p<0.05; ***p<0.01	
	Estimator is OLS. Reference group: immobile publishing scholars.	

In both periods, mobile scholars publish already significantly more than publishing scholars who stayed in the same university during their entire career. Publications of mobile scholars are on average 82, 5% and 58, 7% more numerous than publications of immobile scholars, in 1598-1684 and 1685-1793 respectively. Results are even more striking for scholars connecting a Protestant and a Catholic university. In 1598-1684, our 22 connecting persons have on average 173, 9% more publications compared to immobile scholars. In 1685-1793, our 14 connecting scholars publish on average four times more than immobile scholars..

7 Conclusions

For a long time, the European academic world was an interconnected network with scholars moving positions at will. With the Reformation and the Counter-Reformation, the academic world became divided. Few people held positions in both worlds. We show in this paper that this religious divide had asymmetric consequences. The Catholic South was hit harder by the Reformation than Protestants in terms of centrality, and this was not fully compensated by the creation of new universities by the very dynamic Society of Jesus (Jesuits). Publications in the Catholic world peaked at their pre-reform level.

On the Protestant side, we show that the Reformation impacted positively their publications, partly by improving their relative position in the network of European universities.

These results were obtained by looking at a new database of tens of thousands of European scholars through the lens of network theory. We also create a new tool by generating simulated and counter factual networks as predicted from a dyadic regression. With this tool it is possible to separate the effect of religion and show that the proportion of connections between Protestant and Catholic universities would have been multiplied by a factor of nearly eight if religion did not intervene.

Appendix

A History Cheat Sheet

Table A.11: Timeline of Major Reformation Events

Date	Event
1517	Luther circulates 95 Theses from Wittenberg
1521	Edict of Worms condemns Luther as a heretic
1527	Creation of the first Protestant University in Marburg
1530	Formation of the Schmalkaldic League of Protestant Princes
1529-1536	English Reformation Parliament establishes the Church of England
1534	Formation of the Society of Jesus by Saint Ignatus of Loyola
1545-1563	Council of Trent
1546-1547	First Schmalkaldic War in the Holy Roman Empire(HRE)
1552-1555	Second Schmalkaldic War in the HRE
1555	Peace of Augsburg allows rulers within the HRE to choose either Lutheranism or Roman Catholicism as their official confession
1560	Scottish Reformation Parliament establishes the Kirk
1562-1598	French Wars of Religion
1598	Edict of Nantes grants Protestants substantial rights in France
1648	Peace of Westphalia recognizes Roman Catholicism, Lutheranism and Calvinism as three separate Christian traditions in the HRE
1685	Edict of Fontainebleau revokes Edict of Nantes

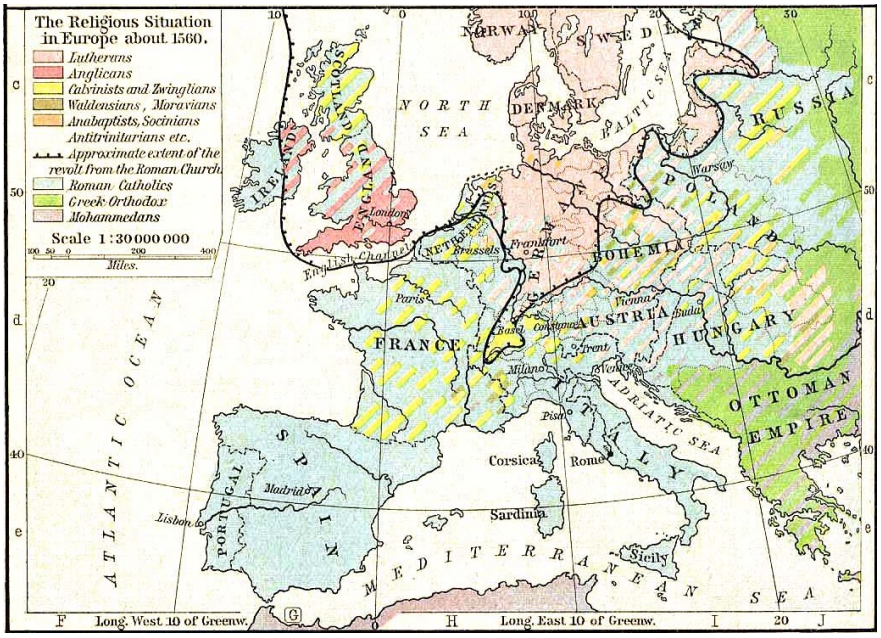


Figure A.4: The Religious Situation in Europe about 1560

Source: The Historical Atlas by William R. Shepherd, 1923. From Wikimedia Commons, see `https://commons.wikimedia.org/wiki/File:Europe_religions_1560.jpg`

B Sources

We list here the sources we have exploited to populate our database. We started from the list of universities in Frijhoff (1996), and added some important institutions. We indicate when the institution is not in Frijhoff (1996). We also indicate when we think that the population of scholars of a university is not covered well by the sources. Our list is limited to the universities for which we have found at least 20 members and at least 200 publications. For some of these institutions, we have published an issue of *Repertorium Eruditorum totius Europae*, which we refer to.

Old Catholic

University of Bologna (1088): Mazzetti (1847). Uncertain foundation date. More details in De la Croix and Vitale (2021a).

School of Translators of Toledo (1126): González (1998), Petersen (2017b), Petersen (2017a). Not a university, not in Frijhoff (1996), but a major center of knowledge.

University of Modena (1175): Mor and Di Pietro (1975). For Frijhoff (1996), started as a Studium in 1682 only.

University of Paris (1200): Antonetti (2013), Courtenay (1999), Hazon and Bertrand (1778), Feret (1904), Gorochov (2012), Genet (2019). Uncertain foundation date. Loose and complex university structure. Suppressed in 1793.

University of Salamanca (1218): Arteaga (1917), Vidal y Díaz et al. (1869). We know very little about the first century of the university.

University of Padua (1222): Pesenti (1984), Casellato and Rea (2002), Facciolati (1757), Del Negro (2015). More details in De la Croix and Vitale (2021b).

University of Naples (1224): Origlia Paolino (1754).

University of Toulouse (1229): Deloume (1890), Barbot (1905), Ferté (2013), Gilles (1992). Suppressed in 1793.

University of Salerno (1231): De Renzi (1857), Sinno (1921). School of medicine active before official foundation date. Unequal coverage over time, continuation of university unclear for some periods.

University of Orléans (1235): Bimbenet (1853), Duijnstee (2010), Fournier (1892). Decent coverage of law faculty. Suppressed in 1793.

University of Siena (1246): Frova, Catoni, and Renzi (2001). Low coverage after 1500.

Univerity of Angers (1250): Rangeard and Lemarchand (1868), De Lens (1880), Denéchère and Matz (2012). Suppressed in 1793.

University of Valladolid (1280): Alcocer Martinéz (1918). More details in De la Croix and Karioun (2021d).

University of Montpellier (1289): Astruc (1767), Dulieu (1975) (Dulieu (1975), Dulieu (1979), Dulieu (1983)), Germain (1874). Uncertain foundation date. Excellent coverage of faculty of medicine (the most renowned one) and law. Weak coverage of faculty of arts. Suppressed in 1793.

University of Lerida (Lleida) (1300): Lladonosa (1969), Lladonosa (1970), Esteve i Perendreu (2007). Low coverage. Suppressed in 1717.

University of Avignon (1303): Laval (1889), de Teule (1887), Fournier (1892), Bénézet (2003), Barjavel (1841), Duhamel (1895). Suppressed in 1793.

University of Roma 'Sapienzia' (1303): Renazzi (1803).

University of Lisbon (1290): becomes university of Coimbra in 1537. Fundação Gulbenkian (1997). Low coverage.

University of Perugia (1308): Frova, Catoni, and Renzi (2001), Zucchini (2008), Quaresima (2021). Comprehensive coverage of the medieval period. Broad coverage of the early modern period.

Studium in Florence (1321): Prezziner (1810), Cerracchini (1738). No university status, but important and well documented.

Majorcan cartographic school (1330). Not a university, perhaps not even a school, but an important center of knowledge. Pastor and Camarero (1960).

University of Cahors (1332): Ferté (1975), Baudel (1876). Suppressed in 1751.

University of Pisa (1343): Fabroni (1791).

University of Prague (1348): Svatoš and Čornejová (1995), Čornejová and Fechtnerová (1986).

University of Perpignan (1350): Carmignani (2017), Capeille (1914),Izarn (1991). Suppressed in 1793.

University of Pavia (1361): Raggi (1879), De Caro (1961).

University of Cracow (1364): Baster (2017). More details in De la Croix and Spolverini (2022).

University of Vienna (1365): Lackner (1976), Schwinges and Hesse (2019), von Aschbach (1865).

University of Cologne (1388): Schwinges and Hesse (2019). Low coverage after 1550. Suppressed in 1798.

University of Ferrara (1391): Borsetti (1735),Pardi (1903). Not fully exploited yet.

University of Wurzburg (1402): Walter (2010), Sommervogel (1890). Disappeared quickly after foundation, resurrected with the Jesuits (1575).

University of Torino (1404): Vallauri (1875).

University of Aix-en-Provence (1409): Belin (1896), Belin (1905), Fleury and Dumas (1929), De la Croix and Fabre (2019). Several schools active before official creation of university. Suppressed in 1793. More details in De la Croix and Fabre (2021a).

University of Parma (1412): Rizzi (1953). More details in Rolla and Vitale (2022).

University of Dole (1422): Beaune and d'Arbaumont (1870). Transferred to Besançon in 1691.

University of Louvain (1425): Ram (1861), Nève (1856), Schwinges and Hesse (2019), Brants (1906), Lamberts and Roegiers (1990b). Suppressed in 1797.

University of Poitiers (1431): Boissonade (1932). Suppressed in 1793.

University of Caen (1432): de Pontville (1997), Boisard (1848). Guerrin (1932), Carel (1888). Coverage can be improved further. Suppressed in 1793.

University of Bordeaux (1441): Gaullieur (1874), Pery (1888). Low coverage and little hope to do better. Suppressed in 1793.

University of Catania (1444): Sabbadini (1898), Carnazza Amari (1867).

University of Barcelona (1450): no good source found yet. Suppressed in 1717.

University of Valence (1452): Brun-Durand (1900), Nadal (1861). Suppressed in 1793. More details in De la Croix and Fabre (2021b).

University of Trier (1454): Sommervogel (1890). Low coverage before the Jesuits came. Schwinges and Hesse (2019) not exploited yet. Suppressed in 1798.

University of Freiburg im Breisgau (1457): Bauer (1957), Kurrus (1977).

University of Ingolstadt (1459): Sommervogel (1890), von Schrottenberg (1978), Wolff (1973). Suppressed in 1800 (transferred to Landshut).

University of Bourges (1464): Arabeyre, Halpérin, and Krynen (2007), Fournier (1892). Decent coverage of top lawyers. Suppressed in 1793.

University of Zaragoza (1474): Catalán (1924) , Borao (1853). First century of existence remains obscure.

University of Mainz (1476): Benzing (1986). Suppressed in 1792.

University of Siguenza (1489): Sanz Serrulla (1985).

University of Alcala (1499): Torrecilla, Arboniés, and Torres (2013).

University of Valencia (1500): López Piñero (2006), Guerau de Montmajor (1999), Office of the principal (2022). Unequal coverage.

Lubransky Academy in Poznan (1519): Nowicki (2015). A university-level college, mentioned in Frijhoff (1996) as a colony of Cracow. More details in De la Croix (2021a).

Old would-be Protestant

University of Oxford (1200): Emden (1959), Foster (1891). Uncertain foundation date.

University of Cambridge (1209): Walker (1927), Venn (1922), Lamb and Masters (1831).

University of Leipzig (1409): von Hehl and Riechert (2017).

University of St Andrews (1411): Junius Institute (2013), Smart (2004). The first two centuries remain quite badly covered.

University of Rostock (1419): Krüger (2019).

University of Glasgow (1451): University of Glasgow (2020), Coutts (1909). Low coverage.

University of Greifswald (1456): Jensen (2018), Junius Institute (2013).

University of Basel (1460): Herzog (1780), Schwinges and Hesse (2019), Rosen (1972).

University of Copenhagen (1475): Slottved (1978). More details in De la Croix (2021c).

University of Tübingen (1476): Conrad (1960).

University of Uppsala (1477): Von Bahr (1945), Astro.uu.se (2011), Jensen (2018). The first century remains quite badly covered (but university was closed for some time).

University of Aberdeen (old) - Kings college (1495): Anderson (1893). More details in De la Croix and Jay (2021).

University of Wittenberg (1502): Kohnle and Kusche (2016). Excellent coverage of faculty of theology.

University of Frankfurt (1506): No specific source so far.

Old Mixed

University of Erfurt (1379): Schwinges and Hesse (2019). Lower coverage after 1550. According to Frijhoff (1996), some Lutheran chairs created in 1566, became Lutheran in 1631, again Catholic in 1648, with some Lutheran chairs maintained next to the university.

University of Heidelberg (1386): Drüll (1991), Drüll (2002). Closed during the 30 Year War. According to Frijhoff (1996), became Lutheran in 1558, Calvinist in 1559, Jesuit in 1629, Lutheran in 1631, Calvinist in 1652, Jesuit in 1700 with Calvinist chairs maintained. More details in De la Croix and Stelter (2022).

New Catholic

University of Compostella (1526): Cabeza de León and Fernández-Villamil (1947). More details in De la Croix and Spolverini (2021b).

Royal College in Paris (1530): Collège de France (2007). Not a university, but a famous higher-education institution. Frijhoff (1996) makes it a part of the university of Paris, but it is a distinct institution. More details in De la Croix (2021b).

University of Coimbra (1537): Sommervogel (1890). More sources will be exploited.

University of Macerata (1540): Serangeli (2010). More details in De la Croix and Spolverini (2021a).

University of Gandia (1547): Sommervogel (1890). Low coverage.

University of Messina (1548): Collective (1900).

University of Reims (1548): Sommervogel (1890). More sources will be exploited. Suppressed in 1793.

University of Dillingen (1553): Fischer (1978), Sommervogel (1890).

University of Milano (1556): Sommervogel (1890). Jesuit college of university status (Frijhoff 1996).

University of Roma 'Gregoriana' (1556): Villoslada (1954). More details in De la Croix and Karioun (2021a).

University of Evora (1558): Nunes and Silva (2009), Sommervogel (1890).

University of Douai (1559): Soetaert and Soen (2018), Sommervogel (1890). Suppressed in 1793.

Imperial College in Madrid (1560): Simón Díaz (1952). Not a university, but a university-level Jesuit college. More details in De la Croix and Karioun (2021b).

University of Mondovi (1560): Vallauri (1875). Suppressed in 1719.

University of Pont-à-Mousson (1572): Martin (1891). More details in De la Croix and Karioun (2021c). Suppressed in 1768 (transfer to Nancy).

University of Oviedo (1574): Canella Secades (1873).

University of Palermo (1578): Cancila (2006), Sommervogel (1890).

University of Vilnius (1578): Bumblauskas et al. (2004), Sommervogel (1890).

University of Fermo (1585): Brizzi (2001), Curi (1880). More details in Di Caprio and Vitale (2021).

University of Graz (1585): Krones (1886), Sommervogel (1890).

University of Zamosc (1594): Kedzoria (2021). Suppressed in 1784.

University of Aix-Bourbon (1603): Méchin (1890), Sommervogel (1890). Suppressed in 1763. More details in De la Croix and Fabre (2021a).

University of Cagliari (1606): Pillosu (2017), Tola (1837). Low coverage.

University of Molsheim (1617): Berger-Levrault (1890). The story of the University of Molsheim is particularly complicated. We considered that it consists in the following institutions: Molsheim Academy (1617-1701), Episcopal University (1701-1792, in Strasbourg), and Molsheim school(1701-1792). Suppressed in 1793.

University of Sassari (1617): Mattone (2010).

University of Munster (1622): Sommervogel (1890).

University of Mantua (1625): Grendler (2009), Sommervogel (1890).

Royal Gardens in Paris (1635): Jaussaud and Brygoo (2004). Not a University but a higher-education institution. Frijhoff (1996) makes it a part of the University of Paris, but it is a distinct institution. Suppressed in 1793.

University of Trnava (1635): Sommervogel (1890).

University of Bamberg (1648): Bamberg (2019).

University of Kassa (1657): Sommervogel (1890).

University of Lwow (1661): Sommervogel (1890).

University of Innsbruck (1668): Sommervogel (1890). Low coverage which can be further improved.

University of Linz (1674): Sommervogel (1890).

University of Besancon (1691): Beaune and d'Arbaumont (1870), Lavillat (1977). Suppressed in 1793.

University of Breslau (1702): Fischer (1978), Sommervogel (1890).

University of Cervera (1714): Rubio y Borras (1914).

University of Fulda (1732): Sommervogel (1890).

University of Rennes (1735): Chenon (1890). Suppressed in 1793.

New Protestant

University of Strasbourg (1523): Started as a higher education institution in 1523 (first professors), evolved into an official university in 1621. Berger-Levrault (1890).

Collegium Carolinum in Zurich (1525): Junius Institute (2013), Godet, Türler, and Attinger (1928).

University of Marburg (1527): Gundlach and Auerbach (1927).

College of Bern (1528): DigiBern (2003). Not in Frijhoff (1996). Predecessor of the university founded in 1834.

University of Lausanne (1537): Kiener and Robert (2005). Not in Frijhoff (1996). Predecessor of the university founded in 1890.

University of Nimes (1539): Bourchenin (1882). Suppressed in 1663.

University of Konigsberg (1544): Schwinges and Hesse (2019) for the beginning, Naragon (2006) for the end.

Gymnasium of Danzig (1558): Hirsch (1837). Not a university, not in Frijhoff (1996). A university level gymnasium.

University of Jena (1558):Günther (1858). More details in De la Croix and Stelter (2021c).

University of Geneve (1559): Borgeaud (1900). More details in Debois and De la Croix (2021).

University of Orthez (1566): Bourchenin (1882). Suppressed in 1620.

University of Helmstedt (1575): Gleixner (2019).

University of Leiden (1575): Leiden (2019). More details in De la Croix and Stelter (2021d).

University of Altdorf (1578): Flessa (1969), Köbler (2019). Low coverage, except for medicine.

University of Edinburgh (1582): Grant (1884).

Herborn Academy (1584): Junius Institute (2013). Not a university, not in Frijhoff (1996), but an important institution of higher learning. Low coverage so far.

University of Franeker (1585): Feenstra, Ahsmann, and Veen (2003), Napjus and Lindeboom (1985).

University of Dublin (1592): Kirkpatrick (1912), Burtchaell and Sadleir (1924).

University of Aberdeen (new) - Marishal College (1593): Anderson (1898a).

Gresham College (1596): Ward (1740). Not a university, not in Frijhoff (1996), but an important institution of higher learning. More details in Debois and de la Croix (2021).

University of Saumur (1596): Bourchenin (1882). Suppressed in 1685.

University of Montauban (1598): Bourchenin (1882). Suppressed in 1685.

University of Sedan (1599): Bourchenin (1882). Suppressed in 1685.

University of Die (1601): Bourchenin (1882). Suppressed in 1685.

University of Giessen (1607): Haupt and Lehnert (1907). More details in De la Croix and Stelter (2021a).

University of Groningen (1612): Groningen (2014).

University of Rinteln (1620): Hänsel (1971).

Athenaeum Illustre of Amsterdam (1632): University of Amsterdam (2007). Not in Frijhoff (1996). Predecessor of the university founded in 1877.

University of Dorpat (1632): Inno (1972).

University of Utrecht (1636): Dorsman (2011).

University of Abo (1640): Jensen (2018).

University of Harderwijk (1647): van Epen (1904).

University of Kiel (1652): Volbehr and Weyl (1956).

University of Duisburg (1654): (Junius Institute 2013), Köbler (2019). Low coverage.

University of Lund (1666): Delen and Weibull (1868). More details in De la Croix (2021d).

University of Halle (1694): Schopferer (2016).

Collegium in Kassel (1709): The university of Kassel (1633-1653) mentioned in Frijhoff (1996) had an ephemeral existence. More important is the Collegium Carolinum founded in 1709.

University of Göttingen (1734): Ebel (1962). More details in De la Croix and Stelter (2021b).

University of Erlangen (1742): Wachter (2009).

Technical University of Braunschweig (1745): Albrecht and Gundler (1986).

University of Butzow (1760): Krüger (2019). Temporary secession from the university of Rostock. Suppressed in 1789.

University of Stuttgart (1781): Gebhardt, Lehsten, and Raberg (2011) . Higher education college since 1775. Suppressed in 1794.

New mixed

University of Orange (1583): Bourchenin (1882). First university from 1362 to 1562 with almost no data. Second university founded in 1583, Catholic coupled with a Calvinist academy. Suppressed in 1793.

C Publications

Table C.12 reports the total number of scholars per university per period. The last 7 columns report the number of publications of the top 5 scholars, per period.

Table C.12: Total number of scholars and number of publications of the top 5, by university, by period (1/7)

University	Start	Members by Period							Publi. of top 5 by Period						
		1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793	1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793
Old Catholic															
Ubologna	1088	89	441	767	549	357	522	496	4.0	2.7	2.2	4.8	8.7	4.9	2.0
Ctoledo	1126	10	12						2.9	1.2					
Umodena	1175	5	21	9	14	54	12	130	0.0	1.2	0.0	0.0	1.8	0.3	3.8
Uparis	1200	42	474	382	141	150	125	330	7.5	35.9	6.2	13.8	10.5	12.2	9.3
Usalamanca	1218			20	123	207	319	421			2.6	5.2	7.7	4.1	4.8
Upadua	1222		100	349	503	792	268	246		1.6	2.0	5.1	15.5	8.3	6.3
Unapoli	1224		106	32	93	132	136	122		13.1	2.1	2.0	1.1	1.3	6.7
Utoulouse	1229		206	190	40	104	66	108		2.0	1.0	0.3	6.9	1.1	1.6
Usalerno	1231	40	61	12	10	35	19	20	1.2	0.3		0.9	0.6	0.0	0.0
Uorleans	1235	3	97	51	32	17	11	15	0.1	0.7	0.2	0.2	3.1	0.2	3.7
Usiena	1246		108	102	57	26	17	10		2.1	1.7	1.6	2.9	0.5	0.9
Uangers	1250	12	10	29	34	26	32	56	0.7	0.0		0.1	2.2	0.1	0.2
Uvalladolid	1280			4	19	180	312	303			0.6	0.2	2.6	1.0	0.1
Umontpellier	1289	12	150	34	75	71	60	71	0.9	3.1	0.7	0.8	3.9	3.1	3.6
Ulerida	1300		6	7	18	7	62	15		1.1	0.1	0.0	0.0	1.9	0.0
Uavignon	1303		42	52	68	65	95	129		0.6	3.4	0.9	4.0	2.2	0.7
Uroma	1303		2	47	288	90	190	181		0.0	12.1	12.2	17.4	8.6	5.5
Uperugia	1308		84	301	239	137	19	61		2.7	1.0	2.8	1.1	0.5	0.4
SFlorence	1321		8	179	78	32	23	72		0.1	3.7	14.5	5.8	3.2	3.9
SMallorca	1330		1	10	10					0.0	0.2	0.0			
Ucahors	1332		4	6	15	38	35	36		0.0	0.0	0.1	3.4	0.5	0.0
Upisa	1343	2	33	12	254	233	387	177	0.1	2.3	0.6	2.4	3.3	6.4	3.0
Uprague	1348			145	27	39	157	358			2.5	0.2	0.9	2.4	4.2

Table C.13: Total number of scholars and number of publications of the top 5, by university, by period (2/7)

University	Start	Members by Period							Publi. of top 5 by Period						
		1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793	1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793
Old Catholic (con't)															
Uperpignan	1350			4	4	9	14	60					0.0	0.1	2.0
Upavia	1361		2	477	574	320	194	159		0.7	3.2	5.2	7.0	1.1	5.9
Ucracow	1364			109	300	293	195	377			0.2	0.8	0.8	1.7	1.1
Uvienna	1365			96	139	67	15	218			2.9	5.7	4.0	4.5	5.7
Ucologne	1388	8	4	197	222	134	54	39	0.0	15.6	6.2	3.1	3.9	1.8	1.0
Uferrara	1391			27	52	23	10	15			1.2	3.2	6.7	0.4	1.3
Uwurzburg	1402			17	11	56	100	159			0.0	1.0	2.1	3.7	2.9
Utorino	1404			51	31	78	12	76			0.2	1.4	2.3	0.1	3.2
Uaix	1409		24	40	9	54	73	149		1.1	0.1		0.1	2.8	2.1
Uparma	1412	7	16	19	12	16	166	135	1.3	0.4	0.9	1.7	1.2	3.1	1.9
Udole	1422			7	50	111	78	3				1.5	1.7	0.3	
Ulouvain	1425			184	257	257	173	224			0.1	3.6	13.0	7.3	4.0
Upoitiers	1431			8	17	36	35	28				1.8	1.6	0.6	0.1
Ucaen	1432			3	8	18	27	49				0.1	0.4	0.2	0.9
Ubordeaux	1441			2	20	101	33	53				0.0	4.6	0.7	1.0
Ucatania	1444			6	49	3	22	25					0.0	0.3	0.3
Ubarcelona	1450					12	8	8					0.7	0.5	0.2
Uvalence	1452				17	52	57	102				0.2	2.3	0.2	0.3
Utrier	1454				5	17	23	28				0.1	0.8	2.1	1.5
Ufreiburg	1457				55	41	55	111				33.6	4.3	0.9	3.1
Uingolstadt	1459				479	184	101	95				5.3	7.4	8.7	4.1
Ubourges	1464				4	27	8	6				0.1	4.1	1.5	0.2
Uzaragoza	1474				3	25	26	32				0.3	2.1	0.4	0.5

Table C.14: Total number of scholars and number of publications of the top 5, by university, by period (3/7)

University	Start	Members by Period							Publi. of top 5 by Period						
		1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793	1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793
Old Catholic (con't)															
Umainz	1476				90	157	223	456				0.4	4.0	3.7	3.7
Usiguenza	1489				1	11	11	8				0.1	1.0	0.0	0.2
Ualcala	1499				17	42	40	16				2.2	4.0	1.2	0.1
Uvalencia	1500				13	84	49	53				0.0	0.7	2.2	4.9
CPoznan	1519				7	3	70	113				0.0	0.6	0.1	0.1
Old would-be Protestant															
Uoxford	1200	11	60	32	26	90	149	119	0.9	5.8	2.9	5.2	8.0	19.9	36.8
Ucambridge	1209	1	18	75	66	183	236	281		0.6	0.0	29.8	12.0	34.5	20.4
Uleipzig	1409			142	495	227	49	147			0.1	8.2	7.9	11.4	16.0
Ustandrews	1411			8	6	9	11	43			0.0	0.2	2.4	2.1	1.4
Urostock	1419			7	6	65	112	109			0.0	1.2	7.8	6.6	5.2
Uglasgow	1451				5	5	14	40				0.2	0.1	12.8	9.5
Ugreifswald	1456			4	35	45	59	89			0.0	0.1	2.5	3.8	3.9
Ubasel	1460			1	122	65	51	73				9.5	18.8	7.6	3.6
Ucopenhagen	1475				16	72	85	132					9.6	7.8	13.8
Utubingen	1476			1	71	113	94	127				6.6	27.5	7.5	7.1
Uuppsala	1477				2	3	81	136					0.3	3.2	27.6
Uaberdeenold	1495				14	58	66	50				0.3	0.7	3.7	2.0
Uwittenberg	1502				30	88	48	63				5.0	132.8	15.5	8.9
UFrankfurt	1506				15	38	28	52				0.3	4.2	10.5	10.7
Old Mixed															
Uerfurt	1379			107	112	22	14	45			0.0	1.9	4.4	2.1	23.2
Uheidelberg	1386			290	377	199	83	226			0.5	5.9	12.1	14.5	3.2

Table C.15: Total number of scholars and number of publications of the top 5, by university, by period (4/7)

University	Start	Members by Period			Publi. of top 5 by Period		
		1523 -1597	1598 -1684	1685 -1793	1523 -1597	1598 -1684	1685 -1793
New Catholic							
Ucompostella	1526	48	146	222	0.0	0.5	0.0
CollegeFr	1530	60	90	103	9.7	4.1	15.4
Ucoimbra	1537	51	39	54	5.5	0.4	1.0
Umacerata	1540	147	280	278	0.5	0.3	1.0
Ugandia	1547	7	8	17	1.2	1.9	0.5
Umessina	1548	28	52		2.6	2.2	
Ureims	1548	9	19	51	0.4	2.6	2.4
Udillingen	1553	20	51	32	3.0	8.7	2.9
Umilano	1556	4	4	15	2.8	0.4	2.0
UromaGregoriana	1556	93	183	153	10.6	11.3	1.5
Uevora	1558	27	58	24	2.2	0.9	0.3
Udouai	1559	48	86	44	4.3	4.7	8.8
Cmadrid	1560	49	267	70	0.2	6.5	1.4
Umondovi	1560	29	6	3	1.0		
Uolmutz	1570	5	36	65	0.0	0.3	0.3
Upontamousson	1572	38	188	235	1.7	1.5	4.6
Uoviedo	1574		68	71		0.1	3.1
Upalermo	1578	7	20	72	3.9	0.8	1.3
Uvilnius	1578	14	34	65	2.3	2.0	2.4
Ufermo	1585	75	244	197	2.1	0.4	1.9
Ugraz	1585	3	50	62	0.1	1.9	1.4
Uzamosc	1594	1	55	59	0.0	0.6	0.6
Uaixbourbon	1603		81	96		1.3	9.0

Table C.16: Total number of scholars and number of publications of the top 5, by university, by period (5/7)

University	Start	Members by Period			Publi. of top 5 by Period		
		1523 -1597	1598 -1684	1685 -1793	1523 -1597	1598 -1684	1685 -1793
New Catholic (con't)							
Ucagliari	1606		13	92		0.1	0.3
Umolsheim	1617		93	306		0.4	1.2
Usassari	1617		19	36		0.1	0.2
Umunster	1622		11	22		1.1	1.2
Umantua	1625		52	14		0.7	0.9
Jplantes	1635		25	55		2.6	26.9
Utrnava	1635	3	30	171	0.1	1.1	2.7
Ubamberg	1648		82	232		0.3	1.0
Ukassa	1657		8	88		0.1	0.2
Ulwow	1661	1	15	23	0.0	0.5	2.2
Uinnsbruck	1668		4	29		0.0	2.2
Ulinz	1674		6	38		0.0	0.3
Ubesancon	1691		1	55			0.8
Ubreslau	1702		13	34		0.1	0.5
Ucervera	1714		1	234			0.5
Ufulda	1732	1	14	64		0.0	0.7
Urennes	1735			30			1.5
New Protestant							
Ustrasbourg	1523	96	74	103	18.9	9.6	5.6
Czurich	1525	17	31	29	24.4	4.9	7.7
Umarburg	1523	88	101	155	6.7	6.0	8.1
Ebern	1528	22	25	42	3.0	0.5	1.5
Ulausanne	1537	51	41	46	23.3	0.3	4.9

Table C.17: Total number of scholars and number of publications of the top 5, by university, by period (6/7)

University	Start	Members by Period			Publi. of top 5 by Period		
		1523 -1597	1598 -1684	1685 -1793	1523 -1597	1598 -1684	1685 -1793
New Protestant (con't)							
Unimes	1539	57	42		2.0	1.5	
Ukonigsberg	1544	37	16	205	5.6	4.7	38.4
Gdanzig	1558	7	39	40	0.1	5.0	3.8
Ujena	1558	89	89	139	11.6	21.4	15.2
Ugeneve	1559	40	38	55	23.1	5.8	5.4
Uorthez	1566	20	13		1.7	0.0	
Uhelmstedt	1575	34	102	142	5.0	12.3	8.7
Uleiden	1575	39	127	92	12.0	21.9	9.2
Ualtdorf	1578	9	19	32	1.4	6.9	7.6
Uedinburgh	1582	1	30	108	0.4	3.4	19.2
Aherborn	1584	4	9	9	2.5	4.6	1.1
Ufraneker	1585	8	59	70	1.1	6.8	5.4
Udublin	1592	4	40	93	0.3	7.0	9.0
Uaberdeennew	1593	1	53	46		0.7	6.2
Cgresham	1596	5	54	38	0.3	5.4	3.6
Usaumur	1596	1	53			4.1	
Umontauban	1598	3	36		0.3	1.0	
Usedan	1599	10	64		1.0	11.9	
Udie	1601	2	42		0.1	0.6	
Ugiessen	1607		99	178		6.7	7.0
Ugroningen	1612		36	59		4.1	3.7
Urinteln	1620	2	73	75	0.5	2.1	2.3
Aamsterdam	1632		24	43		3.6	9.3

Table C.18: Total number of scholars and number of publications of the top 5, by university, by period (6/7)

University	Start	Members by Period			Publi. of top 5 by Period		
		1523 -1597	1598 -1684	1685 -1793	1523 -1597	1598 -1684	1685 -1793
New Protestant (con't)							
Udorpat	1632		28	26		0.6	0.3
Uutrecht	1636		41	63		9.0	5.7
Uabo	1640		26	83		0.6	4.4
Uharderwijk	1647		46	56		3.3	8.0
Ukiel	1652		29	156		4.1	5.2
Uduisburg	1654		14	29		3.7	1.8
Ulund	1666		25	204		4.5	3.6
Uhalle	1694		2	161		4.8	27.8
Ckassel	1709			24			9.3
Ugottingen	1734			262			27.9
Uerlangen	1742			92			6.5
Tubraunschweig	1745			103			7.3
Ubutzow	1760			31			1.4
Ustuttgart	1781			38			2.6
New mixed							
Uorange	1583	1	12	7		1.06	0.01

D Additional regression tables

Table D.19: Dyadic Regressions - Intensity

	Dependent variable: Intensity						
	1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793
d_{ij}	-0.190^{***}	-1.436^{***}	-1.488^{***}	-0.736^{***}	-0.558^{***}	-0.500^{***}	-0.693^{***}
	(0.070)	(0.201)	(0.127)	(0.049)	(0.021)	(0.022)	(0.041)
$\mathbf{I}(i,j \in \mathbf{P}^L)$					-0.225	-0.419^{**}	-0.177
					(0.169)	(0.163)	(0.285)
$\mathbf{I}(i,j \in \mathbf{P}^C)$					0.110	-0.097	0.364
					(0.223)	(0.332)	(0.483)
$\mathbf{I}(i,j \in \mathbf{P}^P)$					-0.730^{**}	0.872^{**}	-0.337
					(0.355)	(0.435)	(0.797)
$\mathbf{I}(i,j \in \mathbf{P}^A)$					1.060^{**}	8.930^{***}	0.706
					(0.421)	(0.526)	(0.965)
$\mathbf{I}(i,j \in \mathbf{C}^S)$					0.861^{***}	0.417^{***}	0.497^{*}
					(0.145)	(0.143)	(0.259)
$\mathbf{I}(i,j \in \mathbf{C}^J)$					0.307	0.344	0.764^{*}
					(0.225)	(0.241)	(0.438)
Observations	153	437	1,225	2,623	7,091	10,565	11,238
Adjusted R^2	0.591	0.373	0.307	0.284	0.237	0.132	0.079
Notes:	*p<0.1; **p<0.05; ***p<0.01						
	Includes university fixed effects, controls for varying coverage & activity periods, interaction terms between all subreligion. Reference category: $\mathbf{C}^S$-$\mathbf{P}^L$ dyads.						

Table D.20: Dyadic Regressions - Number of steps (inverse)

	Dependent variable: Inverse number of steps						
	1000 -1199	1200 -1347	1348 -1449	1450 -1522	1523 -1597	1598 -1684	1685 -1793
d_{ij}	-0.095^{***}	-0.116^{***}	-0.144^{***}	-0.130^{***}	-0.110^{***}	-0.090^{***}	-0.109^{***}
	(0.024)	(0.013)	(0.008)	(0.005)	(0.003)	(0.002)	(0.002)
$\mathbf{I}(i,j \in \mathbf{P}^L)$					-0.026	0.086^{***}	0.330^{***}
					(0.026)	(0.017)	(0.016)
$\mathbf{I}(i,j \in \mathbf{P}^C)$					0.243^{***}	0.289^{***}	0.557^{***}
					(0.035)	(0.035)	(0.028)
$\mathbf{I}(i,j \in \mathbf{P}^P)$					0.072	0.276^{***}	0.550^{***}
					(0.056)	(0.046)	(0.046)
$\mathbf{I}(i,j \in \mathbf{P}^A)$					0.387^{***}	0.575^{***}	0.695^{***}
					(0.066)	(0.056)	(0.056)
$\mathbf{I}(i,j \in \mathbf{C}^S)$					0.161^{***}	0.237^{***}	-0.034^{**}
					(0.023)	(0.015)	(0.015)
$\mathbf{I}(i,j \in \mathbf{C}^J)$					0.196^{***}	-0.048^{*}	0.457^{***}
					(0.035)	(0.026)	(0.025)
Observations	153	437	1,225	2,623	7,091	10,565	11,238
Adjusted R^2	0.604	0.766	0.717	0.712	0.638	0.615	0.688
Notes:	*p<0.1; **p<0.05; ***p<0.01						
	Includes university fixed effects, controls for varying coverage & activity periods, interaction terms between all subreligion. Reference category: $\mathbf{C}^S$-$\mathbf{P}^L$ dyads.						

E Measures of homophily and modularity

The *inbreeding homophily index* is equal to

$$IH_k = (H_k - \omega_k)/(100 - \omega_k)$$

with $k = \{\mathbf{C}, \mathbf{P}\}$ denoting respectively **C** and **P** universities, ω_k denoting the proportion of k universities in the network, and H_k denoting the proportion of k "friends" among k universities. This index measures the amount of bias with respect to baseline homophily as it relates to the maximum possible bias, i.e. the term $(100 - \omega_k)$. We have *inbreeding homophily* for type k if and only if $IH_k > 0$, and *inbreeding heterophily* if and only if $IH_k < 0$. The index of inbreeding homophily is 0 if there is pure baseline homophily and 1 if a group completely inbreeds.

The modularity score measures the difference between the observed number of links within communities in a given network g and the expected number of links in a random network exhibiting the same degree distribution as in network g.[11] The expression of the modularity score is

$$M(\Pi, g) = \frac{1}{2L} \sum_{i=1}^{N} \sum_{j=1}^{N} \left(g_{ij} - d_i d_j / 2L\right) \delta_{ij}$$

where N and L are respectively the number of nodes and links in g, d_i is the degree of university i, and $\delta_{ij} = 1$ if i and j are in the same community, and 0 otherwise. The term $1/2L$ normalizes the measure to enable comparison of the modularity scores of networks with different numbers of links. A community structure with zero modularity has exactly as many links within communities as we would expect if the graph was generated randomly. Positive modularity scores represent good community structures as there are more links in communities than we would expect in a randomly generated graph. Similarly, negative modularity scores represent bad community structures.

[11] The random model used in most definitions of modularity is the *configuration model*, which generates random networks from a given degree distribution. It can be shown that the probability of the existence of an edge between node i with degree d_i and node j with degree d_j is $d_i d_j / 2L$.

F Measures of centrality

We provide here detailed definitions of four classic centrality measures.

Strength: The strength s_i of an university i is the average strength of all its ties (i.e. the number of scholars connecting i with other universities),

$$s_i = \frac{1}{d_i} \sum_{j:g_{ij}=1} s_{ij}$$

Closeness centrality: The closeness centrality score C_i measures the minimum number of steps required to access every other university in the network from university i. Formally, this is the inverse of the average distance $l(i,j)$ between a university i and any other university within the network,

$$C_i = (n-1) / \sum_{j \neq i} l(i,j)$$

Betweenness centrality: The betweenness centrality score $\mathcal{B}_i$ is the proportion of shortest paths between any two universities j and k going through university i. We normalize this score by averaging across all pairs of nodes. Formally,

$$\mathcal{B}_i = \sum_{j \neq k : i \notin \{j,k\}} \frac{P_i(jk)/P(jk)}{(n-1)(n-2)/2}$$

where $P_i(jk)$ is the number of shortest paths between j and k that pass through university i and $P(jk)$ is the total number of shortest paths between j and k in the network.

Eigenvector centrality: The eigenvector centrality score of a university i, $\mathcal{E}_i$, is proportional to the sum of the eigenvector centrality of its neighbors.[12] Formally,

$$\lambda \mathcal{E}_i = \sum_j g_{ij} \mathcal{E}_j$$

where λ is a proportionality factor. This measure assigns a score to a university i based on the connections of i and the scores of these connections, assuming that a connection to a high-scoring university contributes more to university i's own score.

[12] Considering the network g as a square matrix of size n, with entries 0 and 1 denoting the absence or the presence of a connection between two universities, we have in terms of matrix notation, $\lambda \mathcal{E} = g\mathcal{E}$. Thus $\mathcal{E}$ is an eigenvector of g and λ is its corresponding highest eigenvalue, see Jackson (2008).

G Scholars Linking Protestant and Catholic Universities

Important persons

Nicolaus I Bernoulli (1687-1759) obtained in 1716 the Galileo-chair at the University of Padua (Del Negro 2015), where he worked on differential equations. In 1722 he returned to Switzerland and obtained a chair in Logics at the University of Basel (Herzog 1780). ($p_i = 123$)

Giovanni Battista Ferrari (1584-1655) was a Jesuit known for his work in Botany. He taught Hebrew at the Jesuit university of Rome (Villoslada 1954). We also find him teaching Hebrew at the protestant university in Die when he was young (Bourchenin 1882). ($p_i = 451$)

Samuel Thomas von Sömmerring (1755-1830) was one of the most important German anatomists. He taught at the Collegium Carolinum in Kassel, and then at the University of Mainz after 1784. It is said he also received offers from the Universities of Halle, Jena and Heidelberg. ($p_i = 1861$)

Jakob Hermann (1678-1733) was appointed to a chair in mathematics in Padua in 1707 (Del Negro 2015), but moved to Frankfurt an der Oder in 1713, and thence to St. Petersburg in 1724. Finally, he returned to Basel in 1731 to take a chair in ethics and natural law. ($p_i = 169$)

Johann Peter Frank (1745-1821) was appointed professor of physiology and medical policy at the University of Göttingen in 1784 (Ebel 1962), but the next year he went to Italy for his health and joined the faculty of the University of Pavia (Raggi 1879), teaching clinical medicine (1785-1795). ($p_i = 1614$)

Johan Rhode (1587-1659), was a Danish physician who spent most of his time in Padua (Del Negro 2015), but also had positions in Siena and Copenhagen (Slottved 1978). ($p_i = 493$)

Samuel-Auguste Tissot (1728-1797) was a Swiss physician who studied in Montpellier, held a chair in medicine in Pavia (Raggi 1879) before returning to Lausanne (Dulieu 1983) where he was in charge of reorganizing the curriculum in medicine. ($p_i = 4824$)

Gerard van Swieten (1700-1772) was a Catholic Dutch physician. He gave lessons in Leiden, drawing many students. Michaud (1811) wrote that he was professor there, but soon attracted envy. In 1734 the university forbade him from continuing. By May 1745, the Van Swieten family had sold all their belongings in the Netherlands and traveled to Vienna. In his new position he implemented a transformation of the medical university education and founded the botanical garden. ($p_i = 1698$)

Jakob Gronovius (1645-1716) was a Dutch classical scholar who taught in Pisa (1673), Padova (Facciolati 1757), and Leiden. Being Protestant caused him difficulties in Italy, and he returned to the United Provinces in 1674 ($p_i = 3262$)

Johann Andreas Dieze (1729-1785) was a German Hispanist and translator. He is mostly teaching at the

Protestant University of Göttingen (from 1764 to 1784), but also intervenes at the Catholic University of Mainz from 1784-1785. He is however buried as a Protestant (Benzing 1986). ($p_i = 245$)

Johann Georg Adam Forster (1754-1794) was a German naturalist. He took a teaching position as a Natural History professor at the Collegium Carolinum in Kassel (Calvinist). In 1784, he became Chair of Natural History at Vilnius University (Catholic). Later, he settled in Mainz, where he became head librarian of the University of Mainz (Catholic). ($p_i = 3845$)

Thomas Dempster (1579-1625) was a Scottish scholar. The Dempsters were Catholic in an increasingly Protestant country. Dempster's first position as a doctor was a professor of the University of Paris at age 17. He was than elected professor of eloquence at the Protestant academy of Nîmes. A murderous attack upon him by one of the defeated candidates forced him to leave the town. His life was one of an itinerant professor (Paris, Douai, Pisa, Bologna). ($p_i = 983$)

Jean-Nicolas de Parival (1605-1669) was a French Catholic, teaching French at the University of Leiden, and later on, at the University of Louvain (Académie royale 1866). ($p_i = 755$)

Josephus Abudacnus was an Egyptian Copt who traveled in Europe, mainly teaching Arabic. We find him in Oxford, Louvain (1615-1617), and Vienna. "Thanks to his determination to teach oriental languages of which his knowledge was sometimes limited, he had a remarkable aptitude for collecting distinguished acquaintance" (Hamilton 1994). ($p_i = 103$)

Minor persons ($p_i < 100$)

Nicolaus II Bernoulli (1695-1726) was magister of philosophy in Basel in 1711 (Herzog 1780). From 1719 he had the Chair in Mathematics at the University of Padua (Del Negro 2015). ($p_i = 65$)

Micheál Ó Mordha / Michael Moore (1639-1723). He first taught in Paris (Junius Institute 2013), both at the university and at the Royal College. Returning to Ireland, Ó Mordha became the college's first Catholic provost of Trinity College, Dublin. ($p_i = 21$)

Daniel Peyrol was a French Protestant who taught at the Protestant Universities of Nîmes (1622-1625) and Die (1630-1634), but also at the University of Montpellier (1603-1614), which accepted some Protestant teachers during the period between the edict of Nantes (1598) and its revocation (1685). (Brun-Durand 1891). ($p_i = 0$)

Philippe Codurc (1580-1660) was a French Protestant who we find teaching in Montpellier (predominantly Catholic at that time) and in Nimes (predominantly Protestant) (see Bourchenin (1882)). ($p_i = 77$)

Jean-Frédéric Guib (-1681) was a Scottish Protestant. We find him teaching in Valence (Catholic, see Barjavel (1841)), Nimes (mostly Protestant) and Orange (mostly Protestant) ((see Bourchenin (1882)). ($p_i = 11$)

Conversion cases

Joseph Lang (1570-1615) taught logic and mathematics at the University of Strasbourg (still a gymnasium) from 1599 to 1604 (Berger-Levrault 1890), when he became professor of Greek at the University of Freiburg in Breisgau. He converted to Catholicism. ($p_i = 654$)

Andrew Youngson (?-?) was a Regent in the Marischal College (new university of Aberdeen), then elected a Regent at King's College (old university of Aberdeen). He afterwards became a Papist and Jesuit, and a Professor at Madrid (likely Imperial College) (Anderson 1898b). ($p_i = 0$)

Petrus Bertius (1565-1629) was professor of ethics at the University of Leiden (Leiden 2019) from 1599 to 1619. He abjured his calvinist faith, moved to Paris and became professor at the Royal College from 1620 to his death in 1629. ($p_i = 2559$)

Claude Boucard (1567-1624), Jesuit, taught theology in 1595 at the University of Pont-à-Mousson. Then converted to Calvinism and thought physics and mathematics at the University of Lausanne from 1598 to 1617 (Kiener and Robert 2005). ($p_i = 0$)

Jaques Crespe (1586-1653) A former monk, he abjured and switched to Protestantism in 1610. He returned to Catholicism after a first ministry in Crest in 1612. He became professor of Catholic theology at the University of Valence from 1612 to 1642. Returning to Protestantism after thirty years in Valence, he migrated to Switzerland. In Lausanne, he was professor of Protestant theology from 1644 to 1653. (Kiener and Robert 2005). ($p_i = 0$)

Théophile Terrisse (-1676) was first of all a Dominican and professor of theology in Cahors, but abjures Catholicism at Die on November 22, 1637. He was professor in Geneva from 1637 to 1639. There, he took theology courses while practicing medicine and giving a private course in metaphysics. He was appointed professor of theology at the Protestant University of Die, in 1640. (Kiener and Robert 2005). ($p_i = 7$)

Christopher Besoldus (1577-1638) was born of Protestant parents. In 1610 became professor of law at Tübingen (Conrad 1960). He was publicly converted to Catholicism in 1635. Two years later, he accepted the chair of Roman Law at the University of Ingolstadt (Michaud 1811). ($p_i = 3717$)

August Fischer (fl. 1617-1625), a quite obscure lawyer, started his career in Jena then converted to Roman Catholicism and obtained a position in Trier (Stolleis 1988). ($p_i = 0$)

Arnold Geulincx (1624-1669) was made professor of philosophy in Louvain in 1646 according to Lamberts and Roegiers (1990b). He lost his position in 1658, possibly for religious reasons. Geulincx then moved north to the University of Leiden (Leiden 2019) and converted to Calvinism. ($p_i = 433$)

Joseph Leopold Roth (?-?) appears both in the Protestant University of Giessen from 1733 to 1736 (Haupt and Lehnert 1907) and in the Catholic University of Mainz from 1730 to 1733 (Benzing 1986). We have no information on him except that he had a Ph.D in Law. ($p_i = 0$)

François Durand (1727-1816). Benedictine Monk until the age of 27, he left his convent to enter the Reformed Communion in 1754 in Lausanne. Professor of philosophy in Paris, then professor of literature at the Protestant University of Lausanne (1760-1768), and also at Bern (1768-). ($p_i = 111$)

Jacob Reihing/Reyhing (1579-1628) was a German Jesuit, who became in 1608 a philosophy professor at the University of Ingolstadt. In 1621 Reihing revealed his evangelical disposition. He became in 1622 professor at the University of Tübingen (Conrad 1960). His former Jesuit fellows tried to discredit him after his conversion. ($p_i = 341$)

Cases with some uncertainty (weaklinks)

Johann Anton Winter (1612-) has published a few works, is mentioned in Bamberg from 1652 to 1654 (Professor für Physik und Metaphysik (Bamberg 2019)) and in Tübingen from 1663 to 1675 (Conrad 1960). It is not totally certain it is the same person, but it is mentioned in the Tübingen source that he returned to the Catholic Church in 1675. ($p_i = 18$)

Johannes Justus Pistorius (1629-1681), has published a few works, and is mentioned in Giessen in 1656 (Haupt and Lehnert 1907) and in Bamberg from 1669 to 1672 (Professor für Mathematik mit Ethik, Bamberg 2019). It is not totally certain it is the same person though. ($p_i = 45$)

Cornelis Sylvius (15??-16??) is found in the list of professors of the University of Leiden (Leiden 2019), where he taught from 1615-1619. Before, we find him at the University of Louvain. Given the lack on information on the place of birth, we are not totally sure it is the same person, but both were teaching law, and the dates correspond. ($p_i = 0$)

Karl Leonhard Reinhold (1757-1823) was a Catholic priest who taught logic, metaphysics, ethics, preaching, mathematics and physics in the Barnabite college in Vienna (connected to the university). Finding himself out of sympathy with monastic life, he fled in 1783 to Leipzig, where he converted to Protestantism. He taught at the University of Jena from 1787 to 1794, and at the University of Kiel afterwards. ($p_i = 867$)

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